UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING APPEAL BOARD

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

NRC STAFF'S ANSWER TO JOINT INTERVENORS' MOTION TO REOPEN THE RECORD ON SEISMIC ISSUES

Lawrence J. Chandler
Special Litigation Counsel

August 1, 1984

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I. INTRODUCTION

On July 16, 1984, Joint Intervenors filed a Motion to Reopen the Record on Seismic Issues. In this Motion, supported by an attached affidavit of Dr. James Brune, Joint Intervenors argue that new, significant safety information, derived principally from recent earthquakes and analyses, affects explicit determinations made by the Appeal Board in ALAB-644, 13 NRC 903 (1981) and thus reopening the record is warranted.

For reasons discussed below, the NRC staff opposes the Motion and urges that it be denied.

II. BACKGROUND

As relevant to the specific matters challenged in the Motion, the Appeal Board, following a reopened hearing before it regarding information concerning the 1979 Imperial Valley earthquake (IV-79) and on appellate review of the Licensing Board's seismic decision, LBP-79-26, 10 NRC 453 (1979), affirmed the finding that "7.5 M is the largest magnitude earthquake likely on the Hosgri" (ALAB-644, 13 NRC at 923), and, after considering

seismic records from IV-79 and Pacoima Dam, phenomena such as "focusing" and "high stress drop", the character of the Diablo Canyon site (rock/soil), damping and the so-called "tau effect", concluded that a ground acceleration of 0.75 g was appropriately used as the maximum vibratory ground motion for the design of the facility (Id., 923-985).

The Commission declined to review ALAB-644 on March 18, 1982, CLI-82-12A, 15 NRC A-1, (published at 16 NRC 7, 1982)).

III. DISCUSSION

The standards for reopening a record, oft-recited in this proceeding, are not in dispute and will not be restated herein. See, Kansas Gas and Electric Company, et al., (Wolf Creek Generating Station, Unit 1), ALAB-762, 7 NRC 320, 338 (1978). Nevertheless, independent of these considerations, a threshold matter, namely, this Appeal Board's jurisdiction to entertain the Motion in the first instance, requires discussion.

A. As noted above, the Appeal Board's Decision, ALAB-644, has become final agency action, the Commission having declined review of the Decision over two years ago. While there remain before the Appeal Board Joint Intervenors' and the Governor's appeals of the Licensing Board's Initial Decision, LBP-82-70, the matters raised in the Motion simply have no nexus to the remaining matters on appeal. Consequently, this Appeal Board's jurisdiction over the matters raised in the Motion has ceased to exist; Joint Intervenors have chosen the wrong forum in which to seek relief. Virginia Electric and Power Company (North Anna Nuclear Power Station, Units 1 and 2) ALAB-551, 9 NRC 704, 707-709 (1979); Public Service Company

of New Hampshire et al. (Seabrook Station, Units 1 and 2), ALAB-513, 8 NRC 694 (1978).[1/] The Motion, accordingly, should be dismissed.

B. Notwithstanding the foregoing jurisdictional bar, the Staff has considered the Motion in terms of the traditional standards for reopening and, on these grounds, concludes that it should be denied.[2/] Joint Intervenors suggest that the information appended to their Motion affects, in a number of significant ways, the Appeal Board's decision in ALAB-644:

1. Recent seismic events establish that the accepted ground acceleration of 0.75 g underestimates the maximum vibratory ground motion at the Diablo Canyon site (Motion at 7-9);

2. Recent seismic events reveal that the phenomena of "focusing" and "high stress drop" are more significant than determined by the Appeal Board in establishing the appropriate ground acceleration at the Diablo Canyon site (Motion at 10-11);

3. Recent studies disprove the Appeal Board's determination that the Hosgri Fault is principally a strike-slip feature, demonstrating rather that it is characterized by a major component of thrust faulting. Consequently, it could be closer to the site than previously determined and could produce stronger ground motion with less reduction in acceleration in structures due to the "tau effect". (Motion at 11-15); and,

4. The Appeal Board's determination that the Diablo Canyon site is located in an area of low to moderate seismicity is disproved by recent seismic activity, (Motion at 15-17).

1/ Of course, those matters presented in the Motion can be brought to Commission for consideration, for example, pursuant to 10 C.F.R. § 2.206. Independent of this approach, the Staff routinely evaluates information of the type submitted by Joint Intervenors to determine whether enforcement - type action may be warranted. See, e. g. 10 C.F.R. § 2.202. Moreover, with respect to Diablo Canyon in particular, a license condition has been imposed requiring a re-evaluation of the seismic design bases for the facility to incorporate the most recent and evolving information and analytical methodologies. (See attached affidavit at 17).

2/ The Staff does not contest the timeliness of the Motion although it would appear that at least certain of the information could have been and indeed was raised earlier, for example, regarding the Mexicali Valley earthquake.

We address each of the foregoing in turn, based on the appended affidavit of Dr. Robert L. Rothman, Mr. Richard B. McMullen, Dr. Leon Reiter, and Dr. Stephen J. Brocoum. This affidavit, although preliminary in certain respects, establishes that Joint Intervenors have not sustained their heavy burden of coming forward with information which (a) is of significance in terms of the safe operation of the plant and (b) affects the results reached in the Appeal Board's earlier decision, ALAB-644. See, Wolf Creek, supra.

1. Contrary to Joint Intervenors' assertion (Motion at 7-9), the recordings obtained from the Morgan Hill Earthquake of April 24, 1984 and Mexicali Valley Earthquake of June 9, 1980, do not invalidate the Appeal Board's determination that the Newmark Spectrum does not underestimate the ground motion of a magnitude 7.5 event on the Hosgri Fault. (Affidavit at 2-3). Indeed, the Appeal Board, in ALAB-644, explicitly recognized the possibility of exceedances of the Newmark Spectrum, for example, by the Pacoima Dam record from the 1971 San Fernando Valley Earthquake and the Bond's Corner record from IV-79, both of which were events of less than magnitude 7.5. (Id.). Thus, in this respect, the Appeal Board's decision is not disturbed.

Moreover, as with the Pacoima Dam record, the Coyote Lake Dam record from the Morgan Hill Earthquake might reflect a bias caused by the location of the instruments on the dam abutment and thus represent abnormal amplification. (Id. at 4). In any event, a comparison of the Coyote Lake Dam spectrum with the Newmark Spectrum shows that the latter exceeds the

former at all frequencies except above about 14.3 Hertz and between 0.89 and 1.8 Hertz. (Id. at 4-5).

Joint Intervenors contention regarding the significance of the Mexicali Valley data is similarly unfounded, given the questionable applicability of the data to other geologic environments, i.e. sites such as Diablo Canyon, a rock site with no sediment amplification, a factor recognized by Dr. Brune himself. (Id.).

With respect to the Appeal Board's observation that the Bond's Corner record may be distorted, again, the data relied upon by Joint Intervenors does not give cause for a change in the Appeal Board's determination. Indeed, when comparing the Bond's Corner record of the Mexicali Valley event with other stations, it again appears that the former may reflect anomalous site conditions. (Id. at 5).

Respecting the argument that new data on vertical accelerations from Mexicali Valley would exceed those predicted by the Newmark Spectrum, the Appeal Board's decision is also unaffected. As the Appeal Board observed, there is a low increase in total calculated stress (about 1% for the containment shell) resulting from an increase of 50% in vertical accelerations. Indeed, personal observations by the Staff following the Morgan Hill Earthquake revealed little if any damage to structures far less substantial in terms of both design and construction than the Diablo Canyon facility. Similar observations are reported in the literature regarding the Mexicali Valley event. (Id. at 5-7).

Based on the foregoing, it is clear that this new information would have no effect on ALAB-644.

2. Joint Intervenors next argue that recent information from the Morgan Hill Earthquake "contrast sharply with the Board's prior dismissal of the phenomenon [of focusing] virtually out of hand." (Motion at 11). Joint Intervenors, however, misconstrue the Board's decision on this point. The Appeal Board noted that, while high stress drop and focusing are recognized phenomena in seismology and that high values are ascribed to them in some areas, it is Dr. Brune's postulation that they could result in peak accelerations on the order of about 2 g at Diablo Canyon that is "speculative" (Affidavit at 7), a matter not dispelled by the Motion. Joint Intervenors' Motion may add new data points to those already considered but would not affect the Appeal Board's decision.

3. Joint Intervenors contend that the Appeal Board's assumption of the character of the Hosgri Fault as a strike-slip feature has been undermined by recent studies. Rather, they suggest that the Hosgri Fault is predominantly a thrust fault whose dip could approach closer to the site than previously thought and that ground accelerations at the Diablo Canyon site thus could be higher. (Motion at 11-14).

Although a recent article by Crouch et al., referred to by Joint Intervenors, does suggest that the strike-slip component may have been overstated, the literature (including the Crouch paper) still support the view that the Hosgri Fault is influenced by the right-lateral strike-slip tectonics of the San Andreas fault system. (Affidavit at 8-10).

Even if one were to consider the Hosgri Fault to be predominantly a thrust fault, two factors suggest that it likely would have no impact on the design basis of Diablo Canyon. First, it would be inappropriate

to automatically assume the same magnitude for the earthquake under a thrust regime as was postulated for an event on a long, strike slip fault; the magnitude could be different and quite possibly less. (Id. at 10-11).

Second, the Newmark Spectrum for Diablo Canyon, based on the Pacoima Dam record, already accounts for the type of motion postulated by Joint Intervenors to result from a thrust rupture at depth which propagates up-dip. (Id. at 11).

With respect to the implications of the foregoing on the use of the "tau effect", again there is no effect on the Appeal Board's decision. The "tau effect" does not pertain solely to horizontally propagating waves. Rather, as determined by the Appeal Board, both wave passage and wave inhomogeneity effects are encompassed by the "tau effect." (Id. at 12).

Finally, in light of their prior contention and pointing to a number of recent earthquakes on thrust faults, Joint Intervenors contend that the possibility of a concealed thrust fault under or near the Diablo Canyon site requires scrutiny. (Motion at 14-15).

The Diablo Canyon site, however, is both geologically and topographically different from the environments associated with Coalinga, El Asnam, Niigata and Kern County. There is evidence that minor folding observed in sediments above faults of the Hosgri fault zone are not currently active. Moreover, there are no young folds of sizes comparable to those associated with faulting at Coalinga in the sediments or on the seafloor in the Diablo Canyon site vicinity. (Affidavit at 13-15).

4. The last matter raised in Joint Intervenors Motion is a challenge to the Appeal Board's conclusion that the Diablo Canyon site is in an area of low to moderate seismicity (Motion at 15-17), predicated on

their view that there has been a "consistent pattern of major seismic activity" in recent years. (Motion at 16)

The Eaton paper relied on by Dr. Brune (Open File Report 84-477) discusses six earthquakes, the locations of which extend over a distance of almost 300 kilometers. Of the six events, only one, the Pt. Sal event of May 29, 1980, however, appears to have an epicenter near the Hosgri fault zone, and based on fault plane solutions described by Eaton, even that event is associated with faulting that stikes diagonally across rather than parallel to the mapped strands of the Hosgri fault. The largest of the six events, the 5.9 Santa Barbara earthquake, is associated with faulting in a different tectonic setting, the Transverse Ranges, an area of higher seismicity and recognized recent tectonic movement. It is thus inappropriate to take these events, occurring over a widely spread area, and use them to imply a higher probability for the occurrence of a magnitude 7.5 or greater event near Diablo Canyon. (Affidavit at 15-17). In short, the Appeal Board's relative statement that the Diablo Canyon site is located in an area of low to moderate seismic activity remains correct.

In light of the above, it is clear that Joint Intervenors have not demonstrated that any of the new information is significant and would affect the Appeal Board's decision in ALAB-644.

IV. CONCLUSION

For the foregoing reasons, the Appeal Board's jurisdiction over the matters raised in this pending Motion has ceased to exist. Consequently, the Motion should be dismissed. If, notwithstanding the jurisdictional

bar, the Motion is considered, Joint Intervenors have failed to satisfy the standards for reopening the record on seismic issues and thus, the Motion should be denied.

Respectfully submitted

Lawrence J. Chandler
Special Litigation Counsel

dated at Bethesda, Maryland
this 1st day of August, 1984

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NUCLEAR REGULATORY COMMISSION

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PACIFIC GAS AND ELECTRIC COMPANY	)	50-323 OL
	)	
(Diablo Canyon Nuclear Power Plant, Units 1 & 2	)	

JOINT AFFIDAVIT OF ROBERT L. ROTHMAN, RICHARD B. MCMULLEN, LEON REITER AND STEPHAN J. BROCOUM

STATE OF MARYLAND	)	
	)	ss.
COUNTY OF MONTGOMERY	)	

Robert L. Rothman, Richard B. McMullen, Leon Reiter and Stephan J. Brocoum, being of legal age and duly sworn, depose and say as follows:

1. I, Robert L. Rothman, a seismologist, am employed by the Office of Nuclear Reactor Regulation, U. S. Nuclear Regulatory Commission. A copy of my professional qualifications is attached to this affidavit.

I, Richard B. McMullen, a geologist, am employed by the Office of Nuclear Reactor Regulation, U. S. Nuclear Regulatory Commission. A copy of my professional qualifications is attached to this affidavit.

I, Leon Reiter, a seismologist, am employed by the Office of Nuclear Reactor Regulation, U. S. Nuclear Regulatory Commission. A

copy of my professional qualifications is attached to this affidavit.

I, Stephan J. Brocoum, a geologist, am employed by the Office of Nuclear Reactor Regulation, U. S. Nuclear Regulatory Commission. A copy of my professional qualifications is attached to this affidavit.

2. The purpose of this affidavit is to provide our evaluation of the seismological and geological information provided by Joint Intervenors as it may affect the seismic design basis for the Diablo Canyon Nuclear Power Plant (DCNPP). We wish to emphasize that our analysis is based in some instances on preliminary data available from recent earthquakes and preliminary review of recent and ongoing geological studies. However, to date, we have found nothing to warrant changing our previous conclusions concerning the DCNPP seismic design basis, nor those determinations made by the Appeal Board in ALAB-644, 13 NRC 903 (1981) which were challenged by Joint Intervenors, as discussed below.

3. We will address the specific issues raised by the Joint Intervenors in the section titled Specific Evidence in their Motion to Reopen the Record. In items (a) and (b) of the Joint Intervenors' Motion they claim that the high ground motion recorded at the Coyote Lake Dam from the April 24, 1984 Morgan Hill earthquake and at Victoria, from the Mexicali Valley earthquake of June 9, 1980 show that the

Newmark Spectrum substantially underestimates the force of a magnitude 7.5 event on the Hosgri Fault. As explained below, the recordings obtained from the April 24, 1984 Morgan Hill California earthquake at the Coyote Lake Dam abutment and from the June 9, 1980 Mexicali Valley, Baja California earthquake at the Victoria station do not invalidate the Appeal Boards decision as to the adequacy of the Newmark Hosgri Design Spectrum.

The Appeal Board considered the fact that the Newmark Spectrum had been exceeded by response spectra developed from ground motion records obtained from two earthquakes with magnitudes less than the postulated magnitude (M_s) 7.5 Hosgri event, the Pacoima Dam record from the 1971 San Fernando Valley earthquake (M_s 6.5) and the Bond's Corner record of the 1979 Imperial Valley earthquake (M_s 6.9) [ALAB-644 at 951] in reaching its decision as to the adequacy of the Newmark spectrum. This taken with the Appeal Board's finding that the size of near-field ground motion is not strongly dependent on earthquake size, indicates that the exceedence of the Newmark Spectrum by spectra from individual recordings are not cause to reject the Newmark Spectrum. The Appeal Board stated, in making its decision, that future ground motion records may exceed those previously measured [ALAB-644 at 933]. Also in discussing magnitude saturation [ALAB-644 at 932] the Board noted that "There cannot be total assurance that the measurements made in the near field to date sample all conditions that might result in large

local values of acceleration." The Appeal Board also considered the information presented to the Licensing Board of the existence of a peak acceleration of 0.95 g measured close to an earthquake of magnitude 5.5 in making its decision [ALAB-644 at 931].

There are several factors to consider in evaluating the ground motion at Coyote Lake Dam and Victoria. The Coyote Lake Dam record which has the highest horizontal peak acceleration (1.29 g) recorded from an earthquake was made on the dam abutment. It may be significant that the previous highest horizontal peak acceleration (1.25 g) record was from the Pocioma Dam abutment. It is postulated that the Pocoima Dam ground motion may be abnormally amplified due to topographic effects. Roger Scholl, technical director of the Earthquake Engineering Research Institute, attributes the high acceleration at the Coyote Dam in part to the dynamic amplification characteristics of the dam (Scholl, 1984). The applicability of the high accelerations recorded in the Mexicali Valley at Victoria to other sites, especially Diablo Canyon, a rock site, is brought into question by Munguia and Brune (1984, Intervenors' Attachment VII). They state that they can not say whether the accelerations they obtained from their modeling study of Mexicali-Imperial Valley earthquakes are reasonable for other environments such as environments with less sediment amplification or lower stress drop small events.

Joint Intervenors claim that the response spectra for the Coyote Lake recordings are close to and exceed the Newmark design spectra for Diablo Canyon in the period range 0.1 to 1 second. However, our comparison of the Newmark Spectrum with the horizontal spectrum from the Coyote Lake Dam which has the peak acceleration of 1.29g shows that the Newmark spectrum exceeds the Coyote Lake Dam spectrum at all frequencies except above about 14.3 Hertz and between 0.89 and 1.8 Hertz.

The Joint Intervenors take exception to the Appeal Board's characterization in ALAB-644 of the Bond's Corner record as distorted. At the reopened hearing in 1980 there was some discussion as to whether Bond's Corner was an anomalous site since the records obtained there from the 1979 Imperial Valley earthquake were high relative to surrounding stations. A comparison of the peak horizontal accelerations recorded for the Mexicali Valley earthquake as shown in Table 4.1 by Simons (1982, Intervenors' Attachment VI) indicates that the Bond's Corner station (38 km from the fault) for this earthquake recorded higher values than all the stations as near as 20 km from the fault. This lends support to the argument that Bond's Corner may have anomalous site conditions.

The Joint Intervenors also state that the peak vertical accelerations recorded at Victoria from the Mexicali Valley earthquake exceed those predicted by the Newmark spectrum for Diablo Canyon. The occurrence of high vertical accelerations (with

respect to the 1979 Imperial Valley earthquake) was addressed during the 1980 reopened hearing. This issue was included in the Appeal Board's decision (ALAB-664 at 957-962). In an engineering context the Appeal Board pointed out that there is a low increase in total calculated stress, about one percent, resulting from an increase of 50 percent of the vertical acceleration over the design value for the containment shell.

An important consideration when assessing these high recorded ground accelerations is whether they caused damage. We (Reiter and Rothman) visited the area around Coyote Lake Dam on May 3, 1984 where the high acceleration from the Morgan Hill earthquake was recorded. Although there had been media reports of an 18 inch deep crack in the dam, no obvious damage to the dam, to the shed in which the strong motion instrument is housed or in the vicinity of the dam was observed. Conversations with local residents indicated that damage to buildings had been minimal and consisted of some cracked windows, a few bricks which fell from a garden wall and articles that fell from shelves. The IBM Santa Teresa Laboratory is located about 10 kilometers from the presumed rupture. This facility is instrumented with strong motion accelerographs. It is reported (Homer Given, IBM, Personal Communication) that the peak free field horizontal acceleration at this facility from the Morgan Hill earthquake was about 0.5 g and the maximum peak horizontal acceleration in the basement was about 0.4g. The building was

reportedly designed to a response spectrum with a zero period anchor of 0.25g. It is reported that there was no structural damage to the building and the computers kept operating during the earthquake. In discussing the damage from the June 9, 1980 Mexicali Valley earthquake Simons and others (1981) indicate that the damage was surprisingly moderate in view of the high response spectrum at short periods. The Joint Intervenor's inference that the Morgan Hill and Mexicali strong ground motion recordings cast doubt upon the adequacy of the Newmark Spectrum for seismic design at Diablo Canyon is not supported by these observations of little or no damage. Indeed, it was pointed out (EERI, 1984) that one of the lessons learned from the Morgan Hill earthquake is that "There is no evidence that there is a need to improve structural requirements, but they do need to be applied." Needless to say the structural requirements at a nuclear power plant such as DCNPP are far more stringent than those used for the structures affected by the Morgan Hill earthquake.

4. In their item (c), the Joint Intervenors state that "The data obtained from the Morgan Hill earthquake also establish that the Board's characterization of focusing on high stress drop as speculative was erroneous." The Joint Intervenor's misconstrued the Appeal Board's characterization of focusing and high stress drop. The Appeal Board recognized the existence of both high stress drop and focusing. They addressed high stress drop [ALAB-644 at 950]

and said that the potential for high stress drop is accepted in seismology and high values for this factor are known to exist in some areas. The Appeal Board in addressing focusing [ALAB-644 at 945] noted that the Licensing Board had said that focusing is not a new phenomenon. What the Appeal Board considered speculative was Dr. Brune's position that focusing and high stress drop could result in peak accelerations "...on the order of 2 g..." at Diablo Canyon [ALAB-644 at 950]. We find nothing in the Joint Intervenors' arguments that would increase the likelihood of such accelerations at Diablo Canyon.

5. In item (d) the Joint Intervenors state that the Board's assumption about the strike slip nature of the Hosgri Fault has been discredited by recent studies and the June 20, 1984 Pt. Sal earthquake, which provide evidence of thrust faulting in the vicinity of the Hosgri Fault, and that thrust faults may result in higher ground accelerations than strike slip faults. The Joint Intervenors reference three independent studies that support the conclusion that the region of the Hosgri fault is characterized by a major component of thrust faulting, Eaton (1984, Intervenors' Attachment VIII); Minster and Jordan (1984, Intervenors' Attachment IX); and Crouch and others (1984, Intervenors' Attachment V).

The prevailing view at the time of the Appeal Board's decision was and still is that the Hosgri fault was influenced by the right

lateral strike slip tectonics of the San Andreas fault system. There still is considerable evidence for strike-slip displacement on the Hosgri fault as pointed out in the USGS report of April 29, 1976, which is included as Appendix C in Supplement 4 to the Safety Evaluation Report, May, 1976.

It has not yet been demonstrated that there is not a significant component of strike slip faulting on the Hosgri fault. Crouch and others (1984, Intervenors' Attachment V) did not rule out strike slip but stated that "...suggested late Cenozoic right slip offsets on northwest-trending faults in onshore and offshore central California may be overstated and that late Cenozoic basin morphology in central California may be due largely to compression rather than exclusively to wrench-style tectonics."

Eaton (1984, Intervenors' Attachment VIII) studied six of the largest earthquakes that occurred near the coast of California, between Santa Barbara and Monterey, from 1978 to 1984. The primary purpose of Eaton's study was to determine the focal mechanisms of these six events and to try to relate them to faults exposed at the surface. Eaton found that the faulting style progressed from Santa Barbara in the south from left lateral reverse oblique, through simple reverse, to right lateral reverse oblique and finally to right lateral strike slip near Point Sur in the north. The three southernmost earthquakes, which lie about 30-135 km south of DCNPP,

resulted from predominantly reverse faulting. The San Simeon earthquake of August 29, 1983 (about 80 km north of DCNPP), the southernmost of the three northern earthquakes, results from oblique faulting with nearly equal reverse and right lateral components. The two northernmost earthquakes (about 120 km and 150 km north of DCNPP) resulted from nearly pure right lateral strike slip faulting. Based on this study it might be expected that in the region near DCNPP the faulting mechanisms would be of an oblique type somewhere between reverse and right lateral strike slip motion.

Minster and Jordan (1984, Intervenors' Attachment IX) calculate that west of the San Andreas fault deformation must involve crustal shortening (compression) of 4 to 13 mm/yr orthogonal to the San Andreas fault and 6 to 25 mm/yr of right lateral motion parallel to it. This motion is distributed over several faults west of the San Andreas and they indicate that the largest motion is right-lateral strike slip, although they suggest that most of this is probably on the San Gregorio fault.

Another study (Clark and Brabb, 1984) published in the same volume as the Crouch and others (1984) and the Minster and Jordan (1984) papers (Intervenors' Attachments V and IX) presents evidence for 150 km of right lateral strike slip faulting since late Miocene (12 million years before present) on the San Gregorio fault. If this

were true, geometric constraints would require substantial right lateral strike slip faulting on faults lying to the south of the San Gregorio fault, possibly including the San Simeon and Hosgri faults.

The interpretation of the seismic reflection profiles shown in the Crouch and others (1984 Intervenors' Attachment V) paper, the northernmost of which is about 15 km south of Diablo Canyon, suggests that the Hosgri fault system begins curving toward the shore at depths of about 2½ km. If it is very conservatively assumed that the fault does not increase in depth as it is extrapolated to the northeast of the seismic reflection lines, it could pass under Diablo Canyon at a depth of about 2½ km. However, observations of well-studied overthrust belts elsewhere suggest that thrust faults continue increasing in depth accelerated by ramping, and eventually flatten out along a common fault referred to as the sole fault at the base of the system of thrust faults, which is usually much deeper than 2½ km. The model postulated by the authors shows the sole thrust to be 10 to 20 km deep.

In considering the ground motion that might result at DCNPP from an earthquake on a postulated thrust fault, it would be inappropriate to automatically assume the same magnitude for the earthquake under a thrust regime as was postulated under the assumption that the Hosgri was a long strike slip fault zone capable of a magnitude 7.5

earthquake. It may well be that for a thrust type fault the maximum earthquake magnitude could be different and quite possibly less.

The Joint Intervenors postulate that a thrust rupture could initiate at depth and propagate up-dip, toward the site causing much higher accelerations than previously anticipated. The Pacoima Dam strong motion data on which Newmark based the DCNPP Hosgri spectrum is the result of just such an occurrence. Therefore, this type of ground motion (although from a magnitude 6.5 earthquake) is already factored into the design of DCNPP.

The Joint Intervenors present an argument that a thrust event directly beneath the site could lead to a vertically propagating wave front which would minimize any reduction in foundation acceleration due to the tau effect. The Appeal Board addressed the issue of tau effect and its relation to horizontally and vertically propagating waves. The Appeal Board indicates that the Intervenors' complaint, that the tau effect is only appropriate for horizontally propagating waves, is poorly founded. The Appeal Board stated that the record shows that the tau effect as viewed by Dr. Newmark encompasses both wave passage and wave inhomogeneity effects. The Appeal Board concluded that despite the confusion associated with the definition of tau in terms of wave passage, it is clear that the tau effect includes spatial inhomogeneties in the

wave motion over the foundation surface, a characteristic of virtually all seismic motion [ALAB-644 at 967].

Based on the above considerations we conclude that the new studies which suggest a greater component of thrusting on the Hosgri fault than had been previously assumed does not discredit the Board's findings concerning earthquake ground motions that could effect the site.

6. Joint Intervenors' item (e) states that in light of the evidence for 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 (Stein and King, 1984, Intervenors' Attachment X) bears on the extent of the seismic hazard at Diablo Canyon.

The Joint Intervenors state that the 1983 Coalinga earthquake, which occurred 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.

Based on earthquake fault plane solutions and geological information, the reverse fault with which the Coalinga Earthquake is associated extends from a depth of 4 km down to a depth of 12

km. The Pliocene-Pleistocene (2.0-0.5 million years old) strata overlying the reverse fault are deformed into an assymetrical fold with tens of feet of structural relief whose surface expression is a ridge. During the 1983 earthquake this ridge was uplifted about ½ meter. Based on topographic and geologic evidence, it is estimated that there have been 2 to 5 km of cumulative slip on the buried fault in the last million years which caused folding in the overlying sediments and caused the growth of the ridge (Stein, 1983).

Similar relationships, that is strong geologic evidence for recurrent displacements with substantial effects on the topography are also present in the epicentral areas of the 1980 El Asnam (magnitude 7.3), Niigata (Magnitude 7.5), and the 1952 Kern County (Magnitude 7.3) earthquakes.

Examination of the Nekton (Crouch and others, 1984, Intervenors' Attachment V) seismic reflection data across the Hosgri fault indicate that the thrust faults of the Hosgri fault zone either are truncated by the base of the Sisquoc formation (Pliocene) or extend slightly up into this formation. Evidence of minor folding can be seen in the sediment above several of the thrust faults but nowhere is there any evidence of folding or topographic (bathymetric) effects near the magnitude of those found in late Tertiary sediments at Coalinga. This would suggest a substantially smaller rate

of recurrence for large earthquakes on the Hosgri fault. This finding is supported by the relatively low level of seismic activity in the area when compared to known active areas in California.

The Brune Affidavit (attached to the Joint Intervenors' Motion) states that it is not possible to eliminate the possibility of a concealed thrust fault even closer to the Diablo Canyon site than the data of Crouch and others (1984) suggest. The Brune Affidavit cites the folds and minor faults indicated on Plate 2 of the USGS Open-File Report 74-252 (Wagner, 1974) as being indications of concealed thrust faults with surface projections as close as 2-3 km offshore.

Some of these offshore folds on Plate 2 (Wagner, 1974) may well be indications of thrust faults at depth. These folds are mapped entirely within the Miocene and pre-Miocene rocks, similar to folds mapped onshore (Hall, 1979) and in an area of the seafloor which was planed by erosion 10,000 to 15,000 years ago when it was subaerially exposed. Wagner (1974) indicates that these folds apparently developed during a period of tectonism in middle Miocene (15 million years ago) time. He further states that these folds were themselves folded during another more restricted period of deformation during late Miocene or early Pliocene time. During a site inspection in June, 1984, staff geologists observed a re-folded fold, which is likely similar to those mapped by Wagner,

exposed along the sea cliff south of Diablo Canyon. The fold was truncated by an ancient marine terrace demonstrating that the folding occurred at least prior to formation of that terrace 80,000/120,000 years before present, but possibly several million years before present.

There is no evidence that the minor folding in sediments above faults of the Hosgri fault zone are currently active, nor are they of sizes comparable to those related to faulting at Coalinga.

7. In their item (f) the Joint Intervenors claim that 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 significant earthquakes that have occurred since 1978 along the coast of California. They base this contention on a paper by Eaton (1984, Intervenors' Attachment VIII) and try to make an argument for high seismicity in the Hosgri region. Eaton studied six earthquakes (magnitude range 3.9 to 5.9) that occurred over a large area near the coast of California, between Santa Barbara and Monterey. The locations of these events extended a distance of almost 300 kilometers. The northernmost event was the Point Sur earthquake of January 23, 1984 over 150 km from DCNPP and the southernmost event was the Santa Barbara earthquake August 13, 1978 about 135 km from DCNPP. The Point Sal earthquake of May 29, 1980 was the closest of these earthquakes to the Diablo Canyon site at a distance of about

30 km. As already stated the primary purpose of Eaton's study was to determine the focal mechanisms of these six events and to try to relate them to faults exposed at the surface. Of the six earthquakes only the Point Sal earthquake of May 29, 1980 appears to have an epicenter near the Hosgri fault zone. Nevertheless, Eaton found that the fault plane solutions he determined for this earthquake indicate a fault that strikes diagonally across rather than parallel to the mapped strands of the Hosgri fault near the epicenter. The largest, by far, of these six earthquakes, (the magnitude 5.9 Santa Barbara event) occurred in the Transverse Ranges, a different tectonic setting exhibiting higher seismicity and recognized recent tectonic movement. It is inappropriate to take these earthquakes from a widely spread area and use them to imply a greater probability for the occurrence of a magnitude 7.5 or larger earthquake near the plant.

The Appeals Board's finding that DCNPP is sited in an area of low to moderate seismicity is correct particularly when compared to areas of high seismicity in California such as Cape Mendocino, the area near Hollister, Parkfield, the Imperial Valley, the area south and east of Bakersfield and the San Jacinto fault zone (Real and others 1978) to name a few.

8. The DCNPP is in the coastal region of California where there is considerable amount of ongoing research in geology and seismology.

New information and theories are constantly being made known. The staff has proposed as a license condition a reevaluation of the seismic design bases for the plant. This study will incorporate the most recent information available.

At the the direction of the Commissioners, the Advisory Committee on Reactor Safeguards (ACRS) has reviewed the program the staff has proposed. This review has included a comprehensive presentation of his research by Dr. Crouch and discussions of Dr. Eaton's work. In their letter to the Commissioners (dated June 20, 1984), the ACRS stated "We believe that the elements outlined in the NRC staff's proposal will provide a suitable basis for the seismic reevaluation. We believe also that the NRC staff's proposal is responsive to the July 14, 1978 ACRS letter in which the ACRS suggested 'that the seismic design of Diablo Canyon be reevaluated in about ten years taking into account applicable new information.'" The ACRS's final statement in their June 20, 1984 letter is "Based on the information developed in these meetings and considering the above comments, we find no reason to alter the conclusions stated in the Committee's report dated July 14, 1978 regarding operation of this nuclear plant."

In summary, the plant is currently designed for a large near field earthquake and the staff has reasonable assurance that the design is adequate.

Robert L. Rothman

Richard B. McMullen

Leon Reiter

Stephan J. Brocoum

Subscribed and sworn to before me
this 7th day of August, 1984

Notary Public

My Commission Expires: July 1, 1986

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My name is Robert L. Rothman. I am presently employed as a Seismologist in the Geosciences Branch, Division of Engineering, Office of Nuclear Reactor Regulation, Washington, D.C. 20555.

PROFESSIONAL QUALIFICATIONS

I received a B.S. degree in Geology from Brooklyn College and M.S. and Ph.D. degrees in Geophysics from the Pennsylvania State University.

I have been employed by the NRC since October 1979 as a Seismologist in the evaluation of the suitability of nuclear power plant sites. My areas of expertise include seismicity, rupture mechanics, seismic wave propagation and seismic instrumentation. I am now or have been responsible for the seismological safety review of approximately fifteen nuclear power plant sites.

From 1975 through 1979, I was employed by the U. S. Air Force Technical Applications Center as a Seismologist in the nuclear explosion detection program. I was involved in several projects of this program both as a Technical Project Officer and as a researcher. These projects included the detection of and the discrimination between underground explosions and earthquakes, magnitude and yield relationship studies, seismic network detection and location capability studies, regional and teleseismic wave propagation studies and projects to operate seismic instrument arrays and automatic data processing and communications systems.

From 1965 through 1970 I was employed as a Seismologist by the U. S. Coast and Geodetic Survey. In this position I was involved in studies in the areas of engineering seismology, seismicity and earthquake aftershock sequences. This work was performed as part of a program to investigate seismic hazard in the United States.

From 1959 to 1962 and during 1964-1965 I was an Engineering Geologist with the New York State Department of Public Works. In this position, I conducted geophysical field surveys in support of construction projects such as bridges, buildings and highways.

Professional Society Membership

American Geophysical Union
Potomac Geophysical Society
Seismological Society of America
Society of Exploration Geophysicists

RICHARD B. MCMULLEN
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My name is Richard McMullen. I am employed as a geologist in the Geosciences Branch, Division of Engineering, Office of Nuclear Reactor Regulation, Washington, DC 20555.

PROFESSIONAL QUALIFICATIONS

My present duties in this position include: the evaluation of the geological aspects of sites for nuclear power generating facilities and to analyze and interpret the geological data submitted to the NRC in support of applicants for construction and operation of nuclear facilities; the development of guides and criteria; and to act as consultant to the NRC Staff on geological matters.

After completion of three years in the Marine Corps I attended the University of Florida and graduated in 1959 with a B.S. degree in Geology. During my professional employment, I completed correspondence courses in soils engineering and quarrying sponsored by the Army Engineer School at Ft. Belvoir, VA., short courses in the effects of ground motions on structures, and airphoto interpreting. I am a registered Geologist and Engineering Geologist in the State of California.

After graduation I worked as a field geologist with the Corps of Engineers District Office in Jacksonville, Florida conducting field geological investigations for flood control structures, levees, canals, military installations, radar sites, and missile launching complexes. I evaluated and wrote reports concerning the stratigraphy, geologic structure, groundwater conditions, and foundation engineering aspects regarding these facilities in Florida, Puerto Rico, Bahama Islands, several of the West Indies Islands, and Panama. In 1963 I was assigned to the Corps of Engineers Canaveral District Office at Cape Kennedy, Florida, first as a Staff Engineering Geologist, and later as District Geologist. My duties were to plan, direct and evaluate the results of geological and foundation studies for missile launch pads and associated facilities for the NASA in Manned Lunar Landing Program, the Air Force, and the Navy. I acted as consultant to other government agencies and architectural engineers in developing design features of structural foundations, monitored the performance of foundations during and after construction, and recommended and monitored necessary foundation treatment techniques such as vibraflotation, grouting, surcharging, dewatering and compaction. I wrote reports on the investigations, geology, foundation design, and construction regarding these projects.

In 1967, I spent 6 months participating in the geological investigations for proposed sea level canal routes in Panama. The region investigated consisted of complex structures of volcanics and folded and faulted sedimentary strata. Among the techniques employed in this study were

field geologic mapping, geophysical surveying, bore hole photography, and core borings. In 1968, I was transferred to the Huntsville, Alabama Corps of Engineers Division which was responsible for the siting, design and construction of 15 to 20 (later reduced to 4) safeguard antibalistic missile installations throughout the United States. My duties there were to plan and participate in investigations to determine the suitability of these sites for construction of the missile complexes. I performed geological studies and some soil mechanics work to develop design parameters for foundations and excavations. I also served as technical consultant during design and construction to other government agencies, architectural engineers, and contractors.

I have been a member of the Nuclear Regulatory Commission staff since January 1971 and have participated in licensing activities for at least thirty sites for nuclear facilities.

LEON REITER
LEADER, SEISMOLOGY SECTION
GEOSCIENCES BRANCH
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My name is Leon Reiter. I presently reside at 1960 Dundee Road, Rockville, Maryland 20850 and am employed as a Seismologist, Geosciences Branch, Division of Site Safety and Environmental Analysis, Office of Nuclear Reactor Regulation, Washington, D.C. 20555.

PROFESSIONAL QUALIFICATIONS

I received a Bachelor of Arts degree in Geology from Brooklyn College in 1958, a Master of Science degree in Geology (Geophysics from the University of Michigan in 1968, a Master of Arts degree in Mathematics from the University of Michigan in 1970 and a Ph.D. in Geology (Geophysics) from the University of Michigan in 1971. In the year following receipt of my Ph.D. I was a National Science Foundation Post-Doctoral Fellow at the Institute of Geophysics and Planetary Geophysics in La Jolla, California. From 1972 to 1976 I was an Assistant Professor of Geophysics at the University of Oklahoma. During the summer of 1975 I was a visiting scientist of the U. S. Geological Survey National Center for Earthquake Research in Menlo Park, California. I joined the NRC in August, 1976 as a Seismologist and since August 1979 I have been Leader of the Seismology Section in the Geosciences Branch of the Division of Engineering.

My research during my academic career has included the areas of crustal exploration, seismic wave attenuation, midcontinent seismicity and tectonics, earthquake prediction and the application of seismic techniques to engineering problems. At NRC I have been actively involved in review of sites for nuclear facilities in all parts of the United States and in several foreign countries. I have also taken a lead responsibility for studies in the fields of strong motion seismology, near-field groundmotion, and probabilistic risk assessments.

I am a member of the American Geophysical Union, the Seismological Society of America, the Society of Exploration Geophysicists and the Earthquake Engineering Research Institute. I have served as a member of the Plate Interiors Working Group of the U. S. Geodynamics Committee, the Interagency Committee on Seismic Safety in Construction and the Panel on National Regional and Local Seismograph Networks of the National Research Council-National Academy of Sciences. I have authored or co-authored papers published in the Bulletin of the Seismological Society of America, the Journal of the Acoustical Society of America, the Proceedings of the American Society of Mechanical Engineers and National Science Foundation Conference Proceedings.

STEPHAN J. BROCOUM, Ph.D.
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My name is Stephan J. Brocoum and I am presently employed as the Leader of the Geology Section in the Geosciences Branch, Division of Engineering, Office of Nuclear Reactor Regulation, U. S. Nuclear Regulatory Commission, Washington, D.C. 20555.

PROFESSIONAL QUALIFICATIONS

I have a B.S. in Geology (1963) from Brooklyn College of the City University of New York and a Ph.D. in Geology (1971) from Columbia University with a specialty in structural geology and metamorphic petrology. I also possess expertise in tectonics, stratigraphy, rock mechanics, fault identification and behavior, remote sensing, and structural analysis.

As leader of the Geology Section since May, 1981, I have been responsible for the technical accuracy and completeness of all documents concerning geology, such as Safety Evaluation Reports, which are issued by the Geosciences Branch. I supervise and review the work of the geologists in the section, as well as coordinate the reviews with Project Management, the United States Geological Survey, State Geological Surveys, utilities and their consultants, NRC consultants and national Laboratories. To date I have participated in the licensing activity of approximately fifteen sites.

From November, 1979, until May, 1981, I was a geologist in the Earth Sciences Branch, Office of Research of the Nuclear Regulatory Commission. I was responsible for developing regulations and regulatory guides. I participated in developing the technical portion of 10 CFR Part 60 "Disposal of High Level Radioactive Wastes in Geologic Repositories". I also coordinated about 24 people in preparing the Draft Regulatory Guide 4.17 - "Standard Format and Content of Site Characterizatio. Reports for High-Level Waste Geologic Repositories."

From Nov., 1976, until Nov., 1979, I was a Research Geologist at Gulf Science and Technology Company (Gulf Oil Corporation), Pittsburgh, Pennsylvania. I conducted research applying computer enhanced digital imagery to hydrocarbon exploration and relating lineaments and tonal features on remote imagery to tectonic, fault and fracture history of sedimentary basins. I also conducted regional and tectonic studies of the Anadarko, Appalachian and Williston basins in the United States.

From June, 1975 until Nov., 1976, I was Assistant Project Geologist at E. D'Appolonia Consulting Engineers, Pittsburgh, Pennsylvania. I conducted site and regional geology studies for Preliminary and Final Safety Analysis Reports for nuclear power plants sites in the United States and the Caspian Sea Coastal Plain of Iran. My responsibilities

included geologic mapping and reconnaissance of site and regional geology, interpretation of aerial and space imagery, relating historical and instrumentally determined seismicity to regional faulting and tectonics and the determination of tectonic provinces.

From August, 1973, until June, 1975, I was Assistant Professor of geology at Texas Christian University, Fort Worth. I taught undergraduate courses in structural geology, petrology, optical mineralogy and physical and historical geology, and graduate courses in structural geology, petrology and tectonics. I continued my research on the tectonic, metamorphic and strain history of the Sudbury Basin, Ontario, Canada.

From July, 1971, until June, 1973, while a Research Scientist at Lamont-Doherty Geological Observatory of Columbia University, I was a co-investigator of a research grant to study "The Structural Geometry and Tectonic History of the Sudbury Basin, Canadian shield." The research included studying the structural geology (eight months field mapping) and petrology of the Sudbury Basin, Southern Province, Grenville Front, and the determination of the finite strain history of the Sudbury Basin.

For my Ph.D. thesis I used methods of field structural analysis and and structural petrology to unravel the geologic history of the complexely deformed and highly metamorphosed gneiss belt in the Adirondack Lowlands, New York. I also spent two austral summers (1969 and 1971) conducting field work in the Antarctic Peninsula which included the structural geology and petrology of sedimentary, metamorphic and igneous rocks of several islands. I also conducted a photogeological study of the Boothia Peninsula, Northwest Territories, Canada (1967-1968). Prior to beginning graduate studies I spent four months (1963) on Fletcher's Ice Island (T-3) in the Arctic Ocean collecting geophysical data. While a graduate student I received a New York State Scholar Incentive Award, Graduate Teaching and Research Assistantships and Faculty Fellowships from Columbia University and the United States Antarctic Service Medal from the National Science Foundation.

I am a member of the following professional and scientific organizations:

Geological Society of America
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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

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

CERTIFICATE OF SERVICE

I hereby certify that copies of "NRC STAFF'S ANSWER TO JOINT INTERVENORS' APPLICATION FOR A STAY", "NRC STAFF'S ANSWER TO JOINT INTERVENOR' PETITION FOR REVIEW OF ALAB-775", "NRC STAFF'S ANSWER TO JOINT INTERVENORS' PETITION FOR REVIEW OF ALAB-776" and "NRC STAFF'S ANSWER TO JOINT INTERVENORS' MOTION TO REOPEN THE RECORD ON SEISMIC ISSUES" in the above-captioned proceeding have been served on the following by deposit in the United States mail, first class, or as indicated by an asterisk through deposit in the Nuclear Regulatory Commission's internal mail system, this 1st day of August, 1984:

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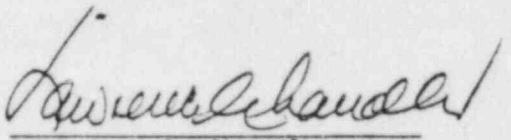

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