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IN THE MATTER OF:

PACIFIC GAS & ELECTRIC COMPANY

(Diablo Canyon Units 1 and 2)

Docket Nos. 50-275
50-323

Place - Avila Beach, California

Date - 19 December 1978

Pages 6360 -- 6472

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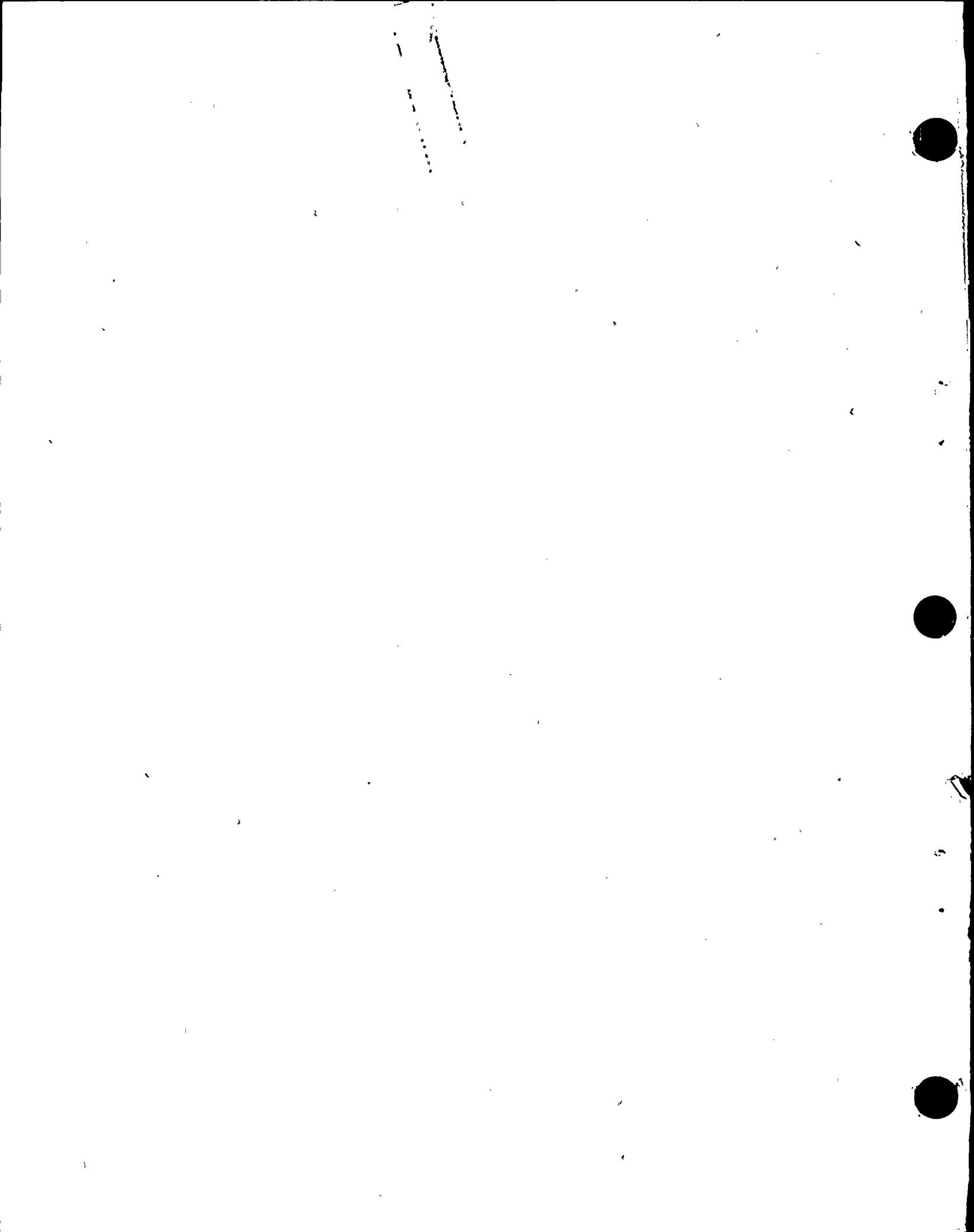
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NUCLEAR REGULATORY COMMISSION

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(Diablo Canyon Units 1 and 2) :
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Docket Nos. 50-275
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Cavalier Room,
San Luis Bay Inn,
Avila Beach, California.

Tuesday, December 19, 1973.

The hearing in the above-entitled matter was reconvened, pursuant to adjournment, at 8:30 a.m.

BEFORE:

ELIZABETH BOWERS, Esq., Chairman,
Atomic Safety and Licensing Board.

DR. WILLIAM E. MARTIN, Member.

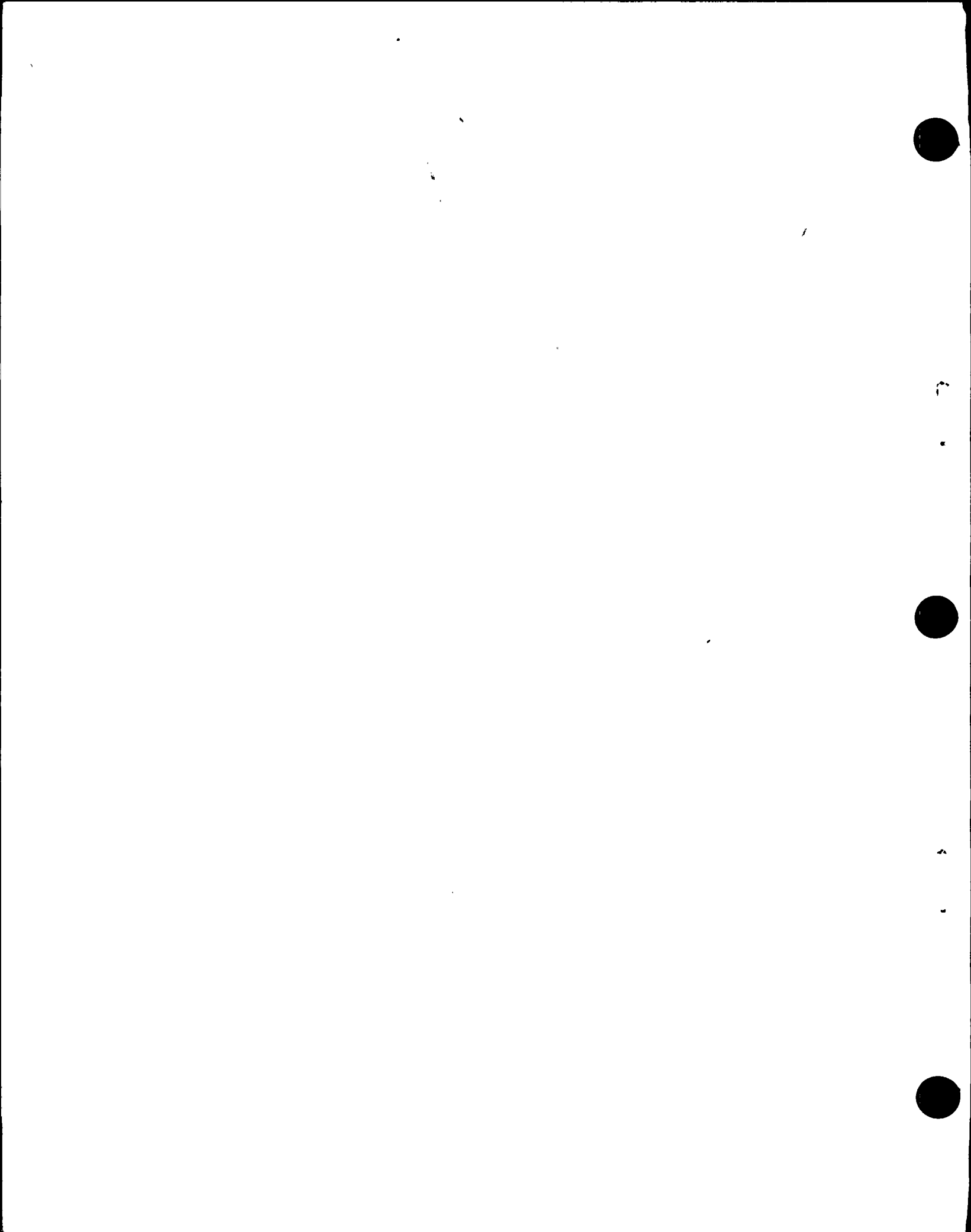
GLENN O. BRIGHT, Member.

APPEARANCES:

On behalf of the Applicant, Pacific Gas & Electric Company:

BRUCE NORTON, Esq., 3215 No. Third Street,
Phoenix, Arizona 85012.

MALCOLM H. FURBUSH, Esq., and PHILIP CRANE, Esq.,
Legal Department, Pacific Gas & Electric Company,
77 Beale Street, San Francisco, California 94105.



1 On behalf of the Joint Intervenors:

2 DAVID S. FLEISCHAKER, Esq., Suite 602,
3 1025 15th Street, N.W., Washington, D. C.

4 STEPHEN KRISTOVICH, Esq., Center for Law in the
5 Public Interest, 10203 Santa Monica Boulevard,
6 Los Angeles, California 90067.

7 On behalf of the Regulatory Staff:

8 JAMES R. TOURTELLOTTE, Esq., MARC STAENBERG, Esq.
9 and EDWARD KETCHEN, Esq., Office of Executive
10 Legal Director, U. S. Nuclear Regulatory
11 Commission, Washington, D. C. 20555.
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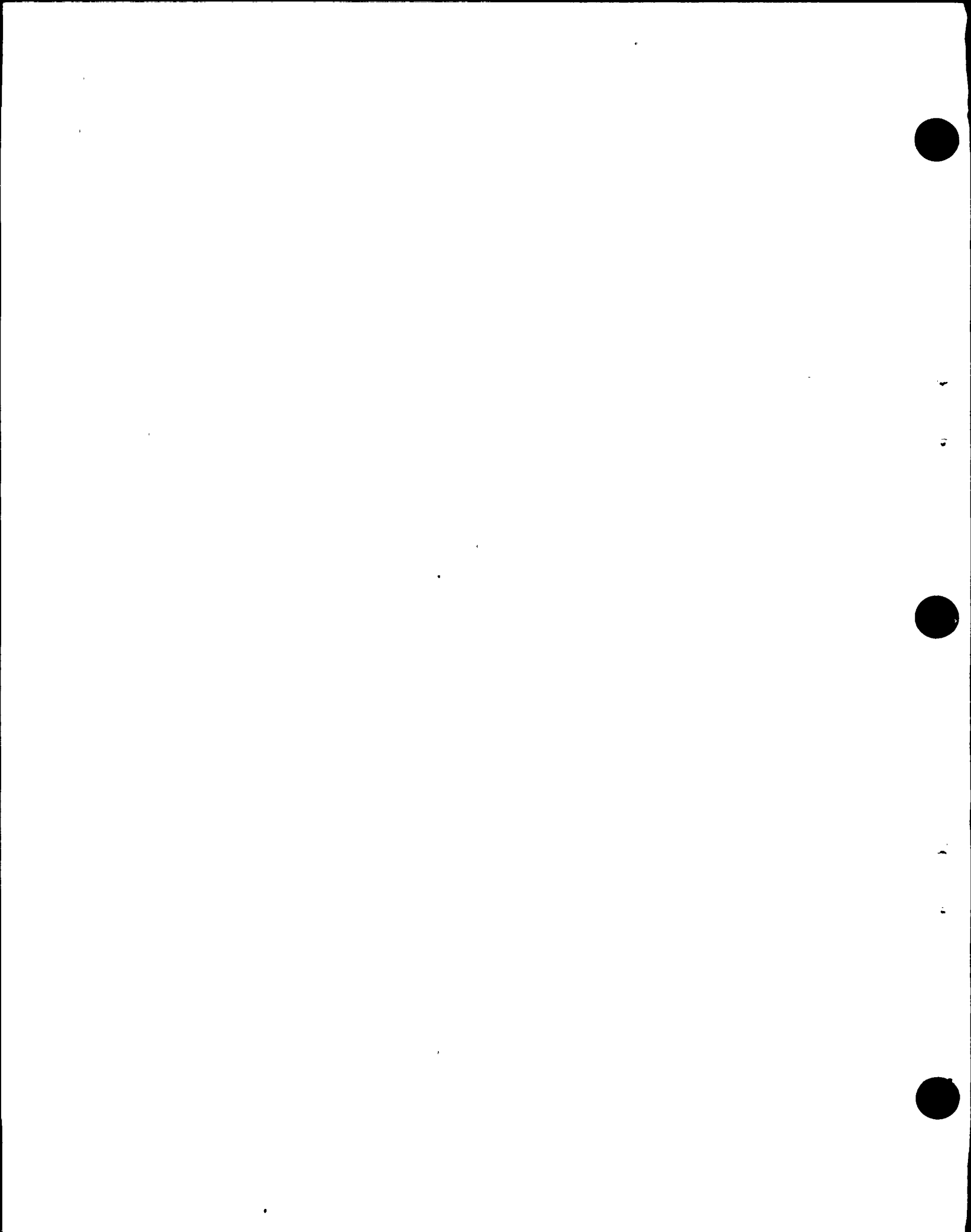
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C O N T E N T S

<u>Witnesses:</u>	<u>Direct</u>	<u>Cross</u>	<u>Redirect</u>	<u>Recross</u>	<u>Exam by Bd</u>	<u>Im Bd</u>	<u>on Qs</u>
Stephan Alan Graham)		6363	6355	6417	6431		6443
Eli Alfred Silver)							
(Continued)							
Richard V. Bettingers	6455	6467				6470	

Exhibits

None



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P R O C E E D I N G S

MRS. BOWERS: Are you ready to proceed, Mr. Norton?

MR. NORTON: Yes, Mrs. Bowers.

Whereupon,

STEPHAN ALAN GRAHAM

and

ELI ALFRED SILVER

resumed the stand on behalf of the Joint Intervenors and, having been previously duly sworn, were examined and testified further as follows:

CROSS-EXAMINATION (Continued)

BY MR. NORTON:

Q Dr. Graham, as I understand your testimony yesterday you have no opinion, really, regarding the present continuity of the San Gregorio-San Simeon-Hosgri fault zone. Is that correct?

A (Witness Graham) First of all, Mr. Norton, I beg your indulgence. I've had a little too much local sunshine. I have a bit of a cold.

Q Okay.

A Your question. Our conclusions have no resolution with respect to the present continuity of that fault system.

Q All right.

And you have, I take it, no conclusions whatsoever



eb2

about the current rate of slip on any of those faults?

A That's correct.

Q And you also have no opinion regarding activity movement or seismic activity on those faults in the past 17,000 years?

A That's correct.

Q You have no opinion on the activity on those faults in terms of seismicity and slip or movement in the past five million years either. Isn't that correct?

A I can't address seismicity. Based on our conclusions which we stated in the paper, particularly with reference to the rate of movement curves, it looks to us as though the predominant right slip, by our interpretation of the fault system, occurred between 15 and five million years.

Q Right.

So in the last five million years, you have no opinion as to rate of movement. Is that correct?

A That's correct.

Q All right.

And you have absolutely no opinion as to the capability of the Hosgri fault today, as to seismic rate or magnitude. Is that correct?

A Quite correct.

MR. NORTON: We have no further cross-examination of this witness.



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MRS. BOWERS: Mr. Stuenkel?

MR. STUENKEL: The Staff has no cross.

MRS. BOWERS: Redirect?

MR. WEISSCHAEFER: Yes.

REDIRECT EXAMINATION

BY MR. WEISSCHAEFER:

Q I would first like to turn to page 67. I will direct redirect with respect to Dr. Silver.

Dr. Silver, can you turn to page 67? Dr. Silver, you don't have a copy of the Appellant's Exhibit Number 33, do you? That's the copy of the abstract of your article written in 1974 I believe.

A (Witness Silver) Yes, I do.

Q You do have that.

At 6706 Mr. Norton questioned you as to that exhibit. Could you state very briefly what the subject matter of that abstract was?

A The subject matter of the abstract was an interpretation of free-air gravity on the California Continental Margin from 35 to 36 Degrees North.

One of the conclusions or suggestions that was made at that time had to do with a suggested offset along the San Gregorio Fault. Now that offset was suggested based on interpretation of geology of that area was constrained. That is, my knowledge of the



eb4

geologic features, the Farallon Ridge, was enhanced by the study of gravity. However, the interpretation of offset was interpreted on the basis of the geologic -- inferred geologic features offset.

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Q So the data upon which you based your conclusions in this abstract was both the gravity and the geologic?

A Yes. The new information that was presented was gravity, but it was based on geologic and gravity.

Q Okay.

Now you don't have the transcript but this is a reference for the Board and the other parties, pages 6236 and 6237. Mr. Norton is reading from your deposition taken in November, and reading your statement of the conclusions that you drew with respect in the 1974 abstract.

At page 6238, Mr. Norton asks this question:

"Now, Dr. Silver, then you did infer this --"

MR. NORTON: Excuse me, Mrs. Sowers. I don't understand why we're reading testimony if there's not a question in front of the witness. That seems to be leading. No matter what the question is that's coming out, it seems to be leading the witness, which is not proper on redirect. I don't understand why we're reading yesterday's testimony if there's no question.

MR. FLESICHAKE: May I respond to that?



eb5

MRS. BOWERS: Yes.

MR. FLEISCHAKER: The reason we're reading this is on several occasions Mr. Norton interrupted Dr. Silver and didn't permit him to give a full answer to the question that he asked. I made several objections at the time, but the Board determined that it would be more appropriate to permit a fuller explanation on redirect.

So I am now trying to put the questions into context and to permit Dr. Silver to give his full answer to the question. The question here is on page 6238.

"Now, Dr. Silver, then you did infer this based on gravity data. Correct?"

The answer is two and a half lines and I think, as suggested by the transcript, was cut off by Mr. Norton. And I'm going to ask this witness to complete his answer.

MRS. BOWERS: Why don't you proceed, Mr. Fleischaker?

MR. FLEISCHAKER: All right.

BY MR. FLEISCHAKER:

Q "Now, Dr. Silver, then you did infer this based on gravity data. Correct?"

That's Mr. Norton in the transcript.

"ANSWER: Based on gravity data to help constrain the geology. But the gravity data alone certainly can't give you a fault ---"



eb6

Could you complete the thought or the answer that you were involved in at that time?

A (Witness Silver) The gravity data alone as we have it cannot give you a value for offset on the fault. At best it can provide constraints perhaps on location of the fault, and it can also provide some constraints on the nature of the geologic structure underneath.

It's extremely difficult to determine offset on the basis of gravity alone, and I did not use gravity alone to suggest the offset.

Q Now the offset that we're talking about here is one of the several offsets that Mr. Graham and Dickinson relies upon in their conclusions in the Graham and Dickinson article. Is that correct?

A Yes.

MR. NORTON: Mrs. Sowers, that's exactly what I mean by a leading question, that last question. It's a classic example of a leading question, and that's what we object to Mr. Fleischaker doing on redirect. I can't think of a more leading question than that one.

MRS. SOWERS: Mr. Fleischaker?

MR. FLEISCHAKER: Is there an objection?

MR. NORTON: Object. Leading, obviously. We're asking that the question and the answer be stricken.

MR. FLEISCHAKER: I'll withdraw the question and



eb7

replace it.

BY MR. FLEISCHAKER:

Q Has this offset been utilized by Drs. Graham and Dickinson?

A (Witness Silver) Yes.

Q When did they use it, in what context?

A They used it in several papers, including their 1978 Science paper, their 1978 California Division of Mines, and a Geology paper.

Q Now I'd like to direct your attention to Applicant's Exhibit Number 31. Do you have that before you? It's entitled "Interpretation of the Preliminary Gravity Map of California and Its Continental Margin." H. W. Oliver, Editor.

A Yes.

Q Did you write anything for this document?

A Yes, I did.

Q Okay.

What is it that you wrote for this document?

A I wrote a short summary overview, an interpretation of the offshore gravity map of California from essentially 35 north to 42 degrees north.

Q Now at pages 6250 through 6252 of the transcript, I believe Mr. Norton had you read sections from this paper, I believe. I would like to show you the transcript and see



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what you recognize this, and then you can confirm that for the record.

(Handing transcript to the witness.)

Before I ask you about that, let me ask you a couple of preliminary questions.

What was the purpose of the article which you wrote which is contained in Applicant's Exhibit Number 31?

A The purpose was to give an overview description of the gravity field of the northern California Continental Margin, and to attempt to draw whatever conclusions would be possible, based on the gravity data. We were asked to try to concentrate on what the gravity data itself constrained about the interpretation rather than simply writing a treatise on the geology of the margin.

Q And succinctly, what were your conclusions?

A Well, the conclusions were that one could quite easily locate the existence of the San Gregorio fault mapped on land from the gravity data. However, one could not determine whether or not there was an offset along the San Gregorio fault from the gravity data alone. That is, one can interpret the gravity map as indicating no offset; alternatively, one could interpret it as having an almost unconstrained offset. In other words it really was ambiguous in terms of the offset.

Q Are these conclusions stated in the paragraphs



eb9

you read that are read in the record here between 6250 and
6252?

A Yes.

la.



13 agb

Q Have you changed, as a result of your -- Now, with respect to the possible offset of the Parallon Ridge from the granitic basement on the Salinian block east of Monterey, has the gravity data that you have viewed and discussed either in '74 or in this newer document changed your views on that matter?

A No, it hasn't changed my views on the interpretation of the geology, which must be the constraining influence for estimating possible offset on a fault. It has enhanced our view of the gravity field and made even more uncertain -- in the past we had little to go on for the on-land gravity -- it has made more uncertain interpretation based on gravity alone.

Q Did you take, in developing your testimony for this proceeding, did you take into consideration the opinions expressed in the 1974 paper and the 1976 paper?

A 1978?

Q The 1978 paper, did you take those into account in --

MR. NORTON: I'm sorry, Mrs. Rowers, I don't know which papers we're talking about. I think Dr. Silver has discussed three 1978 papers.

BY MR. FLEISCHNER:

Q Let me be specific. Did you take the opinions expressed in Applicant's Exhibits 30 and 31 into consideration?



agb2

in reaching conclusions that you have discussed in your testimony here?

MR. NORTON: Mrs. Bowers, again, that is a leading question. It's a classic example of a leading question.

MR. FLEISCHAKER: I don't agree. I don't think that's a leading question.

MR. NORTON: Well Mrs. Bowers, the way you ask that question so it is not leading is, what papers did you take into consideration and then he can pick and choose from his papers, but when you say, did you take this paper and that paper it's a leading question. It's a classic example of how-to and how-not-to.

MRS. BOWERS: Will you rephrase it?

BY MR. FLEISCHAKER:

Q What consideration, if any, was given to Applicant's Exhibit 30 and 31 in developing the conclusion that you discussed in your testimony?

A (Witness Silver) Well I certainly considered those papers in considering the testimony. However, those alone would provide actually very poor constraints on the question of offset.

So if I could expand a little bit: I relied most heavily on the information of geologic offset presented by Graham and Dickinson, just because the gravity affect alone is such a poor constraint.



agb:

Q Again referring to the transcript at Pages 6250 and 6252, after having read portions from Applicant's Exhibit Number 31 into the record, at Page 15, the Applicant asks you this question:

"Can you tell me why you didn't inform me of this during the deposition..?"

My question is, Dr. Silver, did you inform the Applicant of the existence of this map during your -- of this data during your deposition?

A Yes.

Q And didn't you within one week mail him a copy of the data?

A Yes, I did.

MR. NORTON: While we're on the subject, at Page 6252 of the transcript, if you have a copy in front of you, the question:

"Thank you.

"Now, Dr. Silver, can you tell me why you didn't include this information in your submittal to this Board?"

And then I said:

"Well, perhaps we can move on to another question."

I think the record should reflect that there was a long pause between those two statements, between that



agb4

question and that statement. I think we are close enough in time for all of us to remember that there, indeed was a long pause and the record doesn't indicate that and it looks like I asked the question and immediately cut him off so he couldn't answer and that was not true. There was a long pause and I would ask that that be inserted in the record at that place.

MR. FLEISCHAKER: That's not my interpretation of what happened yesterday. I have an entirely different interpretation of the course of cross-examination yesterday and I'll object to any such insertion.

My recollection of the course of cross-examination yesterday was that on many occasions -- and I think the record fairly reflects this fact -- on many occasions Mr. Norton interrupted this witness with multiple questions, essentially engaged in a line of rapid-fire cross-examination which did not permit this witness to fully answer the questions.

MR. NORTON: Well Mrs. Bowers, if Mr. Fleischaker is talking about this specific situation, he is just dead wrong. After that question:

"Now, Dr. Silver, can you tell me why you didn't include this information in your submittal to this Board?"

Dr. Silver sat there for what was clearly a long pause. And if Mr. Fleischaker is willing to state in



agb5

front of the rest of us here now that that's not so I'd certainly like to hear it from his mouth now. And what he says about at other times is not relevant to the motion right now.

MRS. BOWERS: I recall the situation. And if you'll notice, of course, a witness is entitled to collect his thoughts, and perhaps he wasn't given time enough to do that.

But if you'll notice down on that same page, line 21, I say:

"The witness should have the opportunity to answer in some way the question posed."

And so we went back to it.

MR. NORTON: Yes, indeed he did answer the question, but the reason I moved on at that particular point in time is there was indeed a long pause, and that's why I said:

"Well, perhaps we can move on to another question." -- because no answer was forthcoming after that long pause.

MR. FLEISCHAKER: Well the purpose of the redirect is to clear up the implications and the insinuations left, both by the manner of questioning and the fact that there is no clear answer, at least at this point in the record, that this witness was hiding documents and testimony. I think it is quite clear, and Mr. Norton can cross-examine this



agb6

witness as long as he wants and I believe at the end of that cross-examination one fact will be revealed, that is that this witness has disclosed his full data base to Mr. Norton and that, upon request, he in fact delivered a copy of this map post-haste to Mr. Norton so that the Applicant's consultants could review the data.

The purpose of this redirect examination is to clear up any possible ambiguity about the fact or about the question as to whether or not data was hidden, and I think it's absolutely clear from the questions asked on redirect and then the answers given that this witness gave full answers to Mr. Norton and delivered the data upon request.

MRS. BOWERS: Well there was a long pause, and the Board asked Mr. Norton later to not be so rapid-fire in his questions, because it was not always apparent that the witness had completed his answer. But certainly there was a long pause, and that of course is the reason Mr. Norton asked the next question.

MR. FLEISCHAKER: Well I don't know that's the case -- that that's the reason he asked the next question.

But what I want to clear up is the fact -- what I want to clear up, and I think it's important for the record, is the fact that this witness did discuss this matter in his deposition and did, in fact, deliver the information



agb7

1 upon request. That's all.

2 MR. NORTON: Excuse me, Mrs. Bowers, is Mr.
3 Fleischaker testifying now?

4 MR. FLEISCHAKER: No, I think I've accurately
5 restated the testimony that has been stated here today. I
6 think we can move on.

7 MRS. BOWERS: Fine.

8 I have one little housekeeping matter. I thought
9 yesterday that I heard Dr. Silver say Indiana University
10 in Pennsylvania and I figured I wasn't hearing right. But
11 if you look at Page 6179 that's what it says --

12 WITNESS GRAHAM: It is in Indiana, Pennsylvania,
13 the town of Indiana in Pennsylvania.

14 MRS. BOWERS: So it is correct. Indiana University
15 in Indiana, Pennsylvania, is that right?

16 WITNESS GRAHAM: I, myself, am a graduate of
17 Indiana University, Indiana. But this is another Indiana
18 University that has nothing to do with the State of Indiana,
19 yes. It's a small state school in Pennsylvania.

20 MR. NORTON: They even play football.

21 DR. MARTIN: Like Southern North Dakota.

22 MR. FLEISCHAKER: To save time, again, I'd like to
23 let the witness have an opportunity to examine the transcript
24 at Page 6259. Dr. Silver was questioned by Mr. Norton
25 as follows:



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"Do the conclusions --" 6258.

"Do the conclusions expressed in this Exhibit 31 in any way affect that opinion?

"Answer: I'm sorry, which is Exhibit 31?

"Question: The one we've been talking about, the one you were just handed, the one we've been talking about for the last 10 minutes.

"A: No, it doesn't at all.

"Q: It doesn't affect it in any way?

"A: No. And -- Can I expand?

"Mrs. Bowers: Yes."

And then Mr. Norton -- and I don't believe he had the opportunity to expand, but I believe we may have the answer in the record this morning.

So let me have the witness examine this and determine whether or not we need to pursue this any further.

MR. FLEISCHAKER: Again directing counsel and the Board's attention to Page 6258 where, at the bottom of the page, Mr. Norton asks a series of questions regarding the conclusions which is:

"In summary, evidence for continuity of the San Gregorio Fault zone is good from



agb?

near San Francisco to as far south as San
Simeon."

And at the top of Page 6259, the witness says:
"Can I expand," and I don't believe he was given the opportunity
at that time.

BY MR. FLEISCHAKER:

Q Let me ask this question: Dr. Silver, what is
the full answer to the question that was asked, whether the
conclusions expressed in Exhibit 31 affected your opinion?

A (Witness Silver) Well the answer is no, concerning
continuity, because the fault has been mapped through the area
on either side of the -- across the Farallon Ridge. And
evidence for non-continuity would be a continuous gradient
across the projected or assumed trend of the fault. That's
not the case, the continuity of the gravity contours is
clearly broken in the map so that one can locate -- one can
show location of the fault on the gravity map itself.

One simply can't draw conclusions about offset
on the fault based on the gravity map alone.

Q What mapping are you relying on?

A For offset?

Q No, for continuity.

A Well, for continuity, mapping on the ground,
seismic reflection data, magnetic data, to a minor extent,
gravity data.



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1 None of the gravity data -- in the sense that
2 I've stated just now, none of the gravity data precludes
3 continuity of the fault, and a lot of it clearly documents
4 the location of the fault very well.

5 Q In the area of the Farallon Ridge, what is the
6 data upon which you are relying for your conclusion that
7 there is continuity?

8 MR. NORTON: Excuse me, Mrs. Bowers.

9 We keep talking about the fault. I presume he's
10 talking about the San Gregorio Fault. Is that correct,
11 Mr. Fleischaker, that that's what your questioning regarding?

12 MR. FLEISCHAKER: The San Gregorio-Hosgri
13 Fault zone.

14 MR. NORTON: If that's it then I object, because
15 that was not the question and I'll guarantee that's not what
16 the witness is talking about in the last three or four answers.

17 BY MR. FLEISCHAKER:

18 Q Let me ask you: What terminology would you prefer
19 to use at this point in the discussion with respect to the
20 question of the gravity data in Applicant's Exhibit Number 31?

21 A (Witness Silver) Well the gravity data, we're
22 talking there around Santa Cruz-Ano Nuevo. It is the San
23 Gregorio fault.

24 Q And for the San Gregorio fault then what is
25 the data that you're relying on, the mapping data that you're



agb11

1 relying on for your conclusions regarding continuity?

2 MR. NORTON: Again, excuse me, continuity of
3 what fault? I honestly believe the witness has been talking
4 about continuity of the San Gregorio fault.

5 MR. FLEISCHAKER: I think we're in agreement on
6 that now on the San Gregorio fault.

7 MR. NORTON: Mrs. Bowers, I would only ask that
8 the attorney name what he's talking about when he says
9 continuity, because he just evidenced the fact that if he
10 doesn't the witness and the attorney start talking about two
11 different faults.

12 WITNESS SILVER: Well this Exhibit 31, this pre-
13 liminary document that I wrote talks about, specifically about
14 the fault in the area of Ano Nuevo-Santa Cruz. And so, when
15 we're discussing the gravity here in that area, it's the
16 San Gregorio fault.

17 BY MR. FLEISCHAKER:

18 Q And with respect to that area, what mapping
19 are you relying on?

20 A (Witness Silver) Well, mapping on land, zero-
21 magnetic mapping, seismic reflection -- published seismic
22 reflection interpretations and gravity, to the extent that
23 it certainly doesn't rule out the location of the fault.

24 Q What seismic reflection data?
25



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2 mpbl

1 Q What seismic reflection data?

2 A Seismic reflection data published by Gary Graene,
3 McCulloch, and others, 1972, by the U.S. Geological Survey.

4 Q What gravity data?

5 A I'm sorry, seismic reflection data.

6 Q Okay.

7 Now the gravity data.

8 A The gravity data consists of the offshore region,
9 a survey done by the National Ocean Survey, 1970, and a
10 variety of mapping by the USGS and Stanford, and a whole
11 variety of institutions set up and recently put together by
12 Howard Oliver and others in this main document onland.

13 Q Okay.

14 At the top of page 6263 of the transcript, Mr.
15 Norton is questioning you about the southern end of the Hosgri,
16 and the initial question was on 6262 at line 20 -- excuse me,
17 line 19:

18 "All right.

19 "And you're not familiar with the southern
20 end of the Hosgri, are you?

21 "Answer: How far south?"

22 And there's some discussion.

23 Over on page 6263 there is a question about --
24 from Mr. Norton:

25 "So you're just citing someone else's



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mpb2 1 work, and you haven't done any work down there?

2 "Answer: Okay.

3 "Yes, I'm citing Hall's work.

4 "Question: Okay.

5 "Answer: That's a two-part question.

6 Yes, I'm citing Hall. It's not true I haven't
7 done any work in that area."

8 My question to you is --

9 MR. NORTON: Excuse me.

10 Mrs. Bowers, again Counsel is leading the witness.
11 He goes through all of the transcript and then he says "Now
12 my question to you is". That is leading the witness.

13 He should just ask his questions.

14 MR. FLEISCHAKER: I'm getting ready to ask the
15 question, which will not be a leading question.

16 The question will be:

17 What work, if any, have you done in the south?

18 What I'm trying to do is to lay the foundation
19 to put the question in the context.

20 MR. NORTON: Well, Mrs. Bowers, all he has to
21 do is ask the question without reading the transcript. When
22 he starts reading the transcript he's leading the witness.
23 When he says "Now, what work have you done in the south",
24 that's leading the witness.

25 By reading this entire exchange and saying



mpb3

"What work have you done in the south", that's clearly leading the witness.

MR. FLEISCHAKER: Well, I think it's appropriate under the circumstances to put the questions and the answers into the framework here.

MRS. BOWERS: Mr. Staenberg, does the Staff have a position?

MR. STAENBERG: Technically I believe that Mr. Norton is correct, that the Intervenor is putting his questions in such a form as they would be considered leading questions.

However, I believe the Staff's position would be to allow a certain amount of latitude in order to expedite the questioning. And if the Board believes that we can expedite that questioning by putting things in their proper context, then the Staff would not join in the objection of the Applicant in this regard.

MR. NORTON: Well, Mrs. Bowers, I don't know how it expedites the proceedings for Mr. Fleischaker to precede every question by reading a couple of pages of the transcript.

MRS. BOWERS: Well, I think you're exaggerating a little bit on that, Mr. Norton.

Mr. Fleischaker feels that there was a lot of rapid-fire examination yesterday afternoon and there are some gaps and holes. And it seems to me the most appropriate



mpb4

way to get back into that is by referencing the transcript.

So why don't you proceed, Mr. Fleischaker?

MR. FLEISCHAKER: Thank you.

BY MR. FLEISCHAKER:

Q The question, Dr. Silver, is:

What work, if any, have you done in the southern
and of the Hosgri fault zone?

A (Witness Silver) I primarily studied the aero-
magnetic maps done by the USGS and the California Division
of Mines.

Q Could you describe that work, both the kind of
study and the time frame?

A Well, the kind of study is examining the map
for positive and/or negative evidence for continuity of the
fault zone, positive, negative, or allowable, non-restrictive
evidence for continuity of the fault zone.

Q When was the data taken?

A Let's see. The data was taken in 1976.

Q When were your studies performed?

A From early 1977 to the present.

Q Now I'd like to direct your attention to -- the
Board and the attorneys attentions to page 6272.

At this part of the cross-examination I believe
we're discussing the track chart, the large track chart that
was on the board yesterday, as well as Applicant's Exhibit 32,



mpb5

which is a box end of lines 6, 7, and 8. And just a couple of questions.

At lines 4 through 8 there are some questions and answers. The question is:

"Isn't it acceptable to be within maybe 30 or 40 feet of where you're supposed to be?"

"Answer: A satellite will rarely give you that accuracy.

"Question: But pretty close to it?"

"Answer: It's more like a quarter to half a kilometer standard error."

My question is:

With respect to what reference point is that quarter or half a kilometer standard error?

A That's a good question.

With respect to the satellite's knowledge of the position of the earth, that is, with respect to the satellite, the satellite's position is programmed quite accurately. However you're locating yourself relative to the satellite.

Q As we look at the track chart, are we talking about the points or the lines?

A The locations are point locations. They weren't shown on the track chart.

Q How was the line drawn from the point locations?

A The computer does essentially a best-fit to the



mpb6

located points.

Q What was the data, the seismic reflection profiles that were gathered in these runs that were represented on Applicant's Exhibit number 32? For what purpose did you utilize that seismic reflection profile data?

A To get a better understanding of the gross geologic structure of that continental margin, including the offshore basins, the outer ridges, continental slopes.

Q What kind of seismic reflection data was this?

A It was deep penetration sparker data, single channel sparker.

Q And when you talk about basins in the continental shelf, give me the location -- where in terms of distance from shore, were you studying mostly? What were you using this data for? What kind of analysis? What structures? Where were they located?

A They're located on the continental margin west of the coastline. The continental margin is -- It's very wide in that area.

Q Did you utilize the seismic reflection profiles gathered during these runs for any analysis -- for your analysis concerning the location of the Hosgri fault?

A I first saw evidence of the Hosgri on these profiles. However they were much too widely spaced to be of value for the kind of detailed locations that are needed for



mpb7

these studies.

MR. NORTON: Mrs. Bowers, may we inquire if Counsel is to the tact of this line of questioning? Are they trying to show that their Exhibit B42 are not relevant to these proceedings?

MR. FLEISCHAKER: I am simply trying to straighten up the interpretation of this data and what it was used for, and get an accurate fix on this witness's use of that data.

BY MR. FLEISCHAKER:

Q Now on page 6297, I believe there is an inference in the record by Mr. Norton that the question marks on the USGS map were somehow related to the tracking error shown on this track record here.

MR. NORTON: Excuse me, Mrs. Bowers.

Now this again is leading the witness. He's giving a speech that there's an inference laid by my questions. And if that isn't leading the witness on how to answer his next question -- you know, the inferences to be drawn from the testimony are to be drawn by the Board.

MR. FLEISCHAKER: I'll withdraw the question.

BY MR. FLEISCHAKER:

Q Do you know whether --

MR. NORTON: Mrs. Bowers, I'd submit the damage has been done. As soon as he asks the next question, the



mpb8

damage has already been done.

That's the problem with this method of proceeding through this transcript is he's drawing inferences and then asking a non-leading question. But he's obviously leading the witness by his summary of the testimony.

MR. FLEISCHAKER: I withdraw the question.

BY MR. FLEISCHAKER:

Q Do you know whether the USGS relied upon this data in completing the map, MS910 that has been on the easel there and was submitted into evidence yesterday?

MR. NORTON: Mrs. Bowers, I object.

He's already led the witness to answer that.

(The Board conferring.)

MRS. BOWERS: Do you want to respond, Mr.

Fleischaker?

MR. FLEISCHAKER: Yes.

I think it's not a leading question. It's a totally appropriate question. This data was collected by Dr. Silver, and he may well know to what use this data was put. I think it's an appropriate question and should be answered.

MR. NORTON: That question is appropriate that Mr. Fleischaker posed just now. I don't believe that's what he had said quite before.

The question of 'Do you know whether this data



mpb9

was used by USGS' is appropriate. I have no objection to that question.

MR. FLEISCHAKER: Well, we'll let that stand as the question.

WITNESS SILVER: Well, the question may be a little too broad. It was certainly used by the USGS. It was used by myself when I was in the USGS for the purposes that I spelled out earlier.

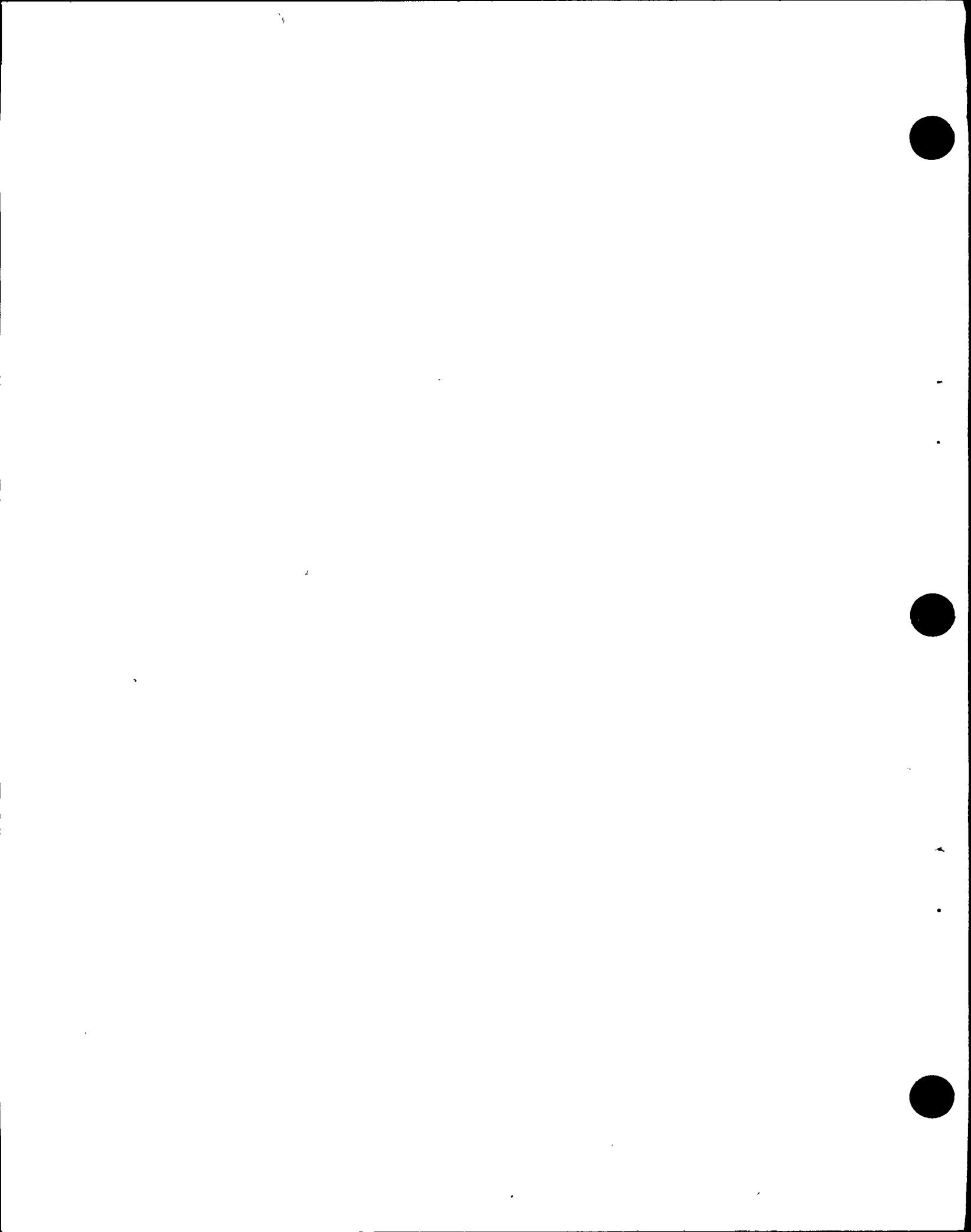
The work of McCulloch and Wagner in preparing the fault map I discussed yesterday relied overwhelmingly on other data. However, they used all the data that they had available.

MR. FLEISCHAKER: Thank you.

MR. NORFON: Mrs. Bowers, I'm going to move to strike that last answer. I was going to do some more re-cross on it; but I think that last answer should be struck without further foundation.

He stated they used -- he said 'However they used all the data they had'. There has been no foundation that this witness knows, one, what data they did have, and two, how he knows that they used it, whether he had conversations and they told him, or received a letter, or the map said, or whatever.

I think the answer should be struck unless that foundation -- it is clearly speculation without further



mpbl0 : foundation.

2 MRS. BOWERS: Mr. Fleischaker, there's a motion
3 to strike. Do you want to respond to that motion?

4 MR. FLEISCHAKER: Yes.

5 I oppose this motion. I think this witness is
6 testifying from his own knowledge. It's apparent from his
7 testimony that he was at one time a member of the USGS. It's
8 apparent from his testimony he's had several discussions with
9 the authors of this map, Dave McCulloch in particular.

10 And so I think that it's perfectly appropriate
11 testimony. It should not be struck. And if Mr. Norton wants
12 to examine him on the basis of the statement, recross, then
13 that's his prerogative.

14 But I think there's sufficient foundation in
15 this record for that kind of testimony from this witness.

16 MR. NORTON: Mrs. Bowers, he said he worked for
17 USGS before this map was prepared. There is no testimony
18 that he worked at USGS at the time that this map was prepared.
19 that he's talking about, none whatsoever.

20 MR. FLEISCHAKER: That's not the point.

21 The point is that he has worked at USGS and he's
22 conversant with these people, and he talks to them on a
23 daily basis and he's had personal communications with Dave
24 McCulloch regarding the construction of this map. He has so
25 testified.



mpbl1 |

2 He has so testified that he's had telephone
3 conversations with Mr. McCulloch, and I think that is a
4 basis, that is a source of information. It's within his
5 personal knowledge. He should be able to testify about it.

6 And if Mr. Norton wants to cross-examine him
7 on it, then that's fine.

8 MRS. BOWERS: I want to check with the Staff.

9 Mr. Staenberg?

10 MR. STAENBERG: May we have a moment?

11 MRS. BOWERS: Fine.

12 (Pause.)

13 MR. STAENBERG: Mrs. Bowers, the Staff likewise
14 has no way of knowing the basis on which the witness answered
15 this question.

16 We take no position on the merits of a motion to
17 strike and believe that it would be equally appropriate for
18 there to be additional recross of the witness on this subject.

19 MR. NORTON: Well, Mrs. Bowers, I think at this
20 time there is no foundation and it is clearly speculation on
21 the part of the witness without the foundation. The founda-
22 tion may exist, but I don't know. There is no foundation for
23 him to make the statement that they used all the data that
24 they had.

25 There has got to be some foundation laid for that
kind of a statement.



mpb12 |

1 MRS. BOWERS: Mr. Fleischaker, in order to give
2 this testimony meaning there needs to be the foundation.

3 MR. FLEISCHAKER: May I please have the answer
4 read back, because we might be able to do without a big
5 hullabaloo here.

6 (Whereupon, the Reporter read from the record
7 as follows:

8 "Witness Silver: Well, the question may
9 be a little too broad. It was certainly used by
10 the USGS. It was used by myself when I was in
11 the USGS for the purposes that I spelled out
12 earlier.

13 "The work of McCulloch and Wagner in pre-
14 paring the fault map I discussed yesterday relied
15 overwhelmingly on other data. However, they used
16 all the data that they had available.")

17 MR. FLEISCHAKER: I have no objection to striking
18 everything after "...relied overwhelmingly on other data."

19 MR. NORTON: Our objection goes to that too
20 for the same exact reason.

21 I have no idea, there is no foundation for that
22 statement at all. I assume it's true, that would be the
23 logical conclusion one would make. But there is no founda-
24 tion for it.

25 MR. FLEISCHAKER: May I have one moment?



mpbl3 1

MRS. BOWERS: Yes.

(Pause.)

MR. FLEISCHAKER: Before the Board decides, I would like to lay a foundation for that, if necessary. I would like to be given an opportunity before the Board makes a decision on whether to strike the answer or not.

MRS. BOWERS: Go ahead.

BY MR. FLEISCHAKER:

Q Dr. Silver, have you had an opportunity over the course of the last year to discuss with any of the authors of the map, MS910, what data they utilized in compiling that map?

A (Witness Silver) Yes.

Q And who have you talked to?

A David McCulloch and Holly Wagner.

Q And how many times would you estimate you've talked with them?

A It's difficult to estimate. Between 10 and 20 times.

Q Is that each or for combination? Is that ten times, 20 times each, or 10 times, 20 times total for both?

A I would say about 20 times total. That's a gross figure.

Q Have you ever met with them over the course of the last year?



mpbl 1

A Oh, yes.

2

Q And during the courses of these conversations have you discussed the data that they've utilized in mapping -- writing -- whatever you do -- authoring Map 910?

3

4

5

A Yes.

6

MR. FLEISCHAKER: Okay. I think sufficient foundation has been laid for the testimony that is in the record.

7

8

9

MR. NORTON: We'll withdraw our objection and reserve it for cross-examination.

10

11

MRS. BOWERS: Your motion to strike, is that right?

12

MR. NORTON: Yes.

13

MRS. BOWERS: Okay.

14

WITNESS SILVER: David, could I add one thing to that, one clarifier to that statement?

15

BY MR. FLEISCHAKER:

16

Q Sure.

17

A (Witness Silver) When I said "use all the data that they had available", I should have prefaced "seismic reflection data". I'm not sure that they incorporated, say, the magnetic, gravity, and that sort of thing in the map.

18

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21

Q In the cross-examining yesterday you discussed with Mr. Norton the fact that you have recently become aware and have had an opportunity to become familiar with work of additional workers in locating the 1927 earthquake, referring

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23

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mpbl5 : to page 6335.

2 Since I believe we were discussing the works of
3 Hanks and Smith in addition to the work of Gawthrop upon
4 which you had relied, what is your current opinion regarding
5 the location of the 1927 earthquake?

6 A Well, as I can see at present, there are at
7 least three opinions, not including Eyerly's opinion on the
8 earthquake, the Hanks and Smith, whose opinions are fairly
9 similar, and Gawthrop's opinion is slightly different. So
10 I have no basis on which to distinguish these. I'm simply
11 aware of three opinions.

12 MR. FLEISCHAKER: Excuse me.

13 We're about at the completion of this. I
14 wondered if we could have a ten minute break so I can re-
15 organize here and finish off the redirect.

16 MRS. BOWERS: All right. Fine.

17 (Recess.)

18 lc flws

19 and
20 MADELON
21 WRBLOOM
22 flws

23
24
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MRS. BOWERS: Are you ready, Mr. Fleischaker?

MR. FLEISCHAKER: Yes.

BY MR. FLEISCHAKER:

Q Dr. Silver, yesterday during the course of cross-examination there was some discussion between you and Mr. Norton regarding some determinations of accumulated offset or rate of slip by Weber and Lajoie.

Can you identify for me the area in which the Weber and Lajoie studies took place?

A (Witness Silver) That was in the Ano Nuevo area north of Santa Cruz, a wide platform.

Q Are you familiar with the technique used by Weber and Lajoie?

A Yes.

Q What is that technique?

A It's a technique of mapping Pleistocene terraces on the wide Ano Nuevo Platform by which they mapped the back edges of the terraces, that is, the old beach lines represented by the breaks in the terraces and, using the age information, the age of the terraces which gives them control on the age of these beach lines, they mapped the beach lines and observed whether or not there is any offset of these beach lines along the terrace.

So in effect if there is offset, if they do observe offset of these beach lines, of these back edges along



eb2

1 fault zones, these back edges essentially become piercing
2 points, they become lines that are offset by a fault.

3 They determined these offsets to their range of
4 error, and also did a great deal of seismic refraction work,
5 trying to determine whether or not those lines they inferred
6 were fault zones, were in fact faults, could they independently
7 map these faults.

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8 Q And what's the information regarding the rate of
9 slip they were able to derive from this?

10 A The information is an accumulated slip over the
11 fault segments which they mapped constrained by the ages of
12 the terraces which they report as 100,000 years and 200,000
13 years offset by the fault. So essentially it's constrained
14 by those ages.

15 And they report a general range, minimum to maxi-
16 mum, approximately a half centimeter a year to approximately
17 one and a half centimeters a year.

18 Q Now there was also some discussion between you
19 and Mr. Norton regarding a triangulation, mention of a tri-
20 angulation in the Coppersmith and Griggs article that was
21 mentioned much earlier in this proceeding.

22 Are you familiar with triangulation as a method?

23 A Yes.

24 Q And can you describe very briefly what that is?

25 A Well, it's a method of surveying points as



eb3

1 accurately as one can relative to other points, tying the
2 whole network into some baseline. One does that at some given
3 time, surveys, triangulates as many points back on each other
4 as you can, and then you go back some time in the future,
5 retriangulate all those points to determine whether those
6 points have exactly the same position relative to one another
7 or have they moved relative to one another.

8 Q Now during the course of the cross-examination
9 Mr. Norton and you did some calculations together where you
10 multiplied 1.6 times 16, the period of the triangulation that
11 was mentioned in the Coppersmith and Griggs article, and then
12 Mr. Norton asked you some questions about that.

13 MR. NORTON: May I have the question read back,
14 or the statement? I guess we don't have a question yet. May
15 I have Mr. Fleischaker's statement read back?

16 (Whereupon, the Reporter read from the record
17 as requested.)

18 MR. FLEISCHAKER: Page 6344 of the transcript.

19 BY MR. FLEISCHAKER:

20 Q Question: Well, all right, what would you get in
21 16 years at 1.6 centimeters per year?

22 MR. NORTON: I'm not objecting. I just wanted to
23 hear it back. I didn't catch it all. That's all.

24 MR. FLEISCHAKER: Okay.

25 BY MR. FLEISCHAKER:



eb4

1 Q Let me set the foundation here.

2 "ANSWER: 16 times 1.6 centimeters.

3 "QUESTION: What distance is that?

4 "ANSWER: 25 centimeters."

5 Dr. Silver, do you have an opinion as to whether
6 the triangulation methodology that we have been discussing
7 here would reveal, would necessarily reveal movement or
8 necessarily reveal the calculated 1.6 centimeters annual slip
9 that has been discussed in Weber and Lajoie?

10 A (Witness Silver) Well, I don't have a personal
11 opinion. Coppersmith and Griggs indicate in their paper that
12 the uncertainty is very large. They do not express, however,
13 quantitatively that uncertainty.

14 The fact that they are only using -- they state
15 they're only using a retriangulation of three points would
16 also indicate probably low accuracy, but on the other hand
17 they don't report it so I don't know what the accuracy is.

18 Q What kind of information would one need in order
19 to make a more definitive determination with respect to the
20 certainty of the accuracy of the triangulation method?

21 A Well, the accuracy certainly improves with many
22 more points and many more triangulations, so what they're
23 using is a bare minimum. So one could improve by the tri-
24 angulation method: more points, more triangulation, more
25 time.



eb5

Q Do you have any opinion as to the implication of the failure to note slip, given a triangulation method established over a fault?

A Well, there are two interpretations that might be applied. Number one, provided of course that the accuracy is tight enough to resolve that question, and there is serious question in this case, provided the accuracy is good enough then one can say either, number one, during that time period-- Well, one can say during that time period there was not slip on the fault.

Now the broader implications of that are either (a) that the fault is not moving or, (b), that the fault moves by what would be called stick-slip; that is, it may move in discrete intervals and one can't resolve those.

All one can say, if the data was good enough, was during the interval you're looking at, there was no movement, but again this data doesn't seem to be good enough to say either one way or the other.

Q Do you have an opinion as to whether there is anywhere on the San Gregorio-Hosgri fault zone that one could do work like Weber and Lajoie which would help resolve questions concerning the maximum capable credible earthquake on the Hosgri?

A Yes. Certainly the Ano Nuevo area was quite a far distance away from the Hosgri, from the southern end of



eb6

1 the fault zone. The area of the San Simeon Platform appears
2 to allow a comparable study area to the Ano Nuevo one in
3 which one could apply the method of Weber and Lajoie, or
4 might apply the method of Weber and Lajoie.

5 Q Are there terraces in the San Simeon land area?

6 A Yes.

7 Q And from those terraces might one-- What kinds
8 of studies would one do on those terraces in order to arrive
9 at a figure of annual rate of slip, the terraces at San Simeon?

10 A Well, one might do the same kinds of studies
11 that Weber and Lajoie did, first to establish whether there
12 is any offset of the terraces and second, by dating them to
13 try to constrain if there were what might be the Late
14 Pleistocene rate of offset.

15 Q And how is that information relevant in assisting
16 us to assess the maximum credible earthquake capability of
17 the Hosgri?

18 A One of the important parameters that one needs
19 in determining earthquake capability of a fault is its Late
20 Pleistocene slip and Late Pleistocene rate of offset. It is
21 certainly not enough by itself but it is certainly a very
22 important parameter in making that assessment.

23 Q Dr. Silver, I would like to direct your attention
24 to a series of questions that were asked to you by Mr. Norton,
25 page 6333 of the transcript. Again you don't have the



eb7

1 transcript, but I'm making the reference for purposes of Counsel
2 and the Board.

3 MRS. BOWERS: What page number again?

4 MR. FLEISCHAKER: 6333.

5 BY MR. FLEISCHAKER:

6 Q In this set of questions Mr. Norton used a
7 criteria, "a reasonable degree of geologic certainty." The
8 question that he put to you was this:

9 "Can you state within a reasonable
10 degree of geologic certainty as to what the maxi-
11 mum capability on the Hosgri is?"

12 The answer is:

13 "No, I can't."

14 My question is: Why?

15 A (Witness Silver) Because I don't see that we have
16 sufficient information on the Hosgri to be reasonably certain
17 about such a determination.

18 Q What does "reasonable degree of geologic cer-
19 tainty" mean to you?

20 A Well, in reference to this question, number one,
21 I'd be reasonably certain about maximum capability if there
22 were an historical record of an earthquake of a given magni-
23 tude. Then I'd be reasonably certain that the fault was
24 capable of having earthquakes of that magnitude.

25 Without that information, I would like good

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eb8

1 information on at least the Late Pleistocene slip and slip
2 rate along the fault. I don't see that we have that infor-
3 mation, and also some information of mechanical properties
4 of the fault zone itself, and see that we have that infor-
5 mation.

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1 Q Could you be more specific and identify the
2 kind of information you believe would be necessary in order to
3 say with a reasonable degree of geologic certainty, to
4 establish with a reasonable degree of geologic certainty what
5 the maximum capability on the Hosgri is?

6 MR. NORTON: Object. Asked and answered. I
7 believe that's precisely what he just stated.

8 MR. FLEISCHAKER: I'm asking him to be more
9 specific.

10 MR. NORTON: Mr. Fleischaker is apparently not
11 happy with the answer. But he's asked the question and he's
12 received the answer and he's not entitled to keep asking it
13 over.

14 MR. FLEISCHAKER: I'm asking a different question,
15 I'm asking him to list with more specificity the kind of
16 information he would need in order to meet this criteria of
17 reasonable degree of geologic certainty.

18 MR. NORTON: Mrs. Bowers, that's exactly what he
19 asked him. And now he's saying tell me more. The question
20 should be: Is there any more.

21 MRS. BOWERS: Mr. Staenberg?

22 MR. STAENBERG: The Staff joins the objection.

23 MRS. BOWERS: The objection is sustained.

24 Can you rephrase?

25 MR. FLEISCHAKER: Okay.



agb2

BY MR. FLEISCHAKER:

Q Let's move on to the second question then.

"Can you state with a reasonable degree of geologic certainty that the Hosgri has never produced an earthquake as large as 6.5 magnitude?"

And let me ask you, what kind of information would you need in order to meet this test of reasonable degree of geologic certainty in order to demonstrate that the Hosgri has never produced an earthquake as large as 6.5 magnitude?

A (Witness Silver) Well again, with the absence of good historical earthquake data, the kind of information one would need is good information on the late Pleistocene slip rate of the Hosgri fault zone, some information on the mechanical properties of the fault zone -- which could be rather difficult to get.

Also what would be difficult to get would be information on the magnitude of slip during any given fault event.

Now of course, to establish maximum magnitude you have to find maximum slip, it's very difficult information to get, but to be reasonably certain of a given magnitude, one would have to -- I would like to see that kind of information.

Q So you've listed three things here. Let me --



agb3

before going into these three, let me ask you with respect to the last:

"Question: Mr. Norton asked you,

'Can you state with a reasonable degree of geologic certainty that the Hosgri will never have a 6.5 magnitude earthquake?"

And your answer is: "No."

Would you list the same three kinds of information that you have just listed?

A Yes.

Q Okay, let me ask you this.

First of all, Pleistocene, information on movement of the Pleistocene, is that your first category?

A Yes, the late Pleistocene.

Q What years are we talking about there?

A For the late Pleistocene, generally something on the order of -- well, late Pleistocene is commonly defined on the basis of younger than 700,000 years. One can get evidence on terraces for slip on the basis of the same kind of technique that Weber and Lajoie used, the basis of the last 1- or 200,000 years.

Obviously, the younger, the more recently in the past you have information the better off you are. On these terraces you seem to be limited to this 100- or 200,000 year data, so I would say that would be where you would want

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agb4

1 to concentrate. If you could get younger data, so much the
2 better.

3 Q In your study of this area, in your discussions
4 with other people, have you been able to -- have you become
5 aware of the existence of information which permits you to
6 make definitive conclusions regarding the amount of movement
7 in this late Pleistocene period?

8 A No, no I haven't.

9 You're referring to the Hosgri?

10 A That's correct.

11 A No, I haven't.

12 Q How long have you been studying the Hosgri?

13 MR. NORTON: Object. That assumes a fact not
14 in evidence.

15 BY MR. FLEISCHAKER:

16 Q Have you been studying the Hosgri?

17 A (Witness Silver) Yes.

18 Q How long?

19 A Well I first began to study the Hosgri in
20 November, 1972. This does not imply continuous study from
21 1972 'till the present, but that's when I first became aware
22 of its existence.

23 Q Have you published articles on the Hosgri?

24 A Yes.

25 Q Have you discussed the matter of evidence of



agb5

1 Pleistocene movement with other scientists in the community?

2 A Yes.

3 Q Have you participated in professional forums
4 in which the question of evidence of movement on the Hogri
5 has been discussed?

6 A Yes. I essentially helped organized two conferences
7 on that subject.

8 Q What two conferences were these?

9 A One was an informal conference held at Stanford
10 University in 1976 with Bill Dickinson and Steve Graham,
11 and the second was a symposium of the Geological Society of
12 American held in Sacramento in April, 1977.

13 Q Now, this 1976 --

14 MR. NORTON: Excuse me, is this redirect? Because
15 if it is, none of this was brought out on cross-examination,
16 Mrs. Bowers.

17 MR. FLEISCHAKER: It sure was. In asking the
18 question about reasonable degree of geologic certainty, Mr.
19 Norton asked a question about what are his standards, and
20 I'm trying to determine that right now, exactly what his
21 criteria are that he applied to these questions. His criteria
22 may be very different from the one that I apply or the one
23 that some other scientist applies.

24 And I think that in understanding what this
25 scientist means when he answers the question: Do you have a



agb6

1 reasonable degree of geologic certainty?, you have to -- it's
2 useful to have into the record information regarding the work
3 that he's done, the information that is available and which
4 he has studied and of which he is aware in reaching that
5 conclusion.

6 Otherwise, the standard, "reasonable degree of
7 geologic certainty" is meaningless, it hasn't been defined
8 in the law, it hasn't been defined in the common law, it means
9 one thing for Mr. Norton, it means one thing for Mr. Hamilton,
10 it means another thing for this scientist.

11 This scientist is on the stand. It is his standard
12 and I deserve -- cross-examination permits us to elicit the
13 kind of information that permits us to define the standard,
14 "reasonable degree of geologic certainty."

15 MR. NORTON: First, Mrs. Bowers, I'm glad
16 Mr. Fleischaker has identified his redirect as cross-examination
17 which is pretty much what it is.

18 MR. FLEISCHAKER: I've been cross-examining for
19 so long I can't remember where I am.

20 MR. NORTON: But the point being is what he's
21 after now is not Dr. Silver's study of the fault, but the
22 opinions of others. He's talking about meetings and so on.
23 Dr. Silver has already told us what he thought of the Hosgri
24 and what his opinions are of the Hosgri. And a redirect now
25 on this witness as to what others' opinions are is not proper



agb7

1
2 redirect. That was not gotten into in cross-examination at
3 all.

4
5 Now if Mr. Fleischaker is simply going to ask
6 him some more questions about his opinions, then I have no
7 real objection. But it was clear to me, or it seemed to me
8 that he clearly was going into the opinions of others.

9 MRS. BOWERS: Mr. Staenberg?

10 MR. STAENBERG: No position.

11 MR. FLEISCHAKER: Can I address that?

12 I wasn't going into the opinions of others. I
13 understand that it's Dr. Silver who's on the stand.

14
15 What my redirect is directed to is the kinds of
16 information that have been available to this scientist, his
17 participation in this question, the studies in which he has
18 engaged, the symposia in which he has engaged, that kind of
19 information I think is relevant in order to permit the Board
20 to properly measure this standard, "reasonable degree of
21 geologic certainty."

22 MR. NORTON: If that's what Mr. Fleischaker is
23 limiting his questions to, no objection.

24 MRS. BOWERS: Why don't you proceed, Mr.
25 Fleischaker?



2a ebl

1 BY MR. FLEISCHAKER:

2 Q Dr. Silver, the second thing you discussed were
3 the mechanical properties. Could you define what you mean by
4 "mechanical properties"?

5 A (Witness Silver) Essentially the strength of the
6 crust, the ability of rocks on either side of the crust to
7 store strain energy and to release strain energy. Some parts
8 of faults, because of their geologic properties, have very
9 low strength with respect to slippage and store very little
10 energy. That is, they move fairly constantly.

11 Other parts, for one reason or another, are much
12 stronger, are able to store much more energy and therefore,
13 release much larger earthquakes. I think there is very little
14 information available on the San Gregorio-Hosgri.

15 Q I was going to ask you with which information are
16 you familiar on this subject? What studies specifically
17 are you familiar with on this question of the mechanical
18 properties of the rocks on the Hosgri?

19 A I'm not aware of any that have been done for the
20 Hosgri.

21 Q How would you do such studies?

22 A For the offshore part of the Hosgri it would be
23 very difficult.

24 MR. NORTON: Excuse me, Mrs. Bowers. I believe
25 this is definitely an area of seismology. I don't know that

4.130



eb2

1 there is any foundation laid that this witness has the ex-
2 pertise to get into this area at all.

3 I am also a little confused about the offshore
4 portion of the Hosgri. It insinuates there's an onshore
5 portion, but I guess I interrupted the witness, but I don't
6 think he has any expertise to get into this.

7 MR. FLEISCHAKER: I asked the question. I'd like
8 to put the question again. And if this witness feels that
9 he doesn't have the expertise to identify these kinds of
10 tests, then he would say that on the record I would expect.

11 MR. NORTON: Well, Mrs. Bowers, this witness'
12 opinion of his expertise is not the test as to whether he is
13 qualified.

14 MRS. BOWERS: Mr. Staenberg?

15 MR. STAENBERG: The Staff believes if the witness
16 can answer the question within his scope of expertise we'd
17 be interested in hearing the answer.

18 MRS. BOWERS: Well, the Board would like for the
19 witness to answer the question.

20 WITNESS SILVER: Much of the knowledge of the
21 ability to store strain energy on a fault such as the San
22 Andreas first of course comes from studies of fault creep
23 along the fault zone, from seismic energy released during
24 earthquakes along the fault.

25 There have been-- I'm not aware of studies that



eb3

1 have been done to measure fault creep along the Hosgri or
2 the San Gregorio faults. There's a fairly low level of
3 recorded seismicity. So I would say that for this question,
4 probably the easiest kind of measurement one could make is
5 a study of creep versus non-creep.

6 BY MR. FLEISCHAKER:

7 Q With respect to the third factor, that is the
8 magnitude of slip during a specific event, how would one
9 measure the magnitude of a slip during a given event? How is
10 that determined?

11 A (Witness Silver) During a given event?

12 Q That is related to a particular event. I think
13 that was the third factor that you listed.

14 A Oh. Well, in the absence of earthquakes in the
15 absence-- I mean one can measure it during an earthquake
16 itself. To go back in the historical record, one would have
17 to find evidence in the sediments of discrete slip events,
18 in trenches across the fault and along the fault.

19 Now such studies have been done, say in localized
20 places along the San Andreas, but only in the vertical plane.
21 It is actually very difficult to get that kind of information
22 in the horizontal plane. It's not impossible but it's ex-
23 tremely difficult.

24 Q To your knowledge, have such studies been carried
25 on with respect to the Hosgri or the San Simeon or any of the



eb4

1 faults within the San Gregorio-Hosgri fault zone?

2 A To my knowledge there has been some trenching
3 of these faults, but I'm not aware of detailed studies to get
4 at that question. And certainly not studies in the horizontal
5 plane.

6 Q Dr. Silver, can you state with a reasonable degree
7 of geologic certainty that the Hosgri has not produced an
8 earthquake as large as 7.5 plus magnitude?

9 A No, I can't.

10 Q Can you state with a reasonable degree of certainty
11 that the Hosgri will never produce a 7.5 plus magnitude
12 earthquake?

13 A No.

14 MR. FLEISCHAKER: No further questions.

15 MR. NORTON: Mrs. Bowers, would you like us to do
16 our recross, the Applicant and the Staff, before the Board
17 questions, and have the Board go last, or would you prefer
18 to go before the recross?

19 MRS. BOWERS: Well, it doesn't matter to us. If
20 you prefer, why don't you go ahead?

21 MR. NORTON: All right.

22 RE-CROSS-EXAMINATION

23 BY MR. NORTON:

24 Q Dr. Silver, this morning when we first started out
25 Mr. Fleischaker asked you, and unfortunately I don't have the



eb5

1 transcript in front of me so I must paraphrase as best I can,
2 but he asked you if indeed you had reported the conclusions
3 or the new gravity data, the paper that you had written,
4 the one we talked about which is our Exhibit --- I believe
5 it is 31, the paper that we discussed on cross, and that
6 Mr. Fleischaker discussed with you this morning.

7 And you stated that yes, indeed you had told me
8 about that in the deposition.

9 Did you volunteer that information in the depo-
10 sition?

11 A (Witness Silver) No, you asked for it.

12 Q Did you tell me about the conclusions that you
13 stated in that paper in the deposition?

14 A I didn't talk about the paper in the deposition.
15 I talked about-- I told you of the existence of the paper.

16 Q Well, let's go to the existence of the paper.
17 I believe that's at page 90 of the deposition, and I believe
18 if we start at line 3, page 90-- I'll read the question
19 and you read the answer, just as it is in the deposition.
20 All right, Dr. Silver?

21 MR. FLEISCHAKER: I'm going to object to this line
22 of cross-examination. I don't see that it's relevant. It is
23 clear that the witness has been through this. The witness
24 told the attorney, Mr. Norton, of the existence of the paper.
25 Unless there is some indication here that he has been



eb6

1 inconsistent on the stand, I think that it is entirely in-
2 appropriate for us to go through this line of cross-
3 examination.

4 MR. NORTON: Well, we won't know until we go
5 through the line of questioning, Mrs. Bowers, as to whether
6 there has been some inconsistency.

7 MR. FLEISCHAKER: I would also like to point out,
8 that the witness has a duty only to answer the questions that
9 Mr. Norton asked during the deposition. He doesn't have the
10 duty to make his case for him.

11 MR. NORTON: All right.

12 BY MR. NORTON:

13 Q Dr. Silver, would you read the answers as I read
14 the questions?

15 "QUESTION: You were talking about
16 gravity mapping of the State of California...."

17 MR. FLEISCHAKER: Could I ask where we are?

18 MR. NORTON: Page 90, line.

19 BY MR. NORTON:

20 Q Are you there, Dr. Silver?

21 A (Witness Silver) Yes.

22 Q "QUESTION: You were talking about
23 gravity mapping of the State of California,
24 from off the coast into the state, and I think
25 you said you were an author on a paper and I've



eb7

1 reviewed --

2 "ANSWER: No, on a map, a gravity map."

3 Excuse me. You were going to read the answer.

4 Excuse me. I'm sorry. Go ahead, and read it.

5 A "No, on a map, a gravity map."

6 Q "QUESTION: Okay.

7 "You used the term 'author' though.

8 A "Yes."

9 Q "Well, did you write anything about
10 that?"

11 A "Yes, but it's not published."

12 Q "Oh. Okay."

13 And then we go on, and you again say you had
14 written something.

15 So you didn't volunteer and I asked you. Is that
16 correct?

17 A Yes.

18 Q All right.

19 Now let's go back to page 45 of the deposition.

20 Now at line 22-- You know, previously you had
21 been discussing-- You said:

22 "Those are the main things that I just
23 recall offhand on the offshore gravity just at this
24 time."

25 Now the paper we've been talking about, this



eb8

1 Exhibit 31, that's onshore data; right?

2 A No.

3 Q It's offshore and onshore?

4 A It's offshore. I made one comment in the paper
5 on the extension, the possible extension of a gravity anomaly
6 but the title and the whole everything is based on the off-
7 shore.

8 Q All right.

9 So let's move to page 46, line 8-- Well, let's
10 back up all the way to where the objection is.

11 "I think I've answered the question.

12 "Well, I'm sorry, you just said there's
13 a wealth of data."

14 And you say:

15 "ANSWER: On the onshore.

16 "QUESTION: Onshore. And I want to

17 know specifically what data you are relying on.
18 You know, is there a specific piece of data that
19 you're relying on, I mean like that aeromagnetic
20 survey you have there, a piece of gravity data
21 that you say Well, this to me shows conclusively
22 Fact X which is integral to my opinion? That's what
23 I'm trying to find out."

24 Now would you read your answer?

25 A "Okay. There's a new unpublished and



eb9

1 as yet unfinal -- not in final form gravity map of
2 the State of California at a scale of one to 75,000
3 put out by a number of people of which I am co-
4 author for my contribution, contouring some of the
5 offshore data. It has just been shown to me in a
6 new, complete form and I haven't at this time uti-
7 lized that map to come up with conclusions. So
8 whether I will have a chance to do anything between
9 now and the hearing I don't know."

10 Q Now isn't that in fact the map which you state
11 your conclusions in in Exhibit 31?

12 A My conclusions are basically-- Well, it did use a
13 small portion of the onshore. I did look at the extension
14 of the ridge onto the onshore. The rest of it was offshore.

15 Q Dr. Silver, isn't it precisely that map upon which
16 you base your statement in PG&E Exhibit 31:

17 "The gravity data apparently conflict
18 with the interpretation of large lateral offset on
19 the San Gregorio fault."

20 MR. FLEISCHAKER: I'm going to object to that
21 question as argumentative. We're not in a criminal trial or
22 in a divorce proceeding. This is a proceeding before the
23 Nuclear Regulatory Commission and I think that under the
24 circumstances that this Counsel can ask his questions in a
25 tone which is less argumentative and less accusatory in nature.



eb10

1 This is a proceeding where we're here to try to
2 decide something about a nuclear power plant. We're looking
3 at evidence. We're trying to do it in an analytical way.
4 And to listen to Mr. Norton, you'd think we had a criminal
5 trial going on here, so I object to the line of questioning
6 because I think it is argumentative.

7 MR. NORTON: I have never tried a criminal case
8 in my life so I don't know how I'm supposed to act in a crimi-
9 nal trial. I'm not trying to treat this in a criminal fashion
10 at all. I'm trying to find out what the witness has said
11 that he did not state, did not draw any conclusions in his
12 deposition. We just read that.

13 Now I'm asking him if this sentence that I just
14 read from that publication isn't indeed a conclusion from
15 the gravity data from which he told me in his deposition,
16 under oath, that he hadn't drawn any conclusions.

17 MR. FLEISCHAKER: I have no objection to the
18 question if it is asked in a manner which isn't accusatory
19 in tone. Scientists aren't brought to this proceeding to have
20 fingers pointed at them and waved at them.

21 So if Mr. Norton --

22 MR. NORTON: I haven't waved my finger at anyone,
23 Mr. Fleischaker.

24 MR. FLEISCHAKER: Verbally you have.

25 (Laughter.)



eb11

MR. NORTON: Well, it was a verbal finger.

(Laughter.)

We'll let the objection stand and I'll withdraw the question. I think the question contains the answer.

MR. STAENBERG: May we clear up one thing for the record?

I believe the witness stated in reading out line 21 of page 46 a scale of one to 75,000. I believe the deposition reads 750,000.

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WB WRB/mpbl

BY MR. NORTON:

Q Now, Dr. Silver, I would like to move rapidly on to another area.

Have you studied the terraces at San Simeon?

A (Witness Silver) No, I haven't.

Q Have you reviewed Dr. Hall's detailed mapping of those terraces?

A I've seen his maps, but I haven't reviewed it.

Q Okay.

Have you reviewed the FSAR data on the San Simeon area that was submitted in this proceeding?

A Not in detail.

Q Have you reviewed the ENVICOM data in the San Simeon area?

A No.

Q Have you reviewed the Fugro data?

A I've seen the report and I've seen a little bit of the data, but not all of it.

Q And when we were talking about changing your B attachment, would you also address the Fugro data as respects the 1927 earthquake?

A Well, I'd like to see -- I'd like to have a chance to look at the Fugro data.

Q You have no reason at this time to disagree with the conclusions in the report, do you?



mpb2 1 A I have no reason to form an opinion of that
2 report.

3 MR. FLEISCHAKER: Excuse me.

4 For clarification, we've had four documents
5 mentioned with respect to possible studies of the San Simeon
6 terraces, Terraces on the San Simeon, Hall, FSAR and Fugro,
7 and ENVICOM, or something like that.

8 Could you give us a more complete citation to
9 that?

10 MR. NORTON: I'm sorry. Are you cross-examining
11 me now?

12 MR. FLEISCHAKER: Yes, you're questioning this
13 witness as to what -- for purposes of clarification of the
14 record, you mentioned four studies. I don't know whether
15 this ENVICOM is a hypothetical study or what it is, and I
16 think the record ought to reflect what study you're talking
17 about.

18 MR. NORTON: Mrs. Bowers, I'm not under cross-
19 examination at all. I'm not going to answer Mr. Fleischaker's
20 questions.

21 I don't understand. Is this an objection? What
22 are we doing here?

23 MRS. BOWERS: Well, let's check with the witness.

24 The names of several reports or data were given
25 to you, and you were asked how familiar you were. Did you



mpb3 1 understand the identification of each one of those?

2 WITNESS SILVER: No.

3 MR. NORTON: Well, Mrs. Bowers, I first asked
4 him if he had studied San Simeon and he said no. The next
5 was Hall's detailed map, and he said he was aware of it but
6 hadn't studied it. He said he'd seen it but hadn't studied
7 it in detail.

8 I asked him about the material in the PSAR,
9 which is in evidence in this case. He said he had briefly
10 looked at it but hadn't studied it. Then I asked him about
11 the ENVICOM, E-N-V-I-C-O-M, data, and he said no, he had not
12 reviewed it.

13 To help Mr. Fleischaker out, I will read in the
14 citation which is in evidence in this case in the direct
15 testimony of Dr. Jahns and Dr. Hamilton. And if you'll
16 look under E in the reference you'll find it.

17 Mrs. Bowers, I don't understand the nature of
18 those kinds of interruptions. There was no objection or
19 anything else, just a speech from Mr. Fleischaker that was
20 not founded in any legal manner in any way.

21 MRS. BOWERS: Well, I think we've ascertained
22 that the witness understood the documents or the reports
23 that were being referred to.

24 WITNESS SILVER: Yes.

25 MRS. BOWERS: So why don't you proceed.



mpb4 1

If it was a formal objection, it's overruled.

2

BY MR. NORTON:

3

Q I'd like to go briefly to the map that you referred to.

4

Did McCulloch tell you all the data that they had available to them. Did he sit down and give you a list of all the data that USGS had available to it in the area of that map?

5

A (Witness Silver) No.

10

Q All right.

11

Did Mr. Wagner do that?

12

A No.

13

Q Did they tell you specifically that that map included all of the data they had available to them?

14

A No.

15

Q Did they tell you, for example, whether they had proprietary data available to them?

16

A Yes.

17

Q Did they tell you they did?

18

A Yes.

19

Q Did they tell you they used it in that map?

20

A Yes.

21

Q Did they tell you which proprietary data they used?

22

A Yes, they did.

23

24

25



mpb5 1 Q Did they tell you which proprietary data they
2 did not use?

3 A No, they did not.

4 Q All right.

5 Did they tell you, for example, that they
6 used all of the proprietary data they had available to them?

7 A Not in those words, no.

8 Q Did they tell you what proprietary data they
9 had available to them, each and every piece?

10 A Not each and every piece, no.

11 Q Well, you know, what I'm trying to get at is
12 how do you know they told you all of the proprietary data
13 they had? How do you know they told you about all of it?

14 A They told me about data sets they had.

15 Q Yes, but how do you know --

16 A But I can't say -- they did not identify every
17 piece.

18 Q So you don't know, really, whether they used
19 all of the proprietary data they had available to them or not?

20 A That's correct.

21 Q And therefore you don't know whether they used
22 all the data they had available to them, is that correct?

23 A That's correct, I can't say for certain.

24 Q Seismic reflection data or otherwise?

25 A Yes, that's right.



mpb6 1

MR. NORTON: We have no further recross.

2

MRS. BOWERS: Mr. Staenberg?

3

MR. STAENBERG: May we have just a moment,

4

please?

5

MRS. BOWERS: Yes.

6

(Pause.)

7

MR. STAENBERG: Mrs. Bowers, Staff has no cross-

8

examination of this witness.

9

MRS. BOWERS: We'll go ahead with our questions

10

now, then.

11

MR. NORTON: Mrs. Bowers, may we have a bench

12

conference for a moment, please?

13

MRS. BOWERS: All right.

14

(Whereupon, a bench conference was had.)

15

MRS. BOWERS: We're going to take a ten minute

16

recess at this time.

17

(Recess.)

18

MRS. BOWERS: We'd like to proceed.

19

During the bench conference just prior to the

20

recess, the parties were considering the extent of the further

21

examination of these witnesses, and also the possibility of

22

Mr. Bettinger going on and the cross and questions for him.

23

And it appears from their positions and the Board's

24

that we probably will complete by 1:00 or 1:30 or something

25

like that. So we won't take a normal luncheon break at 12:00;

2B
2C



mpb7 1 we'll just keep going.

2 Are we correct that it's now time for Board
3 questions?

4 MR. NORTON: I believe so, Mrs. Bowers.

5 EXAMINATION BY THE BOARD

6 BY DR. MARTIN:

7 Q My questions are tutorial in nature. These two
8 members of the Board are glad for the opportunity to learn
9 more about geology and seismology, but we want to get our
10 principles straight if we can.

11 I believe you and other witnesses have indicated
12 that there are several ways to obtain information about
13 underwater faults and two general kinds of data that could
14 be collected are the various kinds of seismic reflection data
15 and aeromagnetic data which could be collected from under-
16 water or land locations, either one.

17 I recall some statement of yours that suggested
18 or made me think perhaps that none of these data -- well,
19 let me backup; that the seismic reflection can provide evi-
20 dence of vertical movement of an underwater fault.

21 A (Witness Silver) Can provide, yes.

22 Q And we saw illustrations that showed us what
23 such data looked like.

24 The data of that sort of any other sort that
25 geophysicists collect concerning underwater faults indicate



mpb8

1 movement along such a fault in the horizontal direction and
2 later strike fault?

3 A It would not be impossible to do that. But one
4 would have to be very fortunate. One would have to see very
5 fortunate relationships on either side of the fault that
6 you were sure you were matching.

7 If there were very distinctive magnetic patterns
8 all the way along the fault or very distinctive packages of
9 seismic reflectors. However, it's extremely difficult to do
10 that. It's rarely if ever --

11 Q Indications of slip in the horizontal direction
12 would be more or less fortuitous from that kind of data?

13 A Very hard to get, yes.

14 Q Not impossible, but --

15 A No, I certainly would never use that word.

16 Q -- but having a low probability.

17 A Yes.

18 Q I see.

19 A (Witness Graham) Dr. Martin, if I can add some-
20 thing, I think one of the principal problems is that in seismic
21 profiles in particular you're looking at vertical slices, so
22 it's easy to sense things that are happening vertically, but
23 not so easy to sense things that are happening in a horizontal
24 plane.

25 Q I appreciate that. You can see a cliff.



mpb9

A Exactly.

Q In the other thing you have to match up things on the two sides that are obviously similar but out of place.

A Right.

Q Now my next question is more to the point:

Are there any data that you know of concerning the Hosgri fault which are clear indications of movement in the horizontal plane?

A (Witness Silver) Offshore data of that sort?

Q Yes.

A No.

Q Thank you.

BY MR. BRIGHT:

Q I was glad to see Dr. Graham got to say something.

(Laughter.)

But my question is directed to Dr. Silver:

I assume that you remember the way this particular session started off, with the move to strike Section 3.3 of your direct testimony, Dr. Silver.

A (Witness Silver) Yes.

Q The problem there was one of expertise, I understand, and qualifications for dabbling in this particular area. And we paralegals -- (Laughter.) -- sometimes have a problem in determining just what constitutes an "expert".

Now my background is reactor physics and



mpb101 1 engineering, so I have absolutely no basis to determine
2 whether you are truly an expert in this area on the basis
3 of what you studied when you went to school because I don't
4 know what you studied when you went to school.

5 But we do have some things in common, and that
6 is we use analyses and we make calculations and whatever,
7 and this is fairly standard throughout the technical commu-
8 nity.

9 So I guess my question really bears -- and I
10 said make the observation that 3.3 is in the record. It
11 will stay in the record and nothing that you or I say here
12 will have anything to do with that. You say you used the
13 method that Dr. Smith propounded in his answer to a question
14 proposed to him by the NRC. And you identified that as
5.180 15 NRC question 2.17, and that was brought into evidence, I
16 think, as Joint Interveners' Exhibit number 44.

17 Now what I want to ask you is:

18 Are you familiar with -- evidently you are
19 familiar with this answer to the NRC.

20 A Yes. I have a copy someplace here.

21 Q Now, first, it says that Brune does the magnetic
22 -- the seismic moment promotion and he propounds a formula
23 to determine this, and then there are a number of assumptions
24 which I made in order to arrive at that formula.

25 And my question is:



mpb111

2 Have you looked at these assumptions critically?
3 That is, have you applied your expertise to determine whether
4 in your mind they are reasonable and can be depended upon?

5 A Let's see:

6 In viewing the assumptions I guess I would agree
7 certainly with Smith's assertion that certainly as he has
8 applied it, they are conservative.

9 But I haven't gone through in a critical way
10 to say Was he perhaps incorrect in making some of his assump-
11 tions in coming up with that formulation.

12 Q Well, another question --

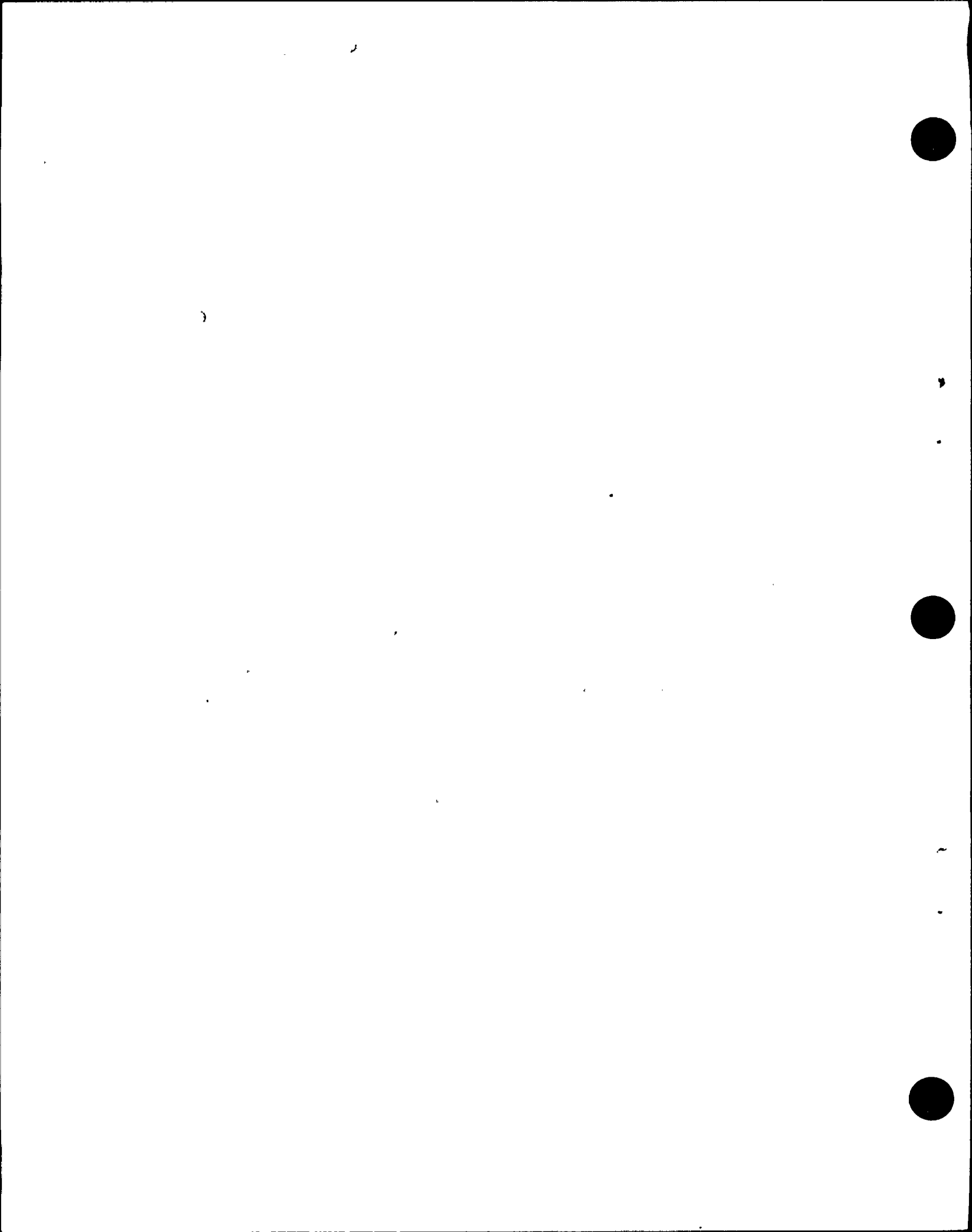
13 A If I could expand once more, essentially to
14 save time because this was given to me rather late and
15 shortly before the testimony. So I contacted Dr. Brune,
16 talked to him about that, and so I -- and so in dealing
17 with his assumptions, I did rely on his opinion for whether
18 or not this could be used and to what degree.

19 So I have not myself gone through and critically
20 challenged the assumptions that Dr. Smith made.

5.210

21 Q Then I guess I can short-circuit a lot of
22 chatter here.

23 Would you agree, then, that if one accepts
24 what Dr. Smith has propounded, would almost anyone in the
25 technical community with a working knowledge of how to solve
equations and this sort of thing, be able to do this



mpb121

particular calculation?

2 A Oh, yes. Oh, sure.

3 Q Fine. Thank you.

4 BY DR. MARTIN:

5 Q I have a little trouble discovering which
6 formulation to use in light of, you know, what's said in
7 these few paragraphs in Section 3.3 of your written testi-
8 mony.

9 You say that using this formula, the Applicant
10 replied to NEC Question 2.17, and so forth. And I have
11 Joint Interveners' Exhibit 44, which seems to be what you
12 have reference to.

13 That's the formulation that you have reference
14 to in your testimony?

15 A (Witness Silver) Yes.

16 That is the answer to Question 2.17?

17 Q Yes.

18 A Yes.

19 I could tell you which equations I used.

20 Q Would you do that, please?

21 A Yes.

22 I don't have it in front of me. But there are
23 two equations. One is the standard equation for determining
24 seismic moment. That's calculated by multiplying a value
25 of -- essentially assumed, but generally an assumed value of



mpbl31
2 crustal rigidity times a value for seismic slip times an
3 area. So those three values, the value of rigidity that is
4 standardly assumed, in absence of any other independent data
is 3×10^{11} dynes per square centimeter.

5 Q That's the number you used?

6 A Yes.

7 Q 3×10^{11} dynes per centimeter?

8 A Yes. That was given to me by Smith and also
9 told to me verbally by Brune. That's the standard number
10 he uses in his published....

11 Then the other two terms are the unknowns in
12 the equation. Essentially if one inserts low values for slip
13 area, low values for seismic slip, seismic moment will come
14 out small. If one puts in high values, it will come out high.
15 And that basically governs the second equation where Smith
16 determined estimated magnitude by an equation which was the
17 log of .33 times the seismic moment minus 17 divided by 1.33.

18 He went into a number of assumptions of how he
19 determined these constants -- a discussion, I'm sorry, about
20 how he determined these constants.

21 I don't have this directly in front of me. I'm
22 recalling this from memory.

23 Q Then in your testimony you list input values.

24 A Yes.

25 Q You've got an input value for fault length, I



mpbl4 1 appreciate that. But the area would be length times width
2 or depth, wouldn't it?

3 A Oh, yes.

4 Q And I don't see in your testimony what value
5 you have --

6 A That was my oversight. I assumed a depth of
7 15 kilometers.

8 Q 15 kilometers.

9 A Yes.

10 Q Where does the duration of 1000 years versus
11 10,000 years come into the calculation?

12 A That was simply arbitrary on my part. I agreed
13 with Dr. Smith that this was a very conservative method,
14 especially over a period of 10,000 years. Assuming that --
15 even 1000 is somewhat conservative. Assuming 10,000 years,
16 this assumes that some time in that time period, or 1000,
17 that some time in that time period there has been one earth-
18 quake of this maximum magnitude.

19 And now we're asking about a second earthquake.
20 So the calculations essentially say, talk about the magnitude
21 of two earthquakes in that time period.

22 So my feeling was to use 1000 years. That would
23 assume two earthquakes in 1000 years, the second one not
24 having yet occurred. That is the hypothetical expected earth-
25 quake. That would be a less conservative value. But the



mpb15 1

1000 years was just arbitrary on my part.

2

Q Okay.

3

And this duration, where does this duration, this time, enter into Dr. Smith's formulation?

5

A Well, the time would govern the value of the slip one would use. That is, I used the number, the maximum number of Weber and Lajoie of 1.6 centimeters per year. And that was based on the northern end--or the central part of the San Gregorio fault. The amount of slip -- I used this because I had no other basis on which to pick a number.

10

11

With the slip rate, the amount of slip that would occur would depend on the time interval one chose.

12

13

So with 1000 years this gave, say, 16 meters. This would give a value of 16 meters, and I put that into the upper equation.

15

16

So that would govern a value of slip since that was using a slip rate.

17

18

Q All right.

19

So the duration was used to estimate the amount of slip.

20

21

A Yes, that's right.

22

Q And it's the amount of slip that goes into the equation for moment.

23

24

A That's correct.

25

Q Okay.

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1
2 And what is the function that relates moment
3 and magnitude? Is it simply proportional?

4 A It's related -- it's in a log relationship. The
5 second one that he used gives the log of the constant times
6 the seismic moment minus a constant, in this case 17
7 divided by a constant, so it's a logarithmic relationship.

8 Q Is it a constant?

9 I mean, so many dynes/cm. equals such and such
10 magnitude?

11 A No.

12 Well, assuming -- yes, assuming all these other
13 values constant, which he has --

14 Q I asked only for the relationship between magnitude
15 and moment.

16 A Yes, that's correct.

17 Q -- for a given moment, what is the magnitude?

18 A Yes, and that would be the only variable in that
19 equation, the moment would be the only variable. So knowing
20 the moment, then one can directly calculate the magnitude.

21 Q You just multiply the moment by a constant.

22 And I'm asking you, what is the constant?

23 A Well it's the log of a constant times the moment
24 so -- of the log in this case of 0.33 times the moment,
25 minus 17, and that quantity divided by 1.33.

I'm doing this from memory.



agb2

1 Q Okay. Now I'm with you. Thanks.

2 Your input is 400 kilometers, which is different
3 from Applicant's, is that correct?

4 A Yes, and that would be certainly a maximum
5 relationship as would the seismic slip, the 1.6 centimeters
6 a year would be a maximum number proposed for that. But it's
7 simply very easy to tabulate the results of using this equation
8 to a variety of inputs.

9 Q Thank you very much.

10 MRS. BOWERS: The Board has no further questions
11 at this time.

12 Mr. Fleischaker, did the Board's questions raise
13 questions on the part of the parties?

14 MR. FLEISCHAKER: May I have one moment?

15 (Pause.)

16 MRS. BOWERS: We'd like to interrupt your
17 consultation for a minute, Dr. Martin has further questions.

18 BY DR. MARTIN:

19 Q Yes, I was using Mr. Bright's copy of your
20 testimony and I found mine and I found I had marked another --
21 one more question on it.

22 One of your inputs, a critical one, in determining
23 or in estimating the 16 meters in 1000 years of slip is
24 Weber and Lajoie's revised estimate of a mean slip of 1.6
25 centimeters per year.



agb3

1 A (Witness Silver) Yes, that's correct.

2 Q Now did they make their estimate for the San
3 Gregorio-Hosgri fault -- in other words, did they recognize
4 the existence of this being a connected fault in arriving at
5 their 1.6 estimate?

6 A No, they didn't. That's my own inference. Theirs
7 only applies to the northern part, to the San Gregorio, three
8 strands along there. In fact, more technically, only to the
9 small area of Ano Nuevo.

10 Q I see, it applies to a small portion of the San
11 Gregorio?

12 A That's correct.

13 Q And you used it to apply it to the full 400
14 kilometers?

15 A That's correct. Unfortunately, I had no other
16 numbers.

17 Q I see. Okay.

18 When an earthquake occurs, does a fault slip
19 along its entire length?

20 A Generally no.

21 Q So would you say that you are sort of reaching
22 here to extend it over 400 kilometers?

23 A Yes, that would be an absolute maximum.

24 Q Now I've run out of questions, so I'm finished.
25 Thank you.



agb4

1 MRS. BOWERS: Mr. Fleischaker?

2 MR. FLEISCHAKER: I have no further questions.

3 MRS. BOWERS: Mr. Norton?

4 MR. NORTON: I think the Staff goes next. We get
5 the last bite.

6 MRS. BOWERS: Mr. Staenberg?

7 MR. STAENBERG: The Staff has no questions.

8 MR. NORTON: I have one question that was raised
9 by Dr. Martin's questions and Dr. Bright's questions.

10 CROSS-EXAMINATION ON BOARD QUESTIONS

11 BY MR. NORTON:

12 Q Dr. Silver, do you know that, in deriving his
13 formula, whether Dr. Smith was looking at fault length or
14 fault zone length?

15 A (Witness Silver) In talking about --

16 Q Excuse me, could you answer that yes or no, do
17 you know, and then you can explain, but my question is do
18 you know?

19 MR. FLEISCHAKER: I'm going to object on the basis
20 that we have yet to establish as between this question --
21 in the context of this question or between this witness that
22 they have arrived at a definition of fault length versus
23 fault zone length. There's been a lot of testimony in
24 this proceeding and we have several definitions.

25 MR. NORTON: Fine.



agb5

1 BY MR. NORTON:

2 Q You and I have gone over this in the deposition,
3 Dr. Silver, and I think we're very clear in my understanding.
4 Tell me if I'm wrong in my understanding of the difference
5 between fault and fault zone, as used by you.

6 Fault is one distinct fault. Fault zone are all
7 the little faults that may be along that -- it's two to three
8 kilometers wide, I believe you said. And in the case of the
9 San Gregorio, it may be directly connected -- the San Gregorio-
10 Hosgri fault zone, it may be directly connected or it may not,
11 but it goes along the same general course and there's a lot
12 of different integral faults that are interrelated.

13 A (Witness Silver) That's almost right. That is,
14 fault zone would imply a continuous crustal break but not
15 necessarily a discretely mapped break along the ground.

16 If I could get to your -- First of all --

17 Q No, excuse me, I'd like to go back to my question.

18 MR. FLEISCHAKER: We have yet to establish the
19 difference between fault per se and fault zone. I think
20 there may be some misunderstanding.

21 BY MR. NORTON:

22 Q Dr. Silver, you know what I'm talking about when
23 I say a fault and you know what I'm talking about when I say
24 a fault zone, do you not?

25 A (Witness Silver) I think yes, in general.



agb6

1 Q We went through this in the deposition at rather
2 great length, didn't we, and you defined them for us, did you
3 not?

4 A Yes, I gave my impression of what they were.

5 Q Dr. Silver, that's the definition I'm using in
6 my questions, all right?

7 MR. FLEISCHAKER: I'd like to have a cite to the
8 deposition where that's been defined.

9 MR. NORTON: Is that an objection or a request?

10 MRS. BOWERS: Will it shorten this just to simply
11 have the witness define them now?

12 MR. FLEISCHAKER: I think so.

13 MR. NORTON: I think he just did, but he can do
14 it again.

15 MRS. BOWERS: Well he agreed with your definition,
16 with minor exceptions.

17 MR. FLEISCHAKER: I agree it would shorten it
18 to have him give his definition of these two terms that we're
19 using in this question.

20 MR. NORTON: I found it in the deposition, Dr.
21 Silver, believe it or not, I opened the book and there it was.

22 MRS. BOWERS I can't believe it.

23 (Laughter)

24 BY MR. NORTON:

25 Q Page 82, Line 19:



agb7

1 "Question: Again will you define
2 fault zone and fault?

3 "Answer: Fault zone refers to a
4 break in the crust, an offset of the crust
5 along which slip occurs. A fault zone may have,
6 often does have, a finite width.

7 "Within a fault zone at any one
8 time, a discrete break will occur on a fault.
9 So a fault would be defined as a discrete
10 break within a fault zone.

11 "Now one could imagine a fault and
12 a fault zone being the same thing where the
13 fault zone had almost zero width, very narrow
14 width. But, in general, fault zones such as
15 the San Andreas, San Gregorio-Hosgri have a
16 finite width and within that zone one can map
17 discrete breaks called faults."

18 Now that's the definition that I'm operating
19 under, Dr. Silver, do you have any problems with that?

20 A (Witness Silver) That's fine.

21 Q Okay.

22 And I believe that's generally the same definition
23 as given by the previous witnesses, geologists and seismologists
24 in these hearings. I don't believe there is any great dis-
25 tinctions, and that's not the point of my question, I'm not



agb8

1 trying to trick you in that sense. All right?

2 Now my question is, are you aware of whether
3 Dr. Smith, when he did this, was talking about faults or
4 fault zones? Yes or no.

5 A Well I'm not aware -- No, I'm not aware of exactly
6 what Dr. Smith did, but I am aware of this derivation of the
7 moment relationship. I should say no.

8 Q Now Dr. Smith was indeed analyzing faults as
9 opposed to fault zones. Then what you did would have no
10 meaning, isn't that correct, in relationship to what he did?

11 MR. FLEISCHAKER: I object, that's a hypothetical,
12 I don't think there's a basis in the record yet.

13 MR. NORTON: Well Dr. Smith's paper is in the record
14 and I certainly believe there is a basis for the question,
15 it's not a hypothetical, it does not assume then anything
16 that isn't in evidence.

17 MR. FLEISCHAKER: Just one moment, I'd like to
18 see that paper.

19 MR. NORTON: Joint Intervenors' Exhibit 44.

20 MR. BRIGHT: Mr. Fleischaker, would you like to
21 look at mine?

22 MR. FLEISCHAKER: I'd appreciate that very much,
23 thank you.

24 (Document handed to Mr. Fleischaker.)

25 MR. FLEISCHAKER: Well I'm looking at this paper



1 and as I recall -- and I think I recall accurately -- that he
2 has applied this equation to --

3 MR. NORTON: Excuse me, I don't want to hear
4 Mr. Fleischaker's interpretation of this paper --

5 MR. FLEISCHAKER: It's an objection.

6 I'd direct the Board's attention to Page 16 of
7 the FSAR, 2.5(e)-77, August, 1975. And there this equation
8 has been applied to first-order branches, Calaveras, Hayward,
9 San Gregorio, length 160 to 320 kilometers; second-order
10 fault of the southern Coast Range, San Simeon, Maciniente,
11 and Rinconada, 80 to 160 kilometers, and third order faults.

12 Now I think it is inconsistent with the
13 distinctions you're trying to draw here that this witness --

14 MR. NORTON: May we have an objection and
15 some of Mr. Fleischaker's arguments as to what this document
16 says.

17 MR. FLEISCHAKER: The objection is that it has
18 not yet been established in the record that this equation
19 applied only to faults. It's quite clear on the record from
20 this document that he was applying it to fault zones of
21 160 to 320 kilometers in length.

22 MR. NORTON: Well Mrs. Bowers, I would like to
23 have Mr. Fleischaker's attention directed up above to
24 Number Four. He said:

25 "With these assumptions, we can take

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the geologic information on total fault length and total slip within a specified time period to determine the total seismic moment characteristic of a particular fault" -- not fault zone or fault system.

And yet over on the preceding page, where he's talking about the area, he's talking about the area of the fault system.

Now it may well, indeed, be that Mr. Silver is just wrong and has not used the right assumptions. He's taking the measurement of the Hosgri -- the San Gregorio-Hosgri fault zone where, indeed, it appears that Dr. Smith was using lengths of discrete faults.

If that's the case then Dr. Silver's calculations are worthless, and I have the right to cross-examine Dr. Silver on whether or not he did fault lengths or fault zones.

MR. FLEISCHAKER: The issue in the objection is not whether Dr. Silver is wrong, but whether Mr. Norton's interpretation of this document is wrong. And I think the document on its face quite clearly establishes that, with respect to this particular calculation, Dr. Smith has mixed the terms fault and fault zone as they have been defined by this witness.

He has used his calculations here with respect to faults or fault zones in the length of 160 to 320



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kilometers and I don't believe there is any evidence from this witness that demonstrates or supports the assumption -- the conclusion that the Calveras, the Hayward and the San Gregorio are a single break, a single fault, in the length of 160 to 320 kilometers.

So it's clear from the face of this paper that this equation was applied to fault zones, as that has just been defined here today.

MR. NORTON: Mrs. Sowers, you know, Mr. Fleischaker and I are not the ones to decide what the document says. It says what it says and it means what Dr. Smith says it means, seeing as how he's the author.

DR. MARTIN: Which document are we talking about?

MR. NORTON: We're talking about Dr. Smith's Joint Interveners Exhibit 44, that's the answer to question from the Staff 2.17.

DR. MARTIN: Would you mind reading the first sentence or two of the second paragraph?

MR. NORTON: Where are we?

DR. MARTIN: Beginning: "During 1966..."

MR. NORTON: That's Brune introducing the important concept of using seismic moment to determine average rates of slip on major fault zones, that's not what we're talking about on the next page.

DR. MARTIN: Seismic moment as applies to zones.



agb12

1 MR. NORTON: But that's not what we're talking
2 about on the next page.

3 DR. MARTIN: Seismic moment is used in the rest
4 of the formulation.

5 MR. NORTON: But the rest of the formulation
6 takes a length, and the question is whether that's the length
7 of a fault or the length of a fault zone. I don't know.
8 It says fault in the paper. And I'm trying to find out
9 whether this witness knows whether Dr. Smith meant fault or
10 fault zone.

11 DR. MARTIN: Okay.

12 MR. NORTON: And you know, I don't think we're
13 the people to determine what it means. That's up to Dr. Smith
14 and other qualified people. But I'm trying to find out if
15 this witness is one of those qualified people, if he does
16 indeed know what he meant by length of the fault.

17 WITNESS SILVER: Can I answer that?

18 MRS. BOWERS: Just a minute.

19 Do you plan to bring Dr. Smith back, Mr. Norton?

20 MR. NORTON: We may bring him back for rebuttal,
21 we may not, we haven't made that decision.

22 MRS. BOWERS: Mr. Staenberg, does the Staff have
23 a position in this matter?

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d2 WRB/mpb1 1 MR. STAENBERG: The Staff's position is that I
2 think we spend too much time listening to arguments on the
3 substance between Counsel.

4 The initial reaction of Staff was that the
5 objection made by Intervenor was not well taken. The question
6 whether on its merits could be answered by the witness was a
7 straightforward question and was not objectionable on the
8 basis of no foundation having been laid. And we would once
9 again leave it to the witness to answer if it can be answered.

10 It seems to me -- we don't want to engage in
11 the same argument on the merits that Counsel for Intervenor
12 and Applicant have been so engaged; but it seems to us that
13 the witness is capable of defining the terms. He's been
14 invited to define the terms and answer it along those lines.

15 MRS. BOWERS: Well, the objection is overruled.

16 We would like to hear from this witness on this
17 point as to what he used in his testimony.

18 BY MR. NORTON:

19 Q Did you use fault length or fault zone length?

20 A (Witness Silver) Okay.

21 Let me say how seismic moment is derived. It's
22 derived on the basis of the slip that occurs during the time
23 of a single earthquake. So that these values that go in the
24 area, the rigidity and the amount of slip, refer to the area
25 of the rupture zone during the slip of the earthquake, the



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1 amount of seismic slip, the amount of actual movement of
2 the ground that occurs during the earthquake, and the proper-
3 ties of the material in the zone.

4 So when you use the terminology of seismic
5 moment, you're talking rigorously about slip that would occur
6 during a single movement, a single earthquake.

7 Now in my use of this to arrive at an outside
8 maximum I had no independent knowledge of the length of slip
9 during a given earthquake. So I said it's unlikely that the
10 fault would be -- that slip would occur along a greater length
11 than the fault itself.

12 Now that's obviously the maximum case one can
13 take for the mapped length of the Hosgxi fault zone. So one
14 will not have during an earthquake breakage along the whole
15 length and over the whole width of two or three kilometers.
16 One will have breakage along a discrete plane for whatever
17 length that earthquake occurs.

18 So getting to that, I would say this would be
19 the maximum length of a hypothetical fault that might occur.
20 It's not a mapped fault; but it would not be breakage across
21 the whole fault zone. And in any case, any earthquake that
22 would be applicable to this would be talking about a discrete
23 slip along a discrete fault over a short time.

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1 MR. NORTON: No further questions.

2 MRS. BOWERS: We have nothing further, no further
3 questions for these witnesses.

4 Do you want them excused?

5 MR. FLEISCHAKER: Yes.

6 MRS. BOWERS: Any objection to there being ex-
7 cused?

8 MR. STAENBERG: No objection.

9 MR. NORTON: No objection.

10 MRS. BOWERS: The witnesses will be excused then,
11 and thank you.

12 (Witness panel excused.)

c7
13 MR. FLEISCHAKER: Mrs. Bowers, I request to be
14 excused. Mr. Kristovich is going to be here for cross-
15 examination of Mr. Bettinger.

16 MRS. BOWERS: All right.

17 MR. FLEISCHAKER: Thank you.

18 MR. NORTON: The Applicant would like to call
19 Mr. Bettinger to the stand.

20 Whereupon,

21 RICHARD V. BETTINGER

22 was called as a witness on behalf of the Applicant and, having
23 been first duly sworn, was examined and testified as follows:
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25



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1 DIRECT EXAMINATION

2 BY MR. NORTON:

3 Q Mr. Bettinger, do you have in front of you a
4 copy of your personal qualifications -- professional quali-
5 fications that were submitted in these hearings?

6 A Yes, I do.

7 Q Are there any corrections to be made to those?

8 A No.

9 Q Are they a true and correct copy of your profes-
10 sional qualifications?

11 A Yes.

12 Q All right.

13 Could you briefly summarize your professional
14 qualifications and experience that lead you to be here today?

15 A I've been with Pacific Gas and Electric since
16 my graduation from the, University of California at Berkeley
17 in 1947, with a bachelor of science in civil engineering.
18 AND since that time I've worked on all types of power plants
19 for the company, in designing and observing the construction
20 and making certain that the construction was done in accordance
21 with our drawings.

22 This included hydro plants, geothermal plants,
23 steam power plants, and nuclear power plants. It also in-
24 cluded power design and the design of substations and sub-
25 station structures.



eb3

1 That in general I think is my experience.

2 MR. NORTON: Mrs. Bowers, we would ask that the
3 professional qualifications of Mr. Bettinger be placed in the
4 record as though read at this place in the transcript.

5 MRS. BOWERS: They, like the others, have been
6 admitted into evidence --

7 MR. NORTON: Yes.

8 MRS. BOWERS: -- as part of Exhibit 7. So the
9 professional qualifications of Mr. Bettinger will be physically
10 inserted in the transcript as if read.

11 (The document follows:)

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1 UNITED STATES OF AMERICA
2 NUCLEAR REGULATORY COMMISSION

3 BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

4 In the Matter of) Docket Nos. 50-275
5 PACIFIC GAS AND ELECTRIC COMPANY) 50-323
6 (Diablo Canyon Nuclear Power) Applicants Ex. No. 7
7 Plant, Units No. 1 and 2) December 1978

8 PROFESSIONAL QUALIFICATIONS
9 OF WITNESSES FOR
10 PACIFIC GAS AND ELECTRIC COMPANY

11 Name: Richard V. Bettinger

12 Title or Position: Chief Civil Engineer

13 Degrees: B.S. in Civil Engineering, University of California
14 1947.

15 Professional Experience: Employed at PGandE since 1947.

16 1963 - Supervising Civil Engineer for Civil-
17 Structural Design.

18 1971-1978 - Chief Civil Engineer.

19 Major projects in which he has participated
20 include Cresta Powerhouse; San Mateo 230 kv Tower
21 Line Crossing; Pit No. 4 Powerhouse; Units 5, 6 &
22 7, Pittsburg Power Plant; all of the Geysers Power
23 Plant Units; Units 3 & 4, Morro Bay Power Plant;
24 Units 6 & 7, Contra Costa Power Plant; Unit No. 3,
25 Potrero Power Plant; Units 6 & 7, Moss Landing
26 Power Plant; and Units 1 & 2, Diablo Canyon Nuclear



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Power Plant. Mr. Bettinger is chairman of the American Nuclear Society Committee ANS-2 on site evaluation.

A member of the American Society of Civil Engineers Task Committee on Nuclear Standards, he served as a member of the joint American Concrete Institute - American Society of Mechanical Engineers Code Committee which produced Division 2 of Section III of the ASME Code for Concrete for Nuclear Service.



ebl

1 MRS. BOWERS: We have one question. We think we
2 have seen you before. Did you testify in the NEPA proceeding
3 for Unit 2?

4 THE WITNESS: No, I didn't.

5 MRS. BOWERS: Maybe it's another Hollywood star.

6 THE WITNESS: A girl in India mistook me for Bing
7 Crosby once.

8 MR. NORTON: We're starting out on the wrong foot,
9 Mr. Bettinger.

10 (Laughter.)

11 BY MR. NORTON:

12 Q Mr. Bettinger, do you have a copy of your testi-
13 mony there in front of you, your prepared testimony?

14 A Yes, I do.

15 Q Do you have any corrections, typographical, to
16 make to that?

17 A Right. There are a few little omissions here.
18 On page 3, about line 10, right after the numeral
19 3, the word "Determine" should be added.

20 Q All right.

21 A On page 4, line 3, right after the word "because,"
22 there should be an insertion of the word "of."

23 On page 11, line 7, toward the end of that line
24 after the word "to" the word "a" should be added.

25 And on page 16, the last two lines, the last



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eb2 1 paragraph on lines 12 and 13 should be amended to read:

2 "The seismic re-evaluation has been
3 completed in a conscientious and exhaustively-
4 detailed manner."

5 Q Well, let's back up on that one a little bit.

6 A Do you want the words by --

7 Q In other words you would strike the last sentence
8 of the testimony?

9 A And add the one that I read.

10 Q Would you repeat that one again?

11 A Strike lines 12 and 13 and in their place insert:

12 "The seismic re-evaluation has been
13 completed in a conscientious and exhaustively-
14 detailed manner."

15 Q Well, then, perhaps for the record only line 12
16 would have to be struck and in its place insert the words
17 "The seismic re-evaluation has been completed."

18 A That's correct.

19 Q All right.

20 At this time, Mr. Bettinger, could you briefly
21 summarize your prepared testimony?

22 A Yes.

23 My testimony deals with the investigation, studies
24 and analyses conducted by the company and our consultants
25 concerning the geological and seismological aspects of Diablo



eb3

1 Canyon.

2 The initial phase of the investigation of the
3 geology and seismology commenced in late 1965. The principal
4 consultants were Elmar Marliava, who is now deceased, and
5 Dr. Richard H. Jahns.

6 In seismology we had Dr. Hugo Benioff, who is now
7 deceased, and Dr. Stewart Smith.

8 From an engineering standpoint we had Dr. John A.
9 Blume and Mr. Edward Keith.

10 These consultants have been assisted by others:
11 Dr. Jahns by Mr. Douglas Hamilton and his staff at Earth
12 Sciences; Dr. Smith by university colleagues through TERA
13 Corporation; and Dr. Blume by the substantial staff of his
14 own consulting engineering firm.

15 In addition, during the Hosgri re-analysis, we
16 called upon ANCO Engineers, Earthquake Engineering Services,
17 EDS Nuclear, Harding-Lawson Associates, Wyle Laboratories,
18 Dr. Jack Benjamin, Dr. Bruce Bolt, Dr. Ailin Cornell, Dr. John
19 Lysmer, and Dr. H. Bolton Seed.

20 Their task was to determine the maximum earthquake
21 shaking motions that can be expected at the site;

22 2. Establish structural design criteria for
23 buildings and equipment such that they will accommodate these
24 motions with a margin of safety; and

25 3. Determine whether the probability of surface



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eb4 1 fault rupture through the site was sufficiently remote that
2 it could be disregarded in the design.

3 The 1966 investigations established that the site
4 is in an area of relatively low seismicity, a conclusion
5 which remains valid today.

6 Because of the absence of seismic activity that
7 would indicate a nearby significant offshore fault and the
8 conservative assumption of a large earthquake anywhere in the
9 region, including one directly under the site, offshore
10 exploration did not seem necessary.

11 The major faults identified at that time by
12 Dr. Smith as governing the seismicity of the region were the
13 San Andreas Fault 48 miles northeast, the Nacimiento Fault
14 20 miles northeast, and the Sant Ynez Fault 50 miles to the
15 south.

16 For each of the controlling faults, Dr. Smith
17 postulated the most severe earthquake which he believed could
18 occur. In addition to the postulation of very large earth-
19 quakes on these faults, allowance was also made for the
20 possible occurrence of a large earthquake not associated with
21 any fault, and this was the assumption of a 6.75 magnitude
22 fault directly under the site.

23 Evaluation of the information on the controlling
24 earthquakes, together with the distance of the site from the
25 faults, the characteristics of the rock at the site, and



eb5

1 other factors, enabled Dr. Blume to specify the corresponding
2 complex pattern of vibrations which comprise the ground motion
3 at the site.

4 Although the postulated San Andreas event would
5 be a significant earthquake, Dr. Blume found that its dis-
6 tance from the site was great enough to result in the
7 Nacimiento event and the aftershock under the site becoming
8 the events which controlled the design.

9 The detailed investigations at the site itself
10 were complete and without precedent in their extent and detail.
11 This work demonstrated that the site had not been affected by
12 significant fault movements. Representatives of both the
13 Atomic Energy Commission and the U. S. Geological Survey
14 inspected the site and the exploration trenches. And they
15 agreed the exploration confirmed the absence of any significant
16 faulting at or near the site.

17 The seismic design criteria which we proposed to use
18 were approved with only minor modifications, and were in-
19 corporated into the construction permits for the two nuclear
20 units.

21 In 1972, Mr. Hamilton learned of an article in
22 Memoir Number 15 of the American Association of Petroleum
23 Geologists published in 1971, which indicated the presence
24 of a fault which has since been named the Hosgud Fault, some
25 four to five miles from Diablo Canyon. The article was



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eb6

1 authored by Ernest G. Hoskins and John R. Griffiths, Shell
2 Oil Company geologists.

3 Mr. Hamilton called our attention to the paper
4 and its map. And then Mr. Hamilton later was able to contact
5 Mr. Hoskins and discuss the Shell surveys.

6 Later, Mr. Hamilton visited the Shell office in
7 Los Angeles and reviewed some of the data used in the paper.
8 These data suggested that the faulting described by Hoskins
9 and Griffiths was relatively old and since the seismic
10 record in the area also suggested at most a low level of
11 seismic activity, the allowances made in the design for an
12 assumed large earthquake beneath the site were judged to be
13 fully capable of accounting for any events associated with this
14 new feature.

15 When we submitted our FSAR in the summer of 1973
16 to the AEC, it included a description of the offshore fault
17 map by Hoskins and Griffiths, including the indications of
18 minor seismic activity possibly associated with it.

19 PG&E learned in mid-November of 1973 that USGS
20 offshore exploration work has supposedly disclosed indica-
21 tions of surface faulting at the sea floor. After consulta-
22 tion with USGS, we commissioned our own survey to supplement
23 their information and to clear up possible confusion over the
24 nature of the sea floor scarp identified in the press as
25 a "surface fault."



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1 Our findings and those of the USGS were reviewed
2 at a meeting with the AEC Staff in January 1974, specifically
3 in relation to three local faults mapped by the USGS.

4 In its report of that meeting, the Staff concluded
5 that one of those faults might be related to the larger
6 structure mapped by Hoskins and Griffiths. However they
7 felt any ground motions produced at the site by an earthquake
8 on any of these faults would be well within the limits for
9 which the plant was designed.

10 In December 1974, after we had responded to AEC
11 questions about the Hosgri fault, the AEC took the position
12 that the Hosgri Fault could affect the seismic design basis
13 of the plant. It therefore requested that the plant be
14 checked for a site ground motion somewhat greater than that
15 specified by us in the original design.

16 Then in January 1975, the USGS evaluation of the
17 Hosgri Fault was forwarded to the NRC. The evaluation took
18 the position that the new, higher ground motion level speci-
19 fied by the NRC was still inadequate. This conclusion was
20 apparently largely influenced by a university senior report
21 sponsored by the USGS.

22 This senior report, by student William Gawthrop,
23 raised the possibility that the origin of the 1927, 7.3
24 magnitude Lompoc earthquake could be reassigned to the
25 southern end of the Hosgri structure rather than to a fault
further offshore.



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The Gawthrop paper was open-filed in May 1975.

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After extensive review and analysis, the

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Company's consultants determined that Mr. Gawthrop's con-

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tention could not be supported by either the seismological or

5

geological data.

6

The NRC requested additional information about the

7

1927 earthquake and other matters in light of the USGS

8

evaluation of January 1975. This information was developed

9

using further offshore data which had subsequently been

10

open-filed by the USGS and proprietary data which was

11

purchased, together with additional seismological studies

12

by Dr. Smith.

13

In April of 1976, after we had submitted to the

14

NRC considerable additional information and had participated

15

in numerous discussions with the staff, a further USGS

16

evaluation was given to the NRC. IN this evaluation USGS

17

repeated its position as set forth in January of 1975 but

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this time recommended a specific basis for estimating

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earthquake parameters. The NRC accepted this April 1976

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assessment and asked us to provide an appropriate evaluation

21

of the plant.

22

The Company, reinforced by the exhaustive

23

studies and opinions of its consultants, believe that the

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earthquake parameters selected by the USGS and the resulting

25

ground motion values are unreasonably high and therefore



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1 result in conservatisms far in excess of that which should
2 be reasonably required.

3 On May 11, 1976 the NRC issued Supplement 4 to
4 the Safety Evaluation Report wherein they established the
5 additional seismic design basis to provide for the earthquake
6 potential of the Hosgri Fault. That report also established
7 the procedures to be used in evaluating the plant's capability
8 to withstand the postulated Hosgri earthquake.

9 Accordingly we developed the response spectra
10 and associated acceptance criteria based on the Safety
11 Evaluation Report of May 11th, 1976. And then we docketed
12 the material in July of 1976.

13 The NRC issued Supplement No. 5 to the SER on
14 September 10th, 1976. This supplement accepted the use of
15 either Dr. Newmark's spectra or those proposed by our con-
16 sultant, Dr. John A. Blume, as a basis for re-evaluation.
17 However the NRC staff required some changes in the details
18 of the Blume spectra and stipulated that they not fall below
19 the Newmark spectra at any frequency.

20 On February 4th, 1977 Company representatives
21 and consultants met with the NRC staff to finalize the
22 specifications for a seismic review of major structures for
23 a 7.5 magnitude Hosgri earthquake which became the basis for
24 our review. This seismic re-evaluation has been completed
25 in a conscientious and exhaustively detailed manner.



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1 MR. NORTON: I would say to the Board, of course,
2 this presentation was to come at the beginning, but, because
3 of scheduling problems we had, it is, of course, almost an
4 after-the-fact chronology. However I think it does serve to
5 put in perspective the sequence of events that have brought
6 us here. And it's unfortunate we couldn't have had it
7 before we started hearing all the testimony.

8 We really have no further direct and would turn
9 Mr. Bettinger over for cross at this time.

10 MRS. BOWERS: Mr. Kristovich.

11 MR. KRISTOVICH: I just have a few questions.

12 MRS. BOWERS: Go ahead, please.

13 MR. NORTON: Excuse me for interrupting.

14 We would ask that the testimony be placed in
15 the transcript as though read.

16 MRS. BOWERS: Any objection?

17 MR. KRISTOVICH: No objection.

18 MR. STAENBERG: No objection.

19 MRS. BOWERS: The testimony will be inserted in
20 the transcript as if read.

21 (Testimony of Richard V. Bettinger follows)

22 INSERT

23

24

25



1 TESTIMONY OF
2 RICHARD V. BETTINGER
3 ON BEHALF OF
4 PACIFIC GAS AND ELECTRIC COMPANY
5 DECEMBER 4, 1978
6 DOCKET NOS. 50-275, 50-323

7 My testimony deals with the investigation, studies
8 and analyses conducted by the Company and our consultants
9 concerning the geological and seismological aspects of
10 Diablo Canyon.

11 The initial phase of the investigation of the
12 geology and seismology of the Diablo Canyon area commenced
13 in late 1965. Our first step was to retain the best consulting
14 expertise available to us to advise as to the suitability of
15 the site, define the investigation required, and to provide
16 criteria to assure a safe design. The principal consultants
17 initially retained were:

18 Geology

19 E. C. Marliave - Consulting geologist.
(deceased) Formerly held the position
20 of Chief Engineering Geologist
21 Dr. Richard H. Jahns - Dean of the School of Earth
Sciences, Stanford University.

22 Seismology

23 Dr. Hugo Benioff - Consulting seismologist.
(deceased) Formerly Professor of
24 Seismology at California
25 Institute of Technology.
26 Dr. Stewart M. Smith - Chairman, Department of
Geophysics, University of
Washington.



1 Engineering

2 Dr. John A. Blume - Consulting structural engineer
3 and head of J. A. Blume &
4 Associates.
5 Edward Keith - At that time Associate of
6 J. A. Blume -
7 Now with EDS Nuclear

8 These consultants have been assisted by others:

9 Dr. Jahns by Mr. Douglas Hamilton and his staff at Earth
10 Sciences Associates; Dr. Smith by university colleagues
11 through TERA corporation; and Dr. Blume by the substantial
12 staff of his own consulting engineering firm. In addition,
13 during the Hosgri reanalysis, the following consultants were
14 called upon:

15 ANCO Engineers

16 Earthquake Engineering Services

17 EDS Nuclear

18 Harding : Lawson Associates

19 Wyle Laboratories

20 Dr. Jack D. Benjamin

21 Dr. Bruce Bolt

22 Dr. C. Allin Cornell

23 Dr. John Lysmer

24 Dr. H. Bolton Seed

25 Initially, our consultants were requested to
26 define the scope of the investigations required to enable
the Company to construct a nuclear power plant at Diablo
Canyon that would be safe in earthquakes. It was decided

12/25



1 that it would be necessary to:

- 2 1. Determine the maximum earthquake
3 shaking motions that can be expected
4 at the site.
- 5 2. Establish structural design criteria
6 for buildings and equipment such
7 that they will accommodate these
8 motions with a margin of safety,
9 and
- 10 3. Whether the probability of surface
11 fault rupture through the site was
12 sufficiently remote that it could
13 be disregarded in the design.

14 At the time the purposes and scope of the investi-
15 gations were established, no AEC criteria had been published
16 for such investigations. For Diablo Canyon, our consultants
17 determined the extent of work required, with Company engineers
18 assisting and coordinating. The work was of course subject
19 to subsequent review by the AEC and its consultants. In
20 1967, the AEC commenced preparation of geologic and seismic
21 criteria for nuclear power plants. We and our consultants
22 have followed development of these criteria in connection
23 with the Diablo Canyon work. The criteria were published on
24 November 13, 1973.

25 The 1966 investigations established that the site
26 is in an area of relatively low seismicity, a conclusion



1 which remains valid today. The regional geology, as
2 evidenced on shore, was used to identify which faults could
3 generate major earthquakes. Because the absence of seismic
4 activity that would indicate a nearby significant offshore
5 fault and the conservative assumption of a large earthquake
6 anywhere in the region (including one directly under the
7 site), offshore exploration did not seem necessary.

8 The major faults identified at that time by Dr.
9 Smith as governing the seismicity of the region were the San
10 Andreas Fault 48 miles northeast, the Nacimiento Fault 20
11 miles northeast, and the Santa Ynez Fault 50 miles to the
12 south. This permitted definition of the most severe earth-
13 quakes that could occur in the region.

14 For each of the controlling faults, Dr. Smith
15 postulated the most severe earthquake which he believed
16 could occur and that the event would start at the points on
17 the faults nearest to the site. The events were described
18 in terms of the length of fault rupturing during the earth-
19 quake, the amount of fault displacement, the duration of
20 shaking, and magnitude. In addition to the postulation of
21 very large earthquakes on these three faults, allowance was
22 made for the possible occurrence of a large earthquake shock
23 not associated with any fault (6.75M) directly under the
24 site. This element of conservatism was necessary because
25 the state-of-the-art in seismology did not permit a conclusion
26 that the absence of surface faulting would preclude the



1 occurrence of a large earthquake, or aftershock anywhere in
2 the local site area. Dr. Smith will discuss this in greater
3 detail in his testimony.

4 Evaluation of the information on the controlling
5 earthquakes, together with the distance of the site from the
6 faults, the characteristics of the rock at the site, and
7 other factors, enabled Dr. Blume to specify the corresponding
8 complex pattern of vibrations which comprise the ground
9 motion at the site. The specification is in terms of maximum
10 displacement, velocity, acceleration, frequency, and duration.

11 The various events and corresponding maximum
12 ground accelerations at the site as recommended by our
13 consultants are summarized below:

<u>Fault</u>	<u>Closest Point to Site (miles)</u>	<u>Length of Fault Rupture (miles)</u>	<u>Maximum Displacement on Fault (feet)</u>	<u>Richter Mag.</u>	<u>Max. Ground Acceleration at (g)</u>
San Andreas	48	200	20 Horiz. 3 Vert.	8.5	.10
Nacimiento	20	60	6 Horiz.	7.25	.15
Santa Ynez	50	80	10 Horiz.	7.5	.05
Under site (not a fault breaking the surface, and perhaps not caused by an event on a fault.)	--	--	--	6.75	.20

24
25 Dr. Blume's recommended design criteria took into
26 account the fact that earthquakes starting from remote



1 sources can cause ground shaking with different characteristics
2 than those starting from nearby sources. The ground motion
3 specified is an "envelope" of the most severe characteristics
4 from the various earthquakes studies.

5 Thus, a great earthquake similar to the San Francisco
6 1906 event on the San Andreas Fault, which had a magnitude
7 estimated to be on the order of 8.25 together with the major
8 aftershock under the site, was considered in determining the
9 most severe shaking at the site. Although the postulated
10 San Andreas event would be a significant earthquake, its
11 distance from the site was great enough to result in the
12 Nacimiento event and the aftershock under the site becoming
13 the events which controlled the design.

14 Dr. Blume specified that normal working stresses
15 (without the customary increase in allowable stress ordinarily
16 permitted for earthquake design) should be used to design
17 the structures and equipment at Diablo Canyon. To assure
18 adequate energy absorbing capability, he further specified
19 that the design be checked using ground motions twice as
20 severe as those calculated from the postulated maximum
21 earthquakes. (The resulting maximum ground acceleration,
22 0.4g, termed the double design earthquake, corresponds to
23 the concept of "Safe Shutdown Earthquake" subsequently used
24 by the AEC in its criteria released on November 13, 1973.)

25 The detailed investigations at the site itself
26 were complete and without precedent in their extent and



1 detail. They involved detailed geologic mapping of existing
2 features and aerial photography. Almost 2 miles of inter-
3 connecting exploration trenches, up to 40 feet deep, were
4 excavated through the area proposed for the reactor and
5 related plant structures. The trenches permitted detailed
6 examination of the bedrock structure, ancient wave-cut
7 coastal terraces and overlying sedimentary deposits. This
8 work demonstrated that the site had not been affected by
9 significant fault movements. The geologic relationships
10 present there showed that the probability of the site being
11 affected by surface fault displacement was so infinitely
12 remote that it could be disregarded in the design of the
13 plant. Representatives of both the Atomic Energy Commission
14 and of the U.S. Geological Survey inspected the site and the
15 exploration trenches. They agreed that the exploration work
16 confirmed the absence of any significant faulting at or near
17 the site.

18 The U.S. Geological Survey transmitted a supple-
19 mental geologic report on Diablo Canyon Unit #2 to the
20 Atomic Energy Commission on June 5, 1970. Part of the
21 conclusions in that report were:

22 "It is concluded that some new data are available
23 now that were not available at the time the initial reviews
24 were made of the geology and seismology of the Diablo Canyon
25 site. These data include some recent, but largely unpub-
26 lished, geologic mapping of the Edna fault zone, and some



1 data on recent seismicity on the continental shelf offshore
2 from the reactor site. However, none of these new data
3 appear to affect the earthquake potential of the site area,
4 and hence do not constitute any threat to the safe construc-
5 tion of a nuclear facility at the Diablo Canyon plant site."

6 The geologic and seismologic studies were reviewed
7 by AEC, by USGS, and by the Coast and Geodetic Survey. In
8 1970, government scientists made use of their offshore geo-
9 physical surveys in evaluating the Company's submittals.

10 The seismic design criteria which we proposed to
11 use were approved with only minor modifications, and were
12 incorporated into the construction permits for the two
13 nuclear units.

14 In 1972, Mr. Hamilton learned of an article in
15 Memoir #15 of the American Association of Petroleum Geol-
16 ogists, published in 1971, which indicated the presence of a
17 fault (since named the Hosgri Fault) some 4-5 miles offshore
18 from Diablo Canyon. The article was authored by Ernest G.
19 Hoskins and John R. Griffiths, Shell Oil Company geologists.
20 They reported on offshore surveys done in connection with
21 oil exploration performed by Shell during the mid-1960's
22 along the central and northern California coast. The work
23 was a survey of conditions at considerable depth beneath the
24 ocean floor to study large offshore basins. Mr. Hamilton
25 called our attention to the paper and its map.

26



1 Given the information developed in our earlier
2 geologic and seismologic investigations, these features did
3 not appear significant in terms of the design criteria for
4 the plant. Nevertheless, investigation continued.

5 Mr. Hamilton was able to contact Mr. Hoskins and
6 discuss the Shell surveys. Mr. Hamilton then visited the
7 Shell office in Los Angeles and reviewed some of the data
8 used in the paper. These data suggested that the faulting
9 described by Hoskins and Griffiths was relatively old.

10 Since the seismic record of the area also suggested, at
11 most, a low level of seismic activity, the allowances made
12 in the design for an assumed large earthquake beneath the
13 site were judged to be fully capable of accounting for any
14 events associated with this new feature.

15 However, the Hoskins and Griffiths work was addi-
16 tional relevant geologic information and when PGandE's FSAR
17 was submitted to the AEC during the summer of 1973, it
18 included a description of the offshore fault mapped by
19 Hoskins and Griffiths, including the indications of minor
20 seismic activity possibly associated with it.

21 During the AEC's review of the FSAR, they requested
22 further information about the faults that had been mapped by
23 Hoskins and Griffiths.

24 PGandE then learned that the USGS, in connection
25 with an ongoing program of coastal research funded by the
26 AEC, was planning on conducting survey work specifically



1 directed to the central California coastal region, including
2 the Diablo Canyon vicinity. This work was in fact performed
3 by the survey ship Kelez in October-November 1973. PGandE
4 learned in mid-November that the USGS work supposedly dis-
5 closed indications of surface faulting at the sea floor.
6 After consultation with the USGS, we commissioned our own
7 survey to supplement their information and to clear up
8 possible confusion over the nature of the sea floor scarp
9 identified in the press as a "surface fault". Our findings
10 and those of USGS were reviewed at a meeting with the AEC
11 staff in January 1974, specifically in relation to three
12 local faults mapped by the USGS. In its report of that
13 meeting, the staff concluded that one of those faults might
14 be related to the larger structure mapped by Hoskins and
15 Griffiths; however, they felt that any ground motions
16 produced at the site by an earthquake on any of these faults
17 would be well within the limits for which the plant was
18 designed.

19 In December 1974, after we had responded to AEC
20 questions about the Hosgri Fault, the AEC took the position
21 that the Hosgri Fault could affect the seismic design basis
22 of the plant. It requested that the plant be checked for a
23 site ground motion somewhat greater than that specified by
24 us in the original design.

25 In January 1975, the USGS evaluation of the Hosgri
26 Fault was forwarded to the NRC. The evaluation took the



1 position that the new, higher ground motion level specified
2 by the NRC was still inadequate. This conclusion was
3 apparently largely influenced by a university senior report
4 sponsored by the USGS. This senior report, by student
5 William Gawthrop, raised the possibility that the origin of
6 the 1927, 7.3M Lompoc earthquake could be reassigned to the
7 southern end of the Hosgri structure rather than to fault
8 further offshore. The Gawthrop paper was open-filed in
9 May 1975.

10 After extensive review and analysis, the Company's
11 consultants determined that Mr. Gawthrop's contention could
12 not be supported by either the seismological or geological
13 data. They instead assigned the Lompoc earthquake to a
14 fault referred to as the "offshore Lompoc fault" located
15 southwest of the Hosgri Fault.

16 The NRC requested additional information about the
17 1927 earthquake and other matters in light of the USGS
18 evaluation of January 1975. This information was developed
19 using further offshore data which had subsequently been
20 open-filed by the USGS and proprietary data which was
21 purchased, together with additional seismological studies by
22 Dr. Smith.

23 In December of 1975, Dr. Clarence Hall published a
24 paper which suggested extensive movement along the Hosgri
25 Fault. Our consultants reviewed this paper and did additional
26 field work to check some of the evidence cited. They were



1 then able to conclude that his postulation of large movement
2 was precluded by other evidence.

3 In April 1976, after we had submitted to the NRC
4 considerable additional information and had participated in
5 numerous discussions with its staff, a further USGS evalua-
6 tion was given to the NRC. In this evaluation, the USGS
7 repeated its position as set forth in January 1975, but this
8 time recommended a specific basis for estimating earthquake
9 parameters. The ground motion at the site from this postu-
10 lated earthquake was substantially more severe than the
11 already higher values studied in December 1974, at the AEC's
12 request. The NRC accepted this April 1976 assessment and
13 asked us to provide an appropriate evaluation of the plant.

14 The Company, reinforced by the exhaustive studies
15 and opinions of its consultants, believe that the earthquake
16 parameters selected by the USGS and the resulting ground
17 motion values are unreasonably high and therefore result in
18 conservatisms far in excess of that which should reasonably
19 required.

20 On May 11, 1976, the NRC issued Supplement 4 to
21 the Safety Evaluation Report wherein they established the
22 additional seismic design bases to provide for the earth-
23 quake potential of the Hosgri Fault. That report contained
24 the following statement:

25 "The ground motion values recommended by
26 the U.S. Geological Survey are based on



1 instrumental data insofar as possible
2 and do not reflect the presence of
3 structures. These values must be
4 translated into quantitative measures of
5 effective acceleration for design
6 purposes. To develop an effective
7 acceleration for Diablo Canyon, we have
8 obtained the advice of our consultant in
9 this area, Dr. N. M. Newmark of N. M.
10 Newmark Consulting Engineering Services.
11 He has recommended, and we have accepted,
12 that an effective horizontal ground
13 acceleration of 0.75g be used for the
14 development of design response spectra.
15 We will provide additional discussion of
16 this matter, and a report from our
17 consultant, Dr. Newmark, in a future
18 supplement to the Safety Evaluation
19 Report."

20 That report also established the procedures to be
21 used in evaluating the plant's capability to withstand the
22 postulated Hosgri earthquake. Those procedures are as
23 follows:

- 24 1. A magnitude 7.5 earthquake on the
25 Hosgri Fault should be assumed with
26 horizontal ground response spectra



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normalized to an effective value of 0.75g for engineering reevaluation of the plant.

2. A revision of the design response spectra will be accepted depending on the equivalent length of the foundations of individual buildings. This revision recognizes that ground motion waves are not synchronized underneath structures during earthquakes. In other words, different points in the foundation base slab will not experience the maxima in the ground motion at the same time.

3. Where such revision in response spectra is used, appropriate allowance for tilting and torsion, which may result from the non-synchronized earthquake motion considered in item 2 above, will be required.

4. In reevaluating the capability of the plant structures, systems and components, inelastic behavior may be relied upon to absorb the ground



1 motion energy. Where such behavior
2 is relied upon, a ductility ratio
3 not exceeding 1.2 is acceptable in
4 determining seismic loads and
5 motions. For each particular
6 structure where inelastic behavior
7 is utilized, justification and
8 bases will be required for assuring
9 that the additional strains and
10 deformations will not affect the
11 safety functions of the plant
12 systems and structures. The use of
13 a ductility ratio is permissible
14 only for near-field earthquakes,
15 such as the earthquake postulated
16 for the Hosgri Fault.

17 Accordingly, we developed the response spectra and
18 associated acceptance criteria based on the Safety Evaluation
19 Report of May 11, 1976. This material was docketed in
20 July 1976. Based on review of this submittal and of addi-
21 tional information which we provided in August and September
22 of 1976, and also based on the recommendations of Dr. Newmark,
23 the NRC issued Supplement No. 5 to the S.E.R. on September 10,
24 1976. This supplement accepted the use of either Dr. Newmark's
25 spectra or those proposed by our consultant, Dr. John A.
26 Blume, as the basis for reevaluation. However, the NRC



1 staff required some changes in the details of the Blume
2 spectra and stipulated that they not fall below the Newmark
3 spectra at any frequency.

4 Inelastic response was generally allowed in applying
5 the Blume spectra to the buildings, whereas only limited
6 instances of inelastic response was acceptable with the
7 Newmark spectra.

8 On February 4, 1977, Company representatives and
9 consultants met with the NRC staff to finalize the Specifi-
10 cations for Seismic Review of Major Structures for 7.5M
11 Hosgri Earthquake which became the basis for our review.
12 The plant and its seismic evaluation have been so reviewed
13 in a conscientious and exhaustively detailed manner.

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MRS. BOWERS: Go ahead, Mr. Kristovich.

CROSS-EXAMINATION

BY MR. KRISTOVICH:

Q Mr. Bettinger, do you know when in 1971 the Hoskins and Griffiths article appeared? --was published?

A What did you ask? I'm sorry; I didn't hear the first part of the question.

Q When in 1971 was the Hoskins and Griffiths article published?

A I don't know the date, no.

Q Do you know when in 1972 Mr. Hamilton became aware of the article?

A No. It's a little bit back there. We could dig it out of the record, I'm sure. We know exactly the time he told us but I don't have it at the tip of my tongue.

Q Was it early in 1972: January, February: or late, December, say, or November?

MR. NORTON: Objection. Asked and answered.

THE WITNESS: I said I don't know.

MR. NORTON: Object. Asked and answered. He said he doesn't know.

We'd be happy to provide the information to Mr. Kristovich, however, if he needs it.

MRS. BOWERS: Objection sustained.



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BY MR. KRISTOVICH:

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Q Do you know who Mr. Hamilton informed of the article?

3

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A Well I believe he informed me.

5

Q And what steps did you take after learning of the article?

6

7

A Well, as I stated, Mr. Hamilton made efforts to look at the information. It would be better to ask Mr. Hamilton the steps that he took in talking with those people, however.

8

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11

Q I'm asking what steps did you take when you learned of the article.

12

13

A We asked what implication this might have, and we discussed it with our consultants, and it was felt it was well within the capability of the plant design; that is, the new information about a possible Hosgri earthquake did not change our opinion that our design was adequate.

14

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Q And which consultants are those?

19

A Well it would have been Dr. Jahns and Mr. Hamilton and Dr. Smith and Dr. Blume.

20

21

Q Mr. Bettinger, when did you begin development of the current response spectra for the re-analysis of the plant?

22

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A The one that is currently in use was one that was accepted in early '77. And Dr. Blume had been working on

25



wb3

1 that sometime in '76. But I don't know exactly the chronology
2 of when that was done. And there again, we can get out our
3 the chronology. There's a chronology in the SER that
4 periodically goes along. And I think you can find dates in
5 there when we discussed with the Staff various spectra.

6 Q Do you know when modifications began based on
7 the current response spectra?

8 A Modifications of the plant?

9 Q Yes.

10 A Let's see:-- Well, I don't know exactly what
11 date we started reconstruction, or doing modifications.
12 We have discussed a number of different modifications and
13 the need for them with the Staff, and I would have to get
14 the chronology to know anything very finite.

15 The first thing that had to be done was a re-
16 analysis based on the criteria that was established early
17 in 1977. And I don't know at this point that I know exactly
18 when we started in the field actual construction on the
19 various pieces, or works of modification.

20 Q Do you have such a chronology?

21 A Well I would suppose that we could go back and
22 find when we issued certain drawings, yes. That's about the
23 best I could do.

24 Q Well is there a comprehensive list in the FSAR
25 which would have a list of the modifications and when they



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wb4

1 were done?

2 A I don't know of the existence of such a list.

3 MR. KRISTOVICH: No further questions.

4 MRS. BOWERS: Mr. Staenberg?

5 MR. STAENBERG: The Staff has no questions.

6 MRS. BOWERS: Do you want any Board questions now?

7 MR. NORTON: If you have any Board questions,
8 fine. I have no redirect based on what's happened so far.

9 EXAMINATION BY THE BOARD

10 BY MRS. BOWERS:

11 Q The only question I have is: In developing the
12 chronological history you've gone down through Supplement 5
13 to the SER issued September 10th, 1976. Now we know 6, 7 and
14 8 have also been issued.

15 A That's right. I would expect that when
16 Mr. Hoke gives his testimony, he being the Plant Engineer,
17 would deal with the issuance of those SERs.

18 MRS. BOWERS: We have no further questions.

19 MR. NORTON: No redirect.

20 MRS. BOWERS: May the witness be excused?

21 MR. NORTON: I think he would enjoy that very
22 much, so he could get back to work.

23 MRS. BOWERS: Well, the witness is excused.
24 Thank you. You've been very patient.

25 (Witness excused)



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1 MRS. BOWERS: Well, since we have no further
2 evidence to listen to today we'll recess and reconvene
3 tomorrow morning at 8:30.

4 (Whereupon, at 12:20 p.m., the hearing in the
5 above-entitled matter was recessed, to reconvene
6 at 8:30 a.m., the following day.)
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