

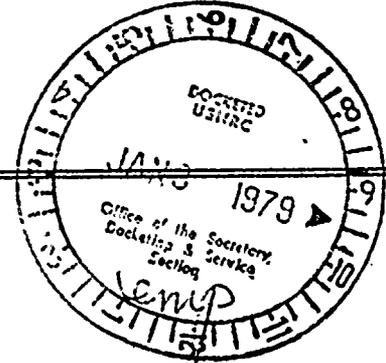
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NUCLEAR REGULATORY COMMISSION



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 - 3 January 1979

Pages  
6950 - 7174

Telephone:  
(202) 347-3700

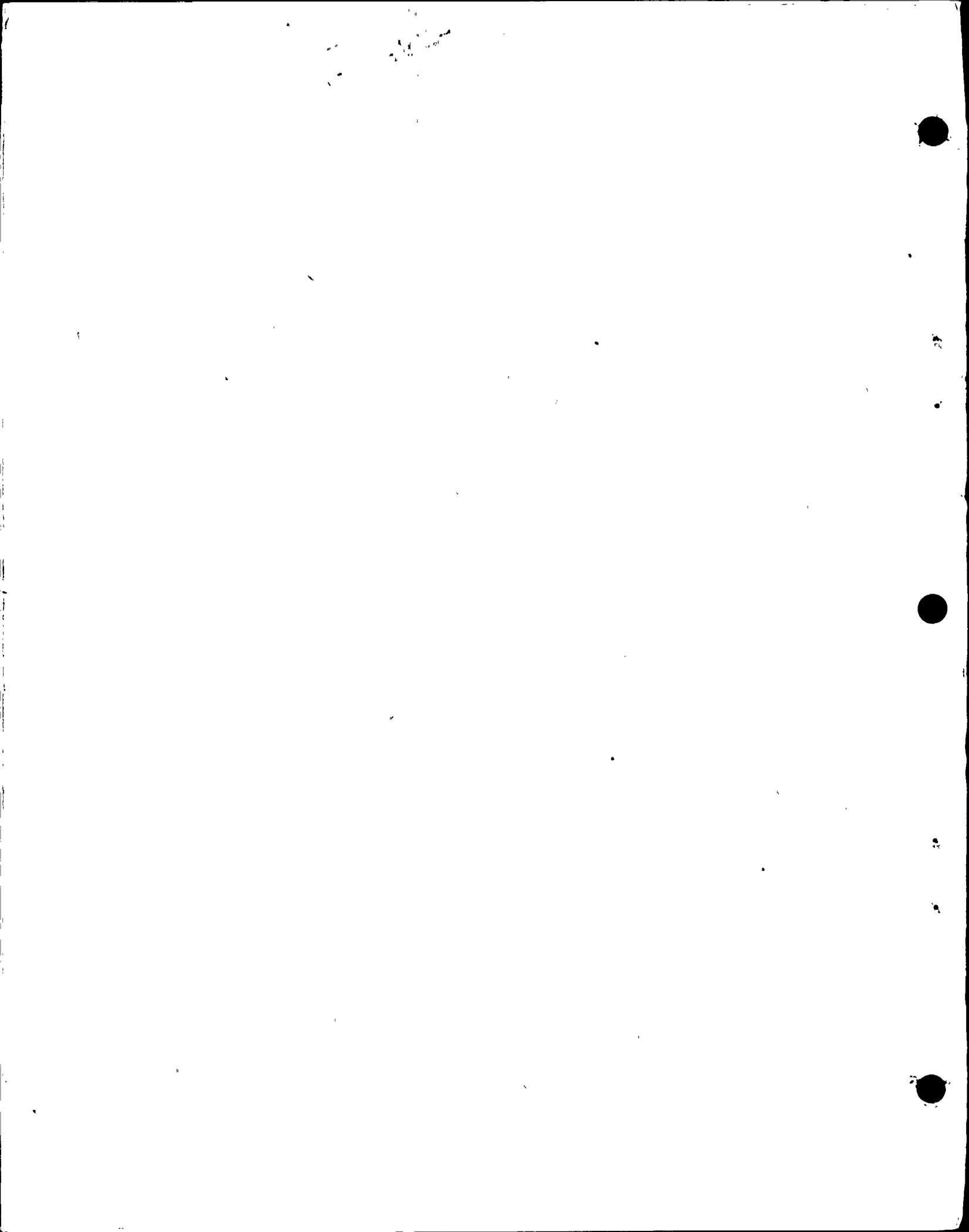
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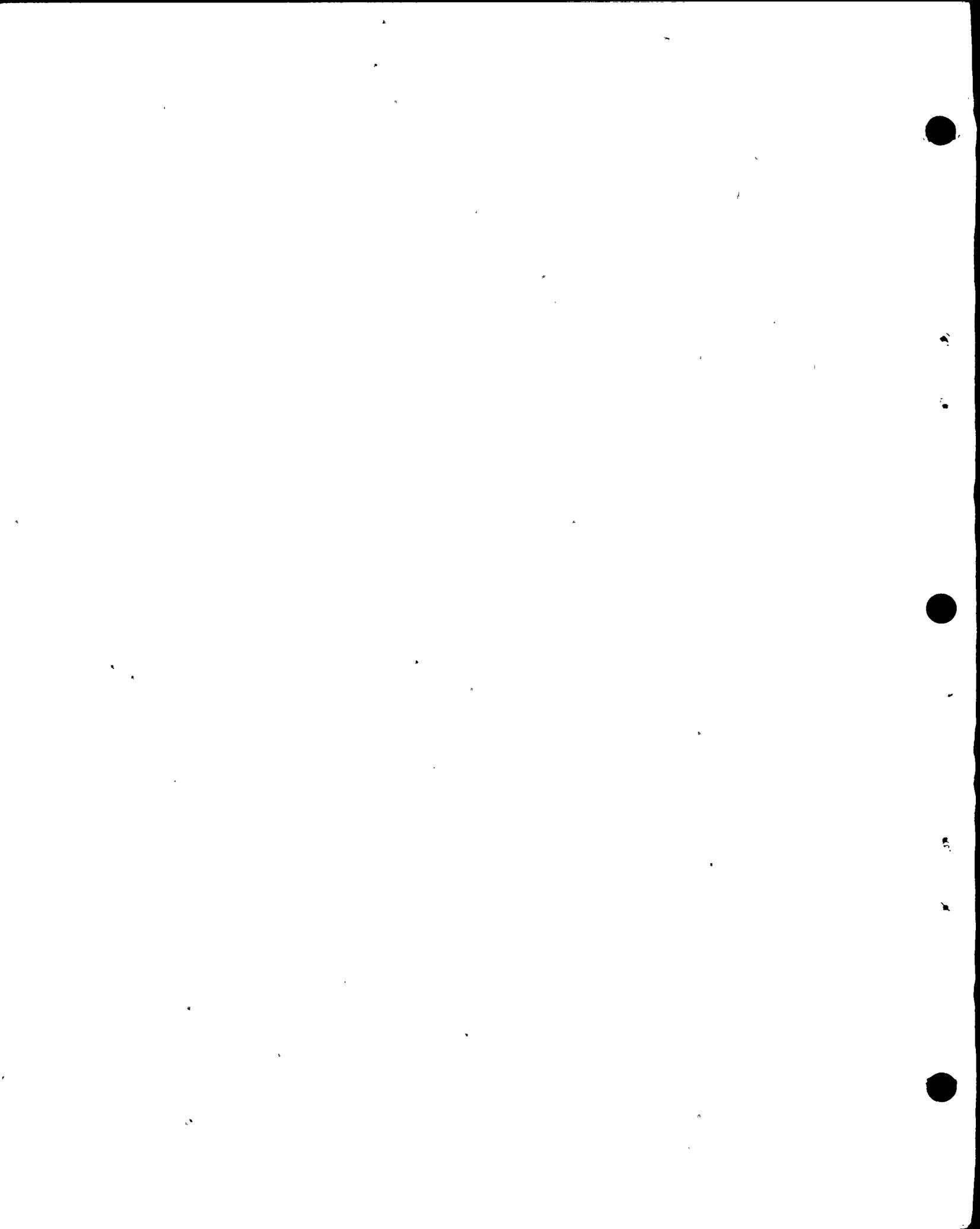
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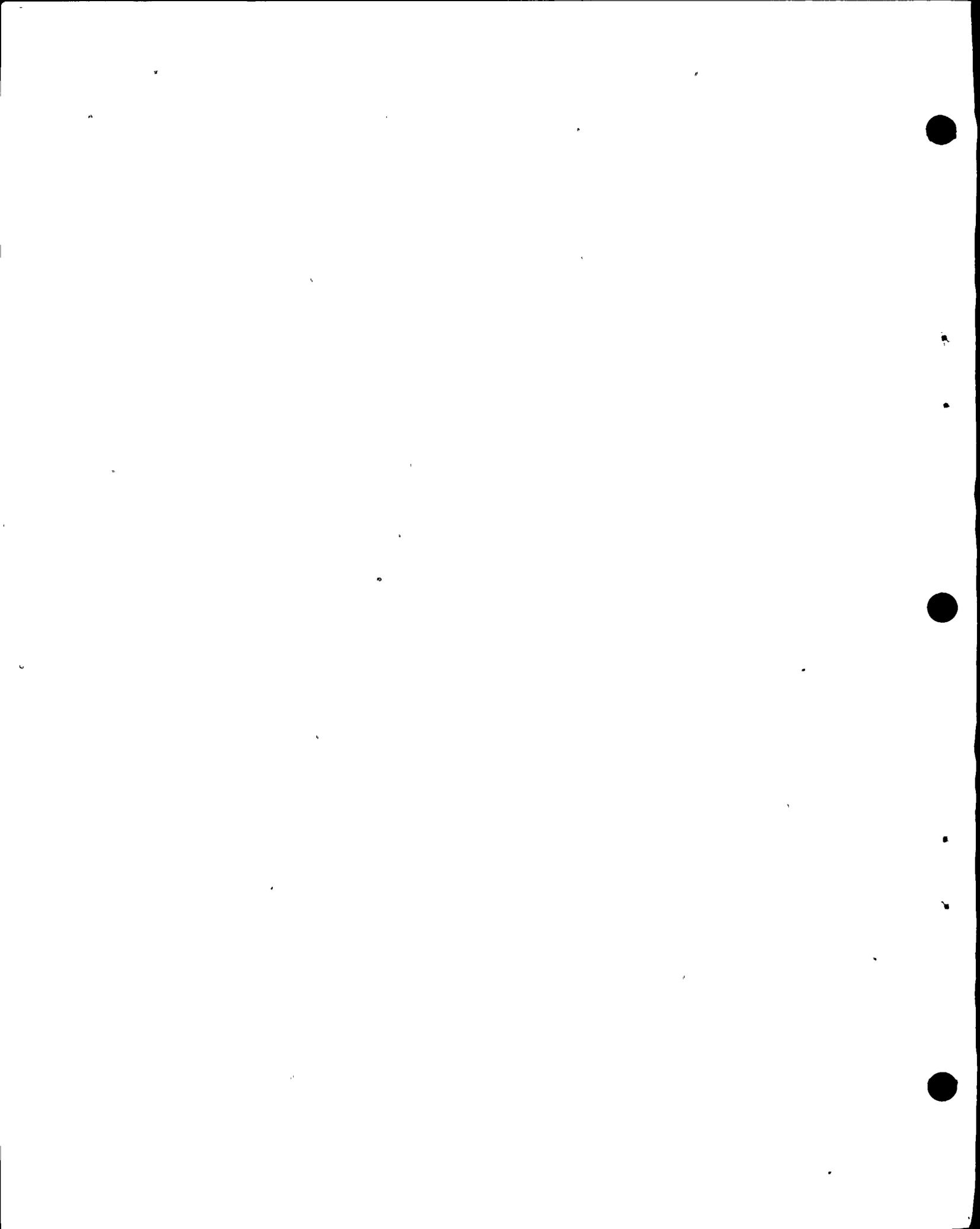
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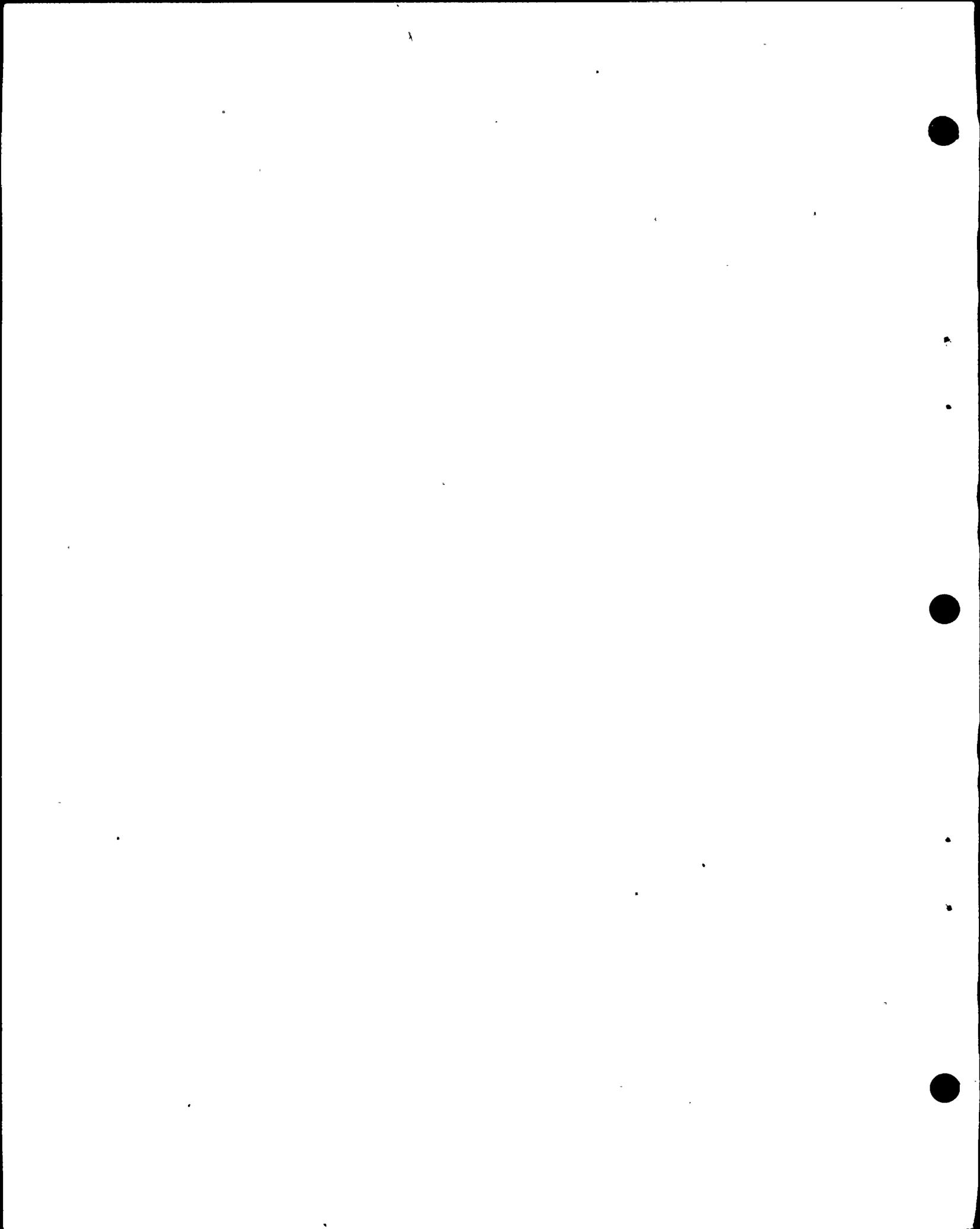
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P R O C E E D I N G S

1  
2 MRS. EOWERS: Good morning.

3 One of the things that was bothering me, and I  
4 still -- I think I sort of understand the difference,  
5 but I guess I don't know why. You know, we have a Richter  
6 scale that measures magnitude, and of course you have the  
7 Modified Mercalli that deals with intensity, and then you  
8 have the gravity factor, and as I understand it that deals  
9 with ground motion.

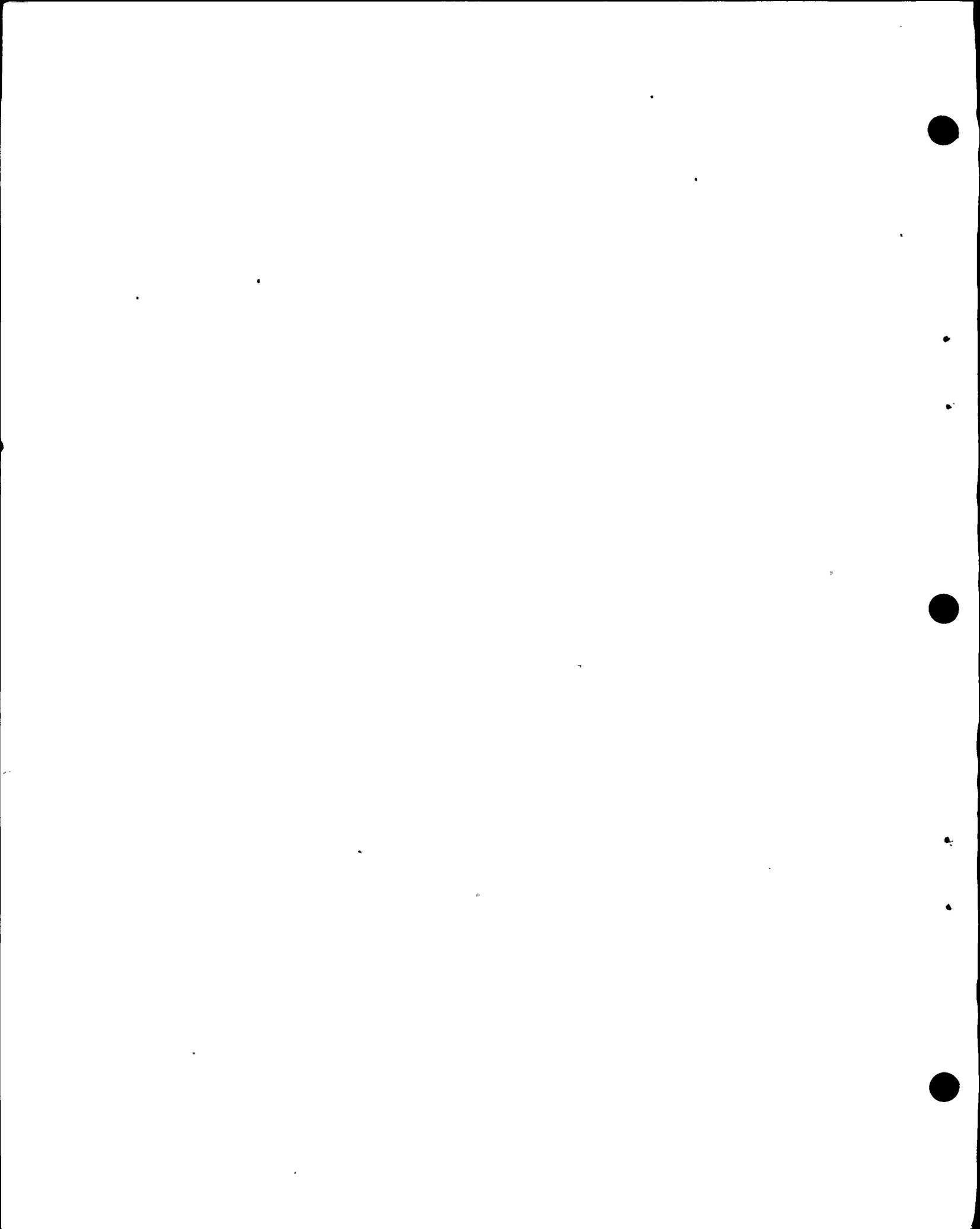
10 But I don't understand why we have Richter  
11 and why we have gravity. You know, I know they measure  
12 two different things, and then in this proceeding it just  
13 happens that the Richter number is the same as the gravity  
14 number. Well, say 7.5, well, the difference is with the  
15 decimal.

16 In the San Fernando earthquake, you had a Richter  
17 of 6.5, and yet the vertical was 0.1g and the horizontal  
18 0.2g.

19 That's not right? I have it black on white.

20 Well anyway, some of these things which are  
21 really very basic I don't feel our record will explain to  
22 the layperson or the judge reviewing it.

23 MR. NORTON: Mrs. Bowers, that is clearly perhaps  
24 an impossibility to develop a record for a layperson to  
25 understand the detailed technical information of this case



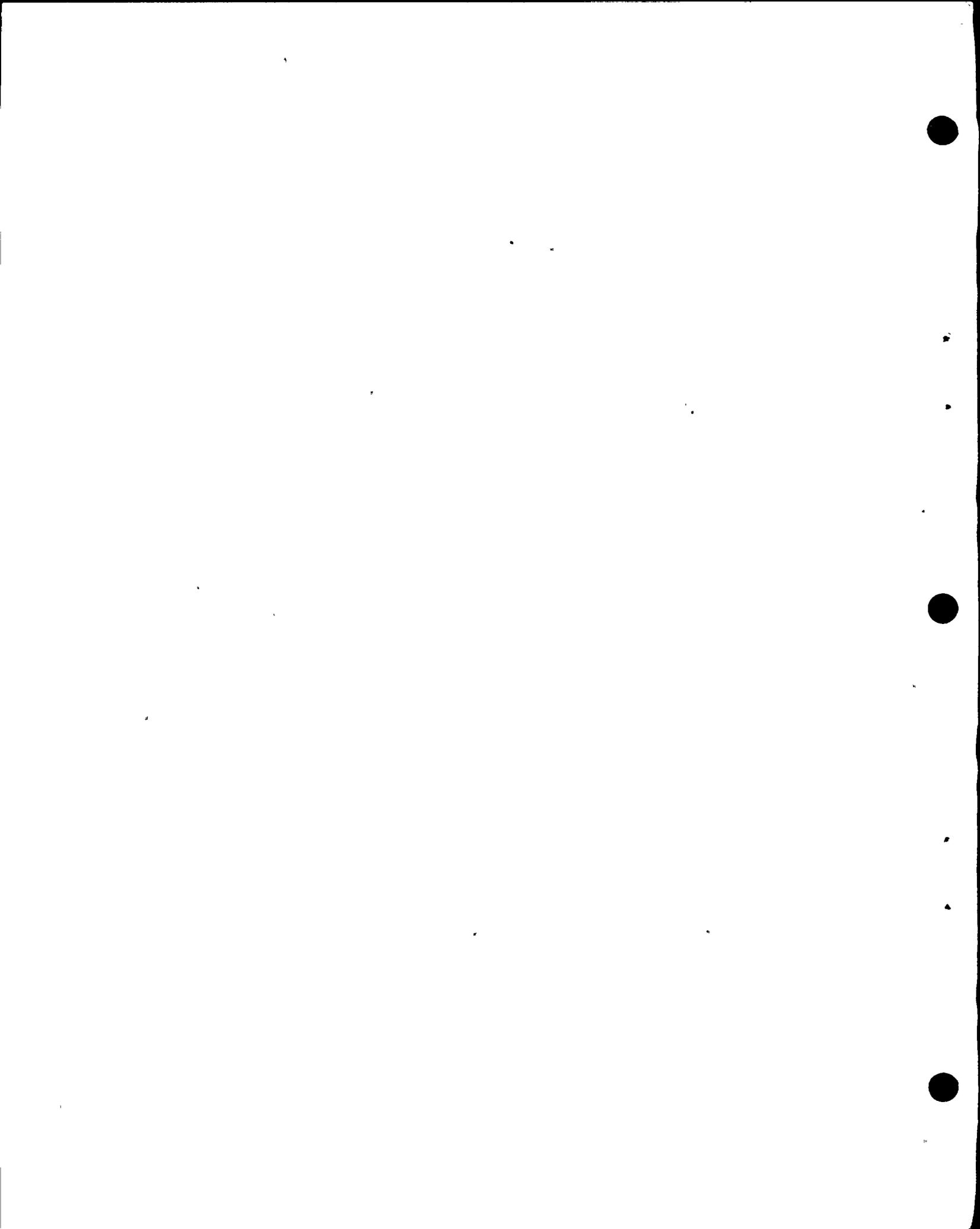
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1 dealing with geology, seismology. I just don't think we  
2 can develop a record, I don't think anybody can develop a  
3 record. I mean, you have to go to college to be a geology  
4 or seismology major, a geophysics science major, for four  
5 years or six years to understand, you know, completely.

6 And I don't think you can in a record in a  
7 proceeding such as this ever develop a record -- I mean,  
8 you'd have to take geology 101, 102 and seismology 101 and  
9 seismology 102. There's no way anybody can develop a  
10 record. And that's why you have expert witnesses.

11 For example, if it were a medical case, there's  
12 no way you could develop a record so that you or I could ever  
13 understand how to do a laminectomy, what's a safe process  
14 and what isn't, and that's why you have expert witnesses.

15 I don't think -- and this is not a reflection  
16 on any layperson at all, because I don't think anybody  
17 could develop a record that a layperson could understand  
18 everything.

19 And I don't think that's what's required. I  
20 think what is required is a record that the Board considered  
21 all the evidence and was able to rely on the opinions of  
22 expert witnesses that something was so, whether they fully  
23 understand how they got there -- for example if you remember  
24 some of the formulas that Dr. Martin and Dr. Bright were  
25 discussing with Dr. Frazier, well I'm afraid I could study



wrb/agb3  
1 those formulas for 10 years and probably never understand  
2 them. It just doesn't happen to be something I have an  
3 aptitude for at all. And I don't think that means that if  
4 I were a judge I would have to say well, gee, I can't accept  
5 it because I don't understand it.

6 So I'm not terribly concerned by that. I'm  
7 only concerned that it concerns you.

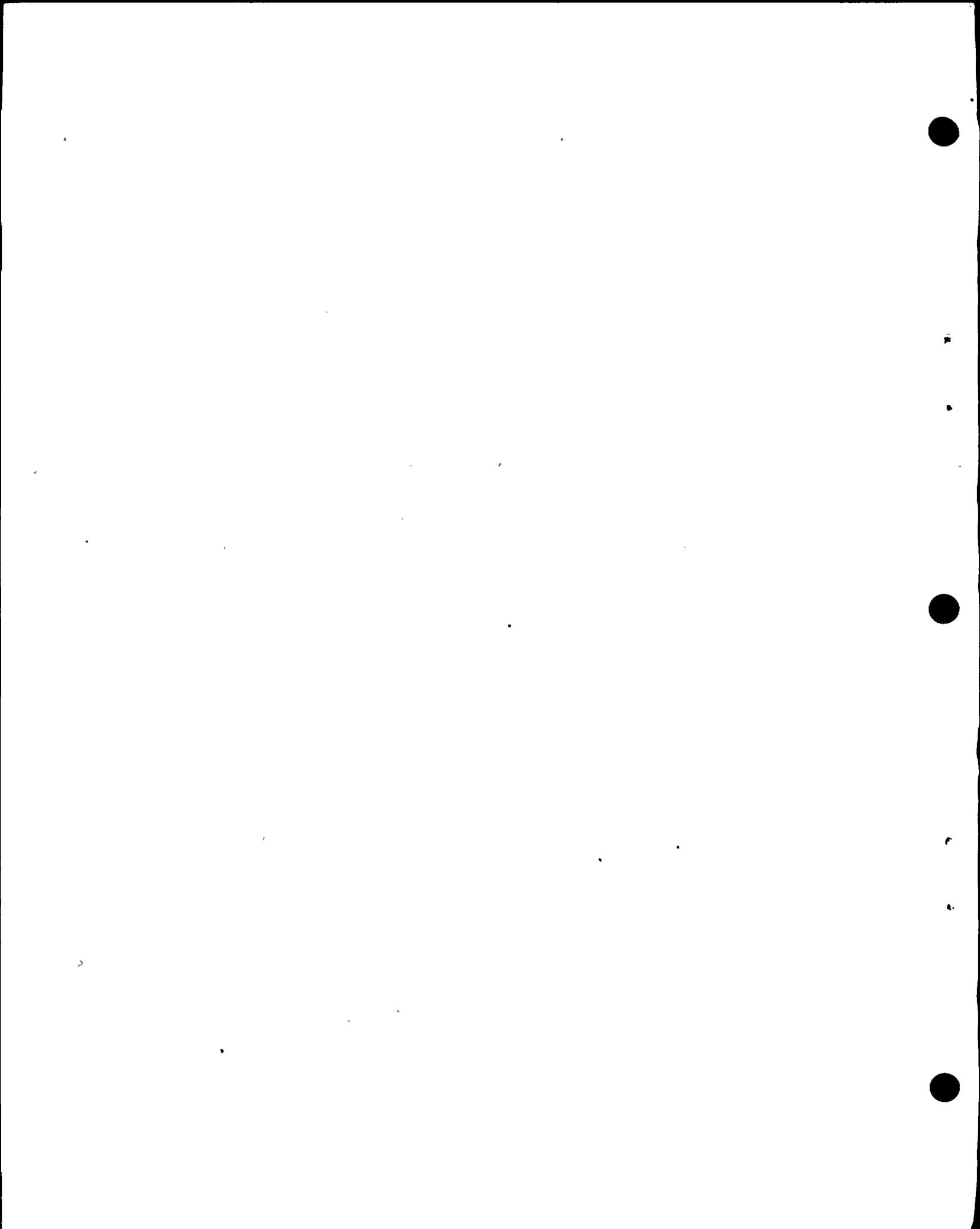
8 MRS. BOWERS: Well I agree with you on some  
9 of the equations and the formulas, as long as we understand  
10 what was applied in a general way.

11 But I was talking a minute ago about the most  
12 elementary things. Now I've got a couple of definitions of  
13 damping that make more sense to me than what I absorbed here  
14 from the glossaries.

15 MR. NORTON: Well Dr. Blume can certainly talk  
16 about damping, that's clearly his -- and he can talk about  
17 intensities also. He's an earthquake engineer and obviously  
18 they understand the difference between "g" and Richter and so  
19 on, and Dr. Blume can answer the questions you've raised  
20 so far without any problem.

21 MRS. BOWERS: Well as I said, with Richter and  
22 gravity, I think I have an idea what each measures, I just  
23 don't know why we have the two.

24 MR. NORTON: Well you know I think one of the  
25 problems, Mrs. Bowers, is that you start out in something



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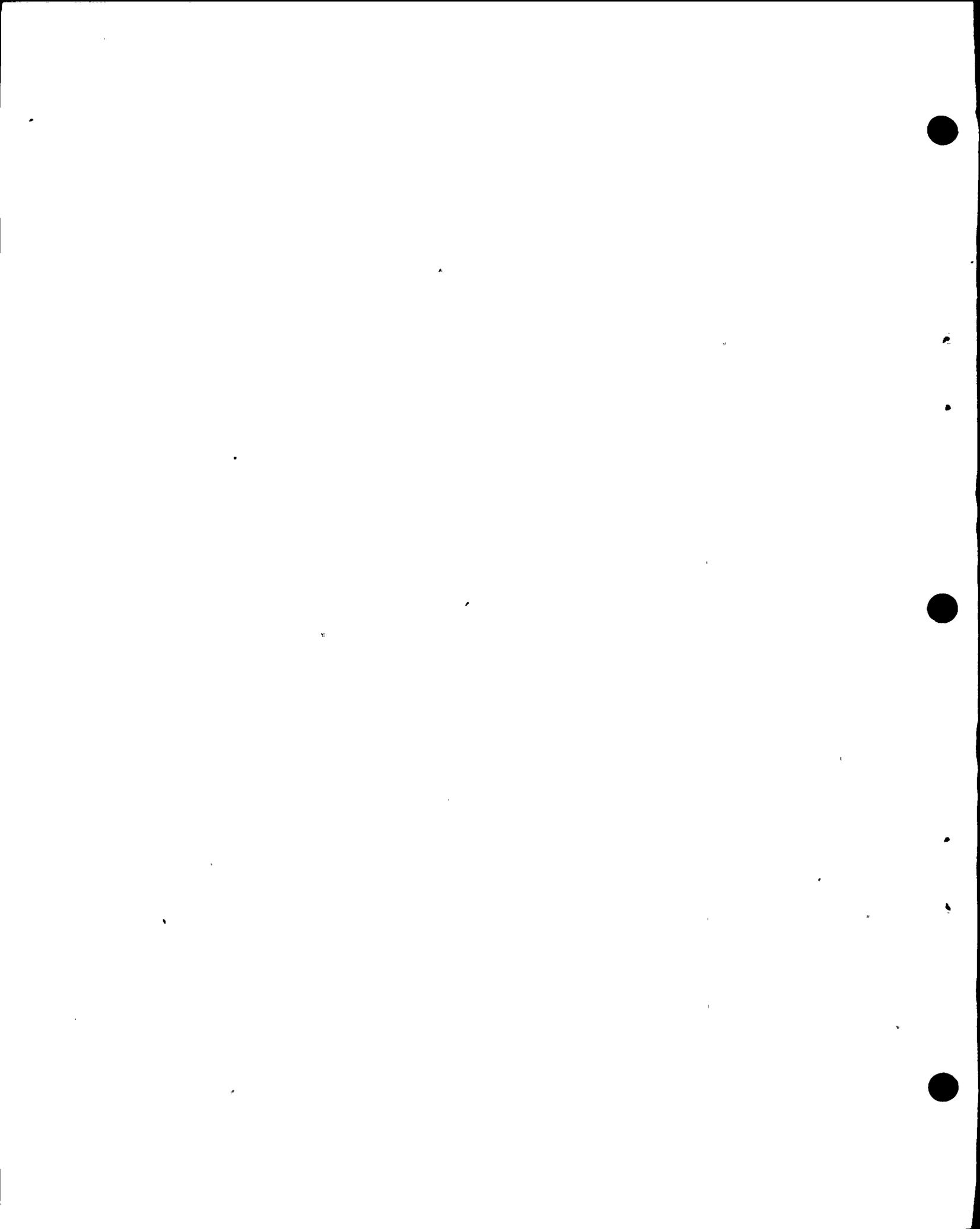
1 like this and you go along and a lot of what you hear at  
2 first you don't understand, but then later you hear something  
3 and you've done some reading on it and you say well, gee, I  
4 don't understand this, maybe it was said in the record at the  
5 beginning but someone didn't understand it at that point in  
6 time because it didn't fit in. But if you go back and --

7 MRS. BOWERS: Well I guess that's my concern,  
8 that some of those early days, that there was evidence that  
9 went into the record that may not be understood by a reviewer  
10 that should have been clarified.

11 Then moving to another point, this is something,  
12 you know, you get 10 days off and you think about things.  
13 I'm not sure -- and I raised this point one day before the  
14 holidays.

15 We are hearing, of course, considerable testimony  
16 from the Applicant's witnesses concerning the reasonableness  
17 of the design based on 6.5, and I think we need to hear from  
18 all the parties. At that time, I tried to raise the point  
19 that why is that relevant? As I understand it, the question  
20 before us is whether the plant can safely withstand a 7.5.

21 MR. NORTON: And I think the witnesses have  
22 testified -- if you review the record, they've testified that  
23 it clearly can withstand a 7.5. And the testimony you're  
24 referring to is that in the opinion of the seismologists,  
25 it'll never see a 7.5 but will only see a 6.5 at a maximum.



wrb/agb5

1 In other words, it's just an added conservatism.  
2 But the testimony you started to hear last Friday, the last  
3 recess day, and the testimony that's coming now is all  
4 assuming a 7.5. But the testimony you've heard up to this  
5 point in time is that it's the position of the Applicant's  
6 witnesses that the plant will never see a 7.5, the most  
7 it will ever see is a 6.5.

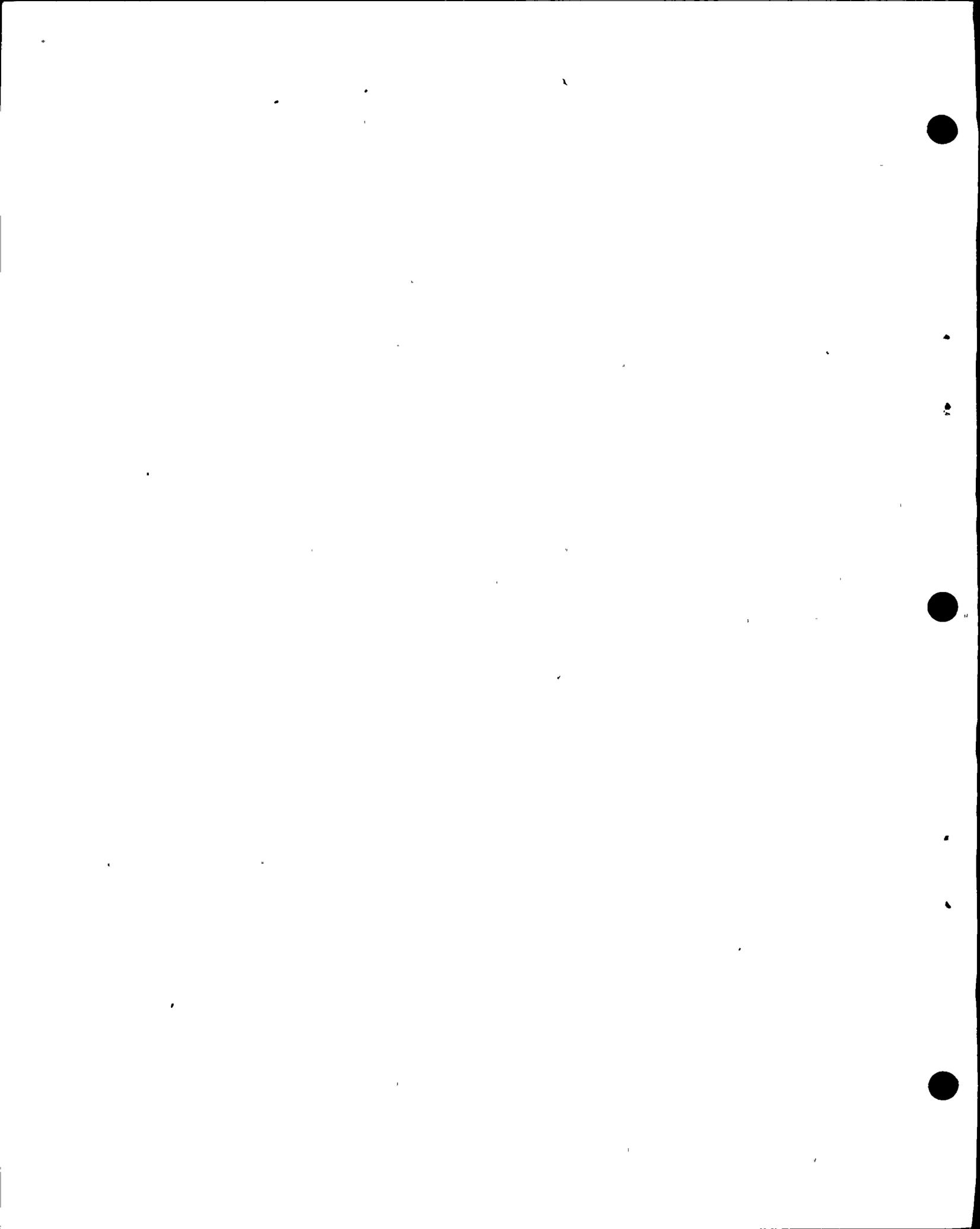
8 And it's our position that a 7.5 is ultra-  
9 conservative, it's not really required. However, that number  
10 was placed on us by the NRC Staff through -- and it was  
11 placed on them, I guess, by USGS.

12 MRS. BOWERS: Well we did have considerable time  
13 spent on the 6.5, and something could withstand a 6.5 that  
14 could not withstand a 7.5.

15 MR. NORTON: But, Mrs. Bowers, that's what I  
16 just said, the thing has been analyzed for a 7.5, and the  
17 testimony you will hear in the next week or the next few  
18 days is that analysis at 7.5, that it will withstand that 7.5.

19 However it's our position that the plant will  
20 only ever see a 6.5, and that can make a possible difference  
21 in terms of operating costs and so on and so forth in  
22 terms of technical specifications, et cetera. And it is  
23 our position that this Board should find that it's only a  
24 6.5 credible earthquake.

25 MRS. BOWERS: That's the point I was getting



wrb/agab6

1 at, do you think the question is open for this Board to --

2 MR. NORTON: It's clearly open. The Intervenors  
3 have raised it, they say it should be more than a 7.5, and  
4 the Staff says it should be a 7.5 and the Applicant says it  
5 should be less than a 7.5. It's clearly a question this  
6 Board should be concerned with.

7 MRS. BOWERS: Well but presently, and in the past  
8 year or so, the plant has been modified to reach a 7.5.

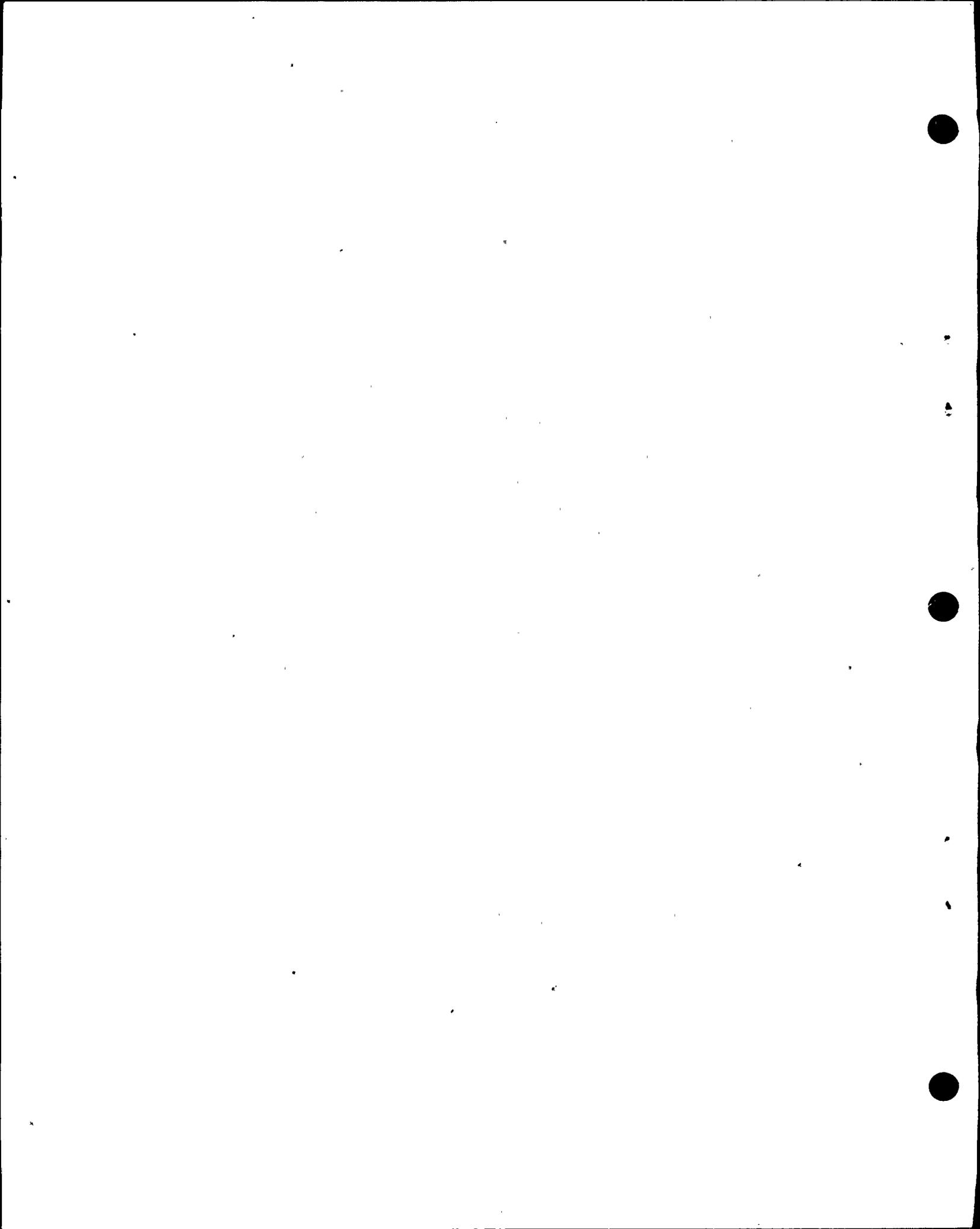
9 MR. NORTON: That's correct. We have no alter-  
10 native. I mean, that's the Staff's position, and if we want  
11 an operating license, we have no alternative. We cannot  
12 risk this Board's saying it should only be a 6.5.

13 You know, we can't go along in time until the  
14 Board says well, we agree with the Staff, it should be a 7.5  
15 and then start modifications. But if this Board should  
16 agree with us that it's a 6.5, then perhaps some of those  
17 modifications can be stopped and some of the operating re-  
18 strictions could be lifted.

19 MRS. BOWERS: Well, if this Board found that the  
20 6.5 was reasonable, the Staff still could decide it wouldn't  
21 go with that.

22 MR. NORTON: That's true. That's why we've been  
23 doing the modifications.

24 MRS. BOWERS: Well, I'll try and ask better  
25 questions from now on.



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MR. NORTON: Well I think all of our people will be back. In other words, the geologists will be back for rebuttal, seismologists, Dr. Frazier will be back for rebuttal and when Dr. Brune is here, so any questions you have like that will be -- you know, the people will be available to answer them.

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MRS. BOWERS: Well as I say, my primary concern was the reviewer of the record. We'll just go along and see if maybe we can -- sometimes, of course, the answers were very well worded for a layperson to understand. The questions weren't always worded for a layperson. Some of the questions sounded like is the bleep related to the bleep-bleep.

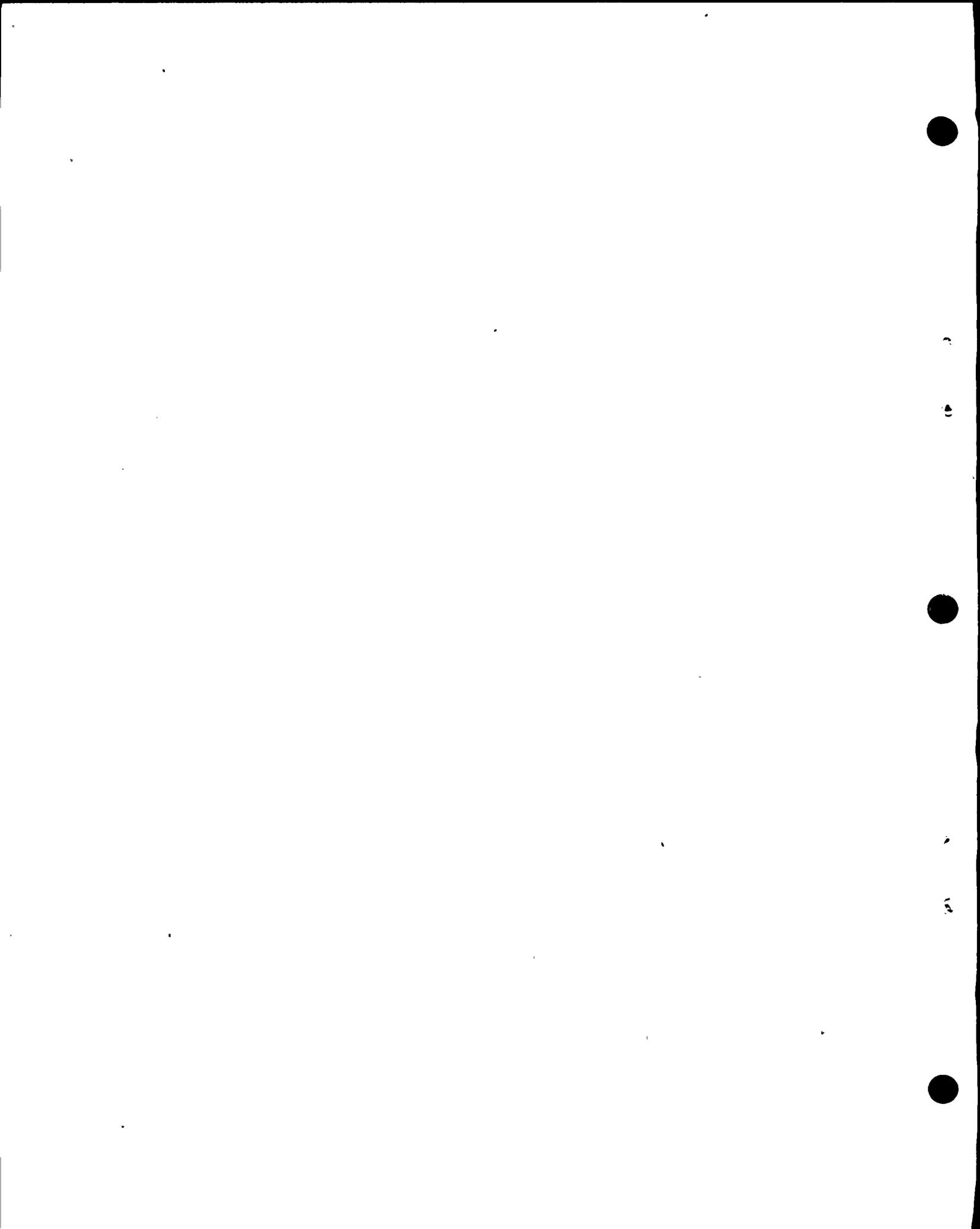
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(Laughter.)

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And you really need a background to translate that.

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But, we'll review the record and try to be more alert to that.

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MR. NORTON: Mrs. Bowers, I think -- you know, the Aeschliman decision bears on what you're raising right now. I think that's exactly why the Supreme Court said they are not going to interfere with the substantive judgment of the Boards in cases like this, because there's no way they can review a record like that and understand what's going on.

And I think it is incumbent upon the Board to



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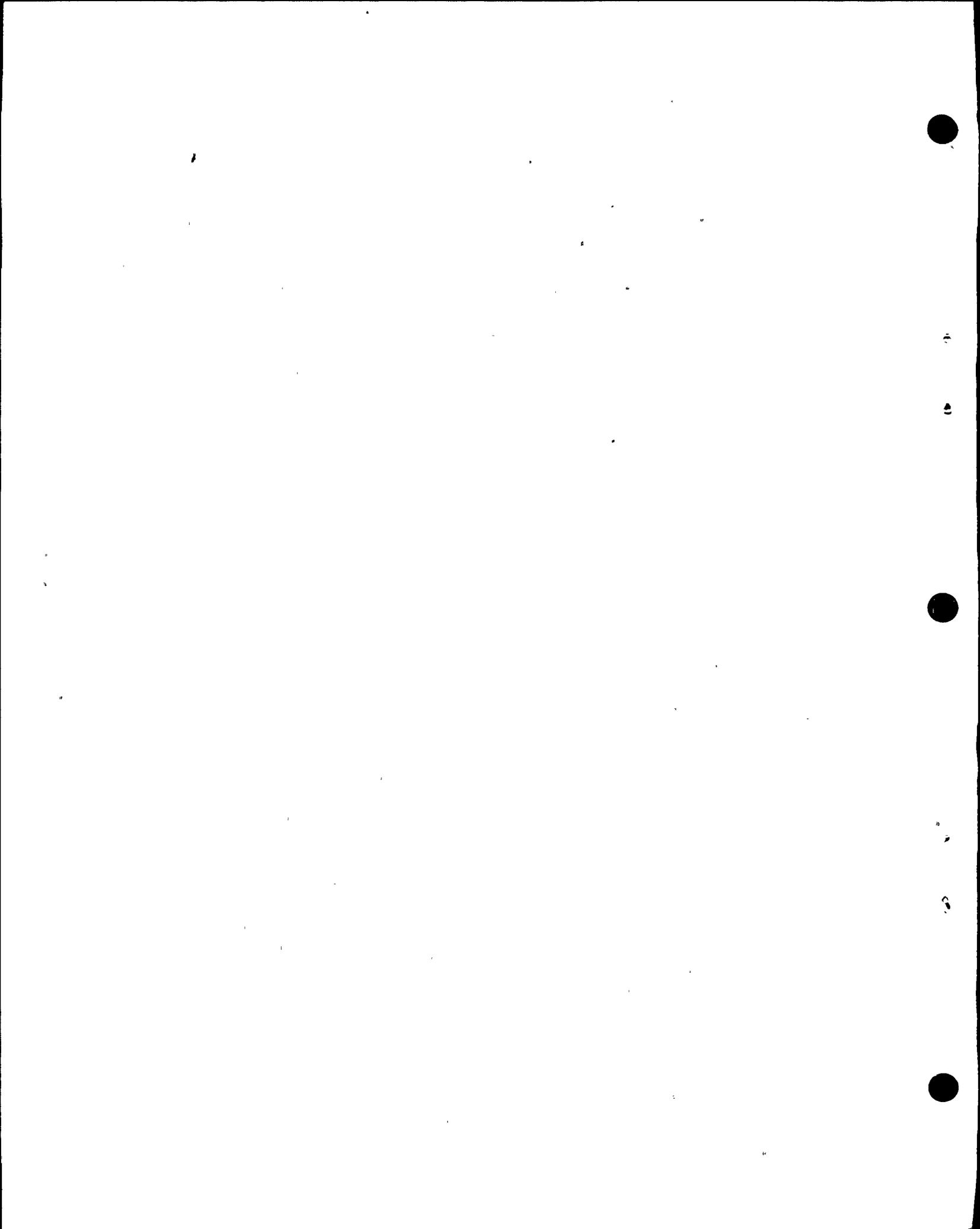
1 ask questions of the witnesses when they're on the stand to  
2 reach a level of understanding so that the Board can make an  
3 informed decision.

4 But I really think it is impossible to make a  
5 record that a layman can just pick up and start reading and  
6 understand all about seismology and earthquakes and geology  
7 and all the things that have to be understood. I don't know  
8 how you do that. It would take months of hearing to do that.

9 MRS. BOWERS: I also, of course, am thinking  
10 while we have scientific technical expertise on this Board  
11 and that would be true on the Appeal Board and in the Com-  
12 mission, at those levels the Board or the Commission cannot  
13 just say we're not going to get into the thing like the courts  
14 do. So I guess my primary concern is developing the kind of  
15 record that would make sense to the Appeal Board or the  
16 Commission.

17 I think, Mr. Norton, your point is well taken.  
18 When you hear the same ground covered several times by different  
19 panels and different witnesses, it all kind of flows together  
20 in a way that's different from the first time around and  
21 there certainly has been an overlapping here in the testimony.

22 I recall, to follow through on the point you made,  
23 I recall at least one decision by the D.C. Court of Appeals --  
24 I don't recall the case, maybe some of the rest of you do,  
25 but anyway the court volunteered the fact that when it considers



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1 matters in the nuclear reactor field, it's the most complex,  
2 difficult subject matter that it's faced with. And in that  
3 particular decision, the court ended up by saying we hope we  
4 don't have another one.

5           So it's a matter for concern, and we do know that  
6 the Supreme Court recently suggested to the D.C. Court of  
7 Appeals that it limit its review greatly over what it con-  
8 sidered necessary to do in the past.

9           Well, let me give the other parties a chance.

10           Mr. Kristovich, do you have any comment on this?

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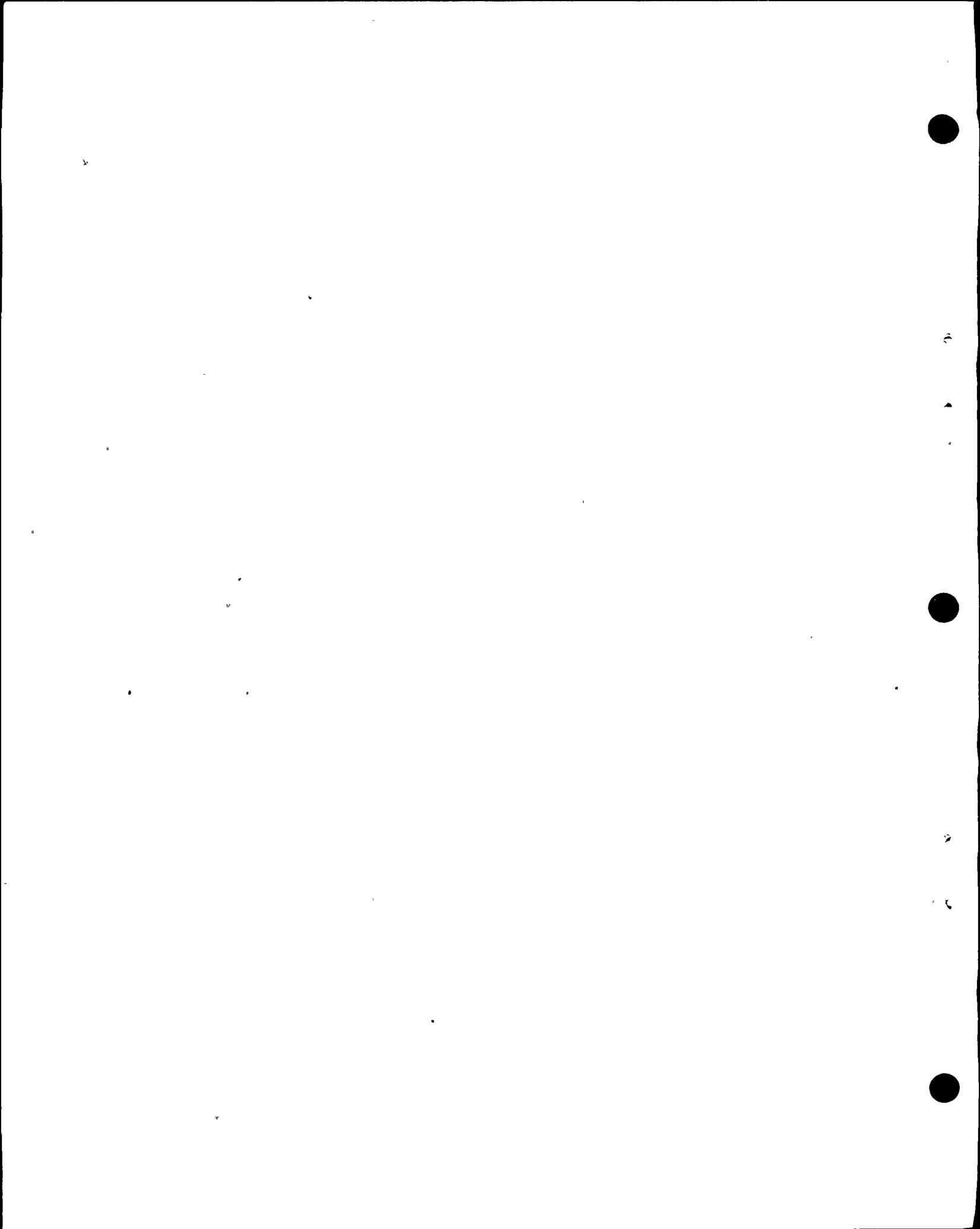
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1 MR. KRISTOVICH: The only comment would be that  
2 Intervenors feel that if the Board did not understand all the  
3 previous testimony then we would like to ask questions when  
4 the Applicant's witnesses are back on the stand for their  
5 final testimony, so that you can clarify in your own mind what  
6 the testimony is.

7 MRS. BOWERS: Yes. Well, actually I don't know  
8 whether "understood" is exactly the right word. I personally  
9 could follow what was being said, but I didn't feel comfortable  
10 in the way some of it was said, thinking in terms of a  
11 reviewer of the record.

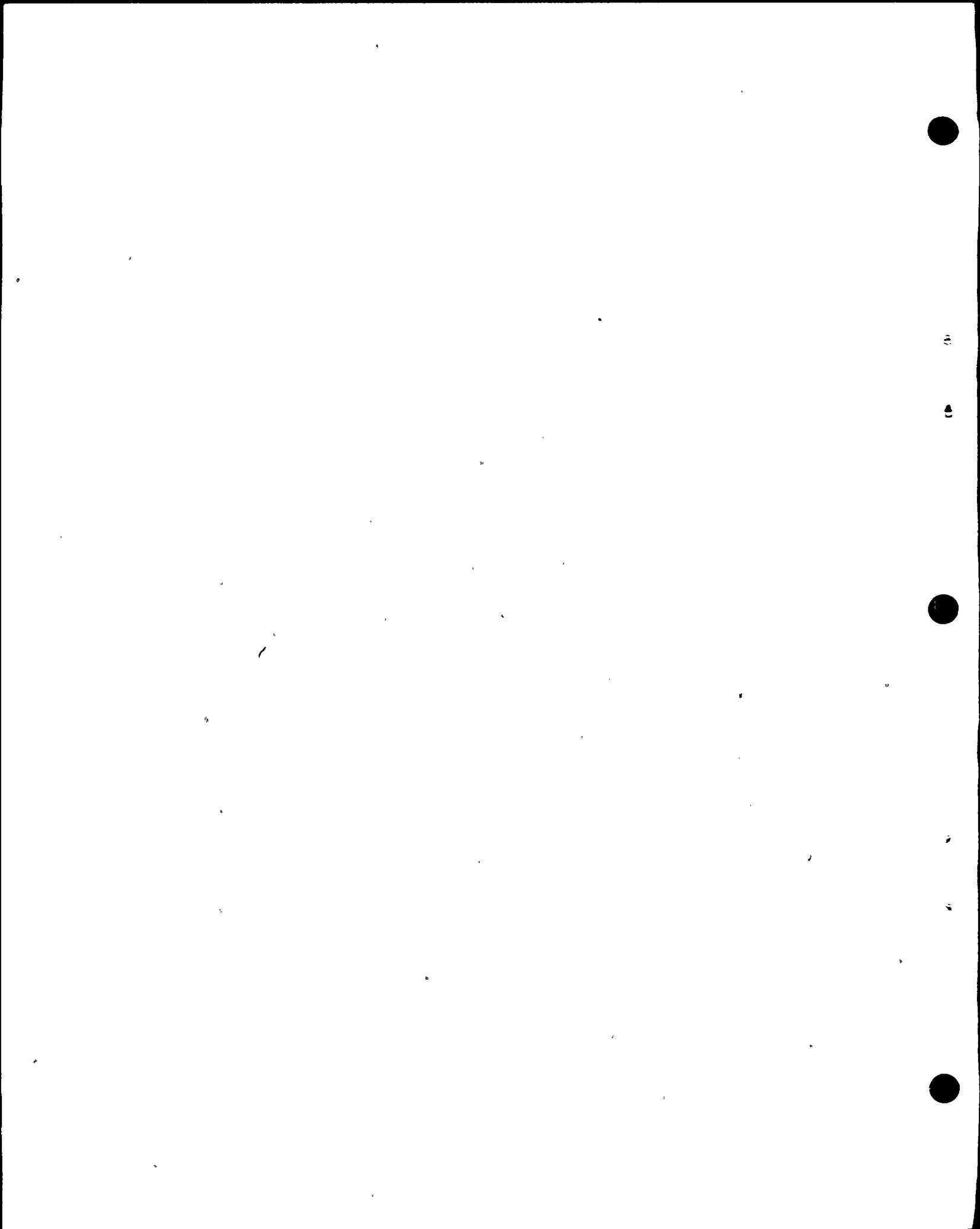
12 MR. KRISTOVICH: We might also suggest, or  
13 reiterate what we said earlier, that it may have made a  
14 tidier record if we had gone issue by issue. Then things may  
15 have been clearer for the record.

16 MRS. BOWERS: Mr. Ketchen, does the Staff want  
17 to comment on this?

18 MR. KETCHEN: Yes, ma'am.

19 Staff witnesses I assume will be going on next  
20 week, and I think one of our obligations to you -- I tend to  
21 agree with you -- if there are any questions or any ground  
22 that you would like for us to cover, for example, maybe an  
23 explanation of the different types of scales that are used,  
24 I think we'd be happy to do so.

25 Also, as you were talking I seemed to recall  
a decision on the point you're making, and I was trying to



wel 2

1 come up with it --it may have been San Onofre -- in which  
2 the Appeal Board had read a decision that was written, and  
3 basically that decision was a redraft of Staff findings.  
4 Well, the Appeal Board did not understand that either  
5 proposed findings or -- I'm sorry -- they did understand it,  
6 but they felt that it wasn't plainly enough written so that  
7 other readers could readily understand it.

8 And I think that's the point you're getting at.

9 But my basic point is that we would be happy to  
10 answer any questions that you have. After all, our purpose  
11 here is I think to make as complete a record as we can, and  
12 if there's any confusion in it, I don't think we'd be happy  
13 with it and we'd like to clear up those things that we can.

14 MRS. BOWERS: Well, definitions, explanations  
15 that were given by the expert witnesses, I think my colleagues  
16 felt very comfortable with. And, of course, we had discussions  
17 about them.

18 But, as I said, my concern was the record.

19 Now, Mr. Norton has expressed an opinion that  
20 in this complicated subject matter you just can't have a  
21 record that an ordinary layman could pick up and read and  
22 understand. Do you think that's true?

23 MR. KETCHEN: Well, I think it's six of one and  
24 half a dozen of the other. I think Mr. Norton is correct  
25 to an extent. It seems to me that anyone that sat here and  
listened to Dr. Jahns for a couple of days, even the ordinary



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1 layman -- me included -- would understand a lot more than he  
2 would have before. But at the same time, the ordinary  
3 layman is not the decision maker, and I think the witnesses  
4 that I've seen are capable of giving fairly straightforward  
5 explanations that the non-geologists, for example, or the non-  
6 technically trained person, can understand. I think that's  
7 been done to a large extent.

8 So, in a sense, I agree and disagree. I think  
9 that the witnesses I've heard are capable of giving that  
10 explanation. I'm not aware of any parts of the record that  
11 are confusing.

12 But I guess my point is that if there is, we  
13 would like to respond to those questions and clear up the  
14 record.

15 MRS. BOWERS: I didn't mean to give the  
16 impression that they are confusing, but I found that I felt  
17 more comfortable with some of the subject matter after  
18 discussion with my other Board Members. But, you see, that's  
19 not a part of the record.

20 My primary point here is to kind of raise this  
21 so that perhaps we can all be aware of it, and see if simple  
22 explanations can be given.

23 Mr. Ketchen, what about the Applicant's position  
24 that the question before this Board is to determine  
25 magnitude of the possible Hosgri event, 6.5, 7.5 or, as



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1 Intervenor's are suggesting, something greater? Is that the  
2 Staff's understanding?

3 MR. KETCHEN: As Mr. Norton laid it out, the  
4 differences in the position are, as I understand the way he  
5 particularized it, or distinctions in the positions, as he  
6 laid it out. And I think it's consistent with the three  
7 parties' positions.

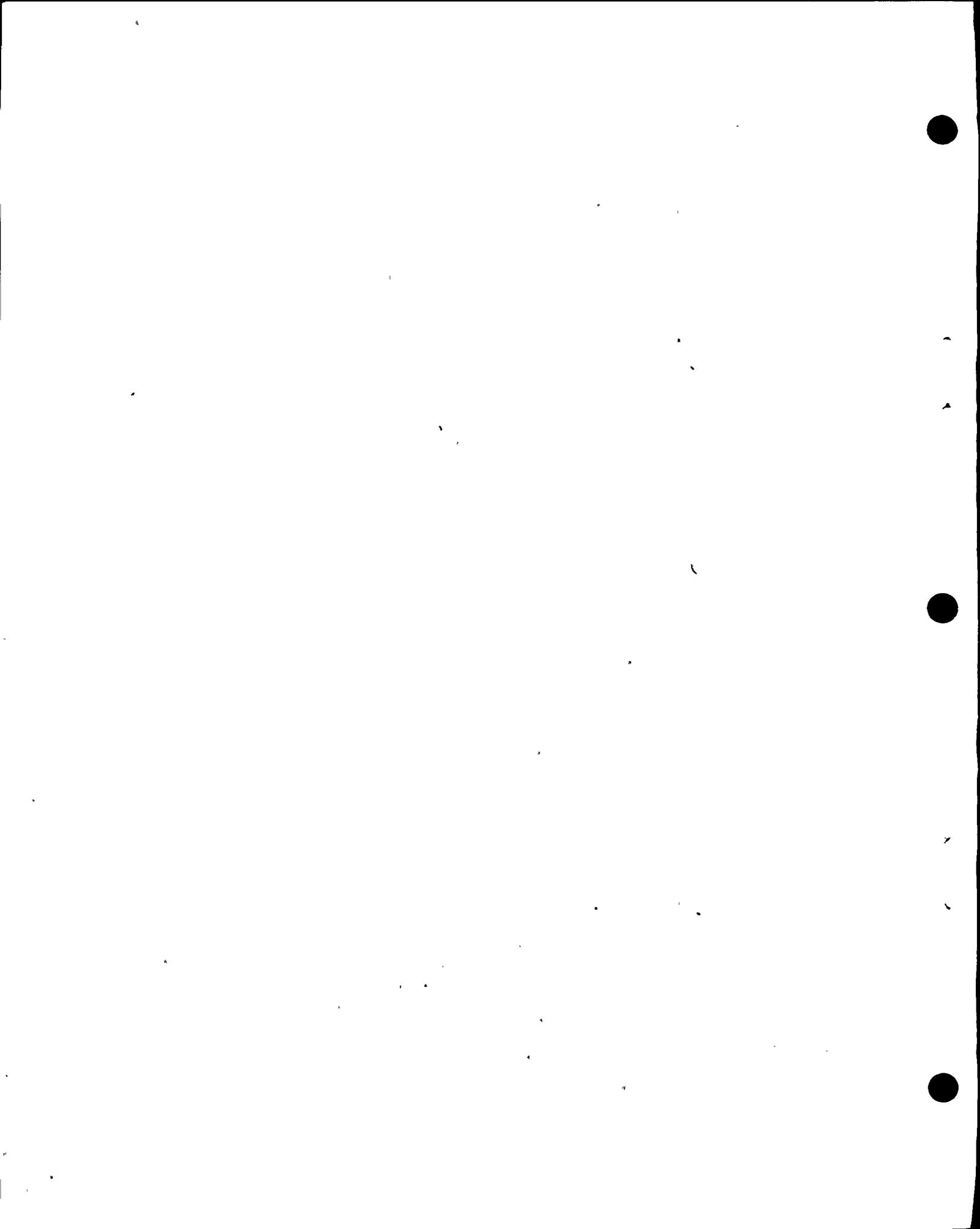
8 MRS. BOWERS: Well, I expressed a very adverse  
9 attitude toward testimony on the 6.5, but it may well be  
10 that it's more relevant than I realized.

11 MR. NORTON: Mrs. Bowers, it concerns me when  
12 you say that the reason -- it's very important, I think,  
13 to understand that everything we have done assumes a 7.5.  
14 Every analysis, every structure and instrument building, and  
15 everything, assumes a 7.5.

16 It is our feeling and has always been our  
17 feeling that that is unnecessary, that that fault is not  
18 capable of more than 6.5, and we hope to convince the Board  
19 of that.

20 That does not mean, though, that we have ignored  
21 the 7.5, and I don't want to leave you with that impression.  
22 Everything that has been done has been assuming a 7.5. All  
23 the modifications, all of the analyses, all of the testimony  
24 you will hear from here on out, assumes a 7.5.

25 It is, and continues to be our position that  
that's unnecessary, that it's a waste of money, a waste of



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1 time and effort, and 6.5 is all that was necessary.

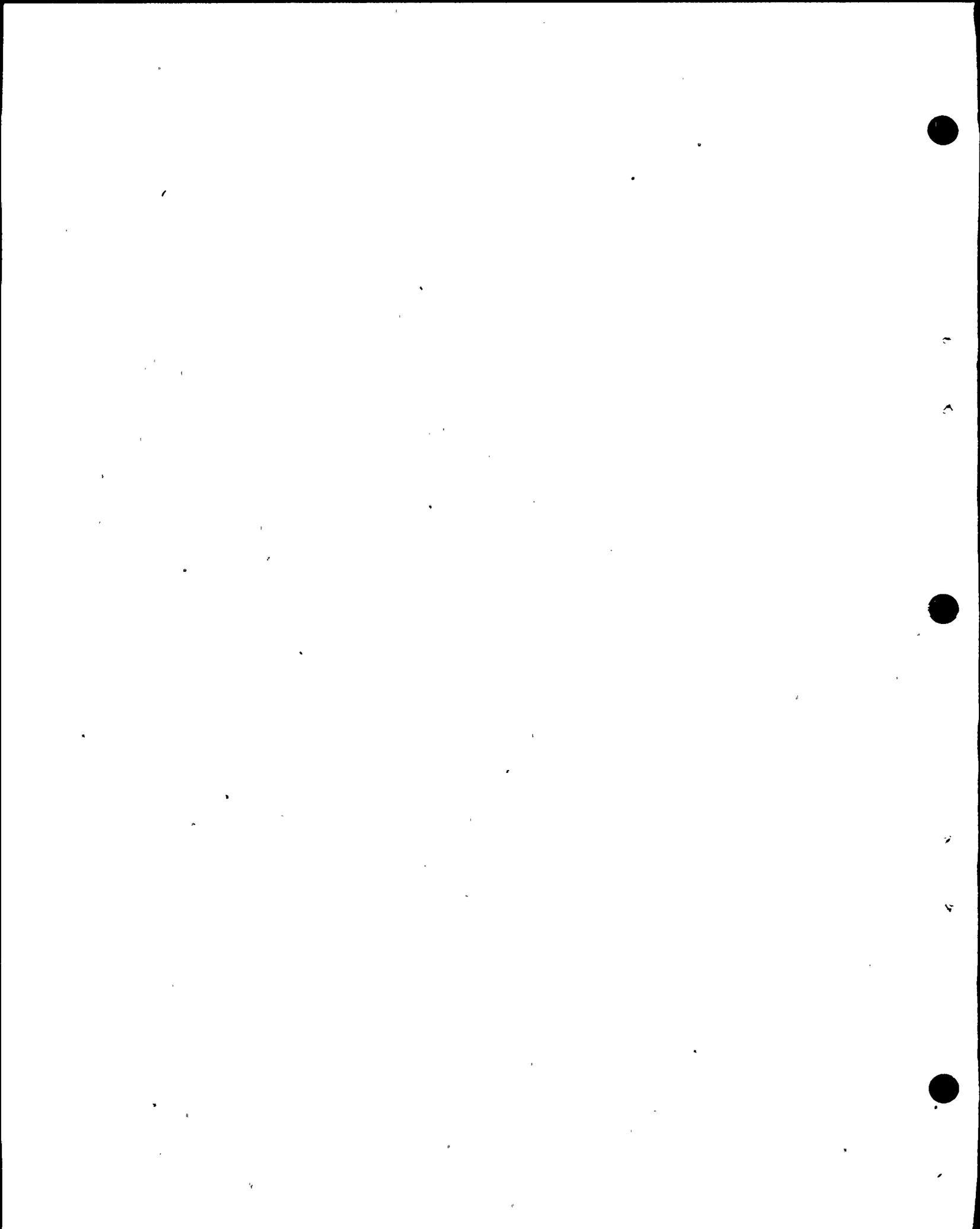
2 Now unfortunately at this point in time a decision  
3 that supports that position doesn't gain us all that much. It  
4 would have gained us much more if we had arrived at that  
5 decision a couple years ago, so that modifications weren't  
6 necessary and expenditure of funds wasn't necessary, and time  
7 wasn't necessary. But that's behind us now.

8 There is something to gain, however, by this  
9 Board finding 6.5 in that cost of operation might go down in  
10 the future because of that, because of some limitations not  
11 being there. So there is still something to be gained.  
12 But in terms of a tremendous amount of money that's been spent  
13 already -- and we had to make that choice, PG&E has had to  
14 make the choice to go ahead with 7.5. We couldn't risk  
15 sitting there hoping this Board decided 6.5 and they wouldn't  
16 have to make the modifications.

17 So everything has been done according to the  
18 7.5, and I want you, you know, to be sure that that is  
19 understood. It's not our position that it has to be. It's  
20 just that it should not have been necessary.

21 MRS. BOWERS: Well, you see, I thought some of  
22 the testimony dealing with the 6.5 was simply self serving,  
23 to try to show the Staff and USGS we're wrong. But I didn't  
24 until this morning realize fully your position.

25 So you feel this Board can make a determination --



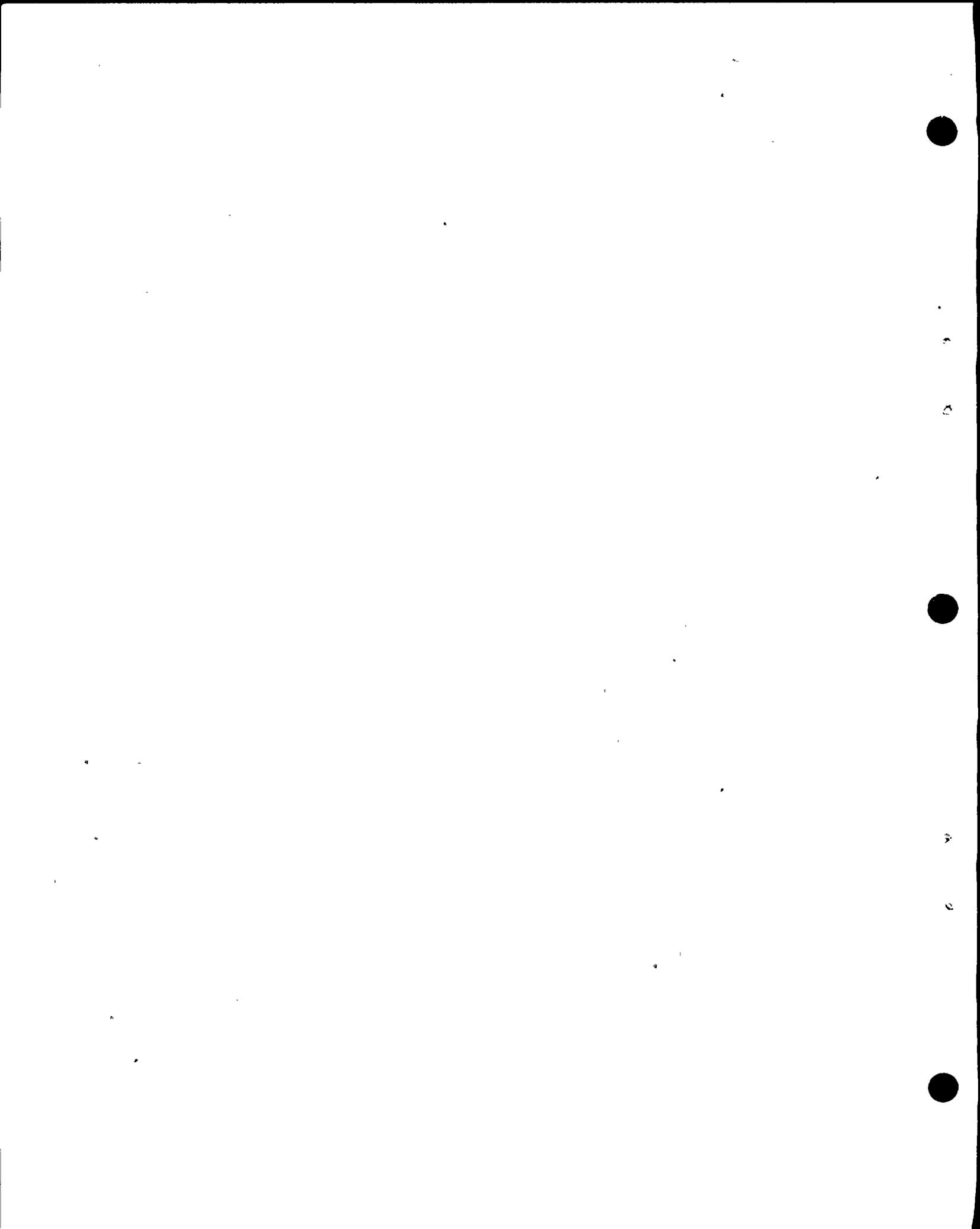
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1 MR. NORTON: Absolutely. Well, I won't even  
2 attempt to quote numbers, but there's a question of savings  
3 in terms of operation. I think it has to do with maybe where  
4 you put the cranes, and when you operate the cranes, and that  
5 sort of thing. But there are some operational savings to be  
6 gained if one were to assume 6.5, and I'm not the one to deal  
7 with those numbers, but it is obviously of importance.

8 (Pause.)

9 MR. NORTON: Mrs. Bowers, there's another reason  
10 for this 6.5, and that has to do with the g's you were talking  
11 about. I don't want to get into that now, and answer that  
12 question for you, but a 6.5 magnitude earthquake would  
13 produce lower peak accelerations than a 7.5 would, and that  
14 does get into some of the conclusions, for example, of  
15 Trifunac, for example, and Mr. Luco, and our witnesses and  
16 Dr. Brune, who will be here. So it does deal with that also.  
17 The level of acceleration would be lower. In other words,  
18 if the Board found that indeed the Hosgri were capable of  
19 only a 6.5, then it makes the rest of the decision much, much  
20 easier, because everything else comes down, see?

21 So, in that sense --and that has nothing to do  
22 with an operational question, that has to do with the overall  
23 findings of the Board. In other words, if you lower the  
24 magnitude earthquake that makes everything else that much  
25 safer. So it ties in across the board, and we feel very



1 strongly, and I think our witnesses were very strong, that  
2 6.5 was the maximum credible earthquake. So it is an  
3 important question.

4 MR. KRISTOVICH: Mrs. Bowers, I would merely like  
5 to refer you to page 3 of Joint Intervenors' number 45, which  
6 is USGS number 672.

7 MRS. BOWERS: Say that again.

8 MR. KRISTOVICH: Joint Intervenors' 45, which is  
9 USGS number 672, and there is a table on page 3 that has  
10 various magnitudes and then various -- like 8.5, 8.0, 7.0,  
11 6.5, and then various accelerations that go along with those  
12 magnitudes.

13 MRS. BOWERS: Well, I recall the table.

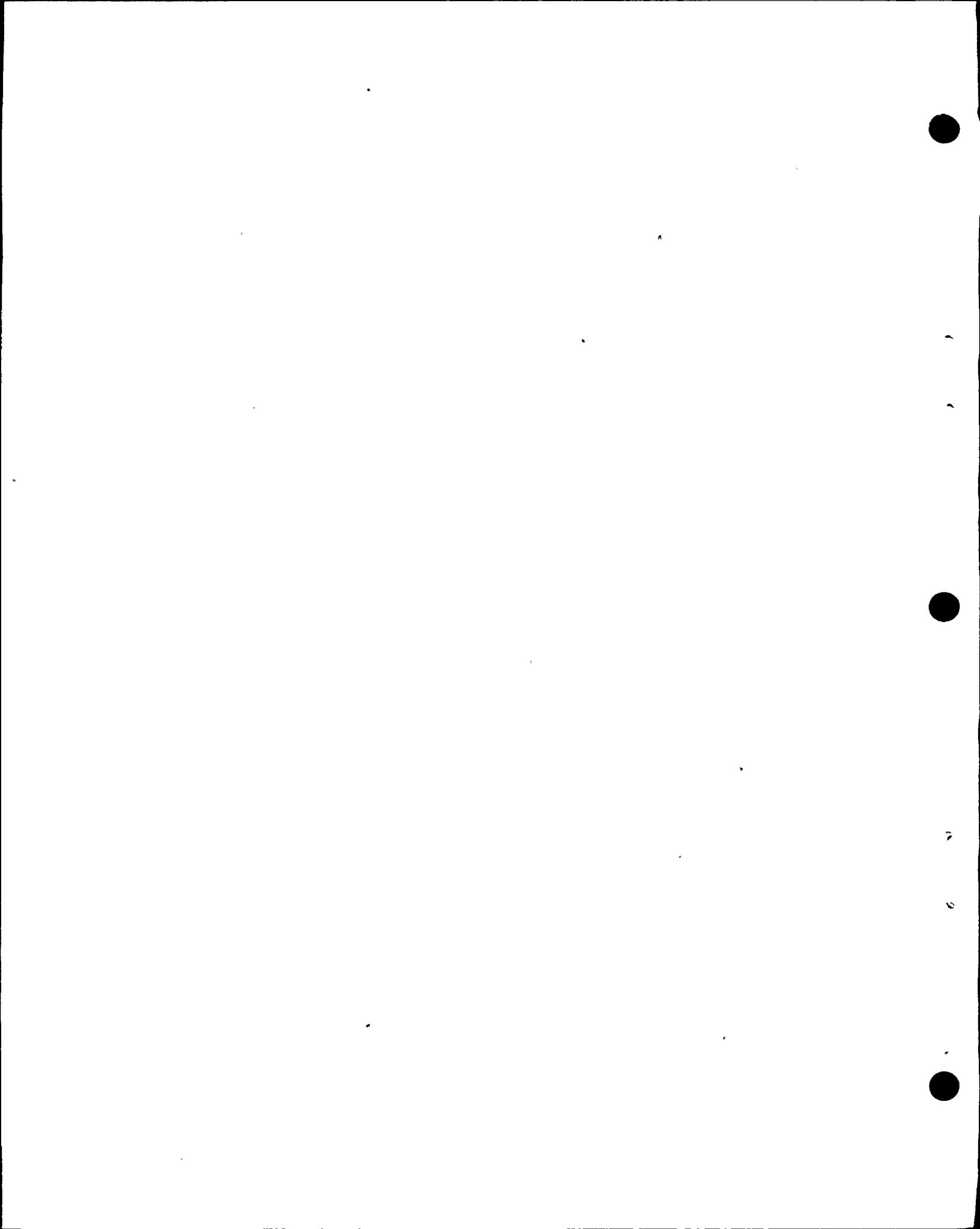
14 MR. KRISTOVICH: So, for example, the 7.5  
15 magnitude it was 1.15 g's, and for the 6.5, 0.90 g's.

16 MRS. BOWERS: Well, there were tables in the  
17 direct testimony too that showed the magnitude as well as the  
18 gravity.

19 Well, can we begin?

20 MR. KETCHEN: Mrs. Bowers, may I have one  
21 moment on one other item?

22 On the document that you referred to earlier,  
23 I'm not sure that that was in the record. I'm not sure that  
24 we had gone on the record at the point you referred to the  
25 document, but I think it's important that that be referenced  
in the record, the book that was reviewed. I would like to



wel 8

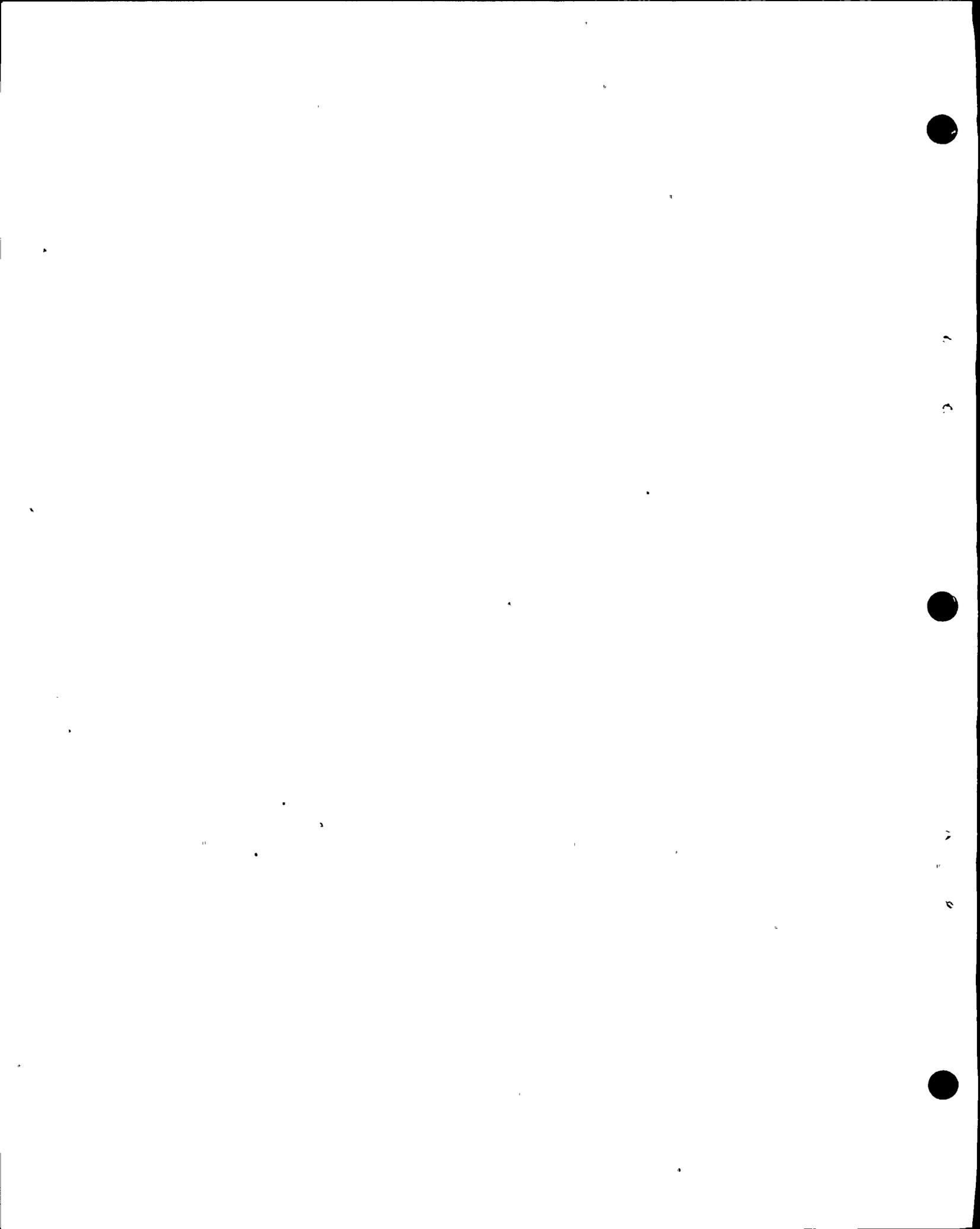
1 get it in the record, because I would like to get a reference  
2 to it -- not in evidence or anything, just a reference to it  
3 so I can get it and have my people look at it, as well.

4 MR. NORTON: I think your people were familiar  
5 with it when Mr. Tourtellotte was here. It was Dr. Bolt's  
6 book, "Earthquakes, a Primer," and Intervenors I know have a  
7 copy and have read it, and I think it should be marked as an  
8 exhibit. That's not moving it into evidence for the facts  
9 contained therein, but I think it should be marked as an  
10 exhibit in the record, and then anyone who reviews the record  
11 can use the glossary to look up a word, or whatever, and  
12 understand what a word means. I think that would be very  
13 meaningful. That's not to say the book itself is evidence,  
14 and I don't think anybody would even have any objection if  
15 it was in evidence -- you know, other than being a glossary  
16 it would serve no other purpose.

17 But I would ask that it be marked as a Board  
18 exhibit, and if we want to move it in evidence, fine, although  
19 it's not necessary.

20 MRS. BOWERS: Well, Dr. Bolt on occasion -- and  
21 of course we kidded him about this -- would say, "As I said  
22 in Chapter 6..." so and so, or "As I said in another chapter..."  
23 and actually I learned about it because the Joint Intervenors  
24 displayed a copy of it and discussed it with him briefly.

25 MR. NORTON: Dr. Bolt would be happy to furnish



1 copies, probably, for the record --

2 MRS. BOWERS: It costs \$7.25.

3 MR. NORTON: I was going to say -- at \$7.25 a  
4 copy.

5 (Laughter.)

6 MR. NORTON: I had to pay that for my copy.

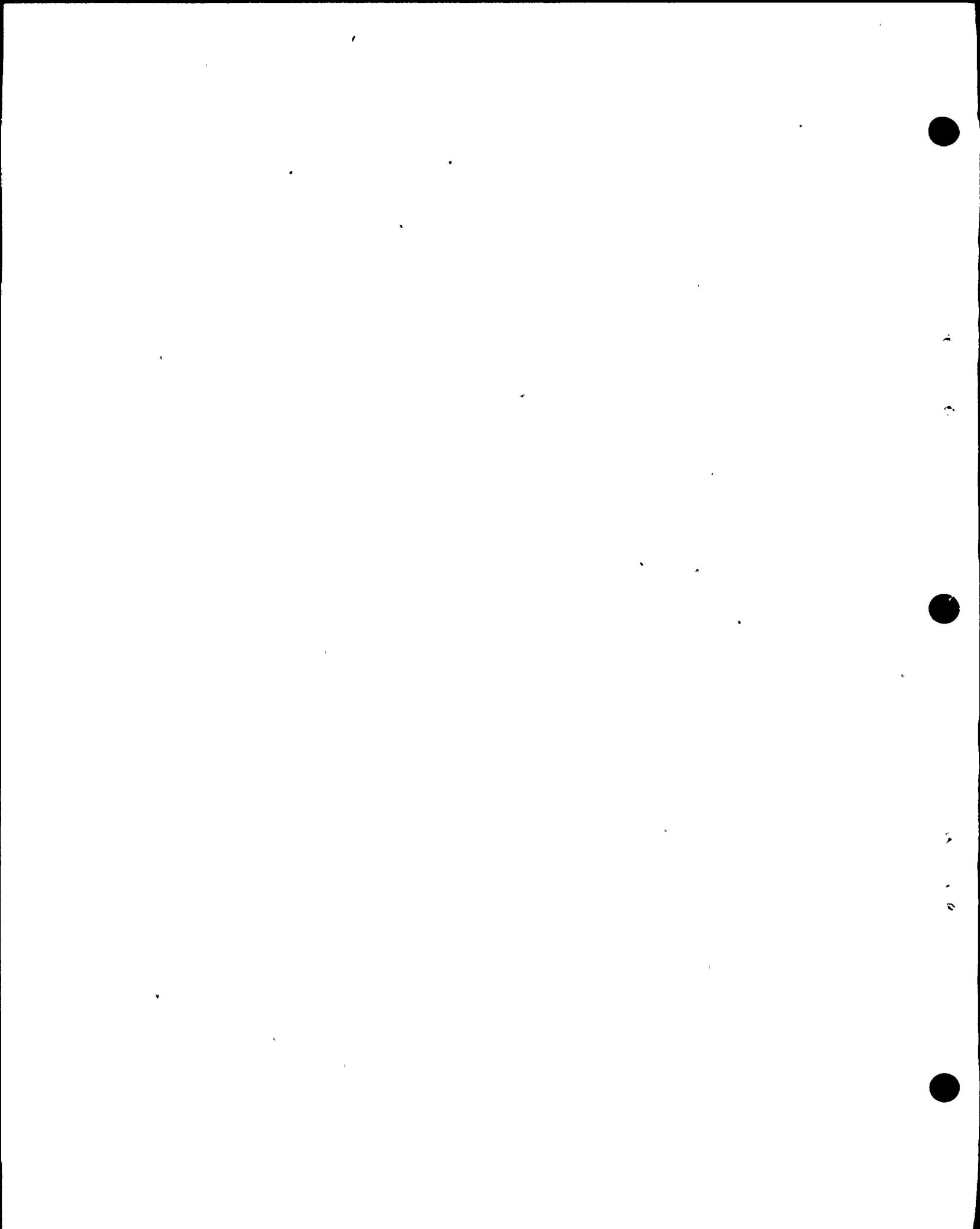
7 MRS. BOWERS: Well, the book I was referring to  
8 off the record was the basic textbook that was referred to  
9 at the time that Dr. Bolt was testifying, and it's entitled,  
10 "Earthquakes," by Dr. Bruce A. Bolt, "A Primer." It is  
11 published by W. H. Freeman & Co., San Francisco. He did  
12 refer to it after, I think, the Joint Intervenors displayed  
13 their copy of it. Then I think he felt comfortable to  
14 actually make reference to various chapters.

15 I mentioned off the record that since I knew  
16 the parties were familiar with this, and that it did contain  
17 a glossary, that I was able to pick up a copy of it and also  
18 took a look at the glossary put out by the American Geological  
19 Institute in 1972, and my primary purpose, of course, was to  
20 review definitions and terms, and I didn't see anything new  
21 and different from the testimony.

22 But it's just by going over them a time or two  
23 that I felt I could recall the definitions.

24 Mr. Ketchen, you started to say something?

25 MR. KETCHEN: I was just going to agree with Mr.



1 Norton that I thought that was a good suggestion he made, and  
2 have no objection to the approach he suggested.

3 MR. KRISTOVICH: Mrs. Bowers, we have no  
4 objection to marking that for identification.

5 MR. NORTON: Well, before we . . . I'm sure we  
6 can get them. What would we need, three copies? How many  
7 copies would we need?

8 MR. BLOOM: Three.

9 MR. NORTON: All right, we'll get three copies  
10 down here and have them marked. We can perhaps mark those and  
11 furnish them to Mr. Bloom before we leave this session.

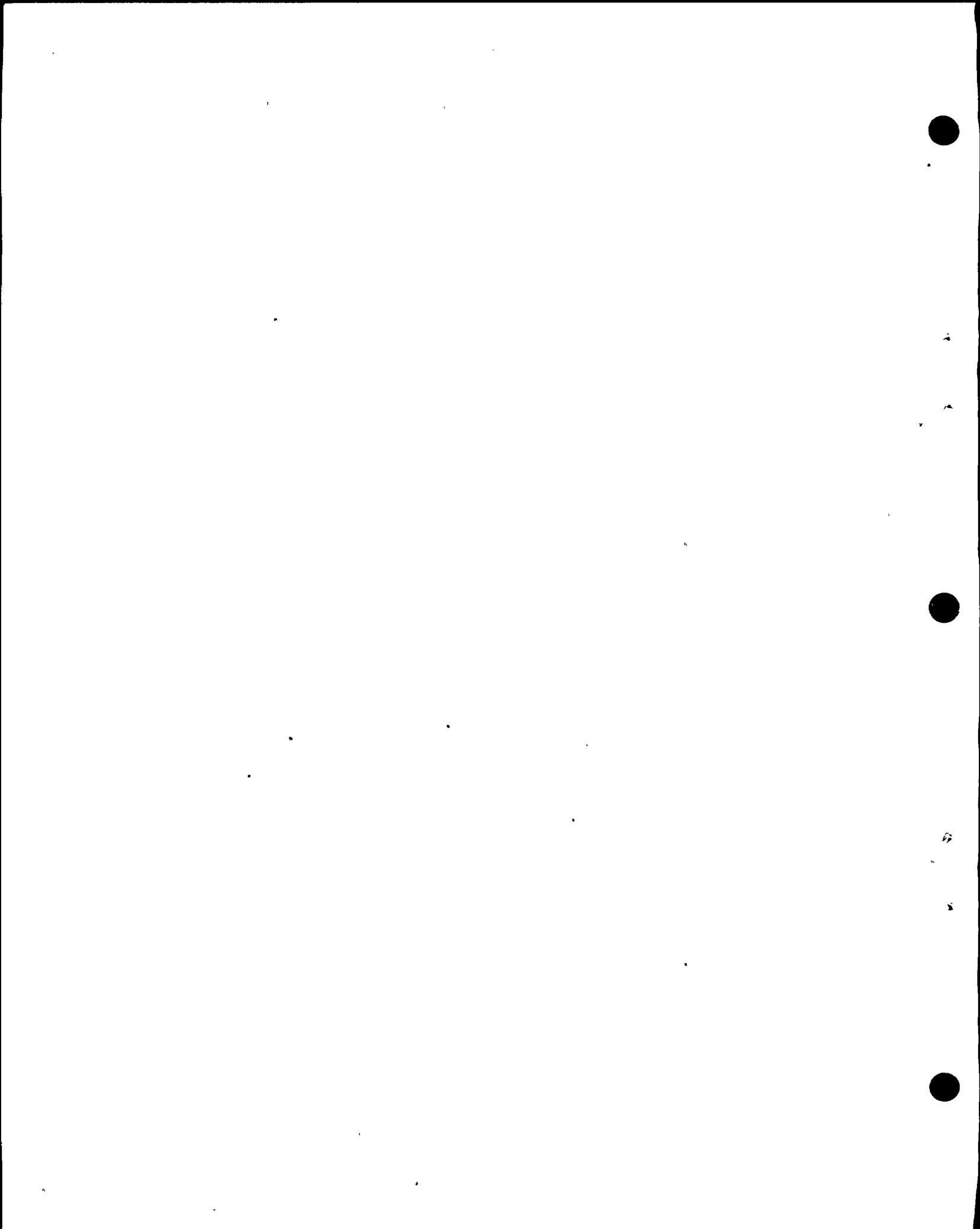
12 MRS. BOWERS: I haven't re-assembled everything.  
13 I recall Board Exhibit Number 2. I don't know whether there  
14 was a number 3 or not.

15 MR. NORTON: No.

16 MRS. BOWERS: All right. So the text which has  
17 been identified will be marked for identification as Board  
18 Exhibit Number 3.

19 (The document entitled, "Earthquakes,  
20 a Primer," was marked for identifi-  
21 cation as Board Exhibit 3.)

22 MRS. BOWERS: There was one interesting little  
23 story when an earthquake occurred in the San Francisco area,  
24 a seismologist was trying to figure out the exact location.  
25 He gave an opinion, "Northwest." So he called the Press to



1 tell them. And a janitor answered and said, "Well, all the  
2 reporters said Northeast San Francisco." So he said, "Well,  
3 tell them that's where the earthquake is."

4 (Laughter.)

5 So perhaps it's not a totally exact site but . . .  
6 well, shall we begin?

7 MR. KRISTOVICH: Is Dr. Martin going to be here  
8 today?

9 MRS. BOWERS: He was snowed in in Chicago, and  
10 finally got out and is driving up from Los Angeles.

11 As you know we can, on a short-term basis,  
12 proceed under the quorum rule. He will be arriving sometime  
13 today. He couldn't get airline reservations, and so is  
14 driving up from Los Angeles.

15 MR. KRISTOVICH: I merely wanted to have the  
16 record show that Dr. Martin would be here.

17 MRS. BOWERS: Yes.

18 WRB fls

19

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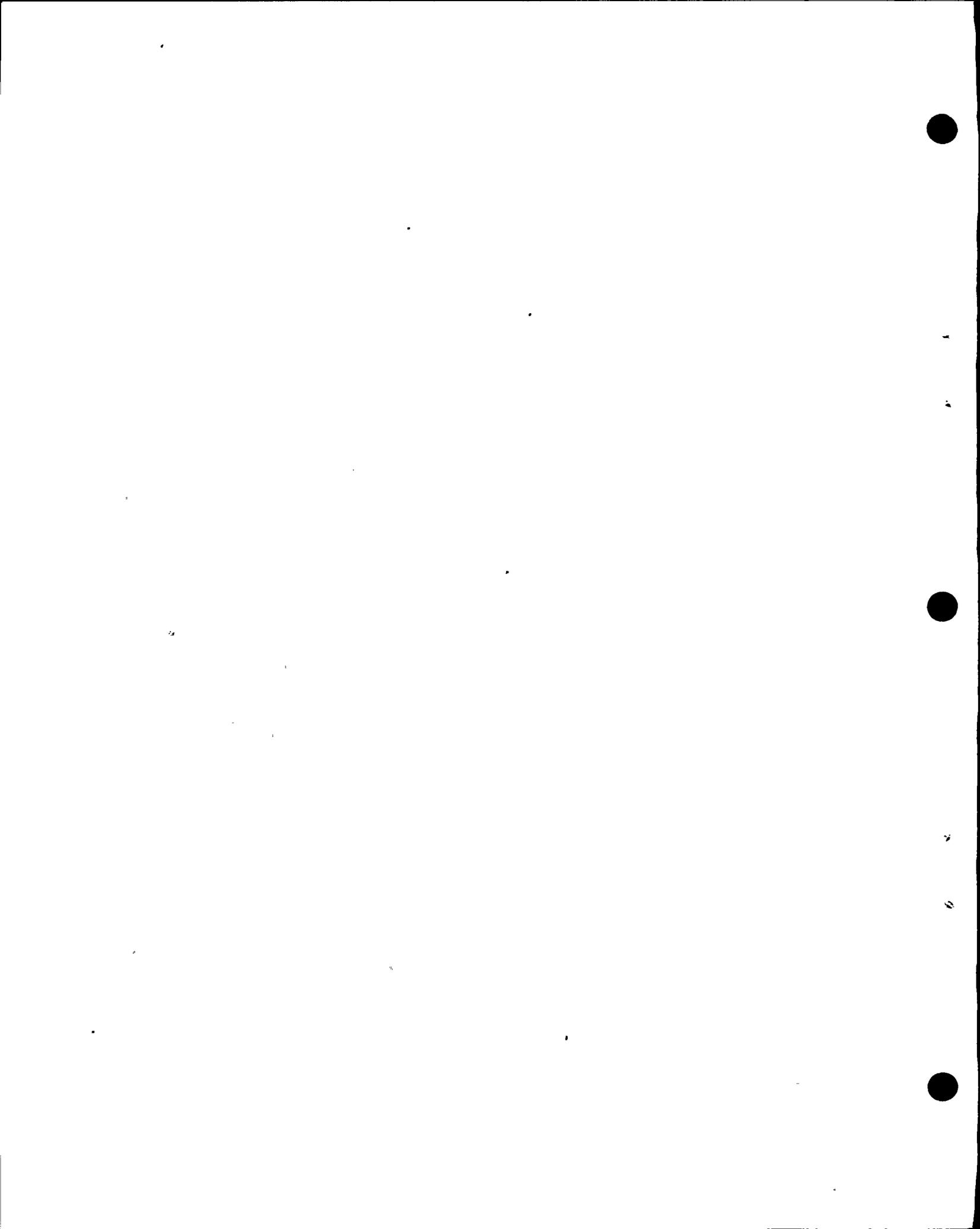
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WBLOOM/wbl 1  
WELandon

1 MR. NORTON: Mrs. Bowers, at this time we'd like  
2 to have you swear in the following people. And I would just  
3 ask that these people stand up as their name is called.

4 Mr. Ghio has already been sworn in.

5 M. Malik, Mr. Sokoloff, Mr. Jhaveri. And Dr. Blume  
6 has already been sworn in.

7 Dr. Lang. Mr. McLaughlin. Mr. Williams.  
8 Mr. Yokoyama. Mr. Li. Mr. Rocha. Mr. Lawson. Mr. Udaka.  
9 Mr. Lee.

10 Whereupon,

11 DILIP P. JHAVERI, DAVID A. LANG, ROBERT T. LAWSON  
12 MING E. LEE, CHUNG M. LI, LINCOLN E. MALIK,  
13 JOHN A. McLAUGHLIN, OSCAR A. ROCHA,  
14 IGOR SOKOLOFF, TAKEHAZU UDAKA, DAVID WILLIAMS  
15 and RALPH T. YOKOYAMA

16 were called as witnesses for and on behalf of the Applicant  
17 and were sworn by the Chairman.

18 MR. NORTON: If Mr. Nyberger is looking for news  
19 he ought to watch Mr. Udaka play ping-pong.

20 (Laughter)

21 MR. NORTON: Excuse me; I missed Mr. Hanusiak.  
22 I'm sorry. We're going to have to swear Mr. Hanusiak in by  
23 himself.

24 MRS. BOWERS: Well, let's check. Is there anyone  
25 else who was missed?



WFB/wb2

1 (No response)

2 MRS. BOWERS: Very well. Mr. Hanusiak, please  
3 raise your right hand.

4 Whereupon,

5 STANLEY A. HANUSIAK

6 was called as a witness by and on behalf of the Applicant  
7 and was sworn by the Chairman.

8 MR. NORTON: At this time we'd like to call to  
9 the stand Mr. Ghio, Mr. Malik, Mr. Hanusiak, Dr. Blume;  
10 Mr. Lang and Mr. Jhaveri. Mr. Hanusiak will sit here at the  
11 table with me since there are only five seats at the witness  
12 table.

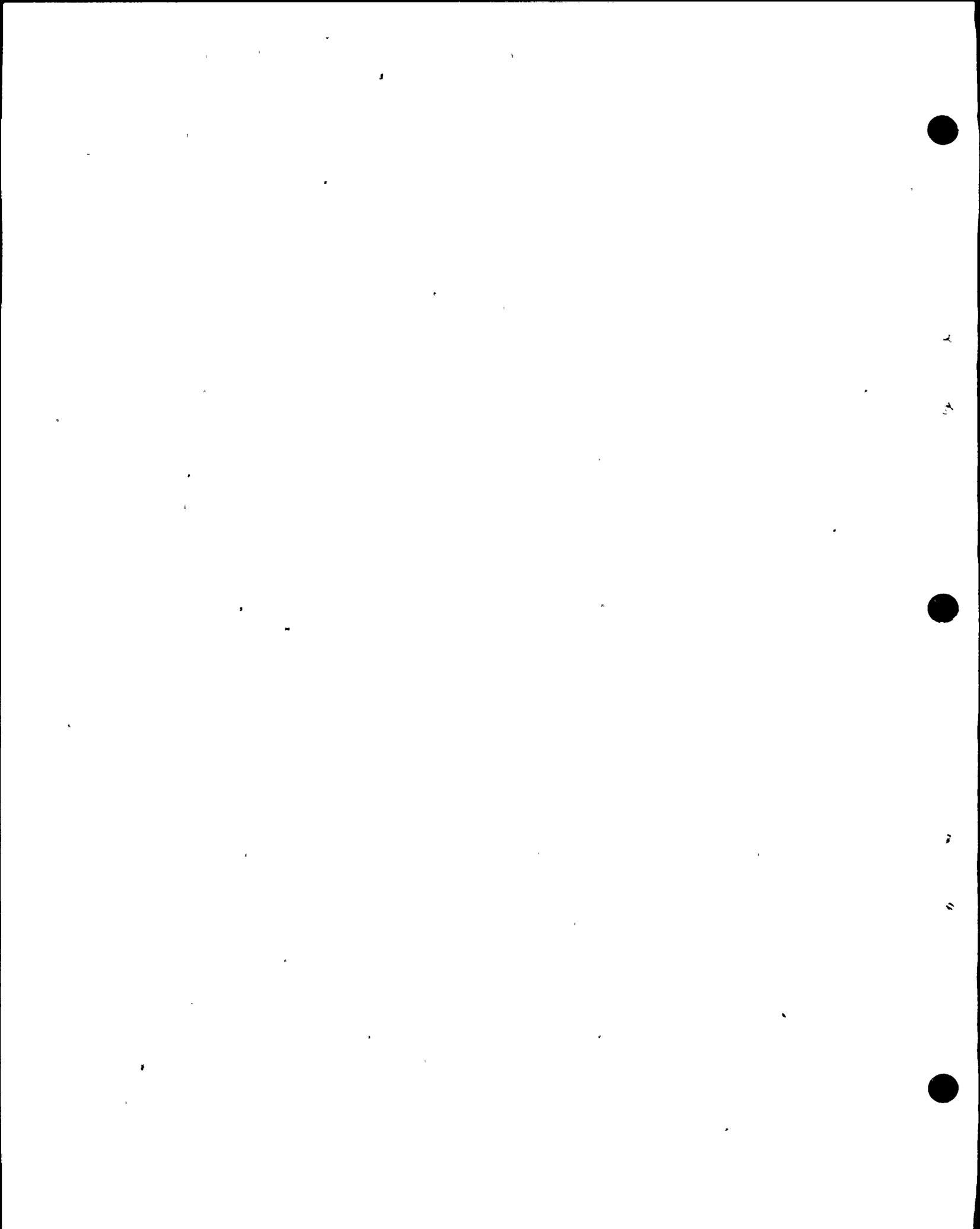
13 MRS. BOWERS: Wait a minute. We can add a  
14 chair. Isn't he a witness?

15 MR. NORTON: He's a panel member, but he's not  
16 giving direct testimony. And if a technical question should  
17 come up that he has to answer, then, you know, he can  
18 answer it.

19 As a matter of fact, in probability half the  
20 panel won't answer any questions, in all probability. But  
21 if a detailed question came up that they specifically worked  
22 on, why, that's why they're here.

23 MRS. BOWERS: Well let's take a minute to move  
24 him physically over to the panel.

25 MR. NORTON: Okay. Fine. We have no objection



WB/wb3

1 to that.

2 We just have two panels with six members. And,  
3 rather than trying to create a sixth place, we thought we  
4 would handle it this way.

5 MRS. BOWERS: Well, we could create a sixth place.

6 MR. NORTON: Okay.

7 MRS. BOWERS: Did you ever play for Notre Dame?

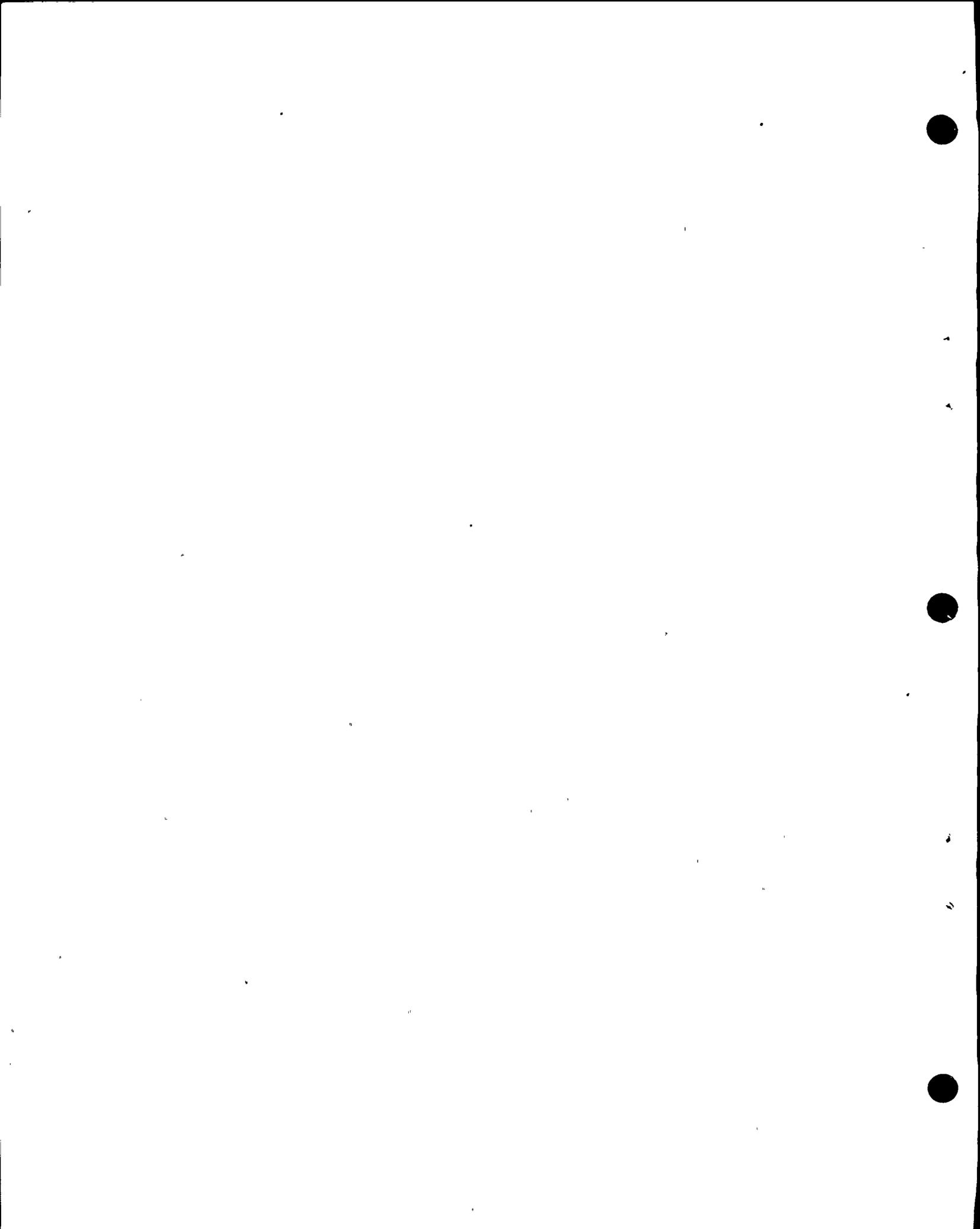
8 (Laughter)

9 MR. NORTON: Mrs. Bowers, if I might take a  
10 moment now. This first panel is going to deal with the  
11 containment structure. Many of the members of these panels  
12 will be on the next panel, too. The next panel, the only  
13 difference is Mr. Hanusiak will not be on it; Mr. Sokoloff  
14 will. And that deals with the auxiliary building.

15 The third panel deals with the intake structure,  
16 and Mr. Sokoloff will not be on that panel, nor will Mr. Malik  
17 or Mr. Jhaveri. But Mr. McLaughlin and Mr. Williams will  
18 take their places.

19 The fourth panel is the turbine building. And  
20 Mr. Ghio and Mr. Lang and Dr. Blume will still be on that  
21 panel. And they will be joined by Mr. Yokoyama and by  
22 Mr. C. M. Li.

23 Then finally the fifth panel will be outdoor  
24 tanks. And that's going to be Messrs. Ghio, Jhaveri, Rocha,  
25 Blume and Yokoyama.



1                   The way we intend to proceed is that Mr. Ghio  
2 has submitted prepared testimony on each of these structures,  
3 and he will give a very short resumé before each panel. He  
4 won't give them all now. He'll do just the containment  
5 structure.

6                   Whereupon,

7                   JOHN A. BLUME, VINCENT J. GHIO, DAVID A. LANG  
8                   STANLEY A. HANUSIAK, DILIP P. JHAVERI and  
9                   LINCOLN F. MALIK

10 were called to the stand as witnesses and, having been previ-  
11 ously duly sworn, were examined and testified as follows:

12                   DIRECT EXAMINATION

13                   BY MR. NORTON:

14                   Q     Mr. Ghio, first of all, do you have any corrections  
15 to the prepared testimony on the containment structures?

16                   A     (Witness Ghio) Yes, I do.

17                   MR. KETCHEN: Excuse me, Mrs. Bowers. I would ask  
18 if the gentlemen could be identified from left to right?

19                   MR. NORTON: That's an excellent idea. And I  
20 think it would be safer if they do it themselves.

21                   BY MR. NORTON:

22                   Q     Why don't you start off, Mr. Lang, and identify  
23 yourself, going from my left to my right. I don't know if  
24 that's everybody else's left to right.

25                   A     (Witness Lang) I'm Dave Lang with URS/Blume.



1 A (Witness Ghio) I'm Vincent Ghio with Pacific Gas  
2 and Electric.

3 A (Witness Malik) I'm Lincoln Malik with URS/Blume.

4 A (Witness Blume) I'd like to say it should be  
5 Doctor Malik and also Doctor Jhaveri, as long as we're being  
6 consistent on the record.

7 I am John Blume of URS/Blume.

8 Q And, to be consistent, it should be Doctor Blume.

9 A That doesn't matter.

10 A (Witness Jhaveri) I'm Dilip Jhaveri, URS/Blume.

11 A (Witness Hanusiak) Stanley Hanusiak, Pacific Gas  
12 and Electric.

13 Q All right, Mr. Ghio, could you go ahead and give  
14 us the corrections to your testimony now?

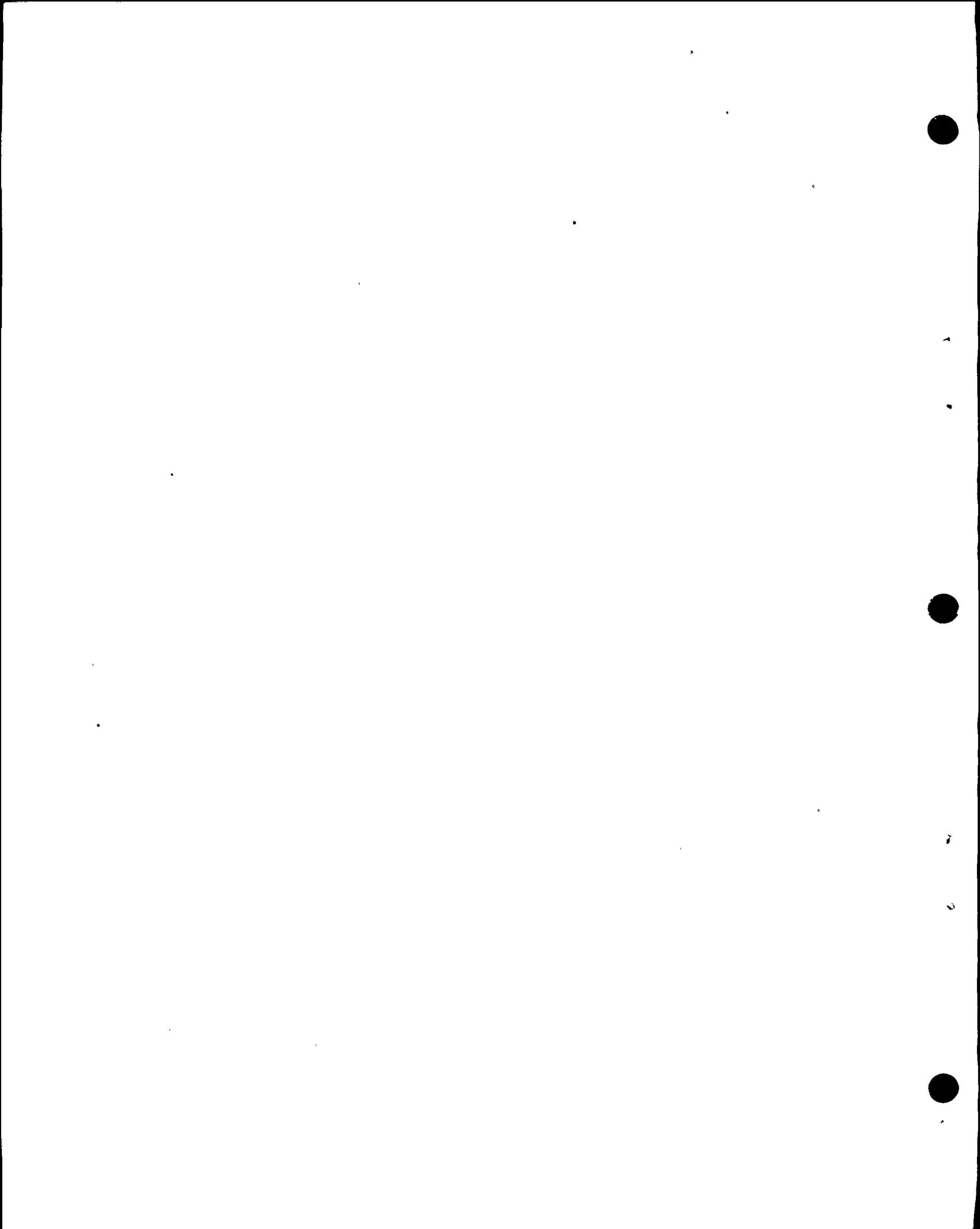
15 A (Witness Ghio) Yes. I have a few corrections  
16 to make on the first piece of testimony this morning which  
17 deals with -- which is entitled The Hosgri Analysis and  
18 Evaluation of the Containment Structure.

19 On page 2, line 19, strike the words "and  
20 vertical."

21 MRS. BOWERS: We already did. Mine's marked off.

22 WITNESS GHIO: Excuse me; I believe just prior to  
23 the recess we had started into this and then terminated. I  
24 couldn't recall at what point we terminated.

25 MR. NORTON: That's correct. We decided to do



1 the individual pieces as the panels came up. I do believe  
2 we had started this.

3 MRS. BOWERS: All right. Fine.

4 BY MR. NORTON:

5 Q Go ahead.

6 A (Witness Ghio) I think there's only one or two  
7 more. Why don't I just run through them and make sure  
8 everyone has them.

9 On line 21, the word "nodal" should be replaced  
10 with the word "nodal," which is spelled n-o-d-a-l.

11 On page 5, line 3, there's a formula there, and  
12 the second part of the formula after the number 100 should be  
13 enclosed by parentheses.

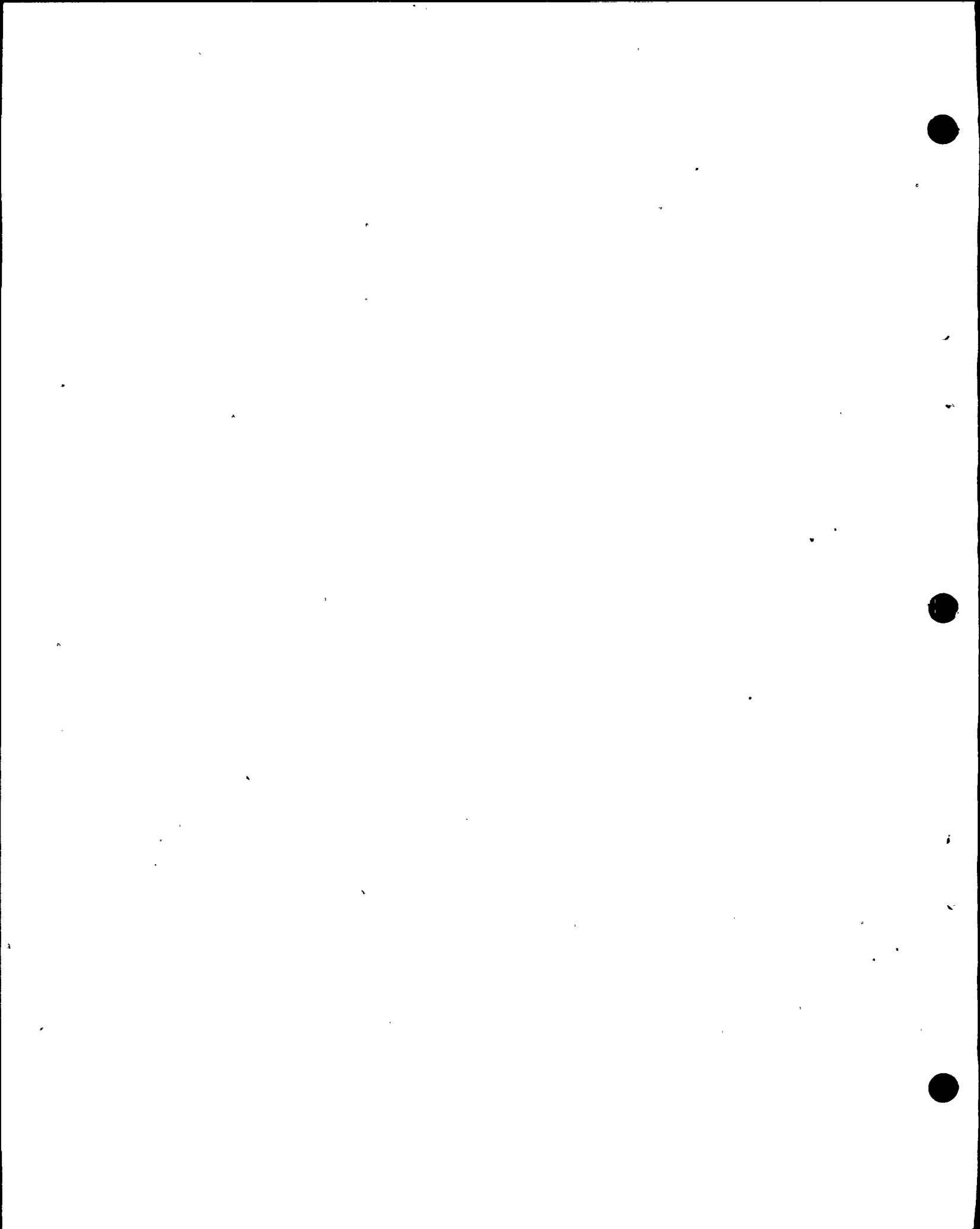
14 MRS. BOWERS: Say that again. Everything following?

15 WITNESS GHIO: Everything following the number 100.

16 The balance of that expression should be enclosed by  
17 parentheses.

18 Those are all the corrections on the first piece  
19 of testimony.

20 MR. NORTON: Excuse me. Before we go any further:  
21 Mr. Hubbard, or, actually, you, Steve, were cross-examining  
22 I believe it was Mr. Hoch about the turbine pedestal. And we  
23 had given a reference as to where an analysis was. And I believe  
24 we told you it was Chapter 4 of the Hosgri Report. Well, it  
25 is referenced in Chapter 13 that it would be in Chapter 4. But



1 it isn't yet formally in Chapter 4. But we do have a copy  
2 of the submission. It was Turbine Pedestal Report dated  
3 9/15/78 submitted to the NRC either the last week in  
4 September or the first week in October. And, of course,  
5 Mr. Hubbard wasn't furnished a copy of that. But we have a  
6 copy of that for him now, in any event.

7 We apologize for the mis-reference. But it just  
8 wasn't there; it was someplace else. And I wanted to get that  
9 cleared up before we went any further.

10 MR. KRISTOVICH: This deals with the piers on  
11 the turbine pedestal?

12 MR. NORTON: Yes.

13 BY MR. NORTON:

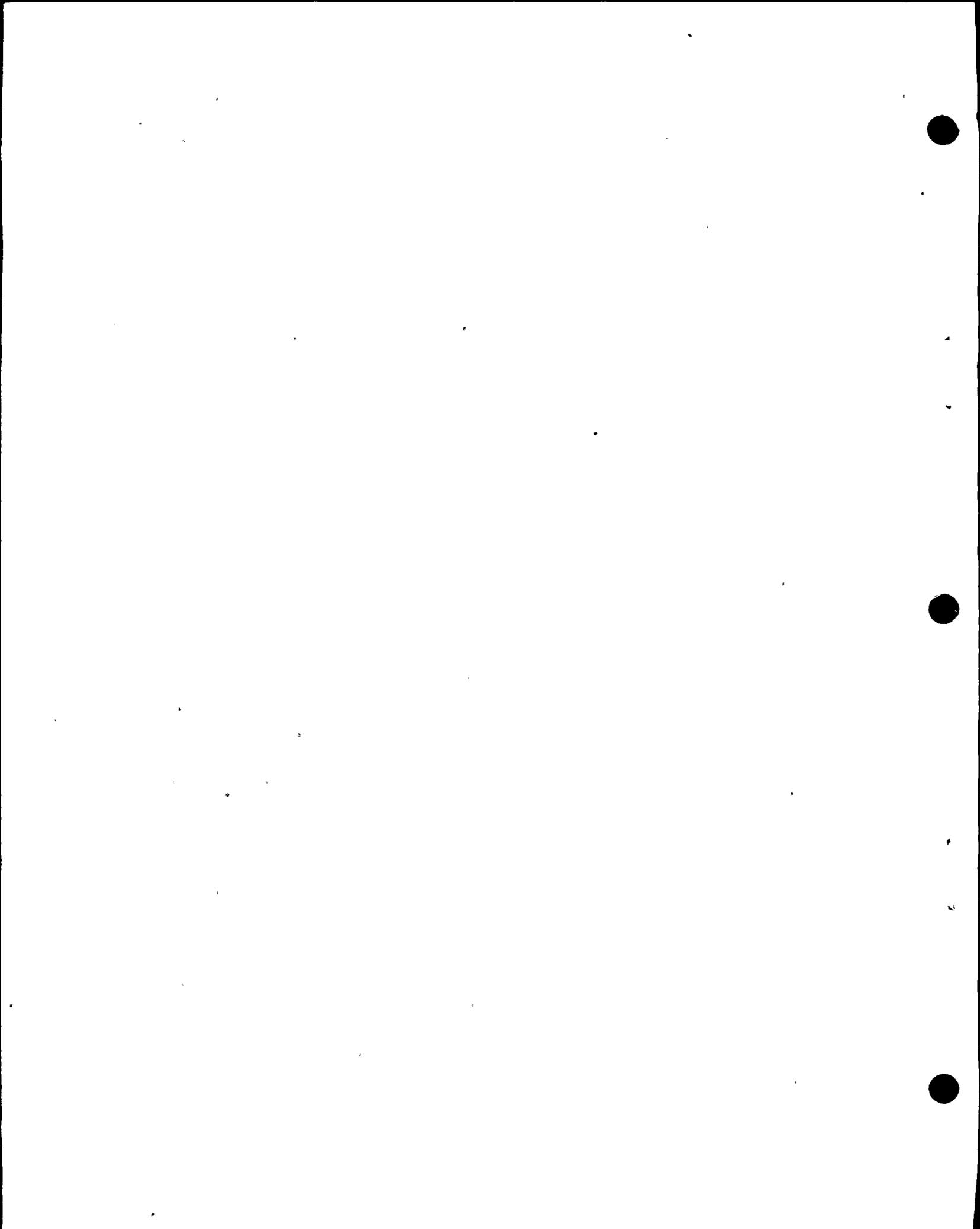
14 Q Okay, Mr. Ghio, would you proceed with your  
15 summary?

16 MRS. BOWERS: Well, what about the qualifications?

17 MR. NORTON: The qualifications of these witnesses  
18 are already all in evidence. And, as I stated earlier,  
19 with this many it doesn't make any sense to put them in the  
20 record as though read. So we will just leave them in as  
21 exhibits. And Mr. Ghio's were inserted as though read prior,  
22 and he is doing the summary.

23 MRS. BOWERS: Are there any corrections to any  
24 of them?

25 MR. NORTON: I suppose I should ask the panel



WPP/wb8  
1 members.

2 BY MR. NORTON:

3 Q Are there any corrections to any of your profes-  
4 sional qualifications that you're aware of that were submitted?

5 A (Chorus of "No.")

6 MR. NORTON: They're all indicating no by shaking  
7 their heads, so evidentially not.

8 BY MR. NORTON:

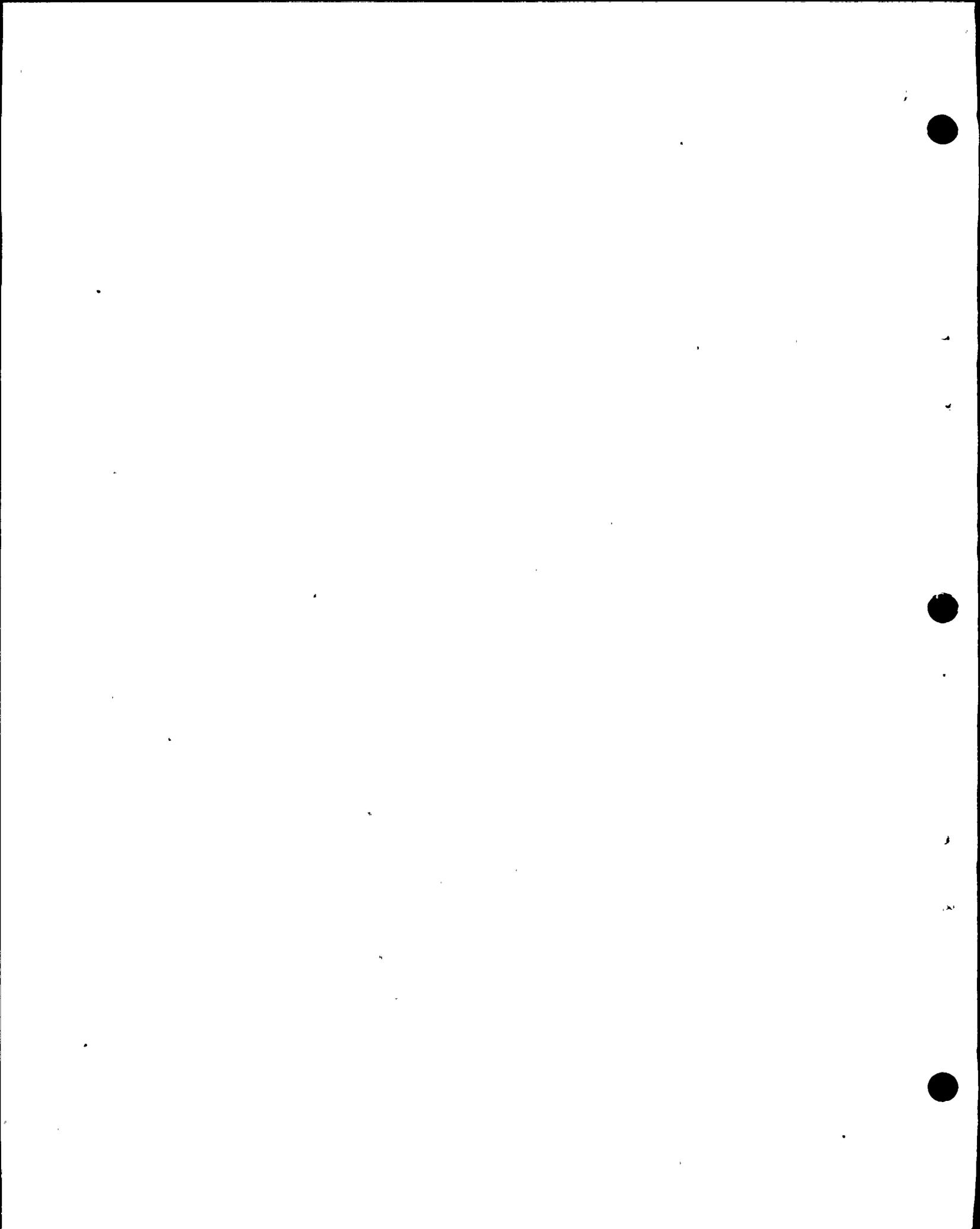
9 Q Will you proceed, Mr. Ghio?

10 A (Witness Ghio) I'll proceed with a brief sum-  
11 mary.

12 This first piece of testimony I would start out  
13 by emphasizing that what we're going to be talking about here  
14 today deals with the Hosgri analysis of the Diablo Canyon  
15 structures for a magnitude 7.5 earthquake.

16 Briefly, then, to summarize the testimony, the  
17 input to the containment structure was based on two independ-  
18 ently derived free field ground response spectra. When I  
19 say "independent" I mean we had two sets, one derived by  
20 Dr. Blume acting as consultant to Pacific Gas & Electric  
21 Company, and by Dr. Newmark acting as consultant to the Nuclear  
22 Regulatory Commission.

23 These structures' specific ground response spectra  
24 were developed from the free field spectra by spatial averag-  
25 ing of accelerations. The vertical spectra was taken equivalent



WRB/wb9

1 to two-thirds of the horizontal spectra. Equivalent  
2 acceleration timehistories were derived and used in the  
3 dynamic analysis of the building.

4 Fixed base mathematical models were used for the  
5 containment structure in accordance with the current NRC  
6 Standard Review Plan.

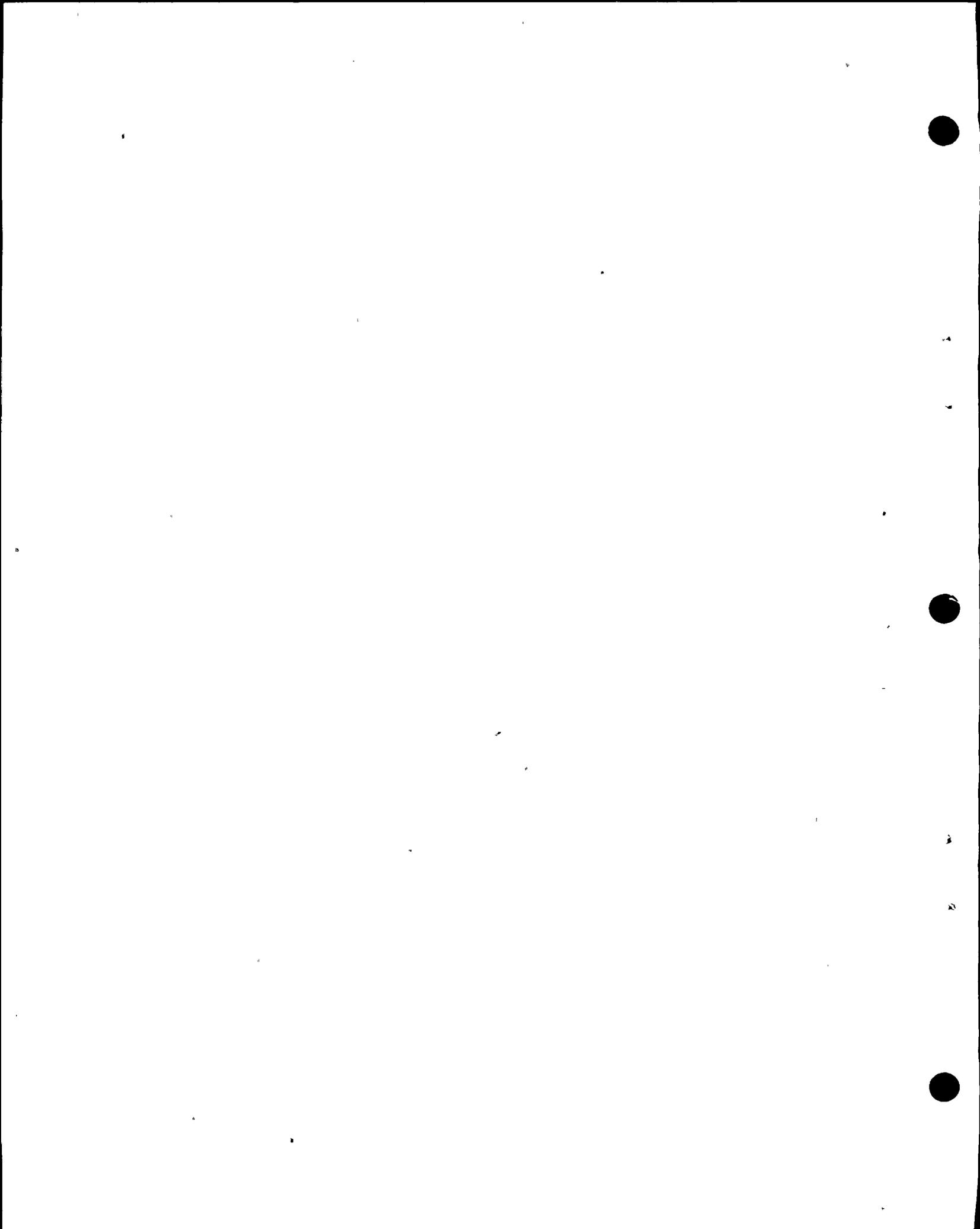
7 Three components of motion were combined and  
8 combined on the square root of the sum of the squares basis.  
9 We used 7 percent damping, which is the currently accepted  
10 value per NRC Regulatory Guide 1.61.

11 We used average concrete strengths in the analysis.  
12 By "average" I mean the analysis of actual test results of  
13 the concrete employed in the construction of the structure.

14 My testimony then goes on to describe the models  
15 used for the translational, torsional and vertical analysis.

16 I discuss how we applied torsion in the analysis.  
17 Briefly, we used a 5 percent torsion; that is, an eccentricity  
18 in the building equivalent to 5 percent of its overall  
19 dimension, and combined this with the horizontal results on  
20 an absolute sum basis. And, in addition, we used 7 percent  
21 eccentricity combined with the horizontal results on a  
22 square root of the sum of the squares basis. In all cases  
23 the 5 percent torsion, combined on an absolute sum basis,  
24 governed the result.

25 In addition, at the request of the NRC Staff

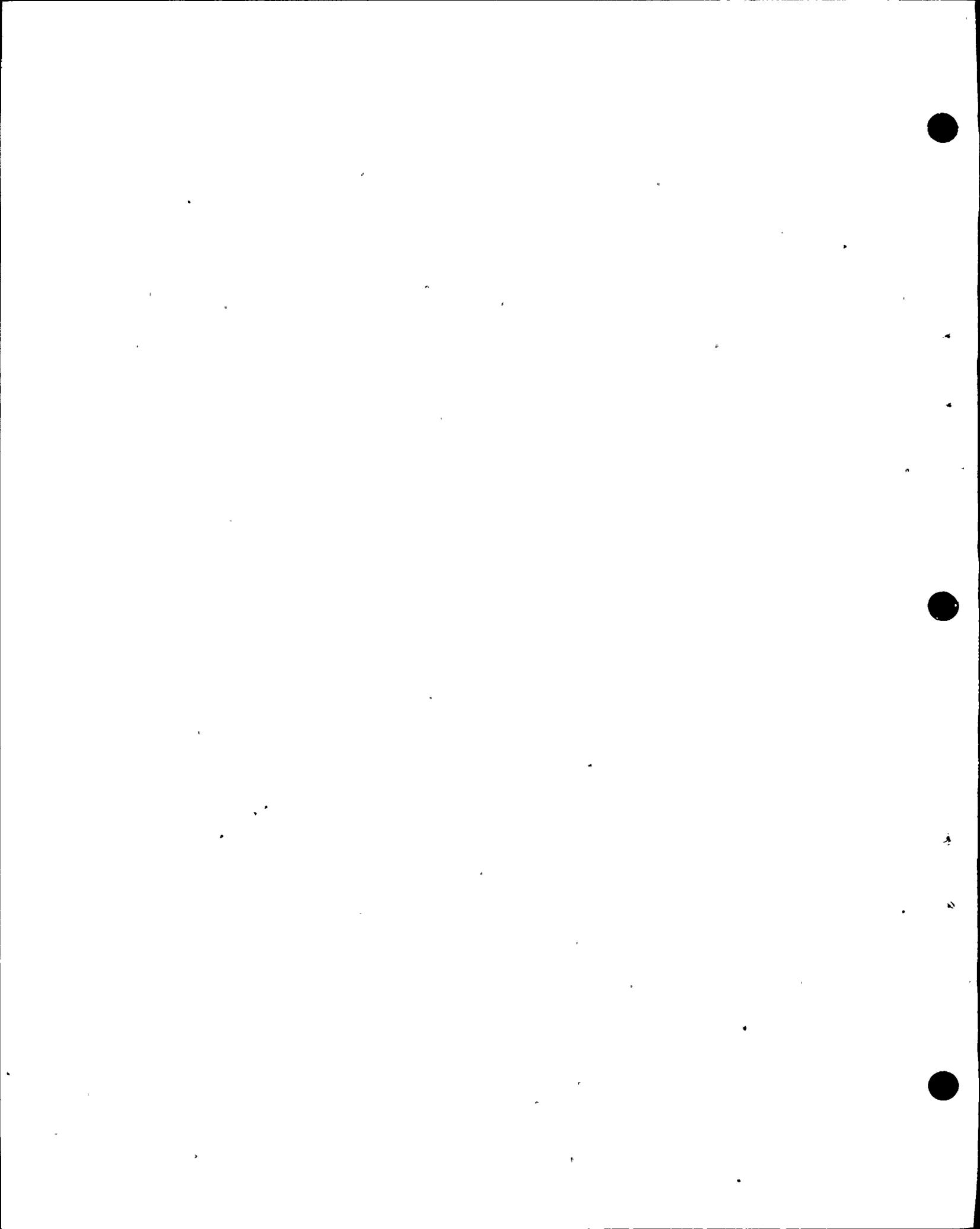


1 these calculated torsional responses were compared with  
2 responses derived by applying the Uniform Building Code  
3 procedures. The Uniform Building Code procedures consistently  
4 gave lower torsional responses.

5 The acceleration time histories used in the  
6 analysis of the structure were also used to calculate the  
7 floor response spectra within the structure. And these  
8 spectra were used as input in evaluating the components  
9 located within the structure.

10 In all cases the maximum response from either the  
11 Blume or Newmark basis were used in qualifying both the  
12 structures and the components located therein.

13 The structural evaluation was conducted in three  
14 phases. The first phase consisted of a review of the  
15 original calculations done for the original seismic criteria  
16 for the plant to determine an available reserve capacity  
17 for higher seismic loads. The second phase consisted of a  
18 comparison of the Hosgri results with the original results.  
19 If the original results exceeded the Hosgri results the  
20 element that we were reviewing was deemed qualified for the  
21 Hosgri condition. If the Hosgri results exceeded the DDE  
22 results the seismic reserve capacity was considered to deter-  
23 mine if it was sufficient to qualify the element for the  
24 Hosgri condition; if not, we conducted a detailed evaluation  
25 in Phase 3 of our overall evaluation of the structure.



WFR/wb11

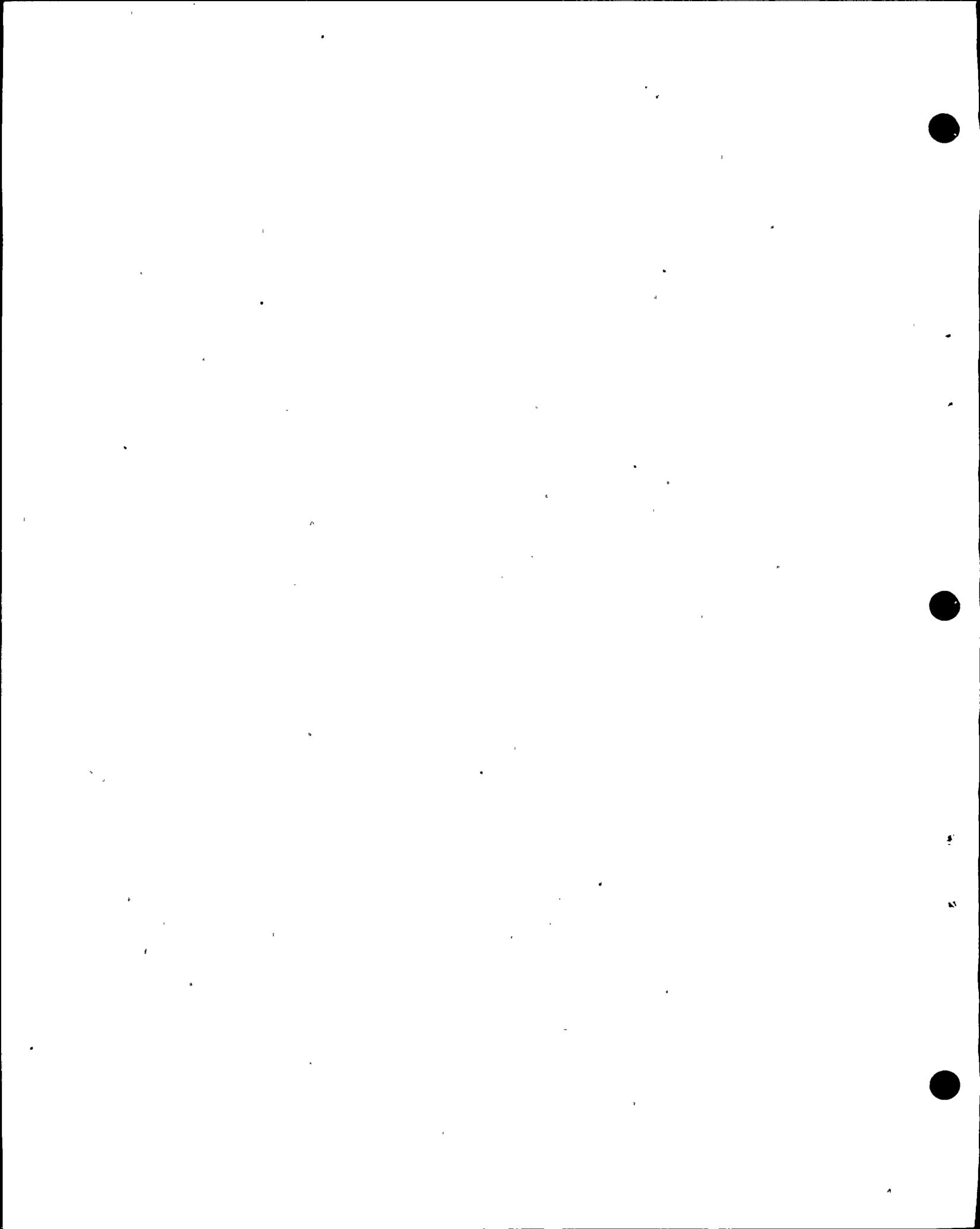
1 Table 1 which is appended to this first piece  
2 of testimony provides a comparison of controlling stresses  
3 in components that were selected for detailed evaluation.  
4 It also provides a seismic reserve capacity beyond -- for  
5 seismic loads beyond the magnitude 7.5 Hosgri.

6 I would point out that the maximum stresses in  
7 the containment were calculated by combining the loss of  
8 coolant accident loads with the Hosgri earthquake, and the  
9 results were all within the elastic limit of the materials  
10 involved.

11 This table that I just referenced also includes  
12 a value for seismic reserve capacity for seismic loads  
13 beyond the Hosgri. This capacity varies from 16 to 123  
14 percent.

15 In addition, a complete re-analysis of the annulus  
16 platforms was performed. The annulus platforms represent a  
17 piece of the structure located between the interior concrete  
18 portion of the containment and the exterior shell. We  
19 determined that some modifications, minor in nature, were  
20 necessary to qualify this area for the Hosgri earthquake.  
21 And these modifications have been completed, physically  
22 completed, and represent the only modifications deemed neces-  
23 sary to resist the Hosgri earthquake.

24 The testimony then goes on to discuss briefly  
25 the conservatism involved in combining the loss of coolant



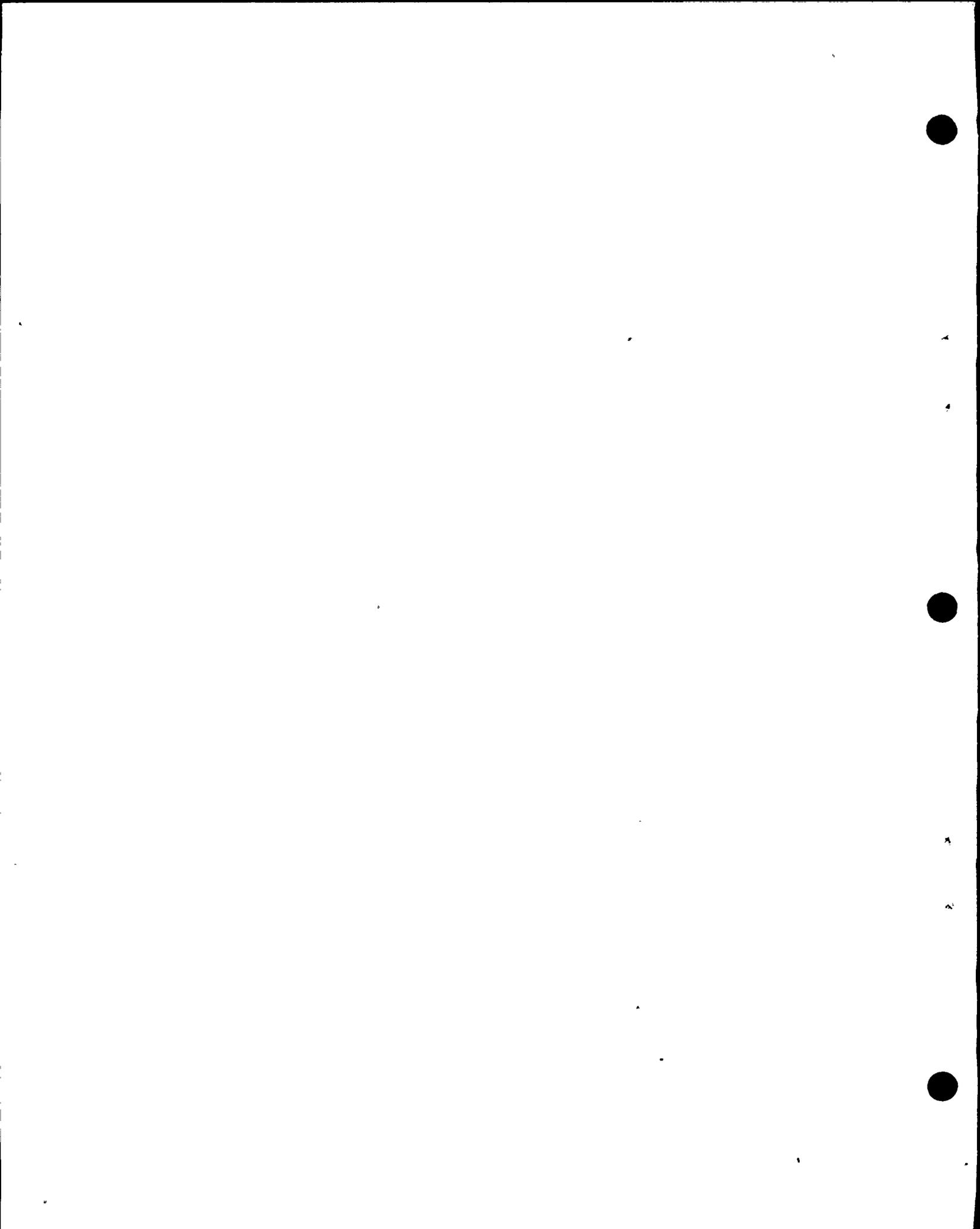
WFS/wb12 1 accident: load with the seismic load. We feel that this is a  
2 very conservative load combination in that the two phenomena  
3 do not peak -- their peak effects do not coincide in time,  
4 and the seismic stresses alone are insufficient to cause a  
5 loss of coolant accident.

6 The prepared testimony then briefly cites what  
7 we feel were some design innovations that were introduced  
8 at the time the containment structure was designed to enhance  
9 its seismic resistance regardless of what earthquake we're  
10 talking about.

11 Regarding containment structure stability, an  
12 analysis has been performed which has shown that the energy  
13 imparted to the structure by the Hosgri seismic input is  
14 less than 1 percent of that which is required to cause over-  
15 turning.

16 I close the prepared testimony by citing the  
17 fact that we have performed a pressure test, an internal  
18 pressure test of the containment to a test load 15 percent  
19 in excess of that which is associated with a loss of coolant  
20 accident, in accordance with Regulatory Guide 1.18. And we  
21 consider the successful performance of this test to represent  
22 a most important supplement to the analysis in the demonstra-  
23 tion of the structure's capability to perform its function.

24 In conclusion, the containment structure with  
25 the minor modifications made to its interior structure is



WRB/wb13 1 capable of resisting the postulated Hosgri earthquake.

2 That concludes my summary.

3 Q Mr. Ghio, just to make absolutely sure: Based  
4 on Mrs. Bowers' earlier questions, when you say -- and I quote  
5 again what you just said: "with minor modifications the  
6 containment structure is capable of resisting the postulated  
7 Hosgri earthquake," that is what magnitude earthquake?

8 A That represents a magnitude 7.5, Richter magnitude  
9 7.5 earthquake.

10 Q All right.

11 And the Blume and Newmark response spectra repre-  
12 sented what magnitude earthquake?

13 A A magnitude 7.5 earthquake.

14 Q All right.

15 MR. NORTON: That's all we have on direct.

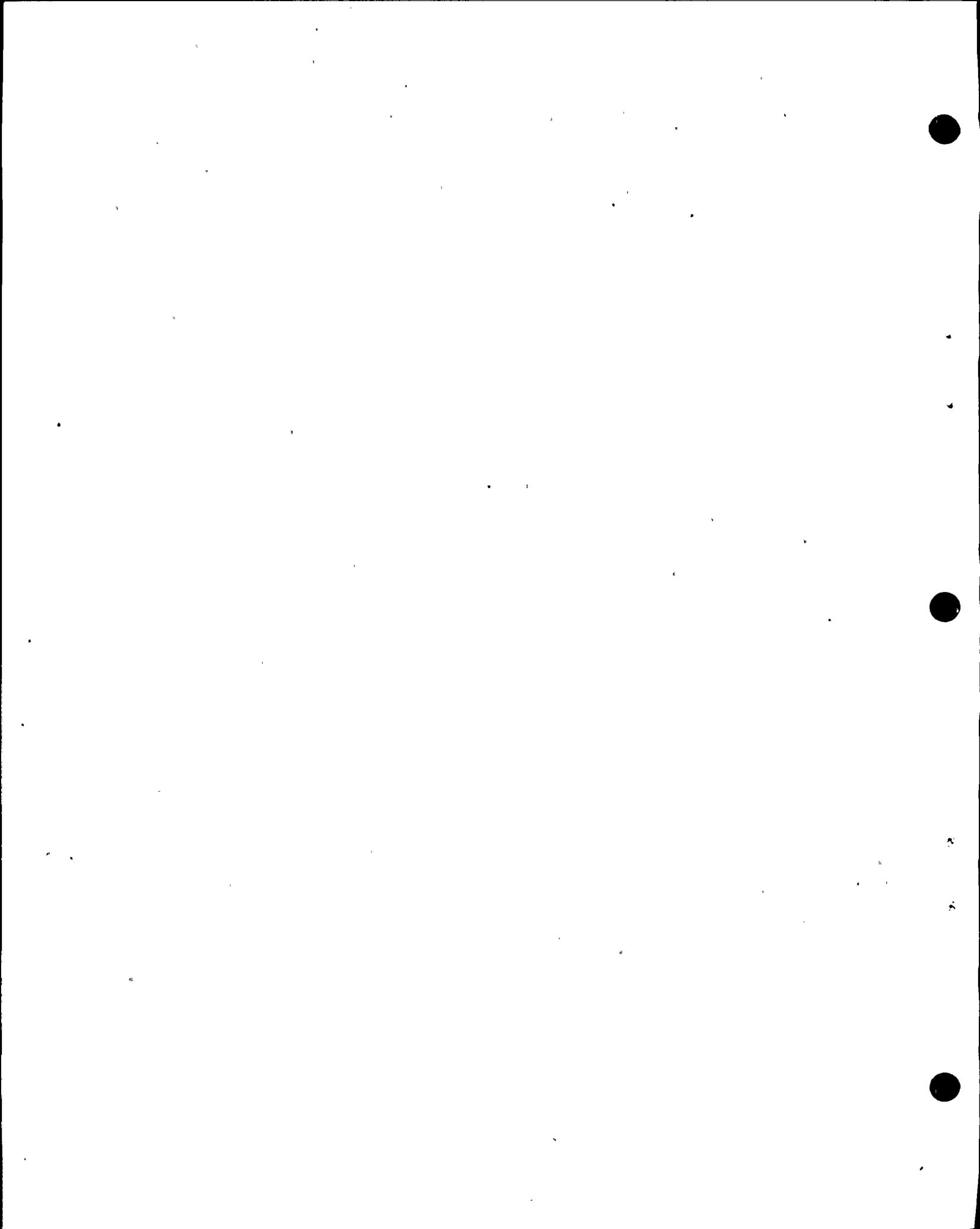
16 MRS. BOWERS: Mr. Kristovich?

17 MR. KRISTOVICH: Are you moving it into evidence  
18 at this time?

19 MR. NORTON: No, we're not moving it into evidence,  
20 but it should be placed in the record as though read. And  
21 we would ask that that be done at this time.

22 MRS. BOWERS: Any objection, Mr. Kristovich?

23 MR. KRISTOVICH: Mrs. Bowers, we would move to  
24 strike page 6, lines 10 through 13, as being outside the  
25 expertise of this witness. In addition, I believe there's



WRS/wb14

1 been no evidence up to this point, no testimony that the peak  
2 effects of the two events do not coincide in time.

3 MR. NORTON: Well, Mrs. Bowers, that's correct:  
4 no else has testified to that. But Mr. Ghio just did. And I  
5 guess he's moving to strike it because he hasn't heard it  
6 before. That's kind of a strange motion.

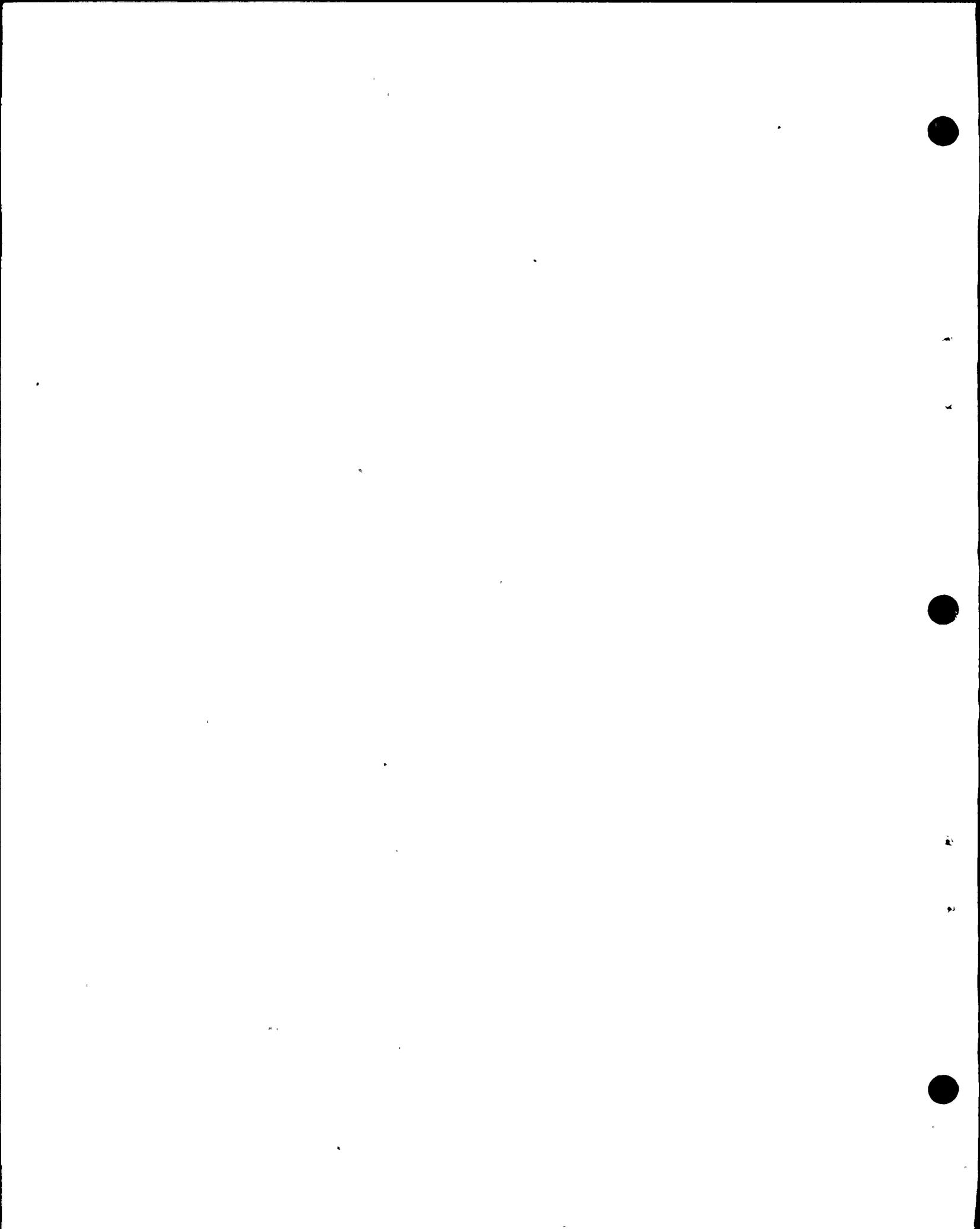
7 MR. KRISTOVICH: In addition to being outside the  
8 expertise of this witness.

9 MR. NORTON: Well I don't believe there has been  
10 any establishment that it is indeed outside the expertise of  
11 this panel. I would suggest that some voir dire or cross-  
12 examination be made before the motion is made. Because I  
13 think the panel is clearly qualified. If he wants to ask  
14 questions he'll certainly find that they are.

15 MR. KRISTOVICH: Are all the panel-- Well, I  
16 would like to know if all the panel members are adopting this  
17 written testimony.

18 MR. NORTON: Well as I understand, this testimony  
19 was prepared by URS/Blume and by Mr. Ghio working in concert  
20 together. And that's who is sitting at the panel, URS/Blume  
21 and PG&E's people. If he has cross-examination questions  
22 maybe he can ask them of the panel, as opposed to me.

23 MRS. BOWERS: Well, we've been following the pro-  
24 cedure of asking panel members if they do adopt the testimony.  
25 So let's follow that here.



WFB/wb15

1 MR. NORTON: Because we have so many, to speed  
2 up, may I ask the question this way:

3 BY MR. NORTON:

4 Q Is there anyone on the panel who does not adopt  
5 the testimony as their own? If so, please indicate.

6 A (No response)

7 MRS. BOWERS: The record will show silence.

8 Mr. Kristovich?

9 MR. KRISTOVICH: May I voir dire on this question?

10 MRS. BOWERS: Fine.

11 VOIR DIRE EXAMINATION

12 BY MR. KRISTOVICH:

13 Q Mr. Ghio, did you conduct the LOCA analysis  
14 on this plant?

15 A (Witness Ghio) No, I did not personally conduct  
16 it. I'm familiar with it. It was performed for us by the  
17 Westinghouse Corporation.

18 Q Did any member of this panel personally perform  
19 the LOCA analysis?

20 A Excuse me; perhaps I can clarify something here.

21 There are many aspects to the loss of coolant  
22 accident analysis. The part that deals with the system in  
23 which the loss of coolant accident is postulated to occur  
24 was performed for Pacific Gas & Electric Company by  
25 Westinghouse. The effects of that analysis in terms of



1 generation of pressures internal, within the containment  
2 structure, and the evaluation of the structure for those  
3 effects was performed by the members of this panel.

4 A (Witness Blume) I might also add that we're  
5 familiar with nuclear plants in general, and the general  
6 probabilities of such accidents as loss of coolant, or LOCA,  
7 and the time sequences over which they are involved. So I  
8 think that would fully qualify us to stand behind the statement  
9 on page 6 without doing the actual analysis on this particular  
10 plant per se.

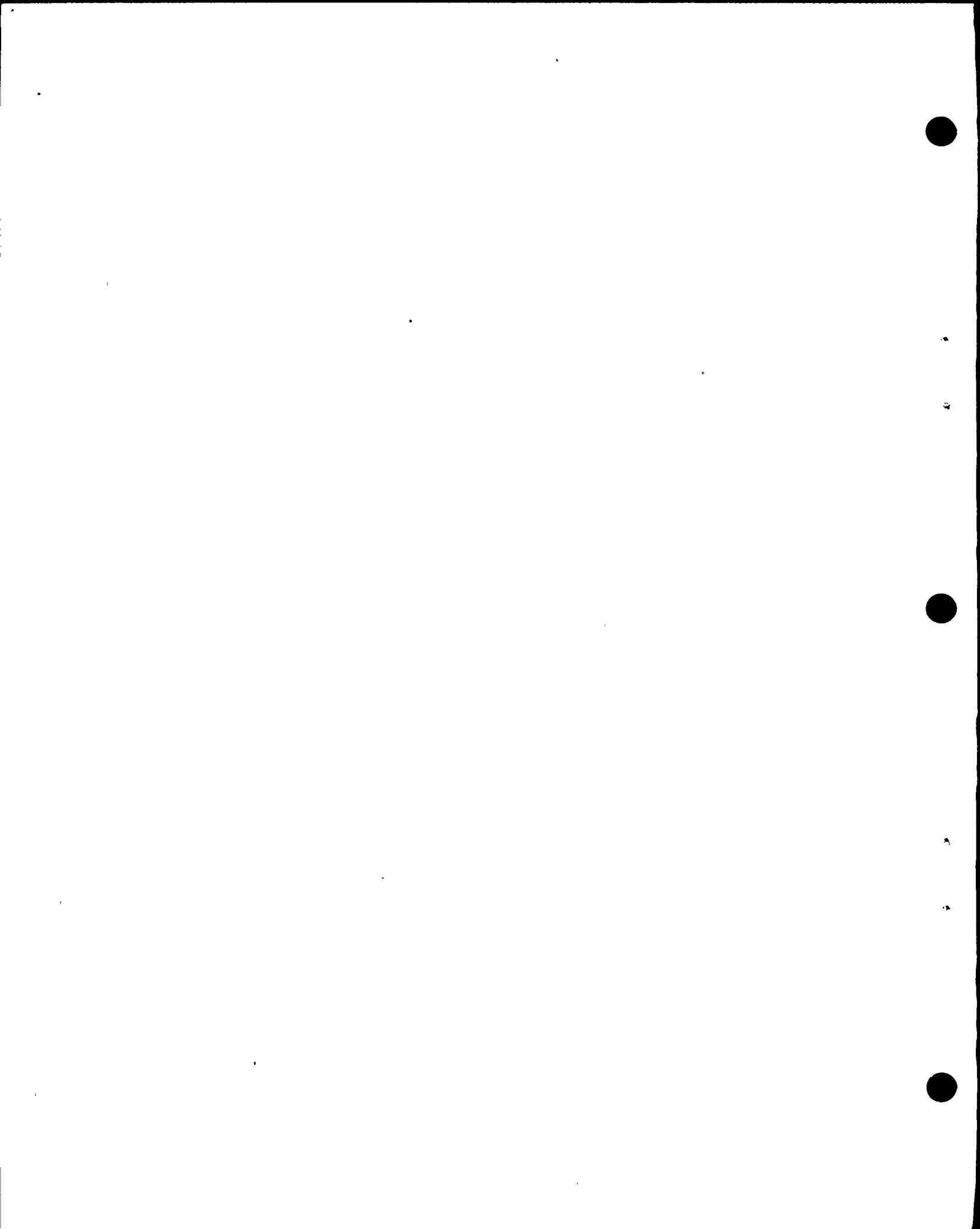
11 MR. KRISTOVICH: Well, Mrs. Bowers, we would  
12 still move to strike. They have not done the analysis.

13 MR. NORTON: What kind of analysis is there that  
14 they haven't done, Mrs. Bowers? I'm confused by the motion.

15 MRS. BOWERS: Mr. Kristovich, will you respond?

16 MR. KRISTOVICH: Well there are three conclusions  
17 stated on lines 10 through 13, that LOCA is considered a  
18 low probability occurrence; that seismic stresses alone are  
19 insufficient to initiate such an accident; that the peak  
20 effects of the two events do not coincide in time.

21 MR. NORTON: Mrs. Bowers, I think Dr. Blume just  
22 testified that-- You know, I don't know what more he can say.  
23 I guess what he's really saying is it's cross-examination and  
24 he feels that it goes to the weight of the evidence, that  
25 it is not very strong evidence because they haven't got the



wbl7

1 analysis. And I'm not sure which analysis they want. But  
2 they don't have an analysis in front of them to show that  
3 a LOCA is a low probability occurrence; which everyone knows  
4 to be the case; but they don't have an analysis for this  
5 plant that a LOCA is a low probability occurrence in front  
6 of them. That doesn't change their right-- Dr. Blume cer-  
7 tainly has a basis to form that opinion.

8 MRS. BOWERS: Does the Staff have a position on  
9 this motion, Mr. Ketchen?

10 MR. KETCHEN: One moment, if you please,  
11 Mrs. Bowers.

12 (Pause)

13 Mrs. Bowers, the Staff doesn't have a position  
14 on this, doesn't wish to be heard.

15 MRS. BOWERS: Well, Mr. Kristovich, we'll give  
16 you one more opportunity to respond to Mr. Norton.

17 MR. KRISTOVICH: Well, Mrs. Bowers, we would  
18 really merely reiterate that this analysis, the analysis under-  
19 lying these conclusions was done by Westinghouse, and on  
20 that basis we would move to strike it.

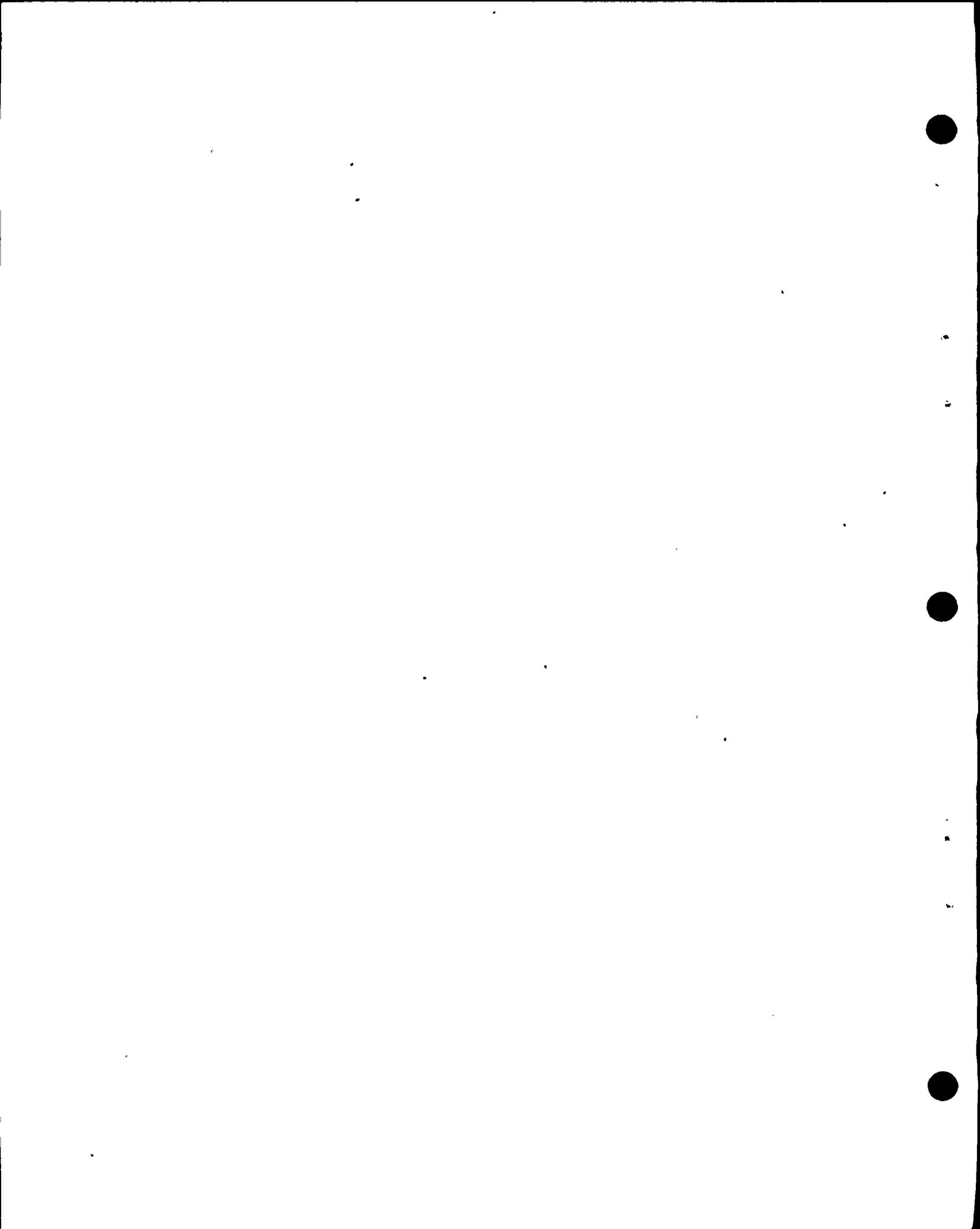
21 MR. NORTON: Excuse me, Mrs. Bowers. Mr. Hoch has  
22 just shown me the FSAR where these conclusions are already  
23 in evidence. I can read them.

24 Chapter 4, Summary and Conclusions, the Hosgri  
25 Analysis. The conclusion of Reference 1 is that "The

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WA 2A fls

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wb18

1 probability of a simultaneous occurrence of a seismic event  
2 and a loss of coolant accident is so remote that the events  
3 need not be combined." It's already in evidence.

4 MR. KRISTOVICH: That was one of them.

5 MR. NORTON: That's what you're moving to strike.  
6 That's the analysis you want.

7 In other words, the conclusion is already in  
8 evidence in the PSAR and the analysis is referenced in the  
9 FSAR.

10 MRS. BOWERS: Well the motion will be denied.  
11 The matter is in evidence.

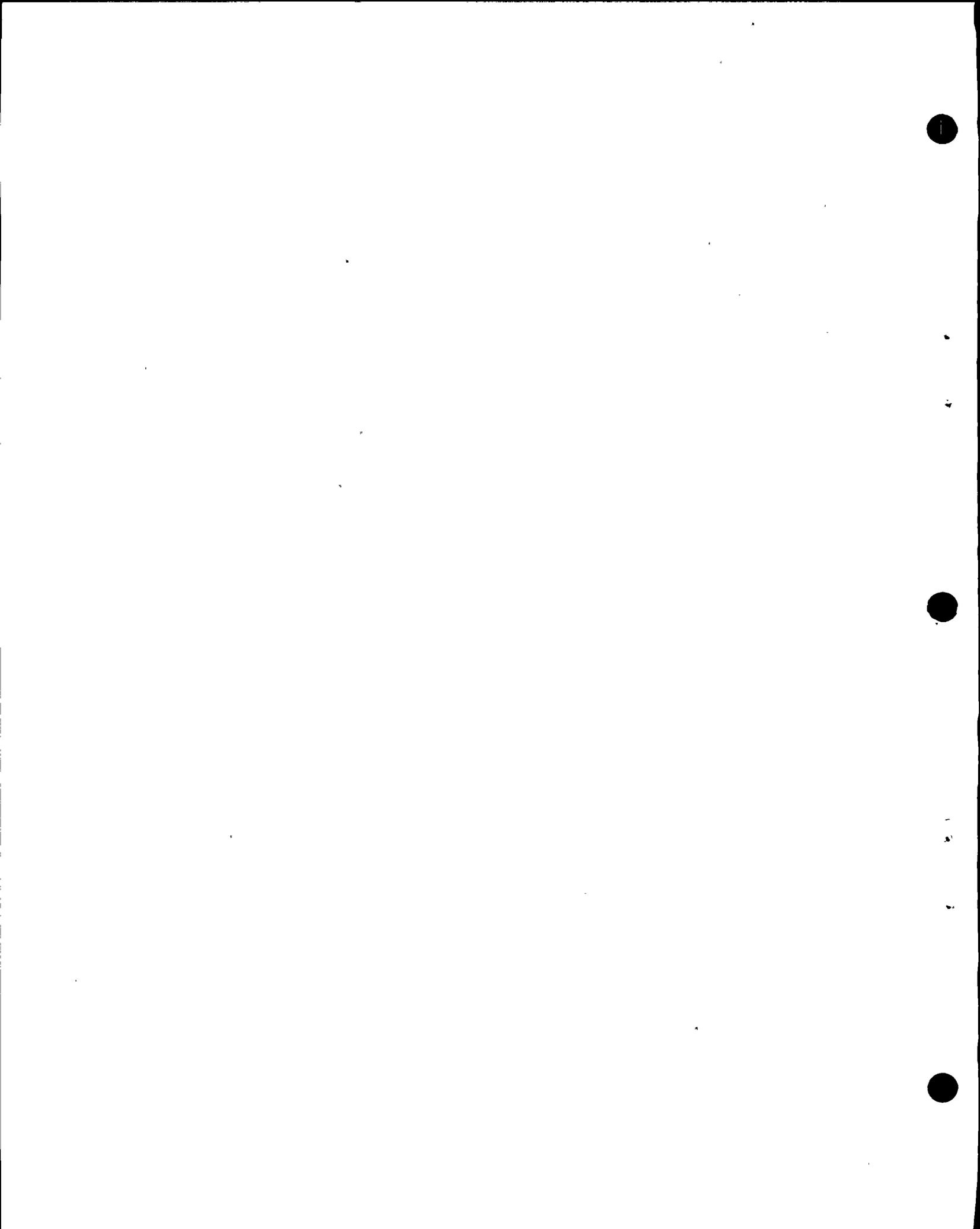
12 Mr. Norton, I know in the past we've had  
13 Westinghouse people observing. Are you having Westinghouse  
14 people testify?

15 MR. NORTON: Yes, Mr. Gangloff and Mr. Esselman  
16 will be here. They're scheduled later in the panels.

17 MR. BRIGHT: My only problem with the statement  
18 here, inasmuch as you say the analysis has been done and is  
19 in the FSAR, is in evidence, where does the seismic stresses  
20 alone are insufficient to initiate such an accident come  
21 from? Is that also in evidence?

22 WITNESS GHIO: I believe it is. But the basis  
23 of that statement is the analysis that was performed by the  
24 Westinghouse Corporation.

25 MR. NORTON: I'm sorry, Mr. Ghio; I didn't hear



B/wb19

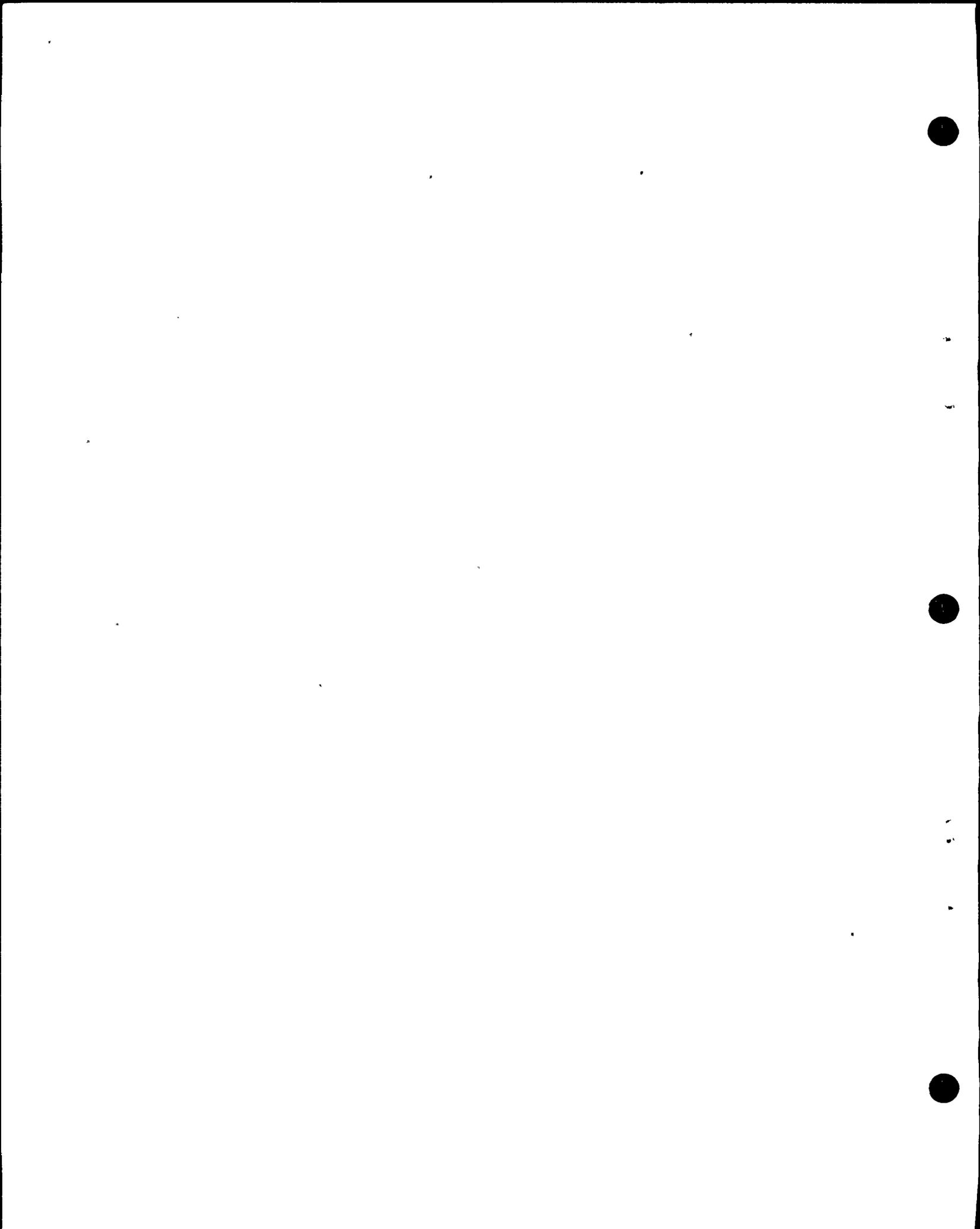
1 what you said.

2 WITNESS GHIO: The question was on the statement  
3 that seismic stresses alone are insufficient to initiate such  
4 an accident. The origins, or the basis for the statement is  
5 the results of analyses performed by the Westinghouse Corpora-  
6 tion for Pacific Gas & Electric.

7 MR. NORTON: Dr. Bright, I apologize for keeping  
8 saying the FSAR because I think we established that the Hosgri  
9 analysis and the Hosgri report was a part of the operating  
10 license application as opposed to the FSAR, and it's contained  
11 in those documents. But if you look at page 110.1-19 the  
12 references -- there are four references given. The first  
13 two references contain-- The second one is "Evaluation of  
14 the reactor coolant system for postulated loss of coolant  
15 accidents for the Diablo Canyon Nuclear Power plant," WCAP-9241,  
16 proprietary, WCAP-9242, non-proprietary, Westinghouse Electric  
17 Corporation, December 1977. And No. 1 is "Integrity of  
18 the primary piping systems of the Diablo Canyon Nuclear Power  
19 Plant during postulated seismic events," November 1977,  
20 Docket Nos. 50-275 and 50-323.

21 So those are the references that underlie those  
22 conclusions. And the Westinghouse people will be here on later  
23 panels. Dr. Esselman I believe is intimately familiar with  
24 those refern

25 MR. KRISTOVICH: Mrs. Bowers, if anything, I think



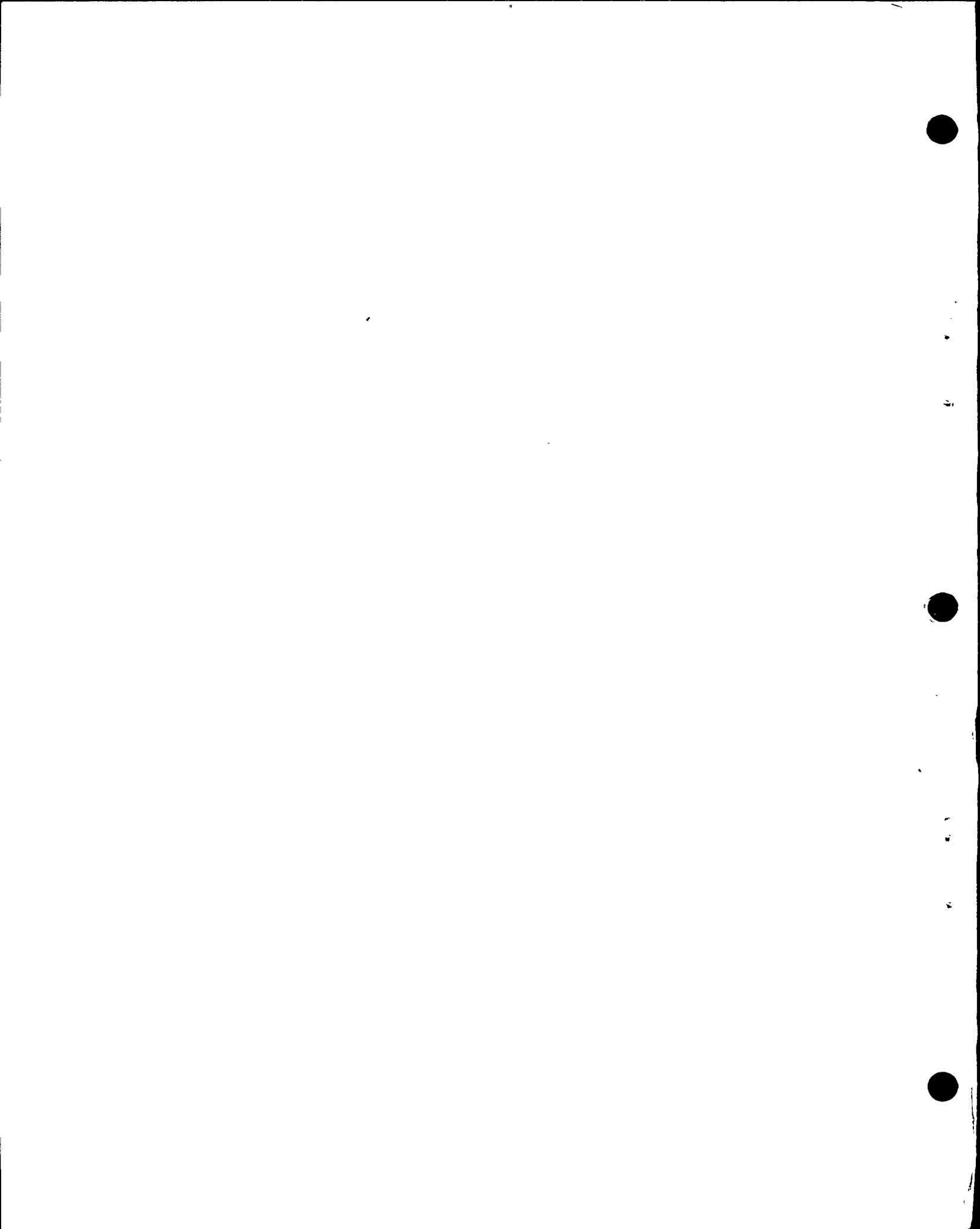
1 that just supports my motion to strike.

2 MR. NORTON: Mrs. Bowers, I disagree. The  
3 statements are already in evidence, the conclusions are already  
4 in evidence. And what we have here is an engineer, or a  
5 group of engineers doing an analysis. And they are given  
6 certain inputs. For example, Mr. Ghio is not qualified to  
7 postulate a 7.5 or a 6.5 or any other magnitude earthquake from  
8 the Hosgri: he's given those numbers as an engineer. He's  
9 probably also capable of doing a floor response spectra that  
10 Dr. Newmark and Dr. Blume did. But he is given those floor  
11 response spectra to do his analysis.

12 The fact that he didn't do the floor response  
13 spectra doesn't mean that he can't say, Well this is the floor  
14 response spectra we used, and these are the same kinds of  
15 conclusions. These are analyses done by consultants. Those  
16 consultants are available for cross-examination.

17 I don't know how you would start with witnesses.  
18 There have to be some givens. And the analyses are already  
19 in evidence.

20 MR. BRIGHT: Well maybe I could get rid of my  
21 problem fairly simply. You make three statements here  
22 which are in evidence evidently. But then you go ahead and  
23 say: All right, even though none of this kind of thing is  
24 going to happen we go ahead and we combine these loads and  
25 we determine that the containment structure is all right.



s/wb21

1 So what you're really doing is trying to make a  
2 statement which says: this is a very conservative way of doing  
3 things.

4 MR. NORTON: That's correct. Absolutely.

5 MRS. BOWERS: Well we have heard nothing in what  
6 was apparently further argument on reconsideration. The  
7 motion to strike is denied.

8 So, if you will proceed with your cross-examina-  
9 tion.

10 First we have before us the offer that this  
11 testimony be physically inserted in the transcript as if read.

12 MR. KRISTOVICH: No objection.

13 MRS. BOWERS: Mr. Ketchen?

14 MR. KETCHEN: No objection.

15 MRS. BOWERS: Well, the testimony that has been  
16 identified will be physically inserted in the transcript as  
17 if read.

18 (This testimony on containment structures follows)  
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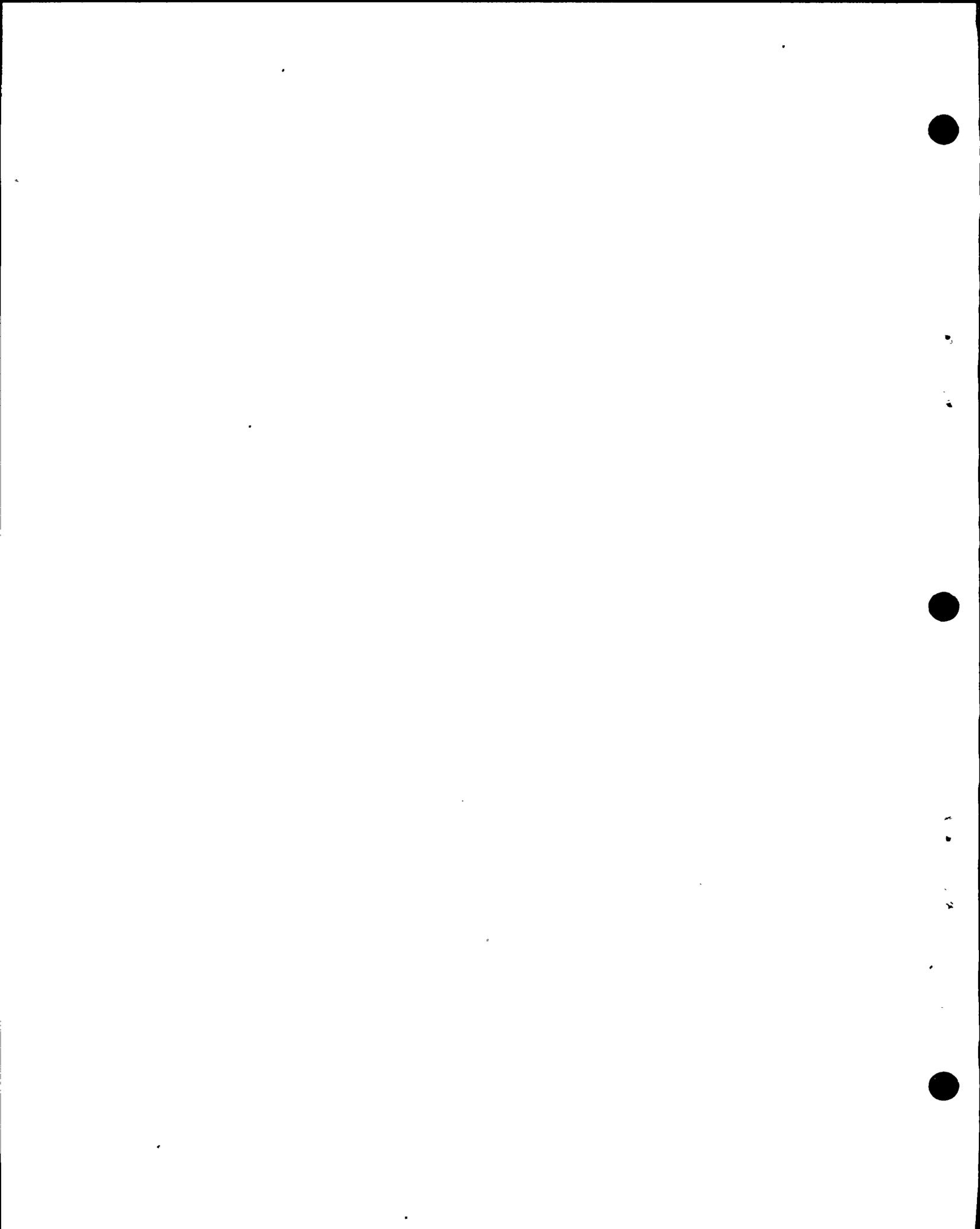
1 TESTIMONY OF  
2 VINCENT J. GHIO  
3 AND  
4 LINCOLN EDGAR MALIK  
5 ON BEHALF OF  
6 PACIFIC GAS AND ELECTRIC COMPANY  
7 DECEMBER 4, 1978  
8 DOCKET NOS. 50-275, 50-323

9 HOSGRI ANALYSIS AND EVALUATION  
10 OF THE CONTAINMENT STRUCTURE

11 The seismic input to the Containment Structure was  
12 based on two horizontal motion free field ground response  
13 spectra developed independently by Nathan M. Newmark, con-  
14 sultant to the NRC staff, and URS/John A. Blume & Associates,  
15 Engineers, consultant to PGandE. Structure specific ground  
16 response spectra were developed from the free field spectra  
17 by spatial averaging of accelerations. This procedure  
18 depends on the shear wave velocity through the underlying  
19 rock and the foundation size. The horizontal components of  
20 the earthquake were conservatively taken as being equal.  
21 The vertical component of the ground motion was taken as  
22 two-thirds of the horizontal free field ground response  
23 spectrum.

24 The structure specific ground response spectra  
25 were used to derive equivalent acceleration time histories  
26 for use in the dynamic analysis of the building.

The final ground motion input to the Containment  
Structure consisted of two horizontal acceleration time  
histories, referred to as the Blume and Newmark time histories,



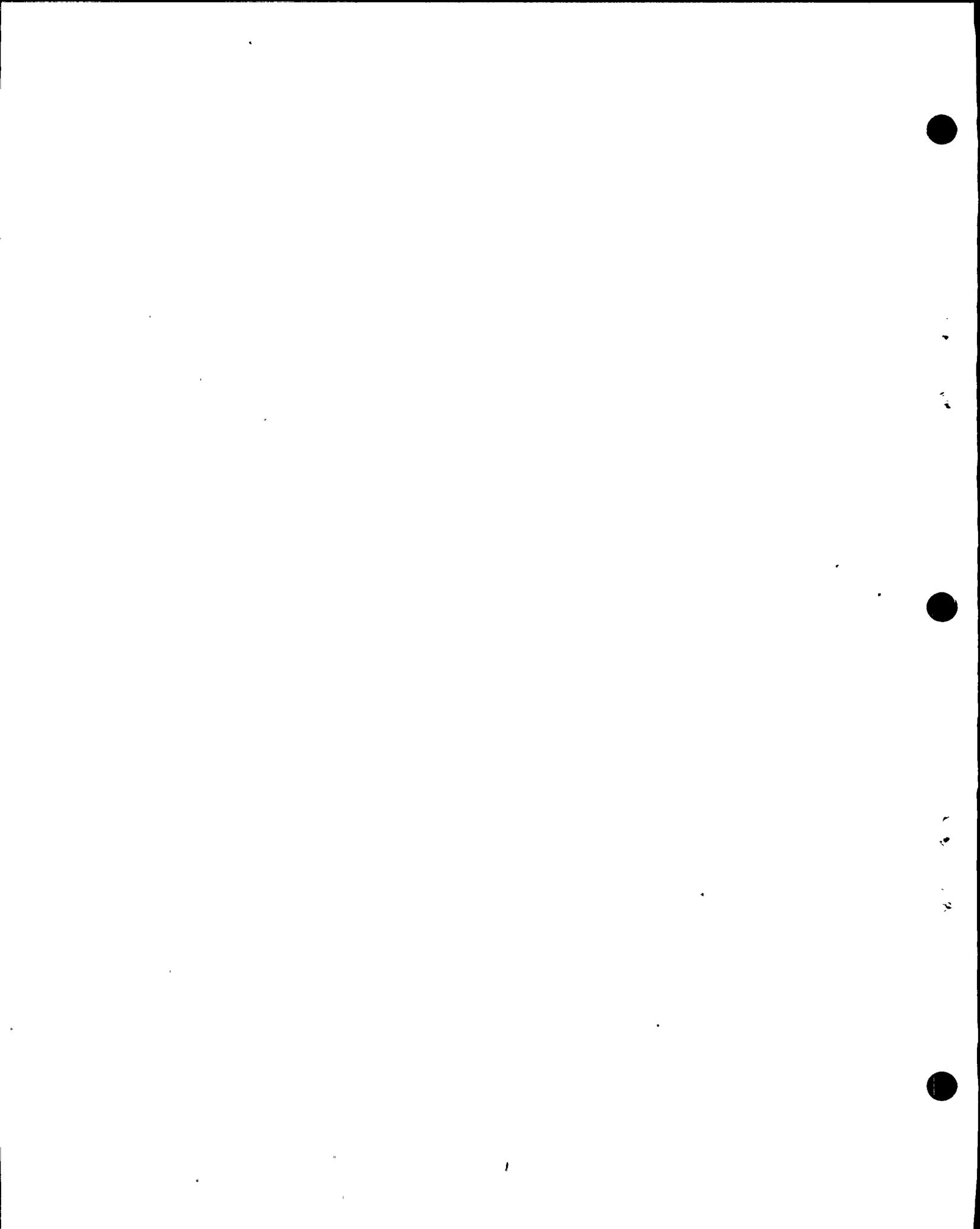
1 and one vertical acceleration time history based on two-thirds  
2 the Newmark free field ground response spectra. A vertical  
3 acceleration time history was not developed for the Blume  
4 free field response spectra, as the Newmark free field  
5 spectra enveloped the Blume spectra virtually everywhere.

6 The Containment Structure was analyzed using a  
7 fixed base mathematical model in accordance with the current  
8 NRC Standard Review Plan. The response to the three components  
9 of ground motion were calculated separately and were combined  
10 on a square root of the sum of the squares basis.

11 The Containment Structure was analyzed using 7%  
12 damping according to the currently accepted NRC Regulatory  
13 Guide 1.61. The concrete strength used was based on test  
14 values for the concrete taken during the construction of the  
15 Containment Structure with no allowance for the increase in  
16 strength associated with aging effects.

17 An axisymmetric, finite element model, shown in  
18 Figure 1, was used to calculate the response of the Contain-  
19 ment Structure to the horizontal and vertical components of  
20 the ground motion. The elements used in the analysis consist  
21 of annular rings such that each model point shown in Figure 1  
22 represents the circumference of a shell element. The equivalent  
23 mass density used for each element reflects the masses of  
24 attached mechanical equipment, shell liner plates, and all  
25 other associated masses, as well as the concrete mass density.

26



1           The torsional response was calculated from the  
2 mathematical models shown in Figures 2 and 3. Two models  
3 were developed for both the exterior and interior structures,  
4 one having an "accidental eccentricity" of 5% of the overall  
5 dimension of the structure, and the other a 7% "accidental  
6 eccentricity". The torsional response from 5% and 7%  
7 "accidental eccentricity" were combined with the horizontal  
8 translational response on an absolute sum and square-root-of-  
9 the-sum-of-the-squares basis, respectively. The absolute  
10 sums of the torsional effects due to 5% eccentricity and the  
11 translational response were consistently the controlling  
12 combination. At the request of the NRC staff, such calculated  
13 torsional responses were compared with responses using  
14 procedures outlined in the Uniform Building Code (UBC). The  
15 UBC procedures consistently gave lower torsional responses.

16           The response of the exterior structure to the  
17 vertical component of the ground motion was calculated using  
18 the finite element model shown in Figure 1. The vertical  
19 response of the Containment interior was calculated using  
20 the lumped mass model shown in Figure 4.

21           The acceleration response time histories at appro-  
22 priate locations in the Containment Structure were used to  
23 calculate floor response spectra at different elevations in  
24 the exterior and interior structures. These spectra were  
25 used as input motions for the seismic qualification of  
26 safety related equipment located in the Containment Structure.



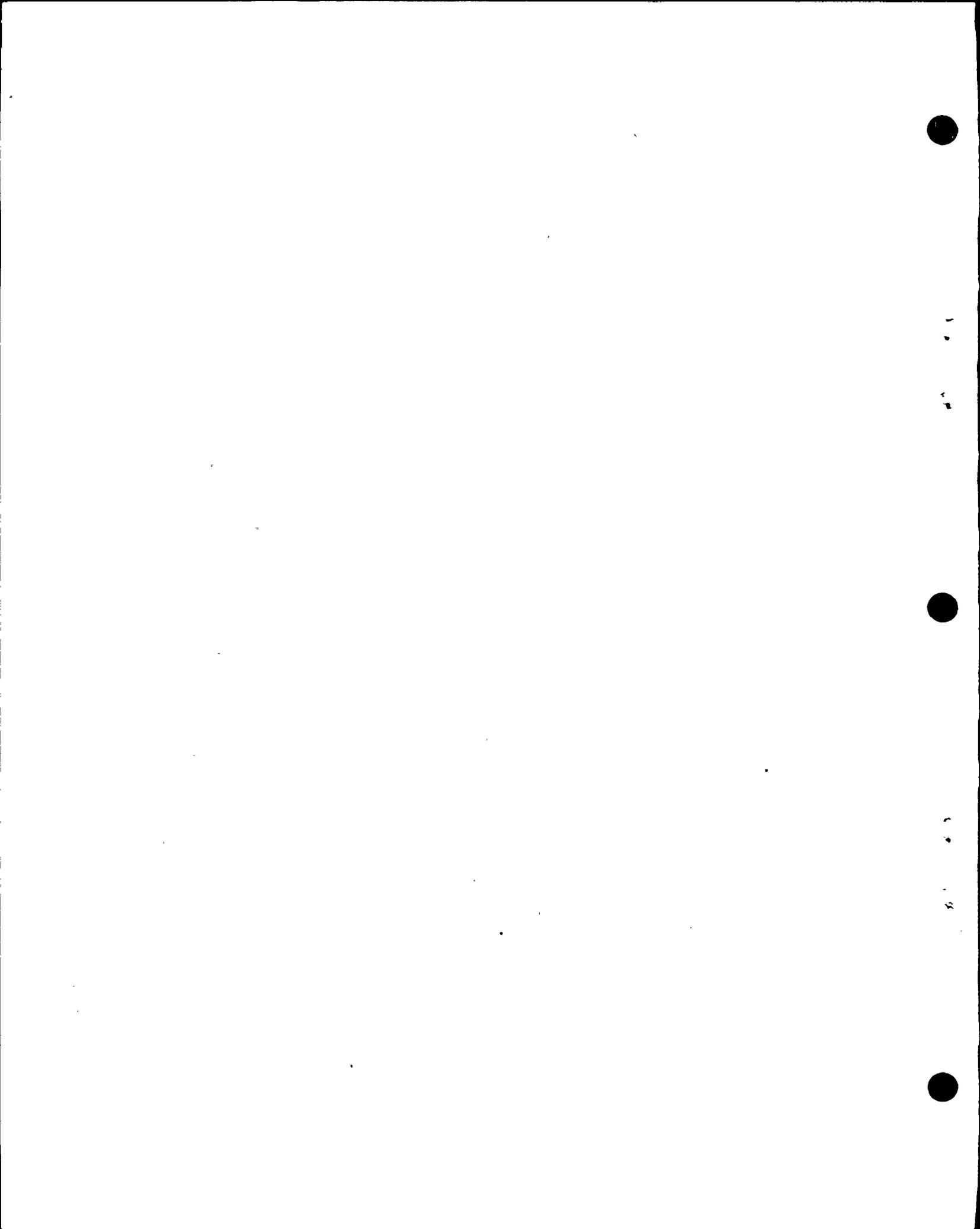
1           The maximum response from the Blume or Newmark  
2 ground motions were used in qualifying the structures and  
3 components in the Containment Structure. Thus, the more  
4 conservative results of two analyses using independently  
5 derived inputs developed by two leading authorities in  
6 seismic design were utilized.

7           The structural evaluation of the Containment  
8 Structure for the response to the Hosgri earthquake was  
9 accomplished in three phases:

10           1. Systematic review of the original calculations  
11 to extract and summarize the results for the Double Design  
12 Earthquake (DDE) analysis and to determine an available  
13 reserve capacity for higher seismic loads.

14           2. Comparison of the Hosgri dynamic analysis  
15 results with the DDE dynamic analysis results for the various  
16 elements of the structure. If the DDE results exceed the  
17 Hosgri results, the element in question was deemed qualified  
18 for the Hosgri condition. If the Hosgri results exceeded  
19 the DDE results, the seismic reserve capacity was considered  
20 to determine if it was sufficient to qualify the element for  
21 the Hosgri conditions. If not, the detailed evaluation of  
22 phase three was undertaken.

23           3. Detailed evaluation of elements identified in  
24 Phase 2. Table 1 provides a comparison of controlling  
25 stresses in components selected for detailed evaluation. It  
26 also provides the seismic reserve capacity for seismic loads



1 beyond the postulated 7.5M Hosgri event calculated as follows:

2  
3 
$$SR = 100 \frac{S_a - S}{S_h} - 1$$

4 Where:

5 SR = seismic reserve capacity  
6  $S_a$  = acceptance limit stress  
7  $S^a$  = stresses due to non-seismic loads  
8  $S_h$  = stresses due to Hosgri loads

9 Maximum stresses due to the combination of loss-of-  
10 coolant accident (LOCA) loads and the Hosgri earthquake are  
11 within the elastic limit of the materials involved. Seismic  
12 reserve capacity for the elements in the tabulation vary  
13 from 16% to 123%.

14 Figure 5 provides a plot of nonseismic and seismic  
15 stresses due to both the Double Design and Hosgri earthquakes  
16 for the containment shell reinforcing steel. These stresses  
17 are within the allowables at all points in the shell.

18 In addition, a complete re-analysis of the annulus  
19 platforms was performed. These platforms, constructed of  
20 structural steel, are located in the annular space between  
21 the interior structure of the containment and the containment  
22 shell and provide support for various piping systems and  
23 components. This analysis identified some members requiring  
24 minor modification. These modifications have been completed  
25 and represent the only physical modifications to the Con-  
26 tainment Structure found necessary to resist the load combi-  
nations involving the Hosgri earthquake.



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1           As noted earlier, the basic function of the Contain-  
2 ment Structure is to prevent the release of radioactivity to  
3 the environment in the event of a postulated loss-of-coolant  
4 accident. This accident would cause the internal pressure  
5 within the containment to reach a maximum of 47psi approximately  
6 7-1/2 minutes after initiation of the event. The postulated  
7 Hosgri earthquake time history is of 24 seconds duration  
8 with the strongest motion commencing at about 5 seconds  
9 and terminating at about 15 seconds into the event.

10           A loss-of-coolant accident is considered a low  
11 probability occurrence. Seismic stresses alone are insuffi-  
12 cient to initiate such an accident. The peak effects of the  
13 two events do not coincide in time. Nevertheless, seismic  
14 stresses were combined with LOCA stresses on an absolute  
15 sum basis as part of the safety evaluation of the Containment  
16 Structure. The structure was found to be capable of resisting  
17 this conservative load combination.

18           It should be noted here that seismic design provisions  
19 have been of paramount importance throughout the course of  
20 the analysis and design program for the structures. In the  
21 case of the Containment Structure, for example, certain design  
22 innovations were introduced to enhance its seismic resistance  
23 such as:

24           1. A triangular/geodesic pattern of reinforcing  
25 steel which is particularly efficient in resisting seismic  
26 shear was used in the containment shell.



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1           2.    The shell reinforcing was fabricated and  
2 installed in continuous loops with both ends anchored in  
3 the containment foundation mat. This detail eliminates the  
4 potential for bond failure in the containment shell.

5           3.    The resulting reinforcing steel pattern was  
6 less congested than other designs and enabled a 1-foot  
7 reduction in shell thickness, which translated to a reduction  
8 in seismic loads of approximately 20%.

9           4.    This reduced the weight of the superstructure  
10 and, together with the 14-1/2-foot thick base mat, lowered  
11 the center of gravity of the structure, thus improving its  
12 stability characteristics.

13           Regarding Containment Structure stability, an analysis  
14 has been performed which has shown that the energy imparted  
15 to the structure by the seismic input is less than 1% of that  
16 required to cause overturning. This analysis, together with  
17 a more conventional analysis which also yielded an adequate  
18 safety factor against overturning, demonstrates containment  
19 stability for the postulated seismic load combinations.

20           Regarding the stresses calculated in the containment  
21 shell reinforcing steel, it should be noted that the containment  
22 steel liner plate has been disregarded as a stress resisting  
23 element. This is a conservative assumption, as the liner  
24 plate is capable of resisting approximately 25% of the  
25 combined loads.

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The Containment Structure has been pressure tested to a test load 15% in excess of that associated with a loss-of-coolant accident (i.e.,  $1.15 \times 47 = 54\text{psi}$ ) in accordance with Regulatory Guide 1.18. The performance of the structure during the test indicated that its structural capacity under the test conditions met or exceeded the acceptance criteria and an evaluation of the test results corroborated the predicted results determined by analysis, thus validating the analytical assumptions and methodology. We consider the successful performance of the containment structural integrity test to represent an important supplement to the analysis in the demonstration of the structure's capability to perform its function.

In conclusion, the Containment Structure, with minor modifications made to its interior structure, is capable of resisting the postulated Hosgri earthquake.



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**TABLE 1**  
**COMPARISON OF CONTROLLING STRESS COMBINATIONS**  
**DDE vs. 7.5M HOSGRI**

LOCATION	LOAD / LOAD COMBINATION (KSI)						SEISMIC RESERVE CAPACITY
	0.95D	LOCA/ RUPTURE	DDE	HOSGRI	0.95D +LOCA +DDE	0.95D +LOCA +HOSGRI	
Exterior shell, El. 166' (terminal point of the inner layer of diagonal bars). Stresses in diagonal reinforcing (KSI)	-8.4	28.0	26.8	40.7	46.4	60.3	16%
Exterior shell, El. 89' (base of the wall). Stresses in diagonal reinforcing.	-9.2	18.7	28.3	44.4	37.8	53.9	29%
Interior structure, circular crane wall — El.91' (base of the wall). Stresses in vertical reinforcing.	w/o Jet Force	-13.2	8.5	43.7	38.6	39.0	85%
	w/Jet Force	-13.2	18.7	51.3	41.9	56.9	
Steam generator shield structure — Vertical reinforcing stresses.	Negligible	21.5	14.1	20.9	35.6	42.4	123%
Steam generator shield structure — Horizontal reinforcing stresses.	—	26.0	22.1	27.7	48.1	53.7	52%



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2/3



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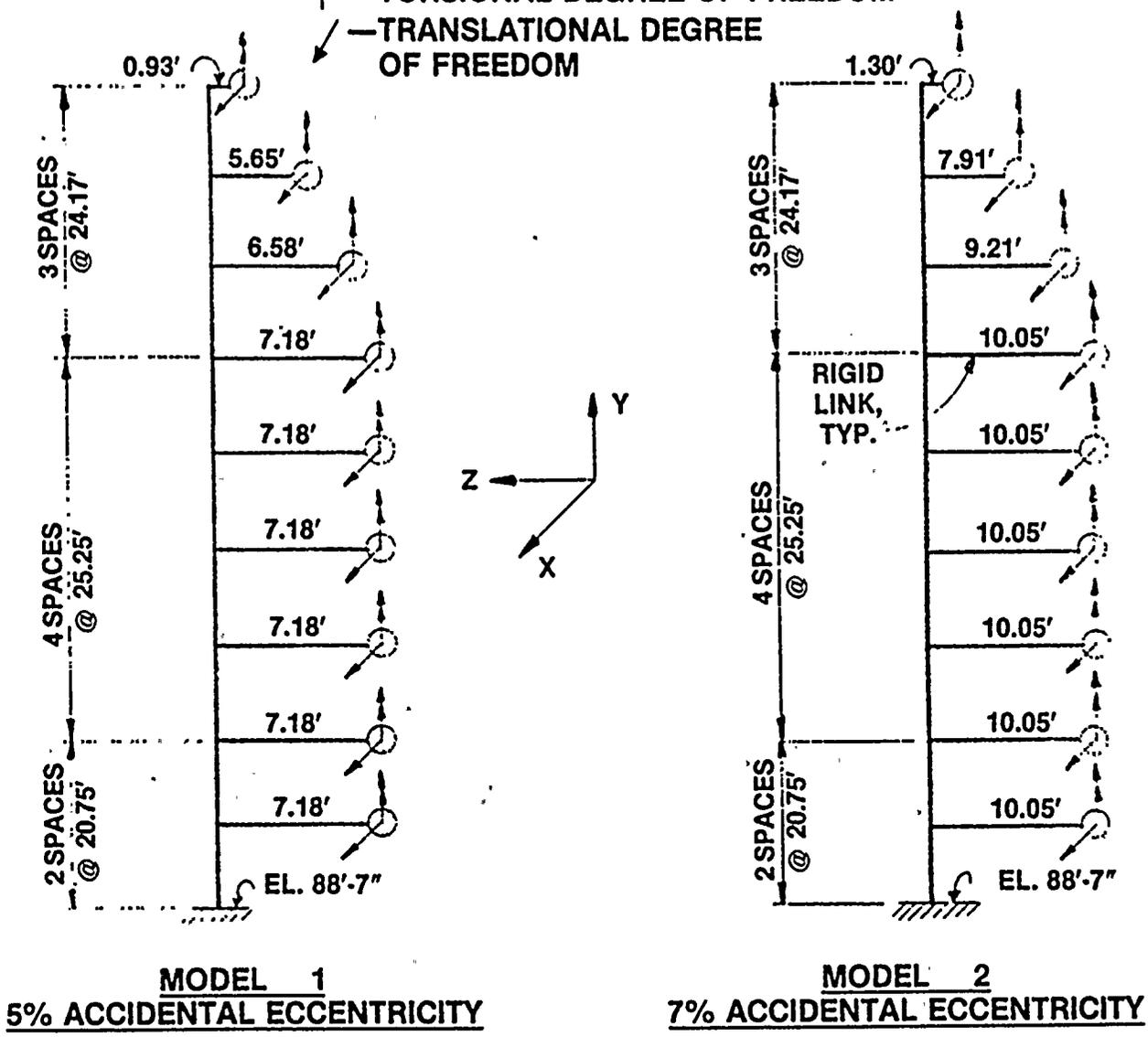


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**LEGEND:**

- — MASS POINT
- ↑ — TORSIONAL DEGREE OF FREEDOM
- ↙ — TRANSLATIONAL DEGREE OF FREEDOM



**DIABLO CANYON NUCLEAR**  
**POWER PLANT UNIT NO. 1**

**FIGURE NO. 2**



1952

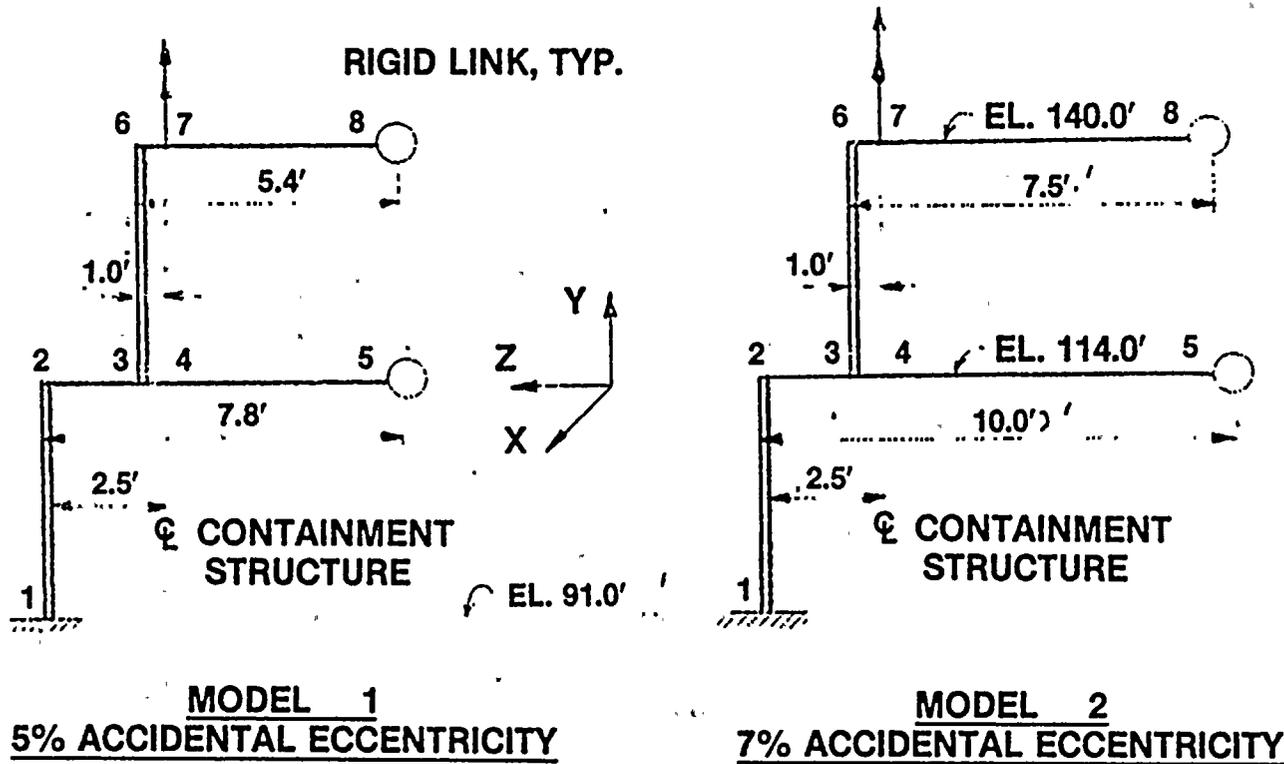


1953



**LEGEND:**

- — MASS POINT
- ↑ — TORSIONAL DEGREE OF FREEDOM
- ↙ — TRANSLATIONAL DEGREE OF FREEDOM



**CONTAINMENT INTERIOR STRUCTURE**  
**MATHEMATICAL MODEL FOR HORIZONTAL**  
**AND TORSIONAL ANALYSIS**

**DIABLO CANYON NUCLEAR**  
**POWER PLANT UNIT NO. 1**

**FIGURE NO. 3**



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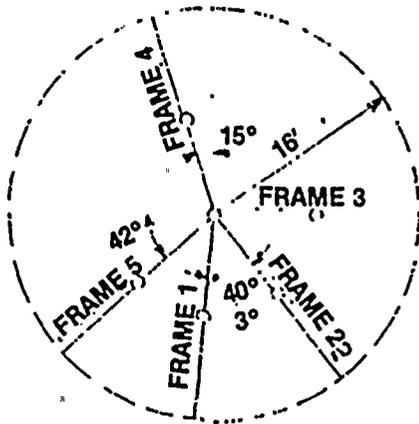


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Q CONTAINMENT

Q CONTAINMENT



**LEGEND:**

□ — ELEMENT NUMBER

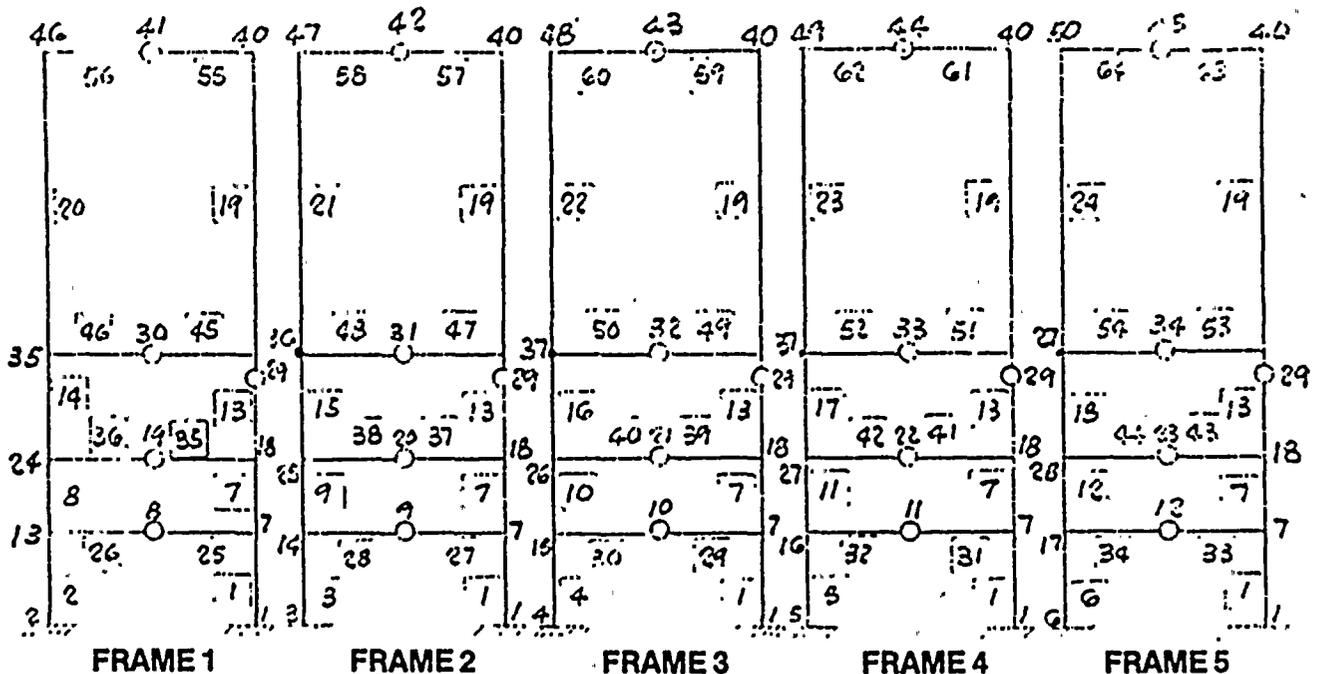
2 — NODE NUMBER

○ — MASS POINT

**NOTE:**

NODES 1, 7, 18, 29 AND 40 ARE ALONG Q OF STRUCTURE AND ARE COMMON TO ALL FIVE FRAMES

**PLAN**



**ELEVATIONS**

**CONTAINMENT INTERIOR STRUCTURE**

**MATHEMATICAL MODEL FOR VERTICAL ANALYSIS**

**DIABLO CANYON NUCLEAR  
POWER PLANT UNIT NO. 1**

**FIGURE NO. 4**

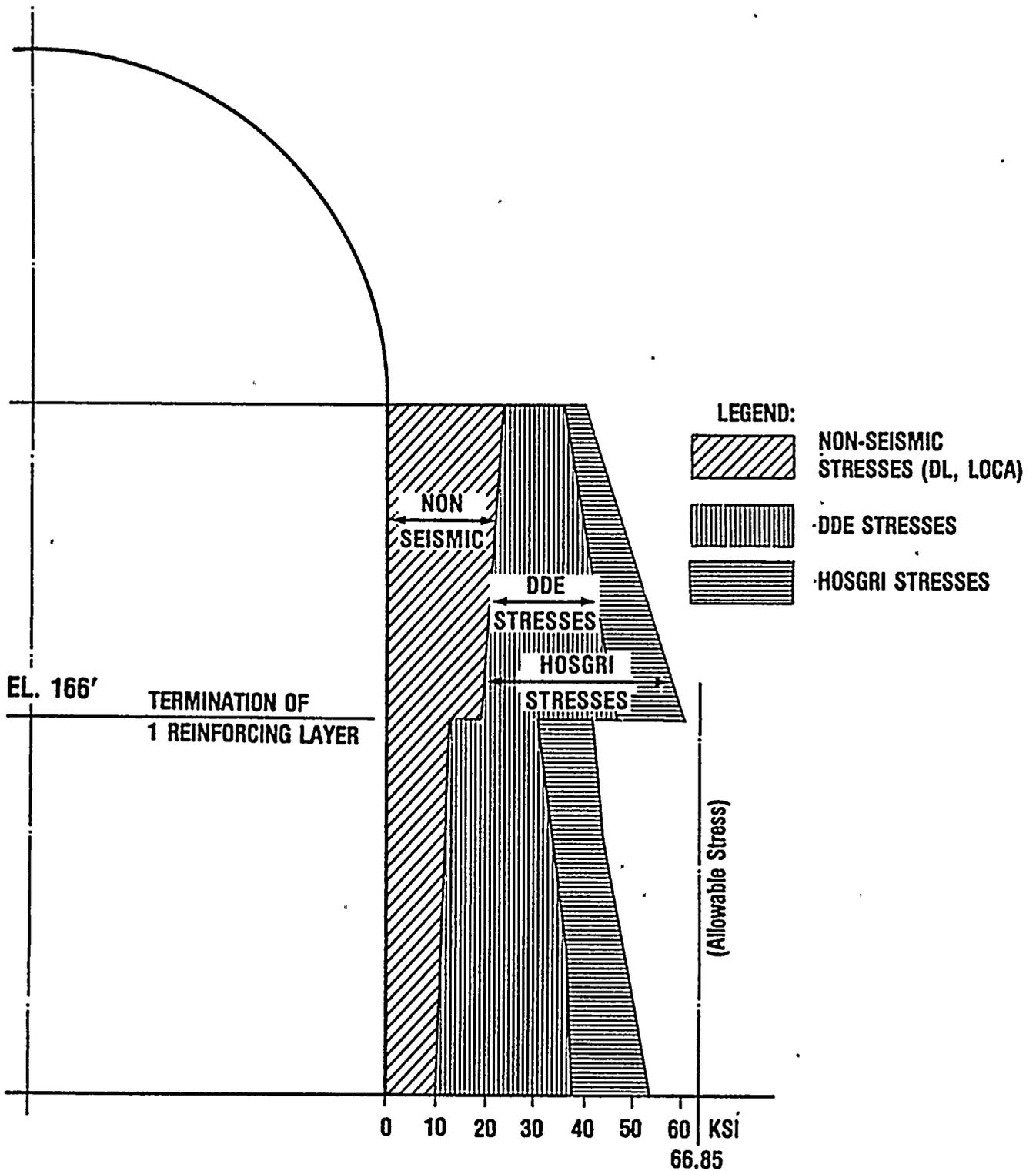


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**CONTAINMENT SHELL  
DIAGONAL REINFORCING STRESS**

**FIGURE NO. 5**



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1 wrb/agbl  
flwswrb/wb23  
2 MRS. BOWERS: The panel is available?

3 MR. NORTON: The panel is available for cross-  
4 examination.

5 CROSS-EXAMINATION

6 BY MR. KRISTOVICH:

7 Q Since we're shifting to a new area now and we've  
8 been away for a couple of weeks, and from the testimony it  
9 looks like we're using terms that haven't been defined yet,  
10 I'd like to make sure we're all talking about the same thing,  
11 so I would like to get some terms defined.

12 Mr. Malik, maybe you can help us with that.

13 Q Could you define for us what a design response  
14 spectra type of analysis is?

15 A (Witness Malik) Design response spectra analysis  
16 of structures?

17 Q Right.

18 A This is an analysis in which you use the dynamic  
19 characteristics of the structure along with the ground response  
20 spectra to get the response, the maximum responses of the  
21 structure.

22 This is different from a time history analysis  
23 in that the type of results you get are not as detailed as  
24 from a time history analysis but nevertheless is a very  
25 commonly used method of analysis for structures if you are just  
trying to get peak responses rather than the detailed time



1.5 8.00



2. 1.00



wrb/agb2

1 history of the response.

2 Q When you go through these definitions, can you  
3 remember that we're doing --- that we're going through this  
4 process to educate the Board and make a complete record, so  
5 could you try to use layman's terms where possible?

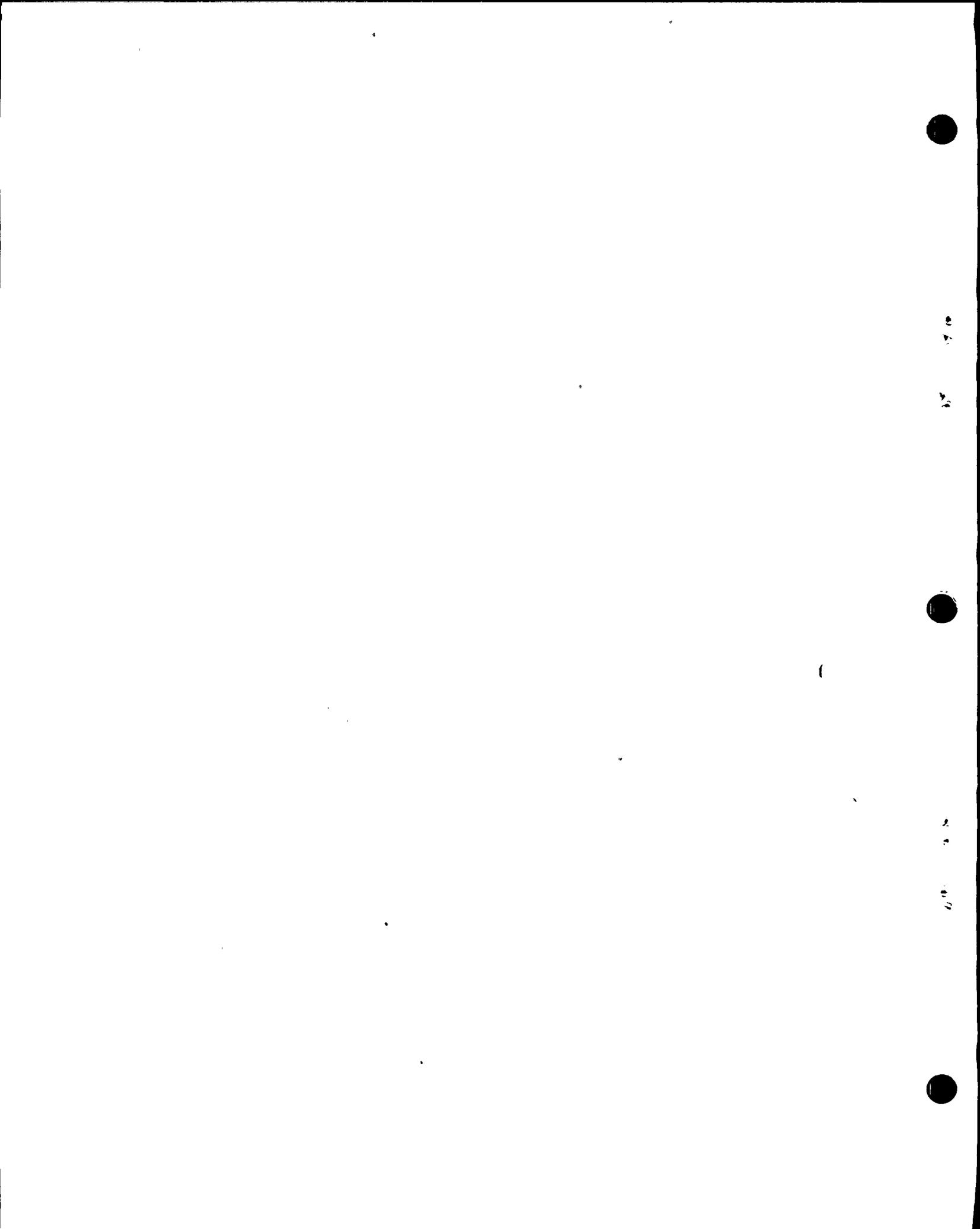
6 MR. NORTON: Excuse me, Mrs. Bowers. I'm going  
7 to object to that. It's incumbent upon the attorney to ask  
8 the questions, it's not incumbent upon the witness to anti-  
9 cipate the questions and he has to answer the question the  
10 way he can, and then if the attorney wants certain words of  
11 that answer explained it's incumbent upon him to ask it.

12 But the witnesses are, you know, trained in a  
13 specialized field and they have to talk in their language.  
14 Now if they use the word "blitz," and they're asked to define  
15 "blitz," then that's fine. But you can't expect them to answer  
16 a question and all the time try to remember to not use their  
17 language. And we would ask if he has questions about any  
18 terms that Dr. Malik or anyone else uses, then he can ask  
19 those questions.

20 MRS. BOWERS: WELL I think the witnesses were in  
21 the room when the discussion took place earlier this morning,  
22 so the objection is sustained.

23 If we have problems, we'll raise them at the time  
24 they occur.

25 MR. FRISTOVICH: That's fine.



p/agb3

1 BY MR. KRISTOVICH:

2 Q Dr. Malik, could you explain to us what a design  
3 time history type of analysis is?

4 A (Witness Malik) Okay. I'll try to -- the one  
5 problem with using non-technical description is that you  
6 lose accuracy. I want that to be recognized, so I'll try to  
7 explain it in more simplified terms.

8 Q Fine. If you would like to use the viewgraph  
9 to explain any of these, that's fine also.

10 A No, I think I can do without it.

11 You have a structure sitting on the ground, and  
12 an earthquake comes and basically shakes the structure at its  
13 base, and then you want to find out what the response -- whether  
14 it is the acceleration at each floor or the stresses at each  
15 point or the displacements at each point, you're trying to  
16 figure out what's happening through the structure.

17 There are many methods of doing that. One of them  
18 is the person comes up and says I don't care what happens  
19 every moment of the time, I just want to find out what's the  
20 maximum acceleration at Floor K, for instance. If that's  
21 what he wants to do, one efficient way of doing that is using  
22 the response spectral analysis.

23 Now, if you are interested in every moment what  
24 that floor is doing, then you do a time history analysis.  
25 And we have done time history analyses of the structures,



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wrb/agb4

1 rather than a response spectral analysis.

2 There have been incidents where we have used  
3 response spectral analysis as another check on our time history  
4 analysis, or because we wanted to get just the maximum result  
5 at a point, but the analysis that we have presented has all  
6 been time history analysis.

7 Q How does using the response spectral type analysis,  
8 in addition to the design time history type analysis give you  
9 a maximum result?

10 A No, no, no. That's not what I said. I said if  
11 you do a time history analysis, obviously you'll get the maximum  
12 plus you will get the response at every moment in time.

13 Like, for instance, the earthquake hits at time  
14 zero, and the response dies out at approximatey in this  
15 structure at 20 seconds after that. Now a time history analysis  
16 will give you the response of each point that you're interested  
17 in from time zero to 20 seconds. At every point you know what  
18 it's doing, so obviciously you will get the maximum as well as  
19 the rest of the history of the response of the structure,  
20 whereas a response spectral analysis will just give you a  
21 number which is the maximum that will happen and it won't tell  
22 you at what time that maximum did happen. This is one of the  
23 differences between the two methods.

24 Q Is the design time history related to the response  
25 spectra in any way?



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wrb/agb5

1 A Of course it is.

2 Q In what ways?

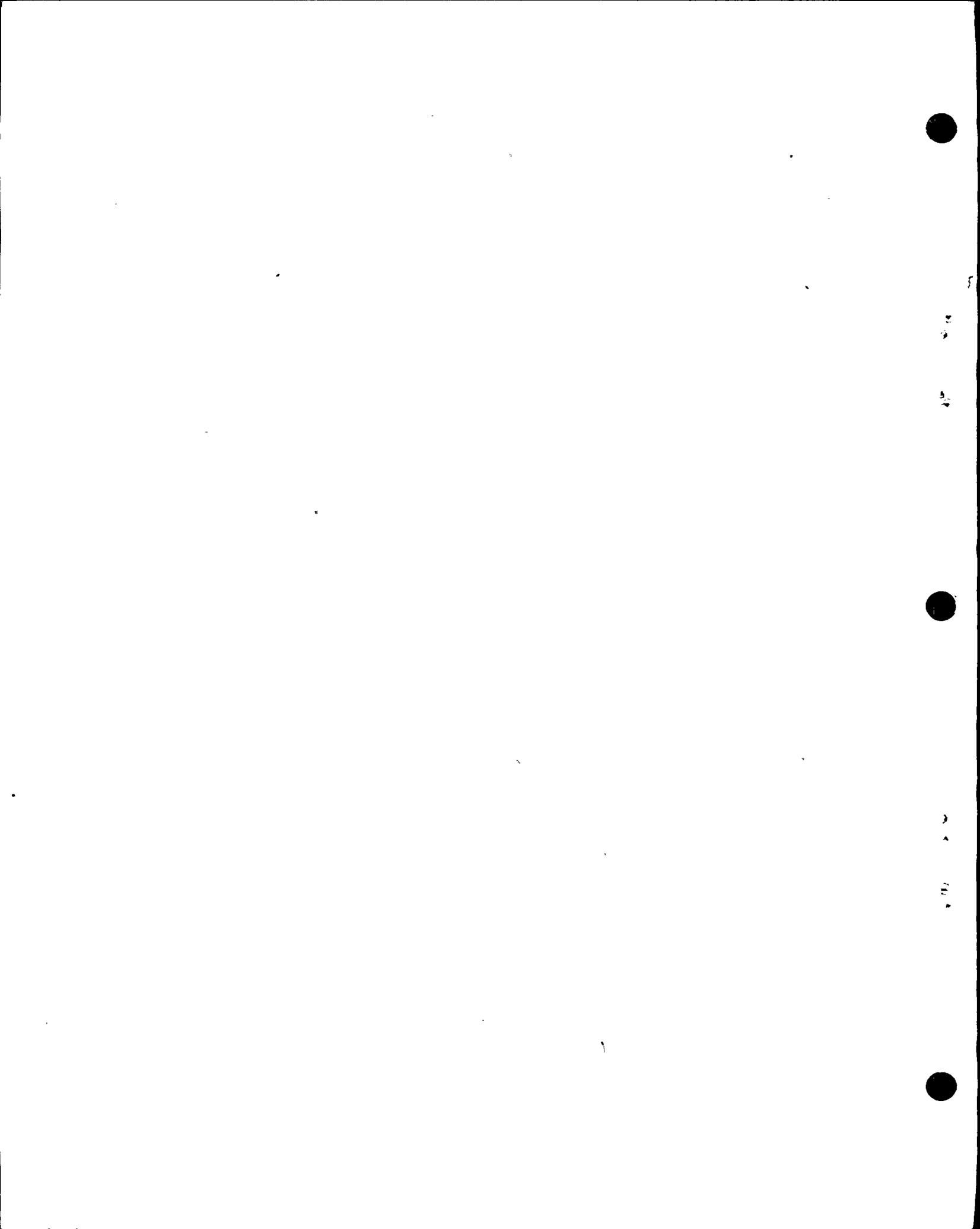
3 A Well, what we do is we start -- as was mentioned,  
4 we got two ground response spectra, one developed by Dr. Blume,  
5 consultant to PG&E and one of them developed by Dr. Newmark,  
6 who is consultant for the NRC.

7 Now, what we take is we take -- this is what we  
8 are given as engineers. Now to do a time history analysis,  
9 we develop time history of the motion of the ground which is  
10 done in a random way with the condition that that time history  
11 which we develop will produce the same response spectrum that  
12 was given to us in this case, the one by Dr. Blume and one  
13 from Dr. Newmark, and that is the shaking that we put at the  
14 bottom of the building from which we get the response at any  
15 point we need.

16 So in that sense, the time history that we develop  
17 is associated with the response spectra and hence the responses  
18 that we get from that time history are also related to that  
19 ground response spectra.

20 Q Could you define what an equivalent static load  
21 analysis is?

22 A Yes. This is a very simplified method that was  
23 developed -- it's mostly used, for instance, in the Uniform  
24 Building Code where, instead of what we call a dynamic analysis  
25 where you're taking and shaking the structure and finding out



wrb/agb5

1 what it's doing, they just come and say Okay, I will get an  
2 equivalent static load that will be produced from this earth-  
3 quake and I will apply that static load to the structure and  
4 analyse it as though it was any other static load like dead  
5 load or gravity load or wind load.

6 Often -- well, wind loads are often dynamic loads  
7 but, for instance, very often they're used as static loads,  
8 it's a much easier type of analysis but definitely less  
9 accurate than a dynamic analysis.

10 Q Was an equivalent static load analysis used in  
11 any aspect of the containment structure?

12 A No.

13 By the way, usually the static loads, the equivalent  
14 static load method especially in the UBC has been shown time  
15 and again to be far less conservative. Actually, it is far  
16 below what dynamic analysis often give you.

17 Q What do you mean "far below?"

18 A Meaning that there has been a lot of discussion  
19 that the equivalent static loads that are being used in  
20 the codes are less than they should be, and if you were to  
21 do a dynamic analysis, you'd find out that loads on the  
22 structure are higher than the equivalent static loads recom-  
23 mended by the codes.

24 Q Dr. Malik, what is the square root of the sum of the  
25 squares method, could you explain that in relationship to



wrb/agn7

1 combining loads?

2 A Yes. When you have several phenomena happening,  
3 let's say you have the seismic loads, LOCA, or let's say even  
4 seismic loads due to different components of the earthquake.  
5 Now you have a maximum of -- from each direction at a point,  
6 a maximum stress or a maximum load but these are not all  
7 happening at the same time, they occur at different times  
8 in the structure.

9 So to do a probabilistic approach as to what will  
10 be the maximum when all of them are combined, often the least  
11 biased way of doing it is to take square root of the sum of  
12 the squares.

13 So that if I have the response due to one com-  
14 ponent is A and to the next component is B, the square root  
15 of the sum of the squares would be I would square A out to  
16 the square of B and take the square root of the sum, and that  
17 I would consider at the maximum combined response due to these  
18 two or three or whatever phenomena that I'm talking about.

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19 Q Was this method used in the containment analysis?

20 A Yes, it was and that's the recommended procedure  
21 from the Nuclear Regulatory Guides.

22 Q Were all the loads on the X axis --

23 A Pardon?

24 Q Were all the loads on the X axis?

25 A Which one is the X axis? I can postulate X to be



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wrb/agb8<sup>1</sup>

anything you want.

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2WEL/wel 1

1 Q Dr. Malik, what is the absolute sum of combining?

2 A (Witness Malik) The absolute sum. That's exactly  
3 what it means, to add the things together.

4 I don't know if the -- I don't know what you're  
5 referring to. You never add the maximums on an absolute sum.  
6 I mean that is not done, because it is not realistic. The  
7 maximum sums don't occur at the same time. If they did, you'd  
8 add them.

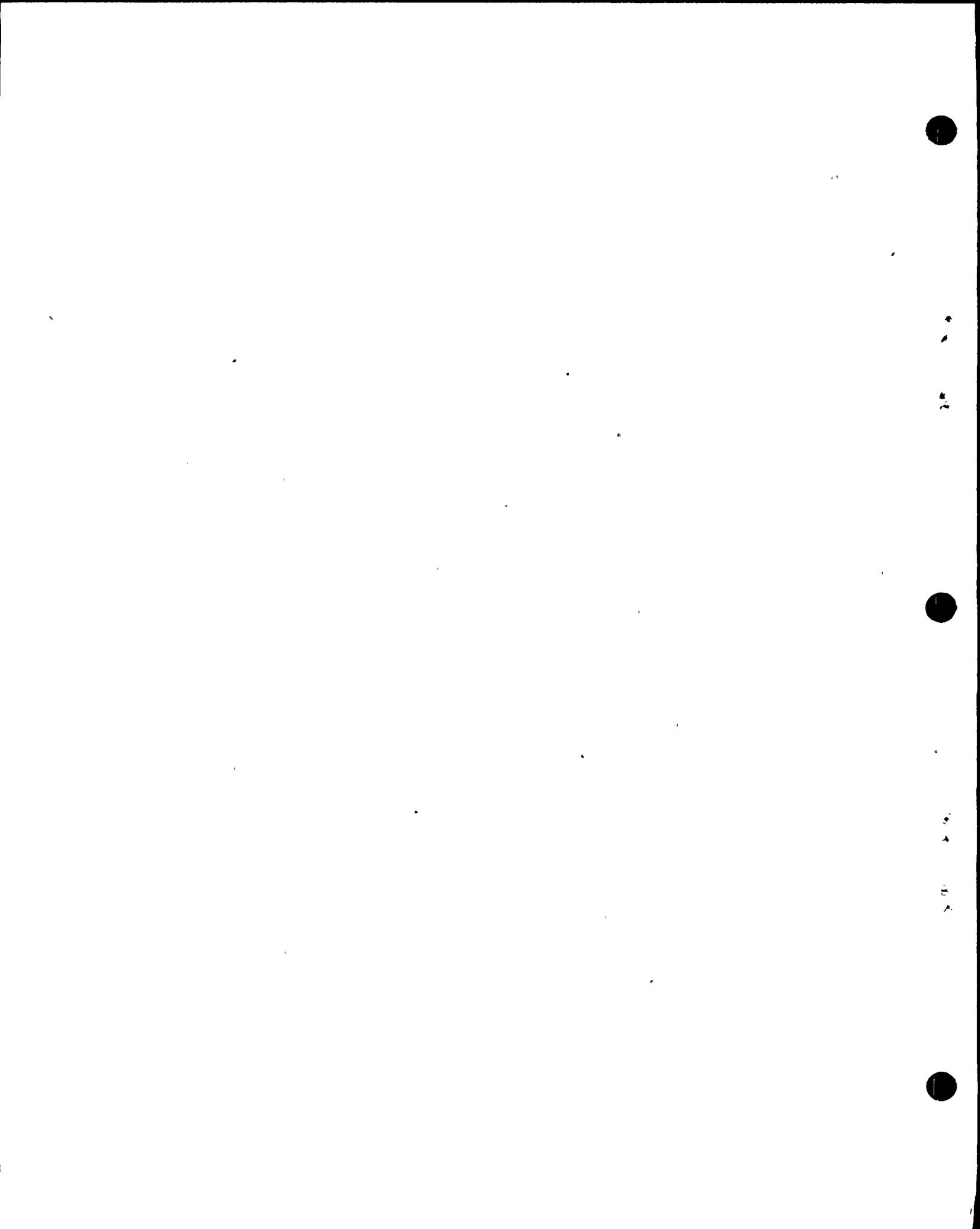
9 Q I'd like to direct your attention to page 3 of  
10 the written testimony. Page 3, line 8. Do you have the  
11 testimony in front of you?

12 A Yes.

13 Q Reading lines 6 through 9, you state in the  
14 written testimony, "The torsional response from 5 percent and  
15 7 percent accidental eccentricity were combined with the  
16 horizontal translational response on an absolute sum and  
17 square root and sum of the squares basis, respectively."

18 Could you define what you mean by absolute sum  
19 there?

20 A Okay. The way we're doing the torsional  
21 analysis, we're taking the mass and saying that instead of  
22 it being where it is it's going to be eccentric. Now, that  
23 eccentricity, as you put the horizontal response -- as you  
24 shake the building at the bottom at its base, that  
25 eccentricity is also going to create some torsion in the



wel 2

1 building because you have assumed that eccentricity.

2 Now, the torsion is being caused by a horizontal  
3 motion, shaking of the ground. So the specifications that  
4 were agreed to by the Nuclear Regulatory Commission was to  
5 say take the horizontal response at any point in the  
6 building and that that torsion is also going to add to that  
7 horizontal response, depending where you are on the floor.

8 Now, that addition -- take it that you're using  
9 5 percent eccentricity, add it directly to the horizontal  
10 response at that point. If you're using 7 percent eccentricity,  
11 add it on a square root of the sum basis.

12 And you take whichever comes out to be larger.

13 So we did try it both ways, and it came out that  
14 the 5 percent eccentricity added on an absolute sum basis  
15 gave us a higher response than the SRSS of the 7 percent.

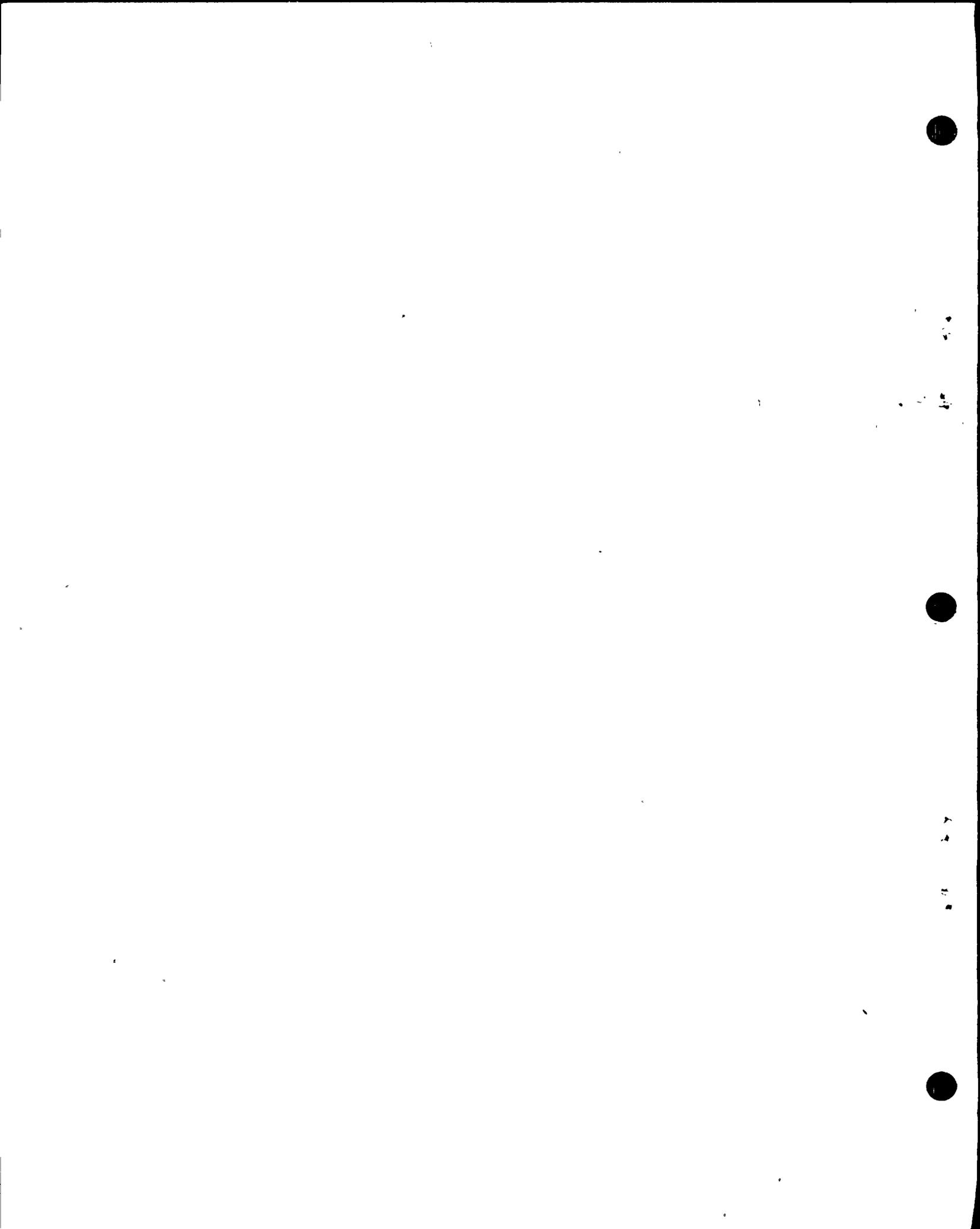
16 Q Are you saying the absolute sum of A plus B is  
17 A plus B?

18 A Yes.

19 (Laughter.)

20 A Yes. Actually, you take the absolute value of  
21 both cases -- like if you had A is plus and B is minus, you  
22 take the sum of the scalar quantity and forget about the sign.

23 MRS. BOWERS: Mr. Kristovich, earlier witnesses  
24 have referred to torsion. I don't think it's ever been  
25 defined in this record.



wel 3

1 BY MR. KRISTOVICH:

2 Q Dr. Malik, would you like to define torsion?

3 A (Witness Malik) It's a twisting of the building.  
4 If I can use sign language (indicating) you take a building,  
5 and it's twisting back and forth. That's what we refer to  
6 as torsion.

7 If I was to take a bar and twist it around, that  
8 would be a torsional force I would be applying on it.

9 MR. KRISTOVICH: Mrs. Bowers, it's been an hour  
10 and a half since we started this morning. I would propose a  
11 break.

12 MRS. BOWERS: Fine, a ten-minute break.

13 (Recess.)

14 MRS. BOWERS: Are we ready to resume?

15 BY MR. KRISTOVICH:

16 Q Dr. Malik, could you explain what a torsion load  
17 is?

18 A (Witness Malik) Okay.

19 In a dynamic analysis when you get a mode where  
20 the predominant motion is that of twisting, that's what we'd  
21 call a torsional mode.

22 MR. NORTON: Excuse me. I thought the question  
23 was torsion load, and the answer --

24 WITNESS MALIK: Load or mode?

25 MR. KRISTOVICH: Load.



1 MR. NORTON: Did you ask for mode or load?

2 MR. KRISTOVICH: Load, l-o-a-d.

3 MR. NORTON: Okay. And he responded to torsion  
4 mode.

5 WITNESS MALIK: I'm sorry. That's a twist that's  
6 applied on any member of the structure.

7 BY MR. KRISTOVICH:

8 Q And what is a rocking load?

9 A (Witness Malik) Rocking is, again, a twisting  
10 in another direction, which rocks the building rather than  
11 twists it.

12 Q And what is a translation load?

13 A That's where it's just a horizontal or vertical  
14 translation, that kind of a load. A push or a pull, either  
15 in the horizontal direction or vertical direction.

16 Q Are there any other kinds of loads?

17 A Yes. When you're talking about the load, it  
18 depends whether you're talking about building member . . .  
19 your question is not clear.

20 Q For the containment building. Did you analyze  
21 any other loads for the containment structure?

22 A I'm sorry. I don't think your question is very  
23 clear. We don't analyze for loads. We analyze for motion.  
24 We analyze for three motions, two horizontal and one vertical  
25 motions.



1 Q Did you want to add something, Mr. Ghio?

2 A (Witness Ghio) Well, I wanted to ask you to  
3 clarify the question, but I think it's all right now.

4 Q Dr. Malik, with regard to soil-structure inter-  
5 action analysis what is the finite element approach?

6 A Well, I can answer that, but let me clarify that  
7 soil-structure interaction is not my area of expertise. I'm  
8 familiar with it, but that's not my area of expertise.

9 MR. NORFON: Well, then, we would ask that Dr.  
10 Blume answer the question.

11 BY MR. KRISTOVICH:

12 Q On page 2 of the written testimony at line 17.--

13 MRS. BOWERS: Following our usual procedure, if  
14 another panel member is considered the expert in the area,  
15 certainly a panel member can hand off to him.

16 WITNESS MALIK: Well, that's not referring to  
17 soil-structure interaction. That's a finite element model of  
18 the structure. I thought you said soil-structure interaction.

19 BY MR. KRISTOVICH:

20 Q Dr. Blume, can you explain what a finite element  
21 approach is with regard to soil-structure interaction?

22 A (Witness Blume) In regard to soil-structure  
23 interaction, that is a method in which the soil and possibly  
24 also the structure -- that depends -- would be modeled as a  
25 series of nodes and inter nodes so that the finite element  
approach would be used as a method of analysis.



1 Now, I want to clarify very clearly that finite  
2 element is not limited to earthquake analysis or to soil-  
3 structure interaction. It's a general mathematical procedure.

4 Q Well, can you describe what it is?

5 A It's a matter of breaking up the structure or  
6 soil or system into fine elements called meshes. Then these  
7 are analyzed by using very large computers as though they were  
8 structures connected by the various nodes and inter nodes.

9 Q And what is a lumped mass spring approach?

10 A A lumped mass approach I talked a little about  
11 before Christmas. That is where a structure or soil is  
12 modeled by assuming lumps of mass or of weight at discrete  
13 points, and these are connected by so-called weightless  
14 springs that represent the compliance or the stiffness of the  
15 soil or of the structure.

16 We sometimes also refer to this as a stick  
17 model, stick meaning a stick with a lot of lumps on it, or  
18 bumps.

19 Q Okay, Dr. Malik, directing your attention to  
20 page 2 of the written testimony, line 17, what do you mean  
21 by finite element model?

22 A (Witness Malik) It's like Dr. Bluma explained.  
23 If you look at the figure we're talking about, it's --

24 Q Which figure is that?

25 A Figure 1 -- you will see that the structure, the



wel 7

1 containment, for instance, the structure is broken up into  
2 elements between the nodes, and then when you do the  
3 analysis you use these elements, this mesh of elements, to  
4 do the numerical analysis that you want to do.

5 It's vary difficult to explain the finite element  
6 mesh in layman's terms. It's a mathematical model. It's a  
7 procedure that we use to do analyses in structures.

8 Q Why do you use that method?

9 A Why? It's considered one of the most accurate  
10 and efficient methods available in structural engineering  
11 today.

12 Q How do you arrive at the number of nodes?

13 A There are several procedures that one would  
14 arrive at them. Sometimes it's through judgment. Sometimes  
15 in extremely complicated cases we might even do comergence  
16 analyses.

17 Q How did you do it for Diablo Canyon?

18 A For --

19 Q For the containment structure?

20 A The containment structure, we had models that  
21 were used as finite element models from before, during the  
22 DE and the DDE analyses, and we relied on that work to choose  
23 the number of nodes. Is that what you're asking?

24 Q Yes.

25 A We did some other studies also, like using  
lumped mass models to see how closely we came up with the



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1 dynamic characteristics, and they were very much in agreement,  
2 which gives us more confidence in the number of nodes we  
3 chose, and elements.

4 Q What do you mean, "very much in agreement?" Were  
5 there points of disagreement?

6 A No. They were closer than is expected when you  
7 use two different methods. Within five percent. And that's  
8 considered to be very good agreement.

9 Q Dr. Blume, what is a fixed base mathematical  
10 model?

11 A (Witness Blume) A fixed base model is one in  
12 which the structure is assumed to be situated on infinitely  
13 rigid material or rock.

14 Q Is the containment analysis a fixed base  
15 analysis?

16 A Yes, in accordance with NRC requirements and the  
17 characteristics of the material at the site, fixed base  
18 analyses were used for the Hosgri reevaluation. Originally,  
19 other methods were used.

20 Q What were the methods originally used?

21 A They were soil-structure interaction methods,  
22 using springs and dash pots.

23 Q And why did you not use those for the reanalysis?

24 A For two reasons: One, it was not required and,  
25 two, our judgment showed that it wouldn't have made any  
significant difference.



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wel 9

1 Q What do you mean, "Significant difference?"

2 A Within a few percent.

3 Q What is the NRC's criteria for a fixed base  
4 analysis for when it can be used?

5 A NRC's criteria for a fixed base analysis?

6 Q Yes.

7 A It would be the same. I mean if they find that  
8 the shear velocity of the material at the site is 3,500 feet  
9 per second or greater they say that a fixed base analysis is  
10 considered acceptable.

11 You see, this was not the case in the early days.  
12 That's the third reason why we couldn't do it in the early  
13 days.

14 Q Dr. Malik, what is meant by degrees of freedom?

15 A (Witness Malik) That's the directions in which  
16 a particular mass point can move. If it's restrained in  
17 certain areas, then those are not considered to be degrees  
18 of freedom.

19 Q And what is meant by number of modes?

20 A Those are the number of ways that the structure  
21 can displace during a dynamic motion.

22 If you have, for instance, a rope and two  
23 people are holding it on each end, and you shake it, there  
24 are many different modes that it can vibrate, and one of  
25 them is just a hopping up and down, and one of them it can  
go like an "S" shape, and so on. And each one of these would



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wel 10

1 be considered a mode.

2 Q How many degrees of freedom are there in the  
3 containment analysis?

4 A Are you talking about significant modes that are  
5 considered in the analysis?

6 Q Yes.

7 A I think there were 12 in the containment exterior  
8 and two in the containment interior structure. Are you  
9 talking about degrees of freedom or modes?

10 Q Degrees of freedom.

11 A Degrees of freedom would be in the axis symmetric  
12 structure we used I think . . . is it three per node? Four  
13 per node. So we have in the containment exterior, something  
14 like 25 nodes, I think, and four a piece . . . that would be  
15 100 degrees of freedom.

16 Q Would you describe the four?

17 A (Pause.)

18 Q Perhaps Dr. Jhaveri could.

19 A No, I have it here as just the description . . .

20 Okay. If you take each one of these nodes as a  
21 conical shell -- it's a shell. So the degrees of freedom  
22 would be one vertical, one radial -- if you take the shell  
23 along the radius -- one tangential to the radial, and one  
24 bending at the top of the element.

25 Those are the four.



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1 Q Dr. Malik, would you explain coupled analysis  
2 versus decoupled analysis?

3 A In general, if you have more than one structure  
4 and they are connected in one way or another, a coupled  
5 analysis would be where you model both of them and you  
6 coupled them together, tied them together, and did the  
7 analysis of the whole thing together.

8 A decoupled analysis, if you can show that one  
9 structure does not affect the response of the other, then you  
10 can untie them and do the analysis of each one of them  
11 separately.

12 Q How do you show that one does not affect the  
13 other?

14 A There are guidelines for that. There have been  
15 many studies to show when you can uncouple structures and when  
16 you can couple them.

17 Q What kind of guidelines?

18 A The Reg. Guides have a guideline in which it  
19 depends on the frequencies of the two structures and the  
20 ratio of their mass.

21 Q Do you know what Reg. Guide that is?

22 A I don't remember the number. Maybe the NRC  
23 people can remember it. It's a standard review plan. I  
24 don't recall the number.

25 MR. NORTON: I don't believe it's a Reg. Guide.



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wel 12

1 It's a Standard Review Plan.

2 WITNESS MALIK: It's a Standard Review Plan, yes.

3 BY MR. KRISTOVICH:

4 Q Could you explain what the criterion in the  
5 Standard Review Plan is?

6 A (Witness Malik) I'll try to recall. I think if  
7 the mass ratio of the appendage to the structure is less than  
8 .01, then you can uncouple, unconditionally.

9 If it's between .01 and .1, you can uncouple if the  
10 frequency ratios are less than .85 and more than 1.15 I think.

11 And if the mass ratio is greater than .1, then  
12 you have to do a coupled analysis.

13 Q Is that the criteria you used for the containment  
14 structure?

15 A In regards to what? I mean . . . you're talking  
16 about equipment and structures here?

17 Q Right.

18 A Where?

19 Q Well, like steam generators and the vessel.

20 A Well, in the case of the vessel itself we did  
21 do an analysis to convince ourselves that in fact there was  
22 no influence. We did a coupled analysis and an uncoupled  
23 analysis, and we found out that the coupling did not change  
24 the response.

25 Q And for that analysis did you use the same  
criteria as in the Standard Review Plan?



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1 A I'm saying we did actually a coupled and an  
2 uncoupled, and compared the two results.

3 Q Do you recall what the difference was?

4 A Very, very small, less than -- if I remember, it  
5 was less than 1 percent.

6 Q Do any of the other members of the panel have a  
7 recollection as to the difference in that analysis?

8 A (Witness Jhaveri) As I remember it, the answers  
9 were pretty close. I agree with Dr. Malik's recollection that  
10 it would be around 1 percent.

11 Q Okay, Dr. Malik, directing your attention to page  
12 1 of the written testimony, at lines 12 through 14, you state:

13 "Structure-specific ground response spectra we  
14 developed from the pre-filled spectra by spatial  
15 averaging of accelerations."

16 What do you mean by spatial average of  
17 accelerations?

18 A (Witness Malik) Would it be more clear if I told  
19 you tau effect?

20 Q Yes.

21 A Okay. That's what it means.

22 Q So then you started with a peak instrumental  
23 acceleration of 1.15 g, and that was reduced to an effective  
24 acceleration of .75 g?

25 A I didn't do that. Dr. Blume did that.

Q Dr. Blume, is that correct?



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1 A (Witness Blume) That is correct, except that that  
2 was specified by NRC. We did not make that reduction.

3 Q Okay. The 1.25 g is the peak instrumental  
4 acceleration for a 7.5 magnitude earthquake?

5 A That's the way it was given to us, yes.

6 Q And then, Dr. Malik, the .75 g was reduced by  
7 the tau factor?

8 A (Witness Malik) Yes. Dr. Blume did that, too.

9 Q What was that reduction, Dr. Blume?

10 A (Witness Blume) As I testified a couple of weeks  
11 ago, in my direct testimony, there were two sets of curves.  
12 One was the Newmark set by NRC, and the so-called Blume set  
13 by us for PG&E. And depending upon which structure was under  
14 consideration, there were certain tau effects made, reductions  
15 in the high frequency range, which varied not only between  
16 the structures but between the investigators. Our procedures  
17 were slightly different than Dr. Newmark's, although not a  
18 great deal.

19 You'll find this in my written testimony.

20 Q Yes, I believe at page 43 of your written  
21 testimony.

22 A Yes, Table 2 on that page shows the basic  
23 results of the two methods that were employed.

24 Q So, for the containment what does the Blume  
25 factor reduce the .75 to?



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1 A To .67 at effective acceleration.

2 Q At zero period?

3 A At zero period, yes. By definition, effective  
4 is at zero period.

5 Q So the .75 is reduced approximately 10 percent.  
6 by the tau factor?

7 A Approximately, at zero period. But the decrease  
8 becomes less as you gain in period.

9 Q And the Newmark factor is reduced to .60 g at the  
10 zero period by the tau factor?

11 A .60 g.

12 Q And that's approximately a 20 percent reduction?

13 A At the zero period.

14 But, again, his also becomes less effective as  
15 the period goes on to other seconds.

16 Q Could you describe that, how it becomes less  
17 effective?

18 A Well, you mean the amounts or why, or . . . I  
19 don't quite understand your question.

20 Q The amount and why.

21 A The amount and why.

22 Well, the amount is also in the testimony. I  
23 think I have it fading away under our method to no effect at  
24 all at a period of about four-tenths of a second.

25 Am I about right on that, boys?



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1 Q That's okay.

2 (Pause.)

3 A Yes, between four and five tenths of a second  
4 our tau effect vanishes. Any period longer than that has no  
5 tau effect whatsoever.

6 Q And, Dr. Blume, has this tau effect been used in  
7 any other nuclear licensing proceedings, to your knowledge?

8 A Not to my knowledge, in this manner, no.

9 Q And is it described at all in the Standard Review  
10 Plan?

11 A I don't believe it is, no.

12 Q Or in the Reg. Guides?

13 A No.

14 Q Or in the Regs?

15 A In the what?

16 Q In the Regulations.

17 A Not to my knowledge.

18 Q Okay, Dr. Malik, still on page 1 at lines 14  
19 through 16, you state that this procedure -- referring to  
20 tau effect -- depends on the shear wave velocity to the  
21 underlying rock and the foundation size.

22 How does the tau effect depend upon shear wave  
23 velocity, and could you provide us with equations, if  
24 possible?

25 A (Witness Malik) As Dr. Blume mentioned, the NRC



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wel 17

1 position is that if -- excuse me.

2 I think that Dr. Jhaveri would be best to  
3 answer that question. He has more familiarity with this  
4 subject.

5 A (Witness Jhaveri) The tau is considered as the  
6 transit time for the wave to pass through the foundation,  
7 length of the foundation of the structure, and that then  
8 depends on the size of the foundation and the velocity with  
9 which the wave moves in the ground.

10 Q Could you give us the specific equation that  
11 is used?

12 A The specific equation would be tau equals some  
13 characteristic length of the structure divided by the shear  
14 wave velocity of the supporting ground material.

15 Q And what did you assume the shear wave velocity  
16 to be?

17 A I don't recall the exact figure, but it was  
18 around 3500 feet per second.

19 Q Do any of the other panel members remember the  
20 exact figure?

21 A (Witness Blume) We, of course, have all that  
22 data. I think it might have been slightly longer than that,  
23 maybe 3700 or so. But I'm not too sure.

24 Q Is that in the FSAR anywhere?

25 A Oh, yes, the information is in there, to my



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1 knowledge, all of it.

2 MR. NORTON: The Hosgri report, we're talking  
3 about, as opposed to the FSAR.

4 WITNESS BLUME: Yes, pardon me, the Hosgri report,  
5 yes.

6 BY MR. KRISTOVICH:

7 Q Do you have a reference that you could give us?

8 A (Witness Blume) Not in my head. I think this  
9 would have to be dug out by the people keeping the files.

10 But you'll recall during Dr. Seed's testimony last  
11 week, or two weeks ago, that there was a table put on the  
12 screen that showed these shear wave velocities. I also  
13 testified as to how we arrived at our shear wave velocities  
14 used for probabilistic work.

15 Under the foundations they are over 3500 feet  
16 per second.

17 Q Dr. Malik, did you participate in the PG&E  
18 seismic research program?

19 A (Witness Malik) Yes.

20 Q And did you take the minutes for the seismic  
21 research program?

22 A Yes, in all but one meeting.

23 Q So you are very familiar with the results of the  
24 seismic research program?

25 A I'm familiar.



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1 Q Did portions of the seismic research program  
2 address factors that might reduce the conservatism in the  
3 containment structural analysis?

4 MR. NORTON: Excuse me, before you answer that  
5 question.

6 May I have that question repeated, please?

7 MR. KRISTOVICH: Okay.

8 MRS. BOWERS: Mr. Landon, would you read the  
9 question?

10 (Whereupon, the Reporter read from the record,  
11 as requested.)

12 MR. NORTON: Okay. My problem with that question  
13 is I think it's inarticulate, and it's misleading in the sense  
14 that it said, "Did it deal with factors which would reduce..."  
15 and I think what he's really asking is, "Did it give results  
16 which would reduce..."

17 You know, it obviously dealt with factors that  
18 could go in all different directions.

19 So I would object that it's a misleading question.

20 MR. KRISTOVICH: I will withdraw the part Mr.  
21 Norton is objecting to, and ask Dr. Malik if portions of the  
22 seismic research program gave results that might affect -- that  
23 might reduce the conservatism in the containment structure .  
24 analysis.

25 WITNESS MALIK: We are not at that point yet to



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1 really know whether it's going to reduce it or not. You  
2 know, until now we haven't even dealt with the structures yet  
3 and we don't even have -- we're not anywhere near the point  
4 to know whether it's going to reduce or not.

5 BY MR. KRISTOVICH:

6 Q Well, what types of programs are you doing that  
7 might reduce the conservatism?

8 MR. NORTON: May we do this for the record? That  
9 is, define what is meant by "reduce the conservatism." That's  
10 a tricky term. It's not always clear which way one is talking  
11 about going when you're talking about reducing the conserva-  
12 tism versus increasing the conservatism.

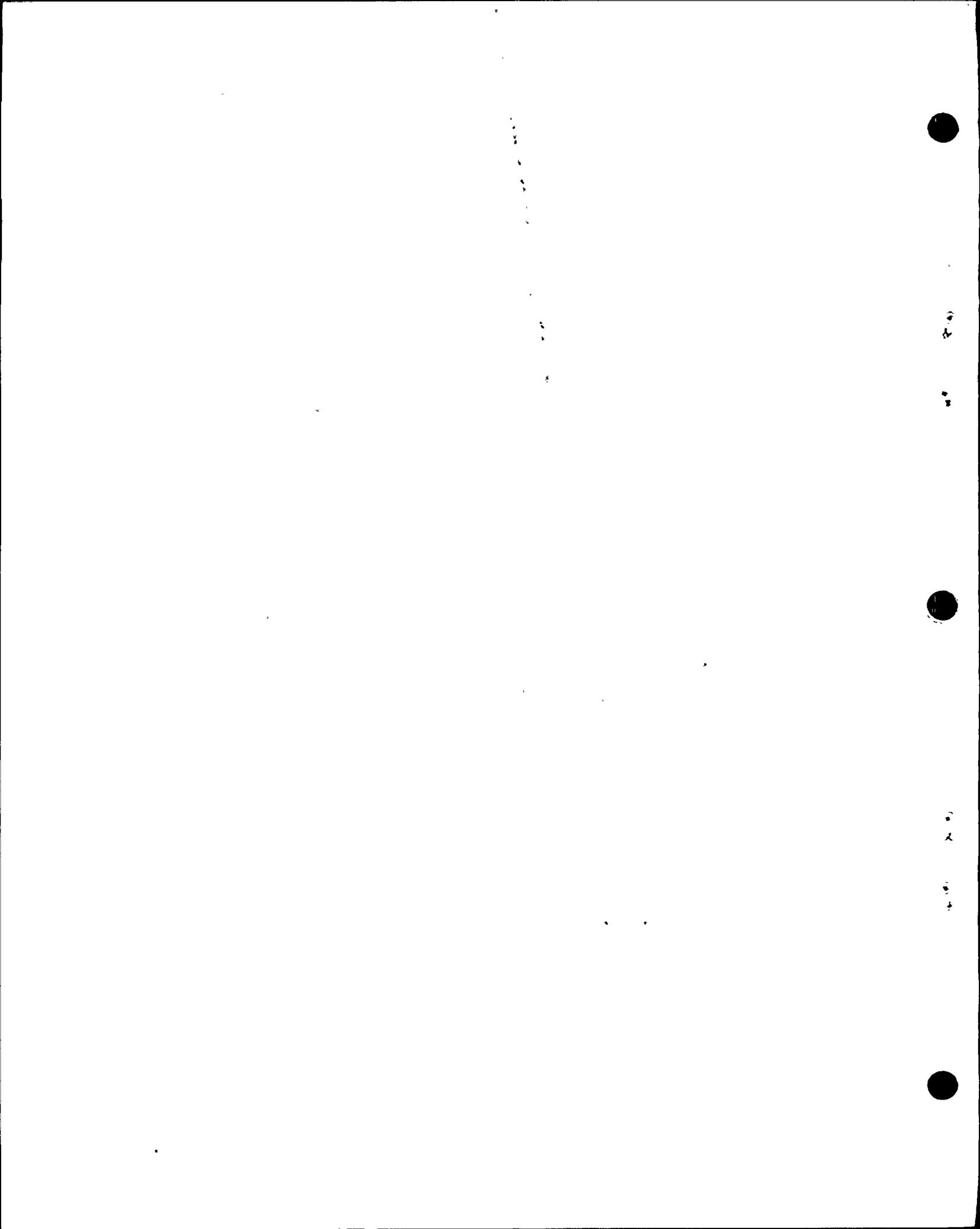
13 MRS. BOWERS: Can the witness respond to that  
14 question, and give the definition?

15 WITNESS MALIK: The seismic research program is  
16 trying to develop --

17 MR. NORTON: Excuse me. Mrs. Bowers, were you  
18 asking the witness to respond to what we mean by reducing  
19 the conservatism, or to respond to the original question?  
20 I think he started to respond to the original question.

21 MRS. BOWERS: Well, defining what you mean by  
22 reducing the conservatism.

23 WITNESS MALIK: What I understand by that is if  
24 we develop more accurate procedures then we don't have to  
25 include artificial conservatism; which are like factors of



wel 21

1 ignorance, just to be sure that -- you know -- because we are  
2 not that accurate we add conservatism. And the more accurate  
3 we become, the less we have to add these superficial conserva-  
4 tism factors.

5 MR. NORTON: Okay, Mrs. Bowers, I think that  
6 proves out my point. I don't believe that's what counsel  
7 was asking at all. What he meant was something entirely  
8 different than that.

9 I think if we can go ahead with these questions  
10 now based on that definition, we're all talking the same  
11 language. But I don't think counsel meant that in his  
12 question.

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WRB/agbl

1 BY MR. KRISTOVICH:

2 Q Well, Dr. Malik, what we're interested in are  
3 factors that might reduce margins of safety that were addressed  
4 by the seismic research program.

5 A (Witness Malik) I don't know of any attempt to  
6 reduce margins of safety that I know of. Margins of safety  
7 are usually allowable stresses that you accept by -- you know,  
8 you consider by what the codes require, and we're not planning  
9 to reduce those to my knowledge.

10 A (Witness Blume) I think there is confusion perhaps  
11 developing with the testimony last week about the Q.  
12 There was much discussion of Q. And the indications are --  
13 and the tentative manner that the Q value is being obtained  
14 are very beneficial to the plant, going just the opposite  
15 way, in other words, providing more conservatism. And that  
16 was discussed at considerable length last week.

17 I would like to also endorse Dr. Malik's statement  
18 that the deeper we get into these matters in the future,  
19 the more we're going to reduce conservatisms that are now just  
20 built into the system or extreme envelopes.

21 Q Dr. Blume, could a lower Q factor reduce the  
22 rocking -- increase the rocking, excuse me?

23 A It might go either way, I don't know right at  
24 this moment. Rocking is only a small part of the overall  
25 picture.



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2 MR. KRISTOVICH: Mrs. Bowers, I would like to  
3 mark for identification Joint Intervenors number -- I'm not  
4 sure of the number because of all the problems we had the  
5 other day.

6 MR. NORTON: 60 was your last one.

7 MR. KRISTOVICH: Okay, this will be Joint  
8 Intervenors' Number 61, and it is PE document 199, and it is  
9 drill hole log number DDH-D, which is of the Diablo Canyon  
10 containment building.

11 (Whereupon, the document  
12 previously referred to as  
13 Joint Intervenors' Exhibit  
14 61 was marked for  
15 identification.)

16 BY MR. KRISTOVICH:

17 Q Dr. Malik, do you have Joint Intervenors' Number  
18 61 in front of you?

19 A (Witness Malik) Yes.

20 Q And are you familiar with this document or could  
21 you explain to us what this document is?

22 MR. NORTON: Excuse me, may he answer the first  
23 question before he answers the second one?

24 MRS. BOWERS: Will you proceed to tell us if you're  
25 familiar with the document?

WITNESS MALIK: I've seen it before. That's about



wrb/agb3 1 the extent of it.

2 BY MR. KRISTOVICH:

3 Q Well can you explain to us what this document is,  
4 starting on the left-hand side of the document?

5 A (Witness Malik) I would not be the one to explain  
6 it. This is a geological matter, and I have no training in  
7 geology. I am assistant to Dr. Blume in coordinating this  
8 but that doesn't mean I have expertise in every field of that  
9 work that's being done, and this is certainly not an area that  
10 I have any expertise in, I'm really a layman in here.

11 Q Dr. Blume, could you explain this document,  
12 starting on the left-hand side with what is labeled the  
13 graphic log?

14 MR. NORTON: Excuse me, may we find out if he  
15 can explain the document first?

16 WITNESS BLUME: Well I know what the document is,  
17 but I don't claim to be an expert in drilling hole logging  
18 which is what this is. This is apparently a log of a drill  
19 hole.

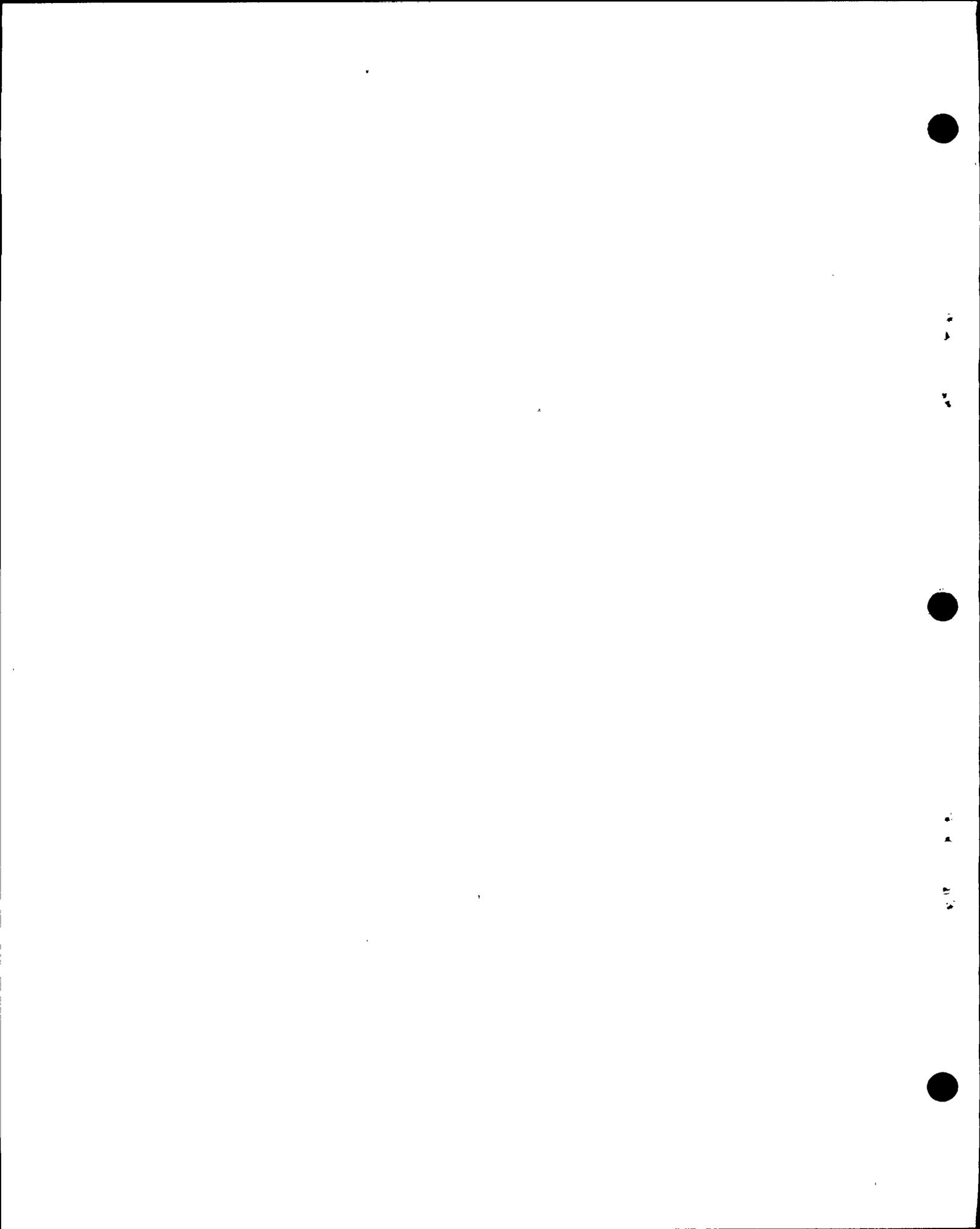
20 BY MR. KRISTOVICH:

21 Q This document was done for your company?

22 A (Witness Blume) Yes -- let me check.

23 (Pause.)

24 Yes, this was logged in by our company. The  
25 drillers were other people.



/wbl

1 Q Who could explain this document in terms of --  
2 well, what sandstone is and what filtered sandstone is?

3 A Well I think anyone who reads the description  
4 there can get a very good idea. In fact that's the only  
5 description that counts is what has been logged in. And I  
6 think it's quite specific in most cases.

7 Q Well directing your attention to the righthand  
8 side of the page at the top, what is meant by rock quality  
9 designation?

10 Have you found what I'm referring to?

11 A Yes. That's a percentage scale that I would have  
12 to refer to the experts on. It has to do with the quality  
13 of the rock with regard to hardness and cracking and so on.  
14 I'm not familiar with the details of that definition.

15 Q Well do you know what 10 percent rock quality  
16 means?

17 A No. I think I just answered that question.

18 Q Does anybody on this panel know what 10 percent  
19 rock quality means?

20 A (No response)

21 Q Dr. Blume, do you know who would know?

22 A Yes, the person who logged it in.

23 Q Is he testifying here?

24 A No, I don't believe he's here today, and I don't  
25 know whether it is planned that he is to be here.



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MR. NORTON: Who is it, again?

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WITNESS BLUME: It's under our Geological Department headed by Cunningham, and Don Frame did this particular logging.

5

MR. NORTON: No, he is not intended to be here.

6

BY MR. KRISTOVICH:

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Q Dr. Blume, you are not prepared to answer questions regarding the underlying surface of the plant?

9

A (Witness Blume) That's a very broad general question. I can answer that easily. But if you're going into all the details of this log, the answer is no.

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Q Then I will narrow the question down. You're not prepared to discuss this log which deals with the surface next to the containment building?

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A I'm not prepared to discuss the details of this log. This is part of a long term study that we are not at all completed on, nor was it a part of our analysis of this plant.

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The general terrain out there is rocky, rocky sandstone and siltstone.

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Q And on what do you base that conclusion?

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A Observation, seeing all sorts of trenching, borings, walking through all the trenching.

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Q What do you mean by sandstone?

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A Sandstone? Well that's a geologic term for fine



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3/wb3

1 particles of sand that are cemented together to form a rock.

2 Q Well do these lines on the graphic log designate  
3 features in the rock?

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

5 Dr. Blume has said that this is not his area of  
6 expertise, that this is a log done by people who specifically  
7 do it, and the best he can do is to say what the log says.  
8 If the log gives a definition and he says, Okay he'd agree  
9 with it. But he says he cannot interpret it.

10 We would object to any further questions about  
11 this particular log. I don't understand where counsel is  
12 going, but even if I did I would have the same objection.  
13 These witnesses are not the people to talk about this log.  
14 It has nothing to do with their direct testimony. Their  
15 direct testimony isn't based on this log in any way.

16 MRS. BOWERS: Mr. Kristovich?

17 MR. KRISTOVICH: Well, Mrs. Bowers, I didn't hear  
18 Dr. Blume say he couldn't interpret various features of this.

19 MR. NORTON: I heard him say it was outside his  
20 area of expertise. And if it's outside of his area of  
21 expertise he's not going to interpret it. It's that simple.

22 MRS. BOWERS: I think he stated that he wasn't  
23 familiar with the particulars of the log.

24 Am I stating that correctly, Dr. Blume?

25 WITNESS BLUME: That's correct. I know logs in



1 general, I know the site in general, but I do not know the  
2 particularz of this particular log.

3 MR. KRISTOVICH: Well, Mrs. Bowers, if he cannot  
4 answer the question he can say so.

5 MRS. BOWERS: Well I think he has said so several  
6 times.

7 MR. KRISTOVICH: He just said he knows logs in  
8 general. And this is a general log. If you'd like to read  
9 the record back I believe that's exactly what he said.

10 MRS. BOWERS: Well, we're puzzled, too. You have  
11 before you a panel of witnesses who say they're not personally  
12 involved or really knowledgeable about drill hole logs.

13 MR. KRISTOVICH: Mrs. Bowers, on page 1 of the  
14 testimony, beginning on line 14 and going to line 16 the  
15 testimony sdiscusses shear wave velocity through the underlying  
16 rock. And we're interested in discussing the underlying  
17 rock, because we have the log that was done for Dr. Blume's  
18 company.

19 MR. NORTON: Mrs. Bowers, this log was not done  
20 to develop the shear wave velocity. If they want to ask  
21 questions about how the shear wave velocity was developed, and  
22 so on and so forth, fine. And then if they want to leap to  
23 their feet and say: This log disproves everything you've  
24 said, fine. But these people are not here to testify about  
25 this log. They've just stated they're not familiar with it.



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1 It's a different program. They're not the people who do  
2 this sort of thing. Those numbers are supplied to them  
3 by other people.

4 They're prepared to talk about the shear wave  
5 velocity. Dr. Blume talked about it at great length two  
6 weeks ago, of the site shear wave velocities. And they're  
7 there to talk about that. They're not prepared to talk about  
8 this specific log.

9 If intervenors have a witness who wants, again,  
10 to jump to his feet and say: Aha, this proves it. Fine.  
11 Let's hear it.

12 But I'm looking at this log and I sure can't  
13 read it. It doesn't mean anything to me. And Dr. Blume  
14 is saying he doesn't want to read it either, that he's got  
15 people who do that who are trained and who are experts in it.

16 MRS. BOWERS: We do have an objection before us.

17 Mr. Ketchen, does the Staff have a position?

18 MR. KETCHEN: Yes, Ma'am, we do.

19 We would support the objection. I think it's  
20 probably, as Mr. Norton points out, beyond the scope of the  
21 direct. In addition to that we've got an answer from these  
22 witnesses saying that they can't respond further. And I think  
23 if intervenors' counsel wants to ask about the direct he should  
24 do so and get back into the testimony and continue. I think  
25 we should move on. But I think we have bogged down here in



1 something that is not within the scope of the direct. And  
2 I think the objection should be sustained. That's the  
3 Staff's position.

4 MRS. BOWERS: Mr. Kristovich, do you have anything  
5 further in response to the objection?

6 MR. KRISTOVICH: Nothing further.

7 MRS. BOWERS: Well, the objection will be  
8 sustained.

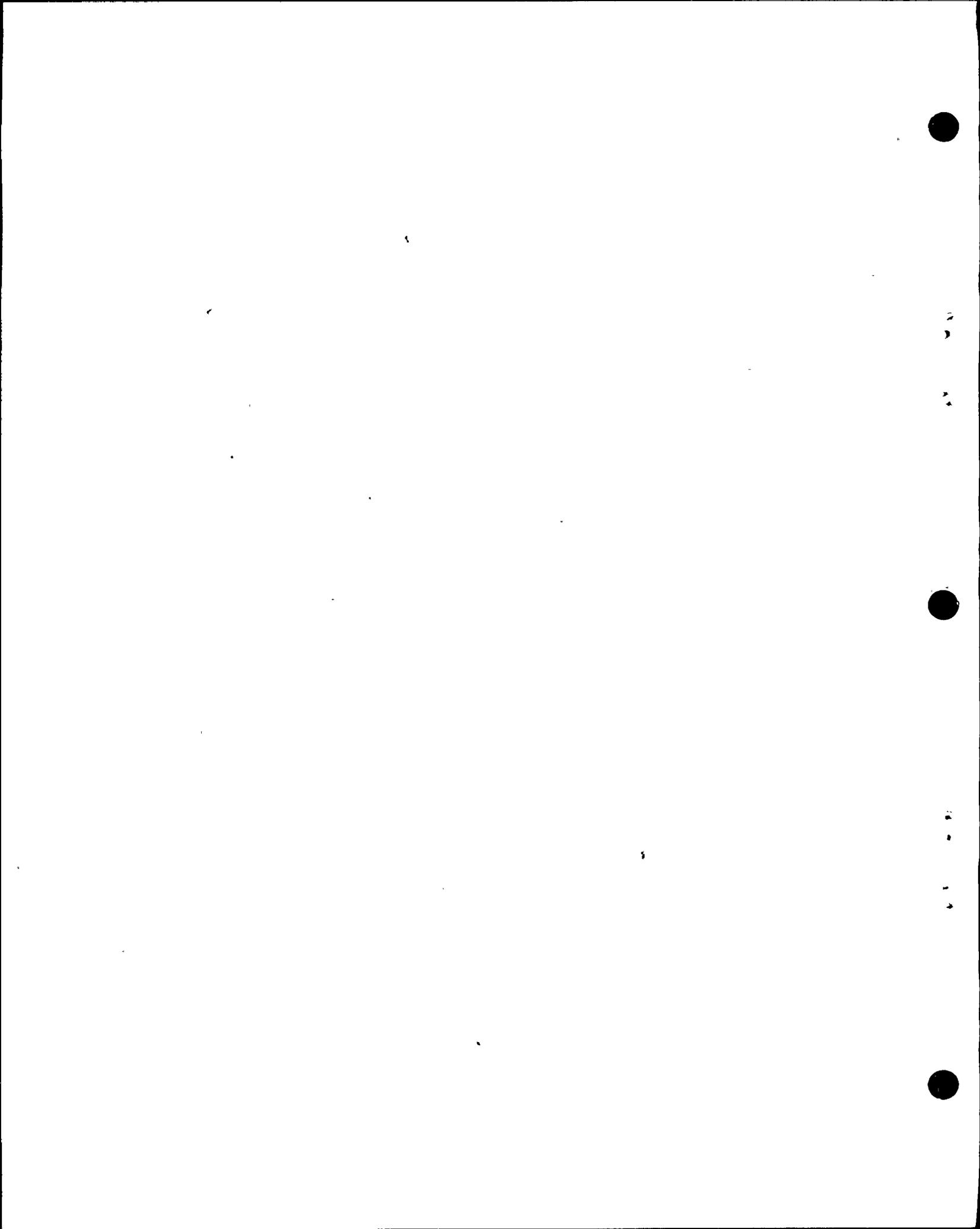
9 Now the question the Board has, and would like  
10 comment from the parties on, is, Haven't we had prior wit-  
11 nesses who would be -- as geologists and geophysics types,  
12 who would be qualified to respond? In other words, why  
13 wasn't it brought up earlier?

14 Mr. Norton, am I correct in the statement I just  
15 made?

16 MR. NORTON: I really don't know. I would assume  
17 you are. I would think that Dr. Hamilton and Dr. Jahns  
18 would have been people who could have testified about this,  
19 but I don't know specifically.

20 I mean certainly it's in the area of geology and  
21 not in the area of structural engineering. And if anybody  
22 would have, they certainly would have.

23 As to why it wasn't brought up earlier, we had  
24 no reason to bring it up. It doesn't have anything to do with  
25 anything we can see. Why Intervenor's didn't bring it up



1 earlier is something only they can answer.

WRB/wb7

2 MR. KRISTOVICH: We thought it would be appropriate  
3 to bring it up when Dr. Blume was on the panel, it being from  
4 his company, and it having to do with assumptions regarding  
5 structures.

6 WITNESS BLUME: May I?

7 MRS. BOWERS: Dr. Blume.

8 WITNESS BLUME: It has nothing to do with the  
9 assumptions regarding the structure. This is part of the  
10 long term research program. And this was not the basis for  
11 any of the analysis done in the program.

12 MR. NORTON: Excuse me, Mrs. Bowers. If I might  
13 interrupt.

14 This is about the -- oh, I don't know -- the  
15 third or fifth time the seismic research program has come  
16 up and I don't believe there has ever been an explanation  
17 of the seismic research program for the Board. And maybe it  
18 should be given at this time to help the Board focus on the  
19 nature of the questions and the objections to questions that  
20 are being asked.

21 It's a difficult thing to put in context and it'll  
22 take a minute.

23 Originally PG&E was given the specifications for  
24 the seismic review, at least on the Hosgri earthquake, from  
25 the NRC staff. PG&E was of the belief at that time, as we



1 talked about earlier today, and still is, that it was a very,  
2 very conservative criteria. We believe that the magnitude  
3 of the earthquake was too high. We believe that even if that  
4 wasn't too high, a 1.15g acceleration was too high, and other  
5 things.

6 For that reason we were concerned that in the  
7 future, in terms of nuclear power plants, and so on and so  
8 forth, that there are all -- that all of these conservatisms  
9 are built in, one piled upon the other, so you end up spending  
10 literally hundreds of millions of dollars that are unnecessary,  
11 that if you deal with reality instead of postulated conserva-  
12 tisms, if you deal with reality you can show that instead of  
13 building something twenty or fifty times stronger than it  
14 needs to be built you can build it, you know, two or three  
15 times stronger than it needs to be built.

16 So this seismic research program was undertaken  
17 for the future, not for this hearing, or for this plant  
18 per se. But many of the numbers that are used in the seismic  
19 research program are taken from this plant simply for  
20 expediency's sake. All this work for the last ten years has  
21 gone into it and, most specifically, for the last three or  
22 four years on the Hosgri re-evaluation, a tremendous amount  
23 of data has been generated.

24 So that's a starting point, to take that data, and  
25 then to develop new methods and new techniques and so on, so



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1 that in the future -- I'm sure Intervenors will be happy to  
2 hear this: in the future when nuclear power plants are built  
3 they can be built much more realistically: instead of spending  
4 twice or three times as much as you have to, you can spend  
5 what is needed to do the job.

6 That's the basis for this program.

7 You know, when they say: Gee, this data isn't  
8 very far along, and so on and so forth, it's in that context  
9 we're talking about: this is something for the future. This  
10 is a research program. It's exactly what it says, a seismic  
11 research program. It's not designed-- The program is not  
12 in any way designed to have any effect on this hearing.

13 Now Intervenors requested discovery of that  
14 information, and we supplied it--

15 MR. KETCHEN: Excuse me, Mrs. Bowers.

16 I just find this procedure objectionable to me.  
17 I think a long speech by Applicant's counsel, which to me is  
18 almost testimony about what some other program is, is  
19 inappropriate.

20 This speech was launched into on Mr. Norton's  
21 assumption that the Board should have an explanation of it,  
22 without a ruling by the Board that they need an explanation  
23 of it. I'm not sure of its relevancy in that regard.

24 But, in addition to that, the explanation of it  
25 I don't think should come from Mr. Norton, if it's relevant



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1 and material to this proceeding. I think it's just a lot of  
2 information that he's putting in the record here by way of  
3 explanation that almost borders on testimony as to facts.

4 I heard the words "methodology," "procedures,"  
5 and so forth and so on. And I find it objectionable. And  
6 I move that it be stricken.

7 MR. NORTON: Mrs. Bowers, it's clearly not  
8 testimony. It's my way of explanation of what the seismic  
9 research program is.

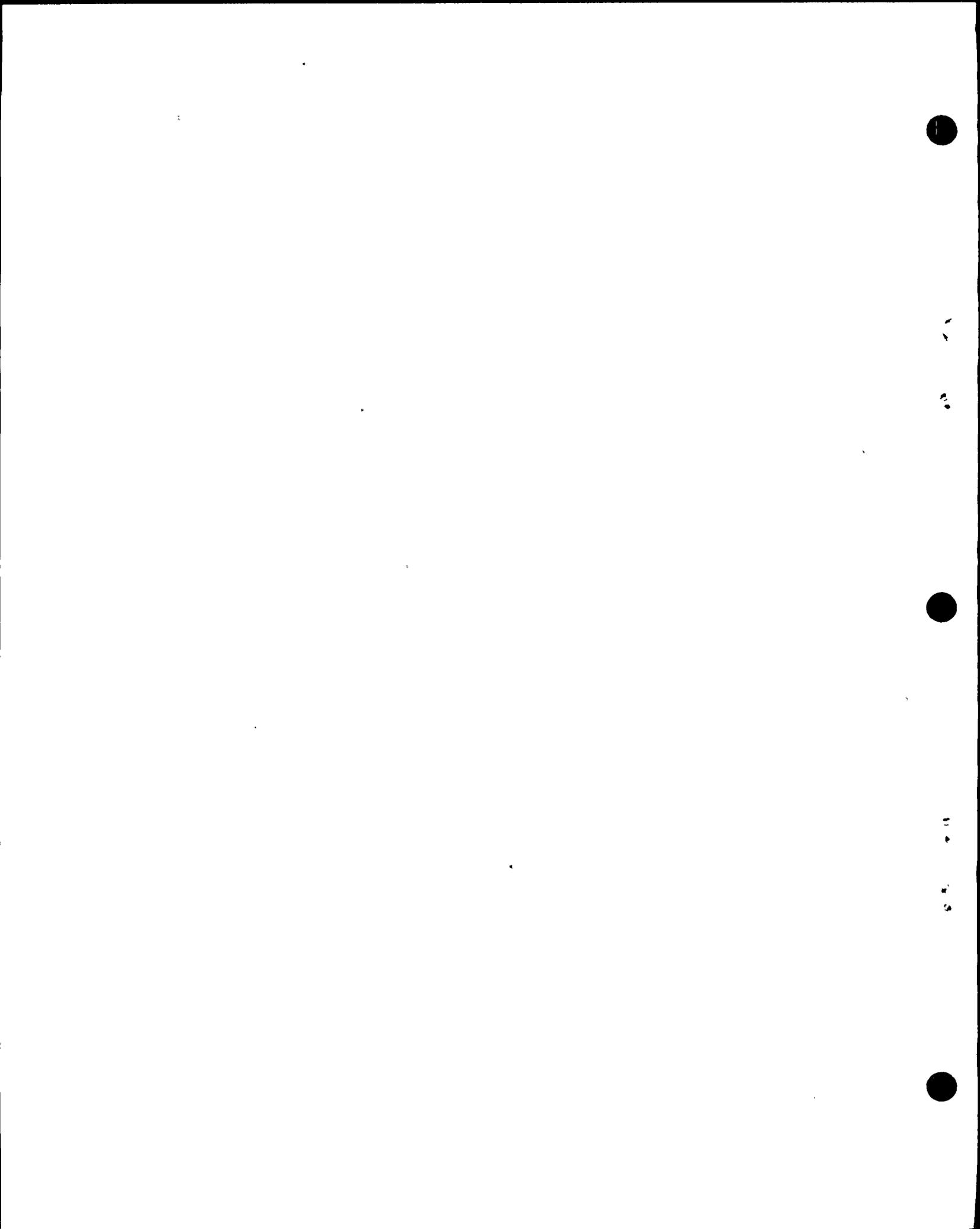
10 Counsel is perfectly correct: I did not wait  
11 for the Board to respond that they were interested. But I  
12 assumed because this term has come up a number of times that  
13 the question would be in your mind as to what was -- or, rather,  
14 what is the seismic research program.

15 MR. KRISTOVICH: Mrs. Bowers, I think Dr. Malik,  
16 since he was the Secretary, could testify as to that.

17 MR. NORTON: No, that's not so. Dr. Malik is a  
18 consultant to PG&E and he's not one to tell the Board what  
19 the seismic research program is. He's doing a piece of work  
20 under the seismic research program. But why the program was  
21 undertaken is PG&E's prerogative, not Dr. Malik's. And  
22 Dr. Malik is not privileged to that information at all.

23 MR. KRISTOVICH: Well perhaps Mr. Ghio can,  
24 or another one of PG&E's witnesses.

25 MR. NORTON: Well, that's fine. Mr. Hoch was on



1 the stand and he was prepared to respond to those questions.

2 You have to understand the context in which this  
3 came up. They discovered documents that had the term "seismic  
4 research program." So then they put out a request for pro-  
5 duction of all documents that dealt with the seismic research  
6 program. And that's where these documents come from. And we  
7 gave them to them because we didn't feel we could argue it's  
8 relevant or doesn't lead to discoverable material, because it  
9 does deal in some cases with the Diablo Canyon site in terms  
10 of numbers, and so on.

11 So we felt that indeed we did have to produce  
12 the documents, and we produced them. And we don't really  
13 object to their being used. But they should be used with the  
14 witnesses who can testify about them. And if there isn't a  
15 witness here, that's too bad, because they don't really deal  
16 with the Hosgri analysis at all. And that's the point I was  
17 trying to make, is to give you the history of how the program  
18 got started, and that it's really in its infancy at this  
19 point in time.

20 MRS. BOWERS: The Staff has made a motion to  
21 strike.

22 MR. NORTON: Well I don't know how you can strike  
23 counsel's comments. It's not testimony at all. I've never  
24 heard of a motion to strike counsel's speeches to the Board.

25 MR. KETCHEN: I think it's an inappropriate



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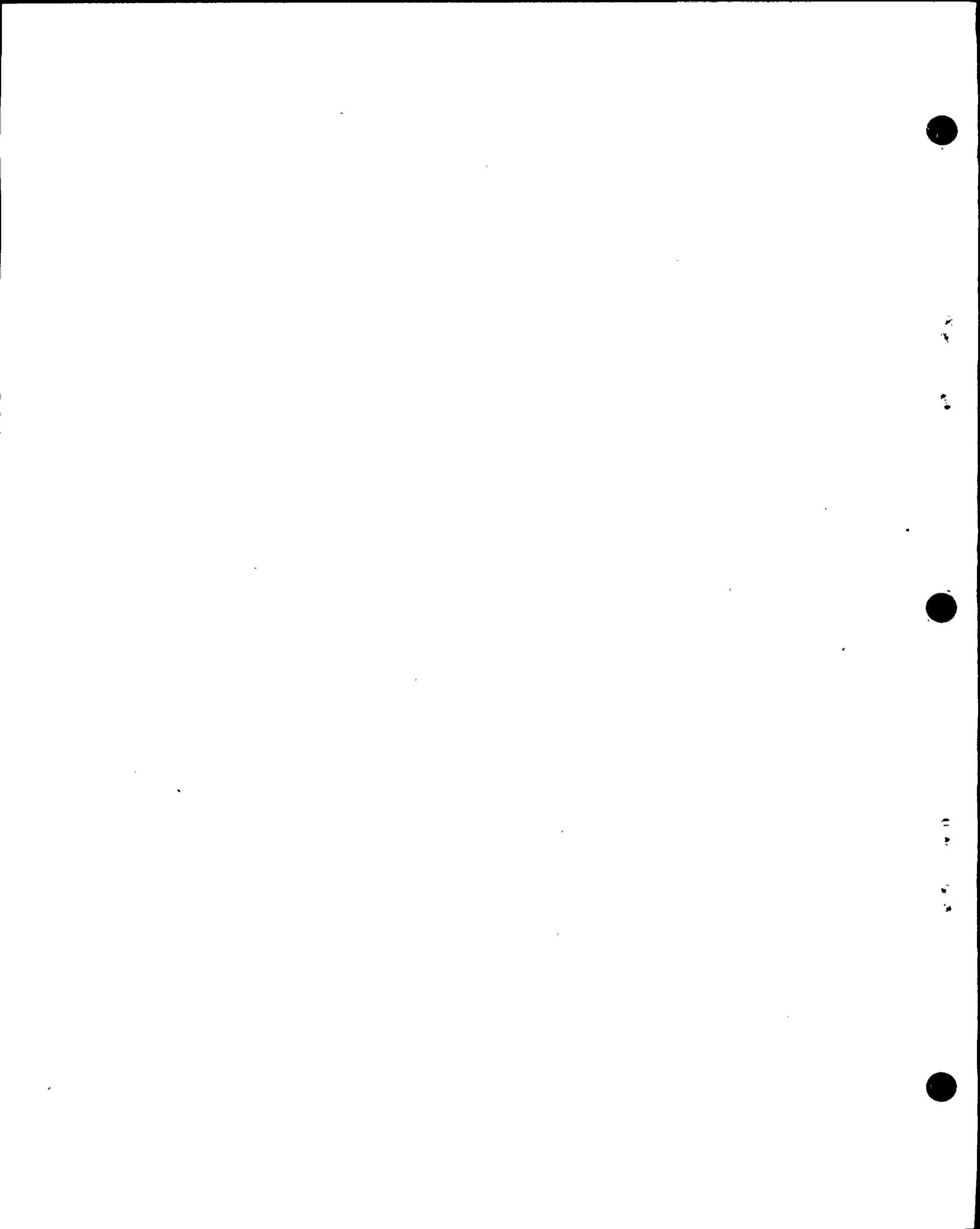
1 procedure to begin with, however you get it there. I don't  
2 think you should be whatever you label it. If you want to make  
3 the testimony, Mr. Norton, go under oath and you can make it  
4 and then I'll move to strike it based on immateriality grounds.

5 But you put me in a position here of having to  
6 move on something that I think is inappropriate, and inappropriate  
7 argument, if you want to call it that in the record.  
8 Because you're talking about facts, and counsel shouldn't  
9 be doing that to the extent that you are. And that's my  
10 objection.

11 I think if it is not stricken it should be limited  
12 in the future. I'm just not sure what its materiality is as  
13 to this panel's testimony. And I'm moving-- I said a  
14 couple of things. But I think we should move beyond this  
15 point and move on and get to these witnesses and get their  
16 testimony on the record.

17 MR. NORTON: I agree with that, that we should  
18 move on. But I think the Board needed an explanation as to  
19 what the SRP was, because it has come up fleetingly on other  
20 occasions. But this time we seem to be talking about it in  
21 more detail, and I just thought the Board was owed an explana-  
22 tion as to what it was.

23 I understand the Staff would not particularly care  
24 for my comments about the unnecessary expense, I understand  
25 that's your motivation to have the stuff struck. But that's



WRB/wb13

1 the way we see it. And I'm just saying that's an argument,  
2 that's not fact. That's the way PGSE sees it and that's the  
3 way they are proceeding with the seismic research program.

4 I guess the results of that program will be the  
5 facts which prove it out, whether that theory is right or  
6 wrong.

7 MRS. BOWERS: I think we've heard enough from  
8 counsel.

9 MR. KRISTOVICH: Is this closing argument now?

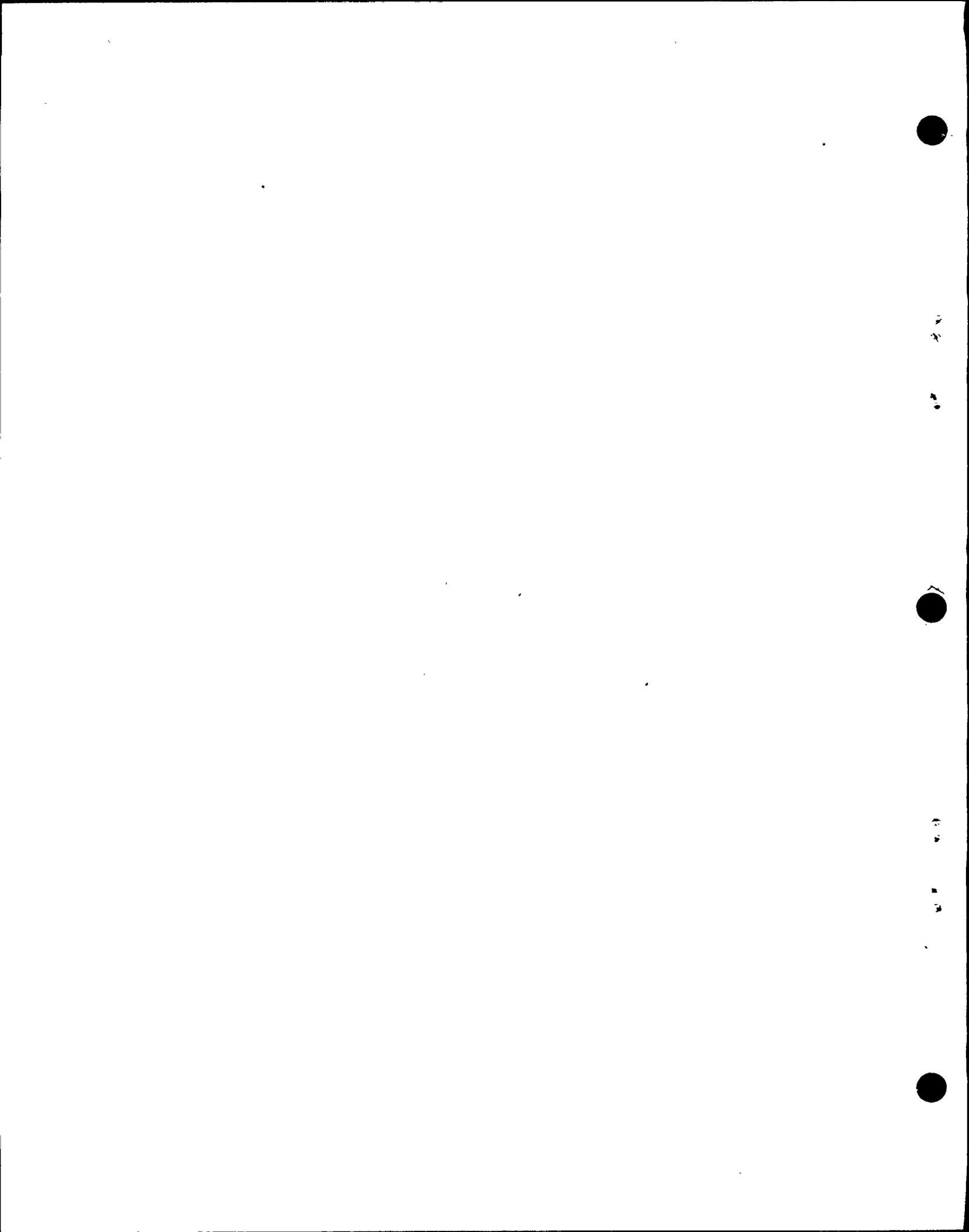
10 (Laughter)

11 (The Board conferring)

12 MRS. BOWERS: This is going to be a two-part  
13 response.

14 The motion is strike is denied. And Mr. Bright  
15 has some questions.

16 MR. BRIGHT: I think the question that concerns  
17 the Board here: we've kept hearing things about the seismic  
18 research program. And it was stated by a part of the  
19 conversation, anyway, that was going on, that the results  
20 which were obtained from the Diablo Canyon borings and all  
21 of this sort of thing, inasmuch as they're a part of the same  
22 kind of thing that people are universally interested in, this  
23 forms sort of a starting batch of data, such as if any  
24 scientist were going to start out on a line the first thing  
25 he would do would be to look through the literature and find



1 out what's available to him. All right.

NRB/wbl4 2 My concern -- and I think this is what the Board  
3 needs to concern itself with -- is, is this on-going program  
4 being used in this hearing; not the data which was gathered  
5 strictly for the Diablo Canyon site but whatever we're  
6 calling the seismic research program, whether that is an on-  
7 going thing which is continuing to have input to analyses or  
8 expected results or whatever.

9 Now I got the distinct impression that no, it  
10 was not. But I have no way of putting this on the record  
11 unless somebody can answer that question.

12 MR. KETCEEN: There's a simple way. If the Board  
13 has that question the Applicant can put on a witness to  
14 answer those questions. That's all my objections.

15 MR. NORTON: I think Dr. Blume can answer that  
16 question. The answer is very simple and he can answer it.

17 WITNESS BLUME: Yes. The SRP, or seismic research  
18 program, is a long term program that has nothing to do with  
19 the re-analysis of the Diablo plant for the 7.5M earthquake.  
20 It's generic in nature. The results are not being used.  
21 That is why I'm not familiar with this particular log.

22 We feel the program should-- We recommended the  
23 program to PG&E because of the problems they were facing and  
24 the conservatisms in the program. And we feel that over a  
25 matter of years this type of approach and analysis which is



1 using new techniques will prove that there can be a lot of  
2 money saved over traditional methods. And this is no reflec-  
3 tion on NRC, but the profession as a whole.

4 I should add that in the early days of the plant  
5 all sorts of borings and trenches were dug and examinations  
6 were made, far beyond that of any other plant that I know of,  
7 even without these more recent things by new techniques.

8 So we had lots to go on in the early days for  
9 the plant.

10 MR. BRIGHT: So we then can assume that this  
11 particular program is not providing input to the Diablo  
12 Canyon analyses?

13 WITNESS BLUME: That's correct.

14 MR. BRIGHT: Thank you.

15 MRS. BOWERS: Mr. Kristovich, do you want to  
16 proceed with your cross-examination?

17 MR. KRISTOVICH: Just one moment, Mrs. Bowers.

18 (Pause)

19 MR. KRISTOVICH: Before we proceed, Mrs. Bowers,  
20 I wonder if we could determine which exhibit PE-47 is, which  
21 Joint Intervenors' exhibit.

22 MR. NORTON: It's 56.

23 BY MR. KRISTOVICH:

24 Q Dr. Malik, how in the finite element model that was  
25 used did you account for the soil properties?

NRB/wb15

End 3A

4A

4 5.410



1 A (Witness Malik) It was a fixed base model, so  
2 the soil properties don't come into it once you assume the  
3 fixed base model.

4 Q Mr. Ghio, did you do an OBE analysis of the con-  
5 tainment structure?

6 A (Witness Ghio) Yes, we did.

7 Q And where was the OBE analysis limiting, or con-  
8 trolling?

9 A Nowhere that I'm aware of.

10 Q Was a vertical dynamic analysis made for the OBE?

11 A No, it was not.

12 Q And does that mean you used two-thirds of .2g at  
13 all elevations in your OBE analysis?

14 A That's not completely true. We did identify in  
15 the original analysis some areas of the structure that we  
16 anticipated would experience vertical amplification. I'm  
17 specifically thinking of the annulus platform area. And this  
18 expectation has been proven out as a result of the Hosgri  
19 analysis, which indicated that we in fact had vertical  
20 amplification in that portion of the structure. And, of course,  
21 the original analysis is somewhat moot in that the Hosgri  
22 evaluation exceeds the original by a substantial margin, and  
23 we qualified it for the Hosgri.

24 Q But you are using the original design earthquake  
25 for the OBE still, are you not?



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1 A That's correct.

2 Q That analysis?

3 A That's correct.

4 Q And didn't that analysis use two-thirds of .2g  
5 at all elevations?

6 A Excuse me; I'm going to have to ask Mr. Hanusiak  
7 to respond to that question.

8 A (Witness Hanusiak) We have identified parts  
9 where we expected dynamic amplification.

10 Q Expected what?

11 A Dynamic amplification. And for those parts we  
12 did make a subsequent dynamic analysis that showed the dynamic  
13 amplification. In fact we came up with dynamic amplifications  
14 that were kind of in line with what we later obtained from  
15 the Hosgri analysis. And those were used in annulus struc-  
16 ture analysis. And so we do have analysis for DE that in  
17 fact is a vertical dynamic analysis.

18 Q For the annulus?

19 A For the annulus; right.

20 Q And for any other points?

21 A Well for other points. Well, for instead,  
22 interior structure, other than annulus, the Hosgri dynamic  
23 analysis indicated that there's no amplification, the struc-  
24 ture is very rigid.

25 So neither for Hosgri, nor DE or DDE we have an



1 amplification.

2 Then for the containment structure, the exterior,  
3 the vertical input has very insignificant, maybe 1 or 2  
4 percent impact on the total value. So it is a moot point to  
5 make a specific dynamic analysis for it.

6 Q Are you familiar with the vertical accelerations  
7 for the containment structure that were used in the Hosgri  
8 analysis?

9 A Yes, I am.

10 Q Well isn't it true that at elevation 301.64 for  
11 the containment exterior structure the vertical acceleration  
12 is 1.60?

13 A Right.

14 Q And that the original DDE was .27?

15 A That is correct. But that particular point, at  
16 elevation 303 is--

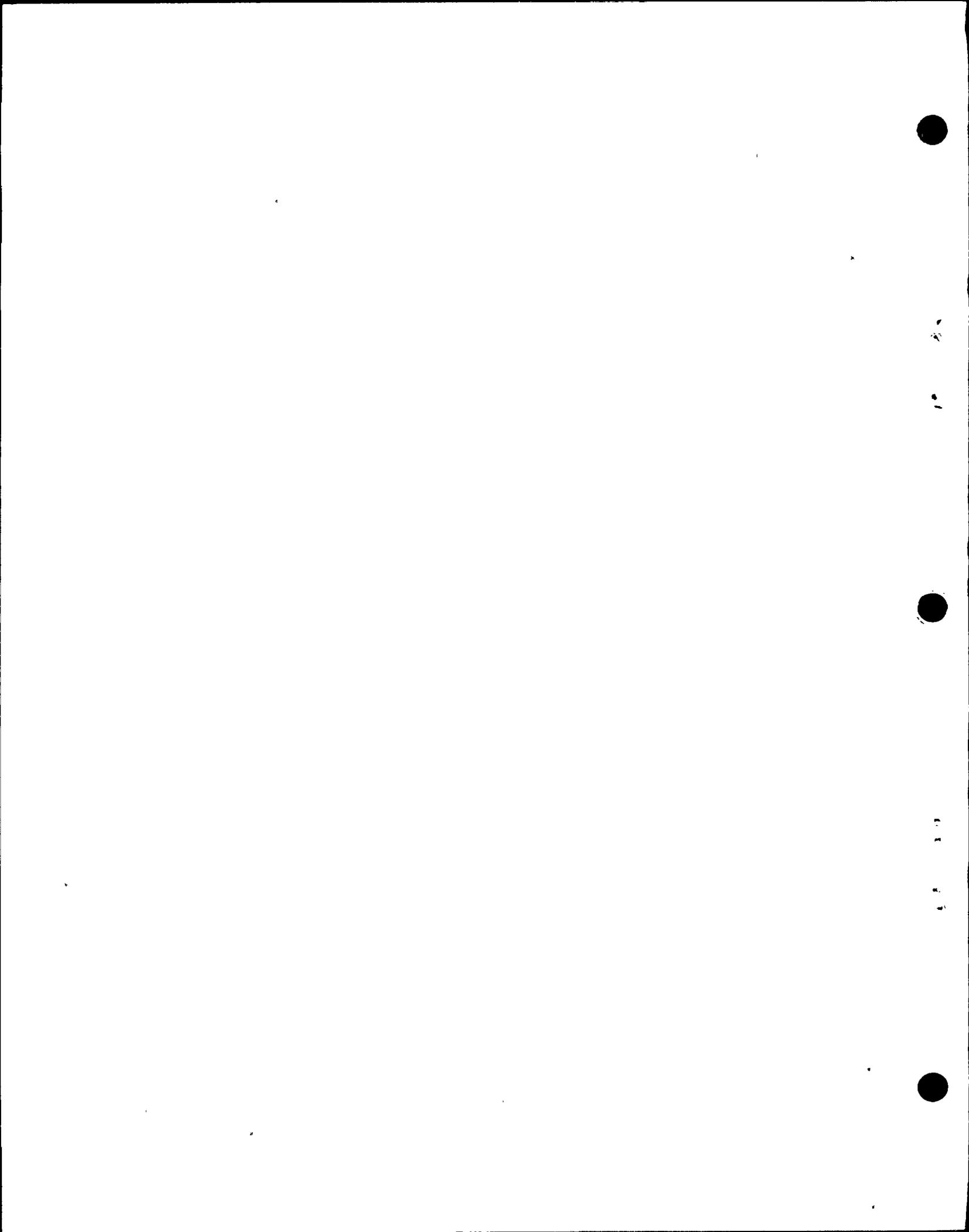
17 Q 301.

18 A 301. --is really a moot point to analyze because  
19 it has the same reinforcing--

20 Q The what?

21 A The same reinforcing at elevation 166. At  
22 elevation 166 all the numbers are so much bigger that even  
23 though there is an increase it has no impact on the overall  
24 stress level. Really, the controlling point is elevation 166.

25 Q What is the vertical acceleration at elevation 166,



1 level 166?

WRE/wb19

2 A Well for this I would have to consult the tables.

3 Q Could you consult the tables?

4 MR. NORTON: Counsel is reading from the table.

5 Why don't you give him the figure, and let's move on?

6 MR. KRISTOVICH: It's not listed for 166.

7 MR. NORTON: You have the table right there in  
8 front of you, don't you?

9 MR. KRISTOVICH: Right.

10 WITNESS HANUSIAK: I suggest you read the point  
11 above and the point below, because you can interpolate those  
12 values.

13 BY MR. KRISTOVICH:

14 Q Well the point above is 181 and the point below  
15 is 155. And the value at Point 181 is .82g and at 155 it's  
16 .72g.

17 (Dr. Martin joining the Board)

18 MRS. BOWERS: The record will show Dr. Martin is  
19 now in attendance.

20 BY MR. KRISTOVICH:

21 Q So would you say at Elevation 166 feet it's  
22 probably .77g approximately?

23 A (Witness Hanusiak) Yes. This would be approxi-  
24 mately okay.

25 Q And that's approximately three times what was



1 originally used?

WRB/wb20 2 A Yes. This might be approximately three times as  
3 much as was used.

4 I just wanted to emphasize the fact that it was  
5 three times. If the influence originally was 1 percent, then  
6 three times makes 3 percent. So I'm just pointing out that  
7 the vertical input has a very insignificant impact on the  
8 overall stress level.

9 Q Can you show us the equation that shows that?

10 A Well not the equation. I would have to refer  
11 you to the analysis, if you would like to review it.

12 Q Well if you can't show us the equation then  
13 refer us to the analysis.

14 A Well I don't think I could supply you with the  
15 analysis right here.

16 Actually this analysis is probably part of the  
17 record.

18 Q What analysis?

19 A The analysis of the exterior shell of the con-  
20 tainmentment.

21 A (Witness Ghio) Excuse me; if I may interject:

22 I think what he is alluding to, and I think he  
23 made the statement here that the impact or the effect of the  
24 vertical seismic contribution to the total stress is of the  
25 order of 1 or 2 or 3 percent. And I do have a Vu-graph here



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1 that illustrates this point. It appears to have been done  
2 for the -- some numbers extracted for the Hosgri calculation.  
3 But I think the concept would apply regardless of what parti-  
4 cular earthquake we're talking about.

5 Now we'd be glad to show that figure to illustrate  
6 what he's attempting to say, with the proviso that although  
7 it is for the Hosgri calculation this concept is independent  
8 of the excitation input level; it just comes out of the way  
9 the loads are combined.

10 A (Witness Hanusiak) I would also want to point  
11 out that, for instance, the DE analysis would certainly show  
12 lower numbers than Hosgri. So even if I use Hosgri numbers  
13 for DE it would still be an insignificant number.

14 A (Witness Blume) While they're getting the screen  
15 set up I would like to note that the principle involved here  
16 applies to many, many parts of these structures, namely,  
17 that the seismic which is getting all the attention may in  
18 fact amount to only a few percent of the total stress pattern.  
19 This means that you can have radical changes in the seismic and  
20 no effect on the overall results as to the capacity of the  
21 member. This was one of the many points I was listing as  
22 safety factors, or margins, that are not normally recognized  
23 last week.

24 (Slide)

25 Q Before you go on I want to follow up with what



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1 Dr. Blume just said.

2 Isn't Table 1 a good example of a total load?

3 MR. NORTON: Table 1 of what?

4 MR. KRISTOVICH: The written testimony we're  
5 cross-examining on.

6 WITNESS BLUME: Table 1 is the direct testimony?

7 MR. KRISTOVICH: Correct.

8 WITNESS BLUME: It's exactly what it says it is.

9 It's load combinations for those particular loads. And you'll  
10 notice that even there -- and this is another extrema case --  
11 that the seismic is not always the predominating part, and  
12 there are other members where it is even less so, such as  
13 the one you're going to see on the screen.

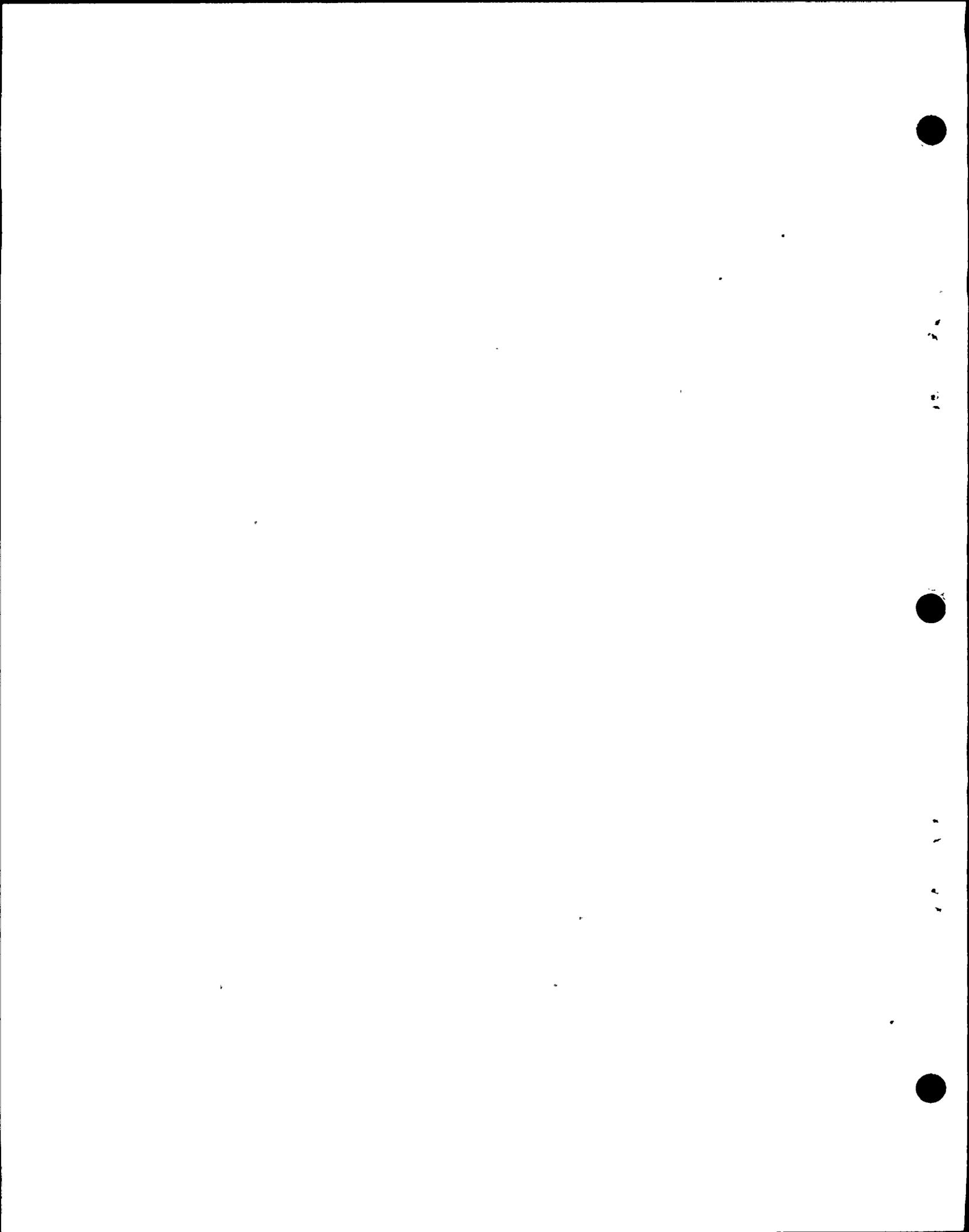
14 MR. NORTON: Excuse me. The figure that's up  
15 there is in part Figure No. 5 to the direct testimony.  
16 Unfortunately it's in black and white. But then there's some-  
17 thing written on in red. The written on in red is not on  
18 Attachment No. 5 to the direct testimony. So this will have  
19 to be marked as an exhibit and placed in the record.

20 MR. KRISTOVICH: This will be Joint Intervenors'  
21 Exhibit No. 62.

22 BY MR. KRISTOVICH:

23 Q Mr. Chio, could you give this a name?

24 A (Witness Chio) Yes. We would title this  
25 Containment Shell Diagonal Reinforcing Stress.



1 (Whereupon the document referred to was  
2 marked for identification as Joint  
3 Intervenors' Exhibit 62.)

4 WITNESS HANUSZAK: This graph shows basically  
5 the same numbers that are given in the table in a graphic  
6 form. And in red is marked the stress that we would have  
7 there if we ignored vertical seismic input altogether.

8 So this means that we can see the impact of  
9 vertical seismic either being included or not, and that the  
10 controlling point at Elevation 166, the contribution of the  
11 vertical seismic is only 1.9 percent of the total stress.  
12 It was actually difficult to even show it graphically,  
13 because in trying to scale it it made it basically the same  
14 line almost.

15 End 4A  
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1 MR. NORTON: Mrs. Bowers, I think the record  
2 should reflect that, as I look at it, the red line is in some  
3 parts offset from the black line, the farthest one to the  
4 right. I don't know that that's going to show up in a xerox  
5 reproduction. This is a pretty large blowup. It may or may  
6 not show up. There are two separate lines, a red line and a  
7 black line, which are clearly going to show up as black lines  
8 on a xerox reproduction.

9 We'll just have to wait and see how it comes out.

10 MRS. BOWERS: Well, it looks to me as if the red  
11 line is slightly inside the black line, is that correct?

12 MR. NORTON: Yes, but this is blown up, and if  
13 you take a little 8-1/2 x 11 xerox, I'm not sure it's going  
14 to show that way. Hopefully it will.

15 MR. BRIGHT: Could you indicate what grade level  
16 was on this? Is that 166?

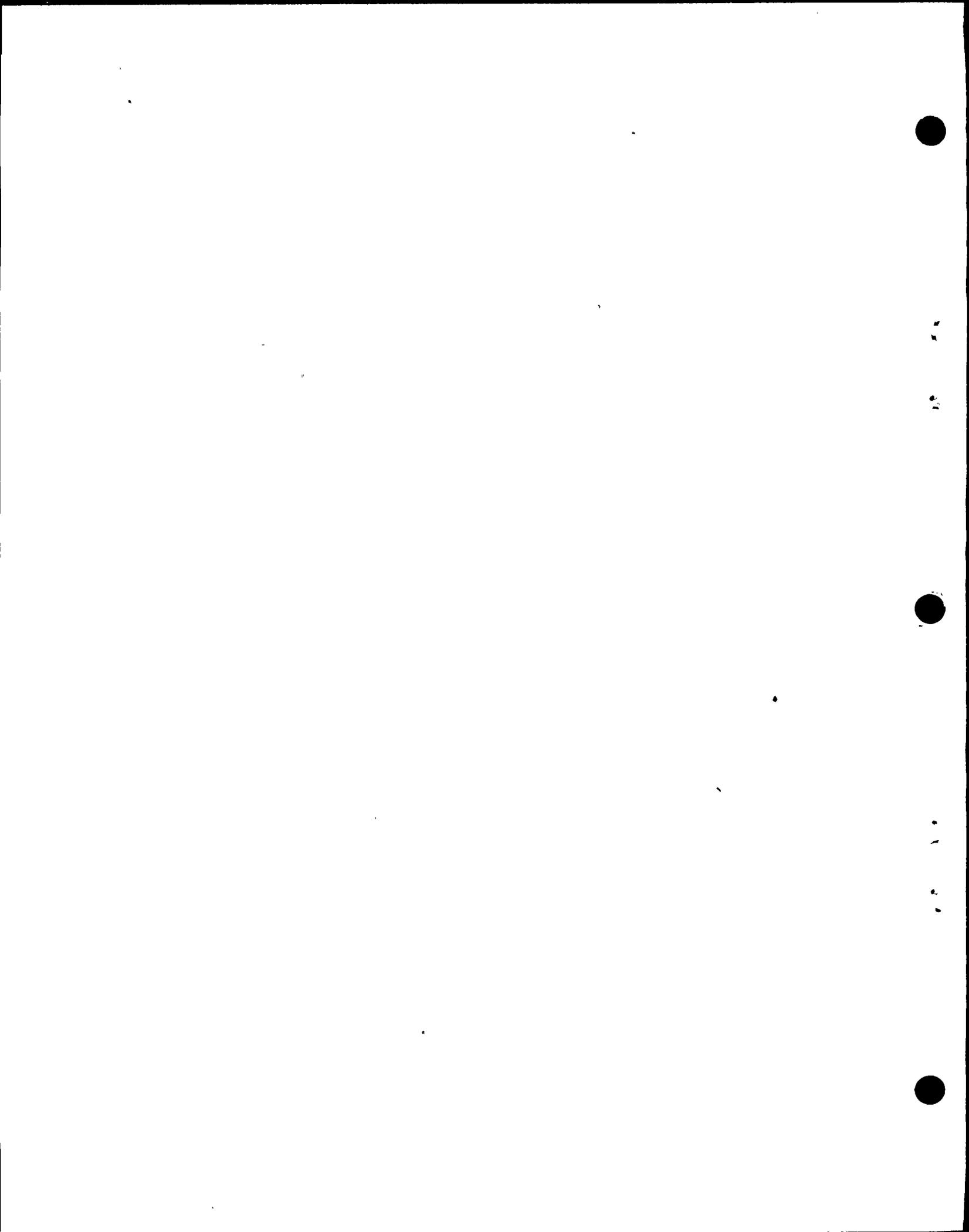
17 WITNESS HANUSIAK: Right in the bottom, slightly  
18 below the bottom, because the bottom elevation is 91, and  
19 grade level there might be like 95. So it's just slightly  
20 below the bottom line is the ground level.

21 BY MR. KRISTOVICK:

22 Q Does the vertical acceleration affect other  
23 stresses, other than the ones shown here?

24 A (Witness Hanusiak) No, it does not.

25 Q Do you agree with that, Dr. Malik? That vertical



wel 2

1 acceleration only affects the stress in this analysis?

2 A (Witness Malik) I have no reason to suspect it.  
3 He's done the work. I haven't done any of the combinations.  
4 So I believe him.

5 Q Can you show us how you got the 1.9 percent?

6 A (Witness Hanusiak) I have calculated the stresses,  
7 leaving all the numbers the same except not including vertical  
8 seismic load. And then, for instance, at elevation 166 where  
9 I have stress with vertical seismic being 40.7, and without  
10 being 39.91, the difference between those two numbers is like  
11 .79. And then I compared the .79 to the total stress at that  
12 level that is shown to be 60.31.

13 Q When did you make this analysis?

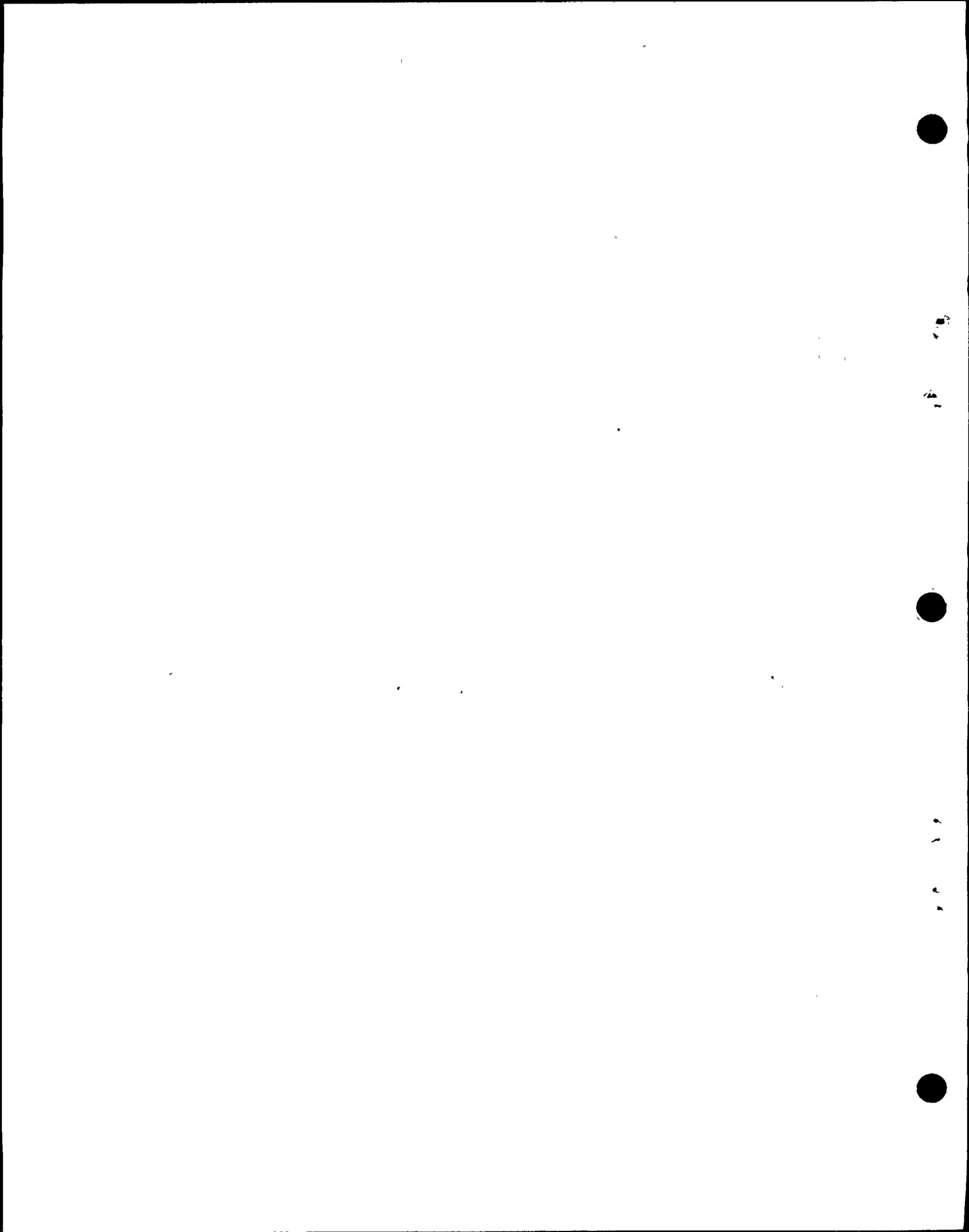
14 A This comparison I made -- this particular one  
15 here I made recently, just to . . .

16 Q How recently?

17 A Probably two months ago. I was, of course, aware  
18 that there was very little significance of vertical seismic,  
19 but since I read one of the contentions of the Intervenor I  
20 wanted to have numbers available if they would care to know.

21 Q Have you done this type of analysis for other  
22 structures?

23 A Well, we have containment shell -- this is for  
24 the containment shell. For the containment interior, they  
25 mentioned the vertical seismic input -- there was no dynamic



1. amplification. And then places like annulus platform, where  
 2. we did expect this to have an impact, then we performed  
 3. analysis.

4. Q Have you submitted the particular numbers herein  
 5. shown in red to the NRC at any time?

6. A No, those red numbers were not submitted.

7. Q The NRC did request you to make a dynamic vertical  
 8. analysis, did it not?

9. A You mean for DE? We did, for Hogri evaluation,  
 10. complete the vertical dynamic analysis. And there was, of  
 11. course, no point for me to do this -- those red numbers,  
 12. because we were interested in total numbers, not numbers  
 13. without vertical, but I needed this for the purposes of  
 14. illustrating the relative significance of vertical seismic.

15. MR. KRISTOVICH: Mrs. Sowers, we haven't given  
 16. this a number yet, but Intervenor's next in order, I think,  
 17. is 63, and it needs a title, too. I guess it could just  
 18. be, "Containment Shell Diagonal Reinforcing Stresses." And  
 19. perhaps one of the panel members, perhaps Mr. Ghio, could  
 20. sign it.

21. MR. NORTON: This is not a drawing.

22. MR. KRISTOVICH: Well, there are numbers written  
 23. in on it.

24. MR. NORTON: It's just a table of numbers.

25. (Whereupon Joint Intervenor's Exhibit 63  
 was marked for identification.)



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1 MRS. BOWERS: I think Mr. Hanusiak told us how  
2 the additional column of numbers came about, and that he did  
3 the work and added the numbers to this table.

4 MR. KRISTOVICH: Well, Mrs. Bowers, we'd like to  
5 move Joint Intervenors' numbers 62 and 63 into evidence at  
6 this time.

7 MR. NORTON: No objection.

8 MRS. BOWERS: Mr. Ketchen?

9 MR. KETCHEN: No objection.

10 MRS. BOWERS: Well, Joint Intervenors' Exhibits  
11 62 and 63 are admitted into evidence, and I assume we'll get  
12 xerox copies of them.

13 (The documents heretofore  
14 marked for identification as  
15 Joint Intervenors' Exhibits  
16 62 and 63 were received in  
17 evidence.)

18 MR. KRISTOVICH: That slide can be taken off  
19 now. We have no further questions on it.

20 MR. NORTON: You'd better label this one with the  
21 same title you gave -RSI, because 62 has the same title.

22 MR. KRISTOVICH: Fine.

23 MR. NORTON: It's on the exhibit, but you  
24 referred to it in the record as having the same name as  
25 Exhibit 62.



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MR. KRISTOVICH: Well, I believe the record now shows that Joint Intervention 63 is "Containment Shell Diagonal Reinforcing Stresses -KSE."

MRS. BOWERS: Mr. Kristovich, could you pull the microphone a little closer to you?

MR. KRISTOVICH: Certainly.

BY MR. KRISTOVICH:

Q Mr. Hanusiak, by what percent would using .13 g understate the OBE loads, .13 g vertical acceleration?

A (Witness Hanusiak) What about it? I didn't . . .

Q By what percent would using .13 g load, .13 g vertical, understate the OBE loads?

A Would you please repeat the question?

MR. NORTON: I think he'd better do more than repeat it. I think he'd better clarify it.

MR. KRISTOVICH: Well, could we have 62 back on the board, then?

MR. NORTON: It's gone. It's not in the room.

MRS. BOWERS: Both of the transparencies have been sent for reproduction?

MR. NORTON: Yes.

MRS. BOWERS: Well, it's almost ten of 12:00. What we might do is recess now for lunch, and -- will they be available after lunch, Mr. Norton?

MR. NORTON: The copies, or the transparencies?



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wel 6

1 MR. HUBBARD: If they'll give me the copies, I'll  
2 make 9 copies over lunch at the hotel.

3 MRS. BOWERS: You can work out the logistics.  
4 But if you want to proceed in this sequence, and we don't have  
5 the documents available, the thought was to recess for lunch.

6 MR. KRISTOVICH: Since it's so close to lunch  
7 time, that's fine with us.

8 MRS. BOWERS: Is there any objection?

9 MR. NORTON: No.

10 MR. KETCHEN: No.

11 MRS. BOWERS: All right. We'll recess and  
12 hopefully can reconvene a few minutes before 1:00.

13 (Whereupon, at 11:50 a.m., the hearing was  
14 recessed, to reconvene at or about 1:00 p.m., this same day.)

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## AFTERNOON SESSION.

(1:00 p.m.)

MRS. POWERS: Mr. Kristovich, are we ready to begin?

Whereupon,

JOHN A. BLUNE,

VINCENT J. GHIO,

DAVID A. LANG,

STANLEY A. HANUSIAK,

DILIP P. JHAVERI,

and

LINCOLN E. MALIK

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

MR. KRISTOVICH: Could we have Joint Intervenor's number 62 on the screen, please?

(Slide.)

MR. KRISTOVICH: And we have distributed copies of both 62 and 63, Joint Intervenor's Exhibits, to the parties and to the Board.

## CROSS-EXAMINATION (Continued)

BY MR. KRISTOVICH:

Q Now, Mr. Hanusiak, with reference to Joint Intervenor's Exhibit 62, I believe you testified before



mpb2 1 lunch that for the SSE analysis, the vertical stresses were  
2 1.9 percent due to vertical seismic at elevation of 166  
3 feet.

4 A (Witness Hanusiak) Right.

5 Q Now for the OBE analysis, if a vertical dynamic  
6 had been used, what percentage of the seismic stresses  
7 would the vertical have been at 166 feet?

8 A I couldn't really give you the percentage,  
9 because I haven't figured it out. But DE or OBE stresses  
10 would be -- the contribution would be obviously less than  
11 the Hosgri because it is a smaller earthquake. So since  
12 we are dealing with a small number such that it is even  
13 difficult to draw to scale, then it's a very small number.

14 So I suppose if it is 1.9 percent, well maybe  
15 it's -- I don't know -- probably in the same range, about  
16 1.9, plus or minus.

17 Q Okay.

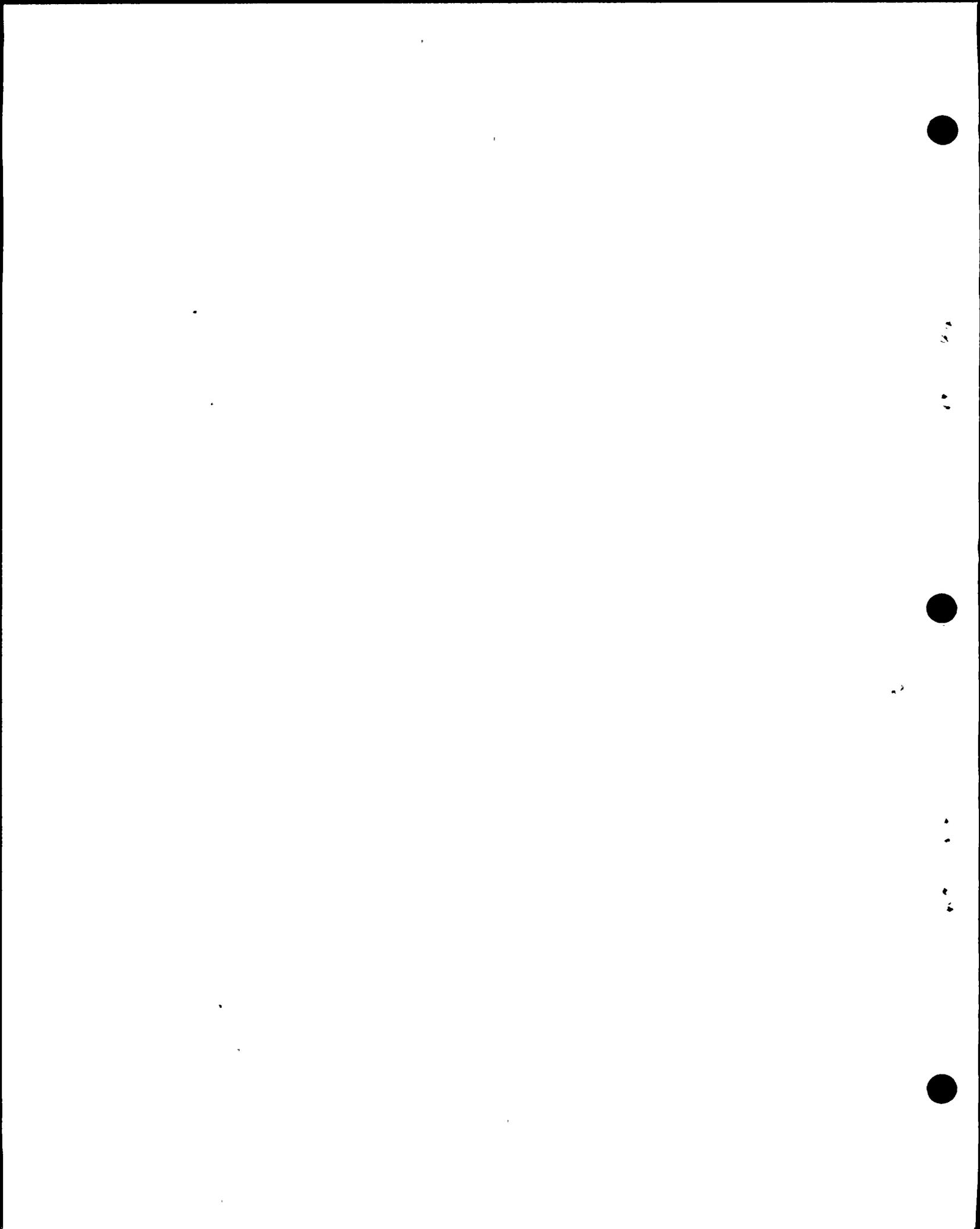
18 MR. KRISTOVICH: We no longer need this on the  
19 screen, then.

20 BY MR. KRISTOVICH:

21 Q Now, Dr. Malik, directing your attention to  
22 page 2 of the written testimony, line 2 --

23 A (Witness Malik) Yes.

24 Q -- was the vertical spectra that was used  
25 based on the Newmark horizontal spectra with or without the



mpb3

1 tau factor reduction?

2 A Without the tau factor.

3 Q Is that true for the other buildings as well?

4 A Yes, it is.

5 Q Okay.

6 Directing your attention to page 3, at lines 12  
7 to 15 --

8 A Yes.

9 Q Well, specifically on lines 14 and 15 you state:

10 "The UBC procedures consistently gave  
11 lower torsional responses."

12 Did the Uniform Building Code give lower torsion-  
13 al responses in all points analyzed in the containment build-  
14 ing?

15 A Yes.

16 Q Okay.

17 Moving back to page 2, lines 13 through 16, you  
18 state that:

19 "The concrete strength used was based on  
20 test values for the concrete taken during the  
21 construction of the Containment Structure with  
22 no allowance for the increase in strength  
23 associated with aging effects."

24 A Yes.

25 Q Did you average concrete strength?



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A Yes.

Q And how did you average the strength?

A Straight averaging. You sum them up and divide by the number of tests that you have.

Q What was the spread of the data that was averaged?

A I don't have it with me. There was a standard deviation, if I remember right, calculated. But it wasn't very wide.

Q What type of distribution did you have?

A It's not a probabilistic model where you postulate a distribution. This is just test specimens, and no curve was fit to it.

Q Well, then, how do you calculate the standard deviation?

A Standard deviation, if I remember the equation, is one over N minus squared summation of all results of S minus -- the strength minus the average strength, the whole thing squared.

Q Did that assume a certain distribution?

A No. This is a statistical derivation. It's where you have a whole number of -- you have a whole bunch of numbers. That's the way you calculate the standard deviation. For any series of numbers that's what you do.

MR. NORTON: Excuse me.

These calculations are in evidence, Volume 4 of



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mpb5

1 the Hosgri evaluation, D-6A.3.

2 WITNESS BLUME: I would like to add that the  
3 table 6A.1 shown on the page D-6A.3 shows the coefficients  
4 of variations in the right-hand column, 6.5, 9.5 and 7.0. And  
5 these are very very low for concrete and indicate the excellent  
6 control of the concrete on the job site.

7 BY MR. KRISTOVICH:

8 Q Dr. Malik, are the mean and the median, the distri-  
9 bution the same?

10 A (Witness Malik) No, mean and median is not the  
11 same. Median is the middle number; the mean is the average.

12 Q For this particular distribution, do you know  
13 whether the mean and the median are the same?

14 A No.

15 Like I said again, you're talking with a whole  
16 bunch of numbers of data. It's not the distribution. I mean,  
17 it's not like you start with the normal distribution and then  
18 you can calculate the mean and the median.

19 This is where you have the numbers and you just  
20 have to order them and find which one comes in the middle.  
21 That would be the median. And the mean is what we've calculat-  
22 ed.

23 Q Well, were these averages sensitive to any other  
24 factors, such as time of year of the pour, or the height  
25 elevation of the pour?



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mpb6

1 A The time of year, I don't think so. They are  
2 cured in the lab. I believe the tests are taken from each  
3 pour.

4 A (Witness Blume) Did you say "core"?

5 Q Pour.

6 A Height of the pour, no that would not be a factor  
7 in this. These were test cylinders that were made, and the  
8 height of the placing of the concrete in the pour wouldn't  
9 have any bearing on the test cylinder results.

10 Q Well, would there be any other factors, Dr. Blume,  
11 that might affect the averages?

12 A No. These are all tests made under standard condi-  
13 tions as prescribed by the American Society of Testing  
14 Materials, where the samples are taken in a certain way,  
15 stored in a certain way, and tested at a certain age.

16 Now some of these were tested at 28 days, as shown  
17 in the table we're looking at, and a few of them were tested  
18 at 60 days. There was no extra strength taken for the aging  
19 factor. So the procedures are all standardized. We call it  
20 ASTM standards, American Standards for Testing Materials.

21 Q Was there more than one vendor making this concrete,  
22 more than one manufacturer?

23 A I think I'll refer to Vince on that one.

24 A (Witness Ghio) I don't recall exactly how many --  
25 primarily it's one source. We had one general contractor



mpb7

1 involved with concrete construction of the facility. So  
2 there may be a few exceptions that came from some other  
3 source, but it's basically one source under one general  
4 contractor control.

5 Q Dr. Blume, is this a type two pour?

6 A (Witness Blume) I'm not familiar with what you  
7 mean by a type two --

8 Q Type two mix.

9 A Oh, type two cement, I guess you mean.

10 Q Correct.

11 A It is my belief that this was type two cement.

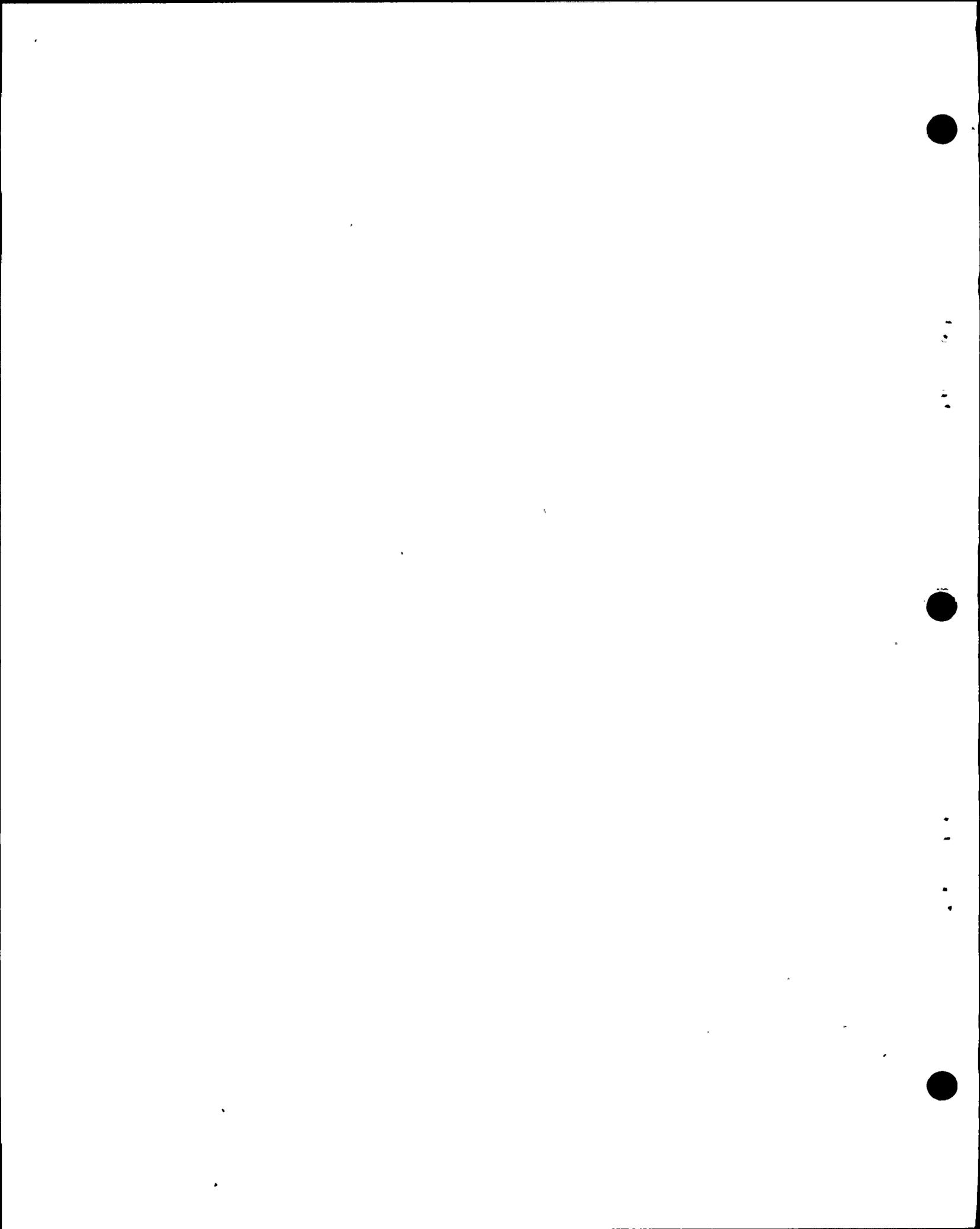
12 I would like to have that verified by Mr. Ghio.

13 A (Witness Ghio) I think he's correct. It was I'd  
14 have to say mostly type two. There possibly were some  
15 exceptions to that.

16 But the point is that we've used the data as we  
17 got it. It's representative of the full spectrum of concrete  
18 that was poured in the facility. And it's unincumbered by any  
19 -- whatever factors influence this are embodied in the data.

20 Q Well, then, were the averages you reached for the  
21 concrete for the containment structure used for the concrete  
22 in all the buildings, or just the concrete in containment  
23 structures? Or did you use samples from all of the buildings?

24 A No. We have, as illustrated in Table 6-A.2 on  
25 page D-6A.4 of the document that we're citing here, we have



mpb8 1 mixes, test samples taken from all the buildings. Each of the  
2 buildings was involved. And you'll note that the concrete  
3 mix type is identified and associated with specific buildings  
4 basically, if you look at the table I just cited.

5 So the average does apply to a particular building  
6 -- the average of the material in the building was to determine  
7 the average that was used in the analysis.

8 Q Okay.

9 Well, you have the Hosgri Report out. Could you  
10 turn to Figure 6-A in the same section?

11 A Would you repeat the figure number?

12 Q 6-A.

13 A We have it here.

14 MR. NORTON: Can he give us the page number that  
15 figure is on? It's a lot easier to find.

16 MR. KRISTOVICH: It doesn't have a page number.

17 WITNESS BLUME: It follows D-6B.3. In other words,  
18 it's the last page in DLL-6.

19 BY MR. KRISTOVICH:

20 Q Okay.

21 So type two that is referred to in Figure 6A, is  
22 that the same type two that was used for Diablo Canyon?

23 A (Witness Blume) Yes.

24 Q Okay.

25 Dr. Malik, did you average the structural steel



mpb9

1 strength?

2 A (Witness Malik) Yes, we did the same thing for  
3 the structural steel.

4 Q And do you have the spread of the data that was  
5 averaged?

6 A I don't see it reported here. I wasn't the one  
7 who did these calculations, although I am familiar with them.  
8 But I don't see any standard deviation shown.

9 Q Well, I think if you look at D-6B.3

10 A Yes, I'm looking at it.

11 A (Witness Ghio) Excuse me.

12 Was that a table or a page reference?

13 Q A page reference. It's Table 6-B.1, Steel Strength  
14 Data. And there is a column -- well, yield psi minimum,  
15 maximum, and average.

16 A (Witness Malik) Yes.

17 Q What does "minimum" refer to there?

18 A That would be the minimum that was recorded in the  
19 testing.

20 Q And what was the maximum?

21 A The maximum would be the maximum recorded.

22 Q So is that the spread of the data?

23 A No, you can't tell from that spread because you  
24 might have one point that was a minimum and one point a maxi-  
25 mum, and all the rest might be concentrated right around the



mpb10 1 average. That's why you would calculate the standard devia-  
2 tion.

3 If you have 500 points, two might be over to  
4 extremes and 99 percent might be concentrated around the  
5 middle. You can't tell from just the minimum and the maximum.

6 Q Did you calculate the standard deviation.--

7 A Like I said, I didn't do those calculations. It's  
8 not reported in here. I don't know if it was actually calculat-  
9 ed or not.

10 Q Do any of the members of the panel know whether  
11 a standard deviation was calculated?

12 A (Witness Blume) I am looking it up right now. If  
13 it was I think it would be in the summary.

14 It doesn't show in the summary.

15 Vince, do you happen to know whether it was calcu-  
16 lated?

17 A (Witness Ghio) I don't recall that it was calculat-  
18 ed. I can't be certain at this point.

19 However, I would venture to say that were it to  
20 be calculated, we would expect to find a very tight deviation  
21 associated with the structural steel, as we found with the  
22 concrete.

23 A (Witness Malik) Excuse me.

24 In fact, typically in steel we would find much less  
25 spread than in concrete because it's a material that you can



mpb11 1 control much better.

2 Q Is there any particular reason why you calculated  
3 the standard deviation for concrete and not for steel?

4 A As I said, I didn't do the calculations myself.  
5 But if I was doing it I would probably do the same thing  
6 because of the fact that I don't expect much of a spread in  
7 steel.

8 I would be much more concerned with finding out  
9 the spread in the concrete.

10 A (Witness Blume) I would agree with that. Steel  
11 has very close tolerances in its manufacture and rolling, and  
12 it's not customary to go through a statistical type thing  
13 except to get the range of values.

14 I believe they too are called for in various ASTM  
15 requirements.

16 MR. NORTON: Mrs. Bowers, excuse me.

17 May I ask here if we're going to go through this  
18 same line of questioning for each panel for each structure?  
19 Because if we are perhaps these questions could be phrased for  
20 all structures because we have the same basic panel members  
21 that would address that portion of the question. And to save  
22 time, I thought we might proceed that way, because if we go  
23 through each one of these for each structure we're going to be  
24 here for days again.

25 MRS. BOWERS: Well, earlier Mr. Kristovich did ask



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1 a witness if that particular matter pertained to all structures.

2 MR. NORTON: Yes, that was one specific question  
3 though, not these.

4 MRS. BOWERS: Well, let's check with Mr. Kristovich.  
5 A suggestion has been made. What's your comment?

6 MR. KRISTOVICH: Well, we would prefer to proceed  
7 as we have been proceeding and deal with each piece of testi-  
8 mony as an individual piece of testimony.

9 MRS. BOWERS: Well, this testimony just covers the  
10 containment, doesn't it?

11 Well, you're entitled to proceed based on this  
12 testimony.

13 BY MR. KRISTOVICH:

14 Q Were these averages for the structural steel  
15 sensitive to any other factors, such as heat, Dr. Malik?

16 Dr. Blume, if you feel you can answer it?

17 A (Witness Blume) I don't think we completely  
18 heard that question. Would you repeat it?

19 Q Were the averages for the structural steel  
20 sensitive to any other factors, such as different manufacturers,  
21 heat, different heat?

22 A No.

23 Again, the tests are made under standard procedures  
24 which tend to eliminate extraneous factors. And whether one  
25 supplier's material ran a little bit more than another's is



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1 difficult to say.

2 What usually happens is each mill run of steel, as  
3 the molten steel, will have properties that are fairly unique  
4 to that particular mill run. So the same manufacturer having  
5 different runs will have different variations. But these  
6 are all closely controlled by ASTM standards.

7 I would say structural steel in the United States  
8 is one of the most closely controlled requirements there are.  
9 The same goes for reinforcing steel.

10 Q For analysis, why did you not use the average  
11 minus two standard deviations?

12 A It would be ridiculously conservative to use such  
13 a value combined with all the other conservatisms.

14 A (Witness Malik) Excuse me.

15 Also that was a specification that was accepted  
16 by the NRC, is to use the averages, to add to what Dr. Bluma  
17 said.

18 Q Okay.

19 Directing your attention, Dr. Malik, to page 3,  
20 line 4, what is five percent accidental eccentricity? Could  
21 you define that for the Board?

22 A You take the largest dimension of the structure  
23 perpendicular to the direction of the ground motion, and you  
24 take five percent of that dimension, and you consider that as  
25 the eccentricity. You take the mass and move it by that much



12 4 19 4



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mpb4

1 distance from the center of stiffness.

2 Q Okay.

3 What is seven percent accidental ---

4 A The same thing. Except for five percent --- it is  
5 multiplied by seven percent of that dimension, and move it  
6 seven percent.

7 Q What are the physical reasons for picking five  
8 and seven percent?

9 A These are judgmental factors. They are not really  
10 --- they're not based on any physical reason. That's why  
11 they're called "accidental". It's just a conservatism added  
12 to structures for engineers based on experience. In fact,  
13 Dr. Blume is one of the engineers who introduced this stuff  
14 into the codes. Maybe he should answer that.

15 A (Witness Blume) Thank you.

16 I did answer it in my direct testimony the other  
17 day. It's in there, I'm sure; namely that old style tradi-  
18 tional buildings such as office buildings and theatres and so  
19 on were being built with most of the structural stiffness and  
20 strength at a central core, wrapped around the stairs and the  
21 elevators, leaving skinny columns on the outside. Such build-  
22 ings have very very low resistance to torsion or twist, which  
23 was not recognized by the old codes.

24 So some of us got together and introduced the  
25 concept of accidental torsion, which we call this, forcing the



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1 designer to put some material in the outside, or toward the  
2 outside of the building in order to get credit for it.

3 Another reason why is that we know these buildings  
4 are going in inelastic during an earthquake and therefore  
5 they couldn't remain symmetric anyway and needed more strength  
6 on the outside.

7 Now as I further point out, these nuclear plant  
8 structures, containment, auxiliary, and all of them in fact,  
9 have strength on the outside walls. They do not need acci-  
10 dental torsions for the same reasons. So the torsions arrived  
11 at here, these accidental torsions of five and seven percent  
12 were arrived at after several meetings with the Staff and NRC  
13 officials and PG&E and its consultants to provide for possible  
14 effects from the ground motion. And it was arrived at after  
15 much study and discussion with Dr. Newmark and myself and  
16 many others.

17 Q Dr. Blums, are these used to your knowledge in  
18 the design of other plants, nuclear power plants?

19 A Accidental torsion?

20 Q Yes.

21 A I'm not sure that other plants have used this or  
22 not; none to my knowledge. We are dealing here with a brand  
23 new subject where we start off with a tremendous earthquake  
24 and try to refine the procedures.

25 It's my prediction that in a matter of just a few



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mpbl6 1 years from now all plants will be designed this way or in some  
2 improved manner.

3 Q Well, is this five and seven percent part of the  
4 Standard Review Plan of the NRC?

5 A I think they would have to answer that. Certainly  
6 it's been done as part of the Hosgri reanalysis.

7 Q Do you know if there are any reg guides that  
8 specify five or seven percent?

9 A I think there are some in the making. I think  
10 again I would refer you to NRC for that, though.

11 Q Dr. Malik, moving to page 4, at lines 24 and  
12 25, you state that:

13 "Table 1 provides a comparison of  
14 controlling stresses in components select-  
15 ed for detailed evaluation."

16 And with reference to Table 1, are these the most  
17 limiting locations?

18 A (Witness Malik) You would have to ask Mr. Hanusiak.  
19 He's the one that did that part of the work.

20 Q Do you want the question?

21 A (Witness Hanusiak) Would you repeat the question?

22 MR. KRISTOVICH: Could the Reporter read it back,  
23 please?

24 (Whereupon, the Reporter read from the record  
25 as requested.)



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1 WITNESS HANUSIAK: Yes, they are.

2 MR. KRISTOVICH: Thank you.

3 BY MR. KRISTOVICH:

4 Q Okay. Moving to page 5, lines 13 to 15, which  
5 states:

6 "Figure 5 provides a plot of nonseismic  
7 and seismic stresses due to both the Double Design  
8 and Hosgri earthquakes for the containment shell  
9 reinforcing steel. These stresses are within  
10 the allowables at all points in the shell."

11 Now, Dr. Malik, is the allowable based on the  
12 average of material strength -- or Mr. Hanusiak?

13 A (Witness Hanusiak) Yes, this was for what it was  
14 used.

15 Q Okay.

16 Is the total allowable 60 ksi?

17 A Code allowable? Yes. Well, this is the specified  
18 minimum yield, 60.

19 Q 60 is the code allowable ksi?

20 A In this case I believe we took 95 percent of the  
21 yields. So in this case it would be 57 ksi.

22 Q Why did you do that? Could you explain that?  
23 Are you saying that the code allowable is not 60 ksi?

24 A Well, it's a code allowable based on....

25 MR. NORTON: Excuse me.



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1 Are we addressing Figure number 5 of the direct  
2 testimony?

3 MR. KRISTOVICH: Yes.

4 BY MR. KRISTOVICH:

5 Q Well, the question is:

6 Is the code allowable 60 ksi?

7 A (Witness Hanusiak) Well, this is not exactly a  
8 code as it is the specification for review of the plant for  
9 the Hosgri earthquake. It specified that we were going to  
10 use the average electrical material strength and we would  
11 be using reduction factors, capacity reduction factors of  
12 .95. And it wasn't quite clear whether we were even obligated  
13 to use that point, but in our discussion with the NRC Staff  
14 they requested that we do use the reduction factor.

15 So the 60 ksi is the average of actual material  
16 strength and it's used by an arbitrary capacity reduction  
17 factor of .95. So we are really not even using the average,  
18 but five percent below.

19 A (Witness Malik) Excuse me.

20 I would like to add --

21 MR. HORTON: Excuse me.

22 I'm having trouble following both the questions  
23 and the answers, because I'm looking at Figure number 5 and  
24 I see it says 66.95 allowable stress, and Counsel keeps ask-  
25 ing 60 and the witness keeps asking 60. I don't know where



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P A



2 3  
P A



mpbl9

1 that number is coming from, so I can't follow the questions  
2 or the answers.

3 MR. KRISTOVICH: The question is very simple. I'm  
4 asking the witness is the code allowable 60 ksi.

5 WITNESS MALIK: First of all, the codes don't  
6 specify an allowable because it depends on the steel you use.  
7 The codes say if you start with a steel of so much strength,  
8 then the allowable is so much. And that's why if you take  
9 the average yield, for instance, in the containment interior,  
10 that it's 68 ksi, and he takes 95 percent of that.

11 So the codes don't tell you use 60, no matter  
12 what kind of steel you're going to be building your material  
13 out of. There is no such thing as a code allowable of 60.

14 BY MR. KRISTOVICH:

15 Q Well, Mr. Hanusiak, turning to page D-6B.3 in the  
16 Hosgri report, which is TABLE 6B.1, Steel Strength Data --  
17 are you there, Mr. Hanusiak?

18 A (Witness Hanusiak) Yes, I am there.

19 Q Well, under the column psi and under Reinforcing  
20 Steel Average, is the 66 for containment, 66,854 the same  
21 as the 66.85 in number 5?

22 A Oh, yes. Yes, this is the same number.

23 Q Then why did you not reduce it by the .95 factor?

24 A This was really a difference in interpretation. We  
25 interpret the specification that was used as using actual



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1 material strength without the reduction. And --

2 A (Witness Ghio) Excuse me.

3 May I interject something here?

4 Q I would like to have Mr. Hanusiak finish the  
5 answer, if he could.

6 MR. NORTON: Mr. Ghio, you may certainly inter-  
7 ject something. That's the way we've been operating these  
8 panels all along.

9 MR. KRISTOVICH: Mrs. Bowers, Mr. Ghio may inter-  
10 ject something when Mr. Hanusiak finishes his answer. I would  
11 like to hear what Mr. Hanusiak has to say.

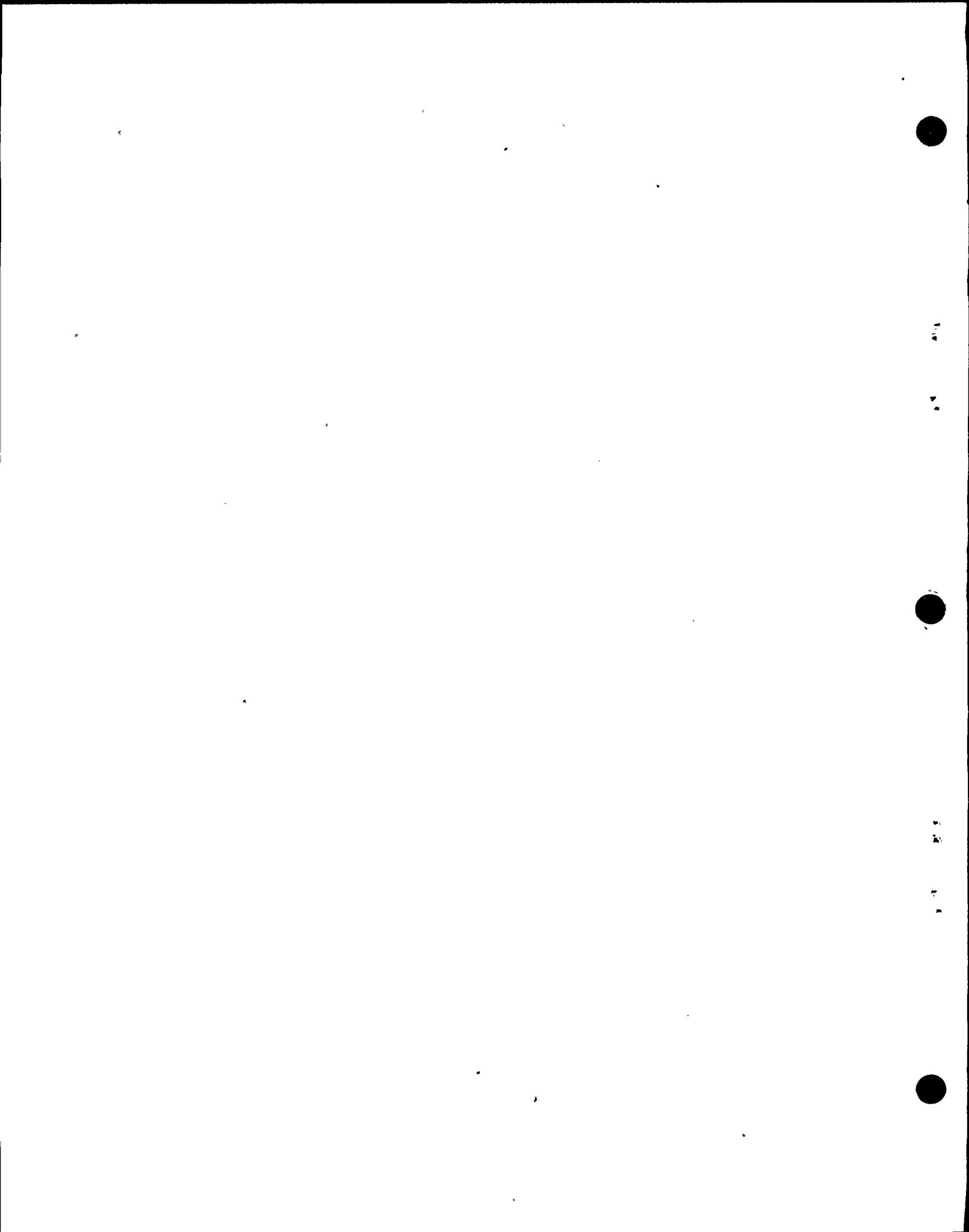
12 MRS. BOWERS: Well, we have permitted the witnesses  
13 on all panels to jump in. It's not very polite, I might add.

14 (Laughter.)

15 WITNESS HANUSIAK: I don't feel offended.

16 MR. KRISTOVICH: Well, I feel offended. I would  
17 like to hear the answer.

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1 MRS. BOWERS: Well, I think the panel was attempt-  
2 ing to use the person who had the best first-hand knowledge.  
3 Maybe that's not correct.

4 MR. KRISTOVICH: Dr. Malik referred me to Mr.  
5 Hanzusiak, who has been answering questions on this figure.

6 MRS. BOWERS: Let's have the interjection, and  
7 if we find it's valid we'll let it stand.

8 WITNESS GHIO: I think your question relates to  
9 the use or non-use of the so-called reduction factor, .95.  
10 That factor is embodied in codes to account for the fact that  
11 you're using a code at the front end of a design, and you  
12 don't know at that time where your material properties are  
13 going to end up, you don't know what kind of spread of data  
14 you're going to have.

15 In this particular instance we do know that.  
16 We've built the plant, we've got the material properties, and  
17 it seems to me, therefore, appropriate to use the actual  
18 material value unreduced.

19 However, if we were to reduce it by the .95  
20 factor, I think the calculation works out that the calculated  
21 stress at this single point in the exterior shell of the  
22 containment structure would come within the .95 reduced value.

23 I would emphasize we're talking about one  
24 elevation and one point around the circumference of the  
25 structure.



WEL 2

1 WITNESS HANUSIAR: We could, in fact, tolerate  
2 a 10 percent reduction, because it's 66 versus 60.3. So  
3 either way, we are making it.

4 BY MR. KRISTOVICH:

5 Q Mr. Hanusiak, what if 60 was reduced by .95?

6 A (Witness Hanusiak) If 60 was reduced by that, it  
7 would be then 57, approximately.

8 Q And that would be the normal code allowable?

9 A Right, something that would be done before we  
10 actually tested the material.

11 A (Witness Blume) I feel I have to jump in again,  
12 even though it's impolite.

13 I hear words about "normal code allowable." This  
14 is not a normal code job. This is a .75 g earthquake. The  
15 normal codes have coefficients in the order of .05 to .10,  
16 or .12 at the most.

17 So what might be provided in some so-called  
18 normal codes would certainly not apply to a nuclear power  
19 plant under these conditions. These conditions were agreed  
20 to after long debate, I might almost say argument, with the  
21 Staff and its consultants, as very reasonable and conservative  
22 criteria.

23 So I think the use of the word "code" all the  
24 time is misleading here.

25 Q Dr. Blume, has PG&E requested an exception to the



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wel 3

1 normal codes?

2 A Why should they? They're not operating under  
3 normal code. They're operating under codes here that are  
4 far in excess of all normal codes.

5 Q So then it's your testimony that this was not  
6 designed to normal codes?

7 (Laughter.)

8 A I think my testimony is on record.

9 Q Fine. It is.

10 Dr. Malik, directing your attention to page 6,  
11 lines 6 through 9, you state:

12 "The postulated Hosgri earthquake time history  
13 is of 24 seconds duration, with the strongest motion  
14 commencing at about five seconds and terminating at  
15 about 15 seconds into the event."

16 Where in the previous testimony have these  
17 figures been given?

18 A (Witness Malik). I don't understand your question.

19 Q Where did you get these figures?

20 A The five seconds and the fifteen seconds?

21 Q Correct.

22 A In the testimony? Where we got the figures?

23 Q I'm asking you where did you get these figures?

24 A These are from the ground motion that we  
25 developed that coincides with the ground spectra that was



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1 developed by Dr. Newmark and Dr. Blume.

2 Q Have these figures been given in the FSAR, Dr.  
3 Malik?

4 A I don't recall.

5 A (Witness Ghio) May I answer?

6 Q Yes.

7 A I believe that the depiction of the time history,  
8 parameters for which are cited in here, is embodied in the  
9 Hogri report.

10 A (Witness Blume) Also I believe it's covered in  
11 the discussion with the seismology panel in this hearing. I  
12 remember hearing parts of it. It has to do with the arrival  
13 time of the shear waves, which was talked about at great  
14 length, and also about the total duration from that arrival  
15 time to the end of the strong motion for that magnitude  
16 earthquake.

17 By the way, these are fairly common usages.

18 Q I'd like to direct your attention to Joint  
19 Intervenor's Number 45, which is USGS Number 672.

20 MR. NORTON: Do you have copies for the witnesses?

21 MR. KRISOVICH: We provided copies previously.

22 MR. NORTON: Not to these witnesses.

23 MR. KRISOVICH: Dr. Blume was one of the  
24 previous witnesses.

25 WITNESS BLUME: I might have a copy in this box.



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1 It'll take me a half hour to find it.

2 MR. KRISTOVICH: That probably isn't necessary.

3 WITNESS BLUME: Why not lend me one?

4 MR. KRISTOVICH: We'll let you look at ours.

5 WITNESS BLUME: Thank you.

6 (Document handed to Witness Blume.)

7 BY MR. KRISTOVICH:

8 Q I'm referring to the bottom of page 3. I believe  
9 it speaks of duration as being 40 seconds.

10 A (Witness Blume) Well, you have to define the  
11 definition of the word duration.

12 I see a footnote number. I can't make it out.

13 I think it's 2. Let me read through.

14 (Pause.)

15 Footnote 2 doesn't seem to address the matter  
16 of duration. Maybe it's 1.

17 Oh, here it is. Time interval between first and  
18 last peaks of absolute acceleration equal to or greater than  
19 .05 g.

20 So you are referring to the 40 seconds that  
21 apply to the 7.5 magnitude, whereas .05 g is so minor in the  
22 design of this plant that we wouldn't consider that as any  
23 controlling duration.

24 We're designing for many, many times that.

25 So the statement on page 6 of the written



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1 testimony about -- let's see -- it says, "strongest motion  
 2 occurring at 5 seconds and terminating at about 15 into  
 3 the event would apply not to .05 g but to some greater value."  
 4 I don't know exactly what it was, but it's probably in the  
 5 order of 10 or 15 or 20 percent of g, because we're dealing  
 6 with such large amplitudes of motion here.

7 So whenever you talk duration, you have to  
 8 define what limits of amplitude you're talking about.

9 Q Well, what were the limits when 24 seconds was  
 10 referred to in the written testimony?

11 A I just mentioned, I'm not exactly sure. My  
 12 estimate would be it's probably 10 or 15 hundredths, or maybe  
 13 two-tenths of g.

14 Do you have it?

15 A (Witness Malik) I have it.

16 MR. NORTON: Excuse me. There's a table in the  
 17 Hongri report, again, Figure 4-7, Containment Zaka Structure.

18 WITNESS MALIK: No, that's the period. There's  
 19 another drawing -- I don't have the number of it -- in the  
 20 PSAR. We have it in the report that was given to PG&E, up  
 21 to 24 seconds. And you can see the peak there is already, I  
 22 would say, something like .1 g at 24. And if you were talking  
 23 about strong motion, we're talking about more like .4 at around  
 24 15 seconds, .4 g.

25 BY MR. KRISTOVICH:

Q What is your definition?



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1           A           (Witness Malik) When you do time history, I  
2 believe this 5 and 15 came out of the question when the NRC  
3 asked us for the rise time duration and decay.

4                   Is that right? Do you remember that?

5                   Well, in a time history you have what's called  
6 the rise time, and then the strong motion duration and the  
7 decay time.

8                   Now, when they're talking about 40 seconds,  
9 they're not talking about this aspect, they're talking about  
10 the time from the time the instrument was triggered until the  
11 time that the instrument stops recording anything above .05  
12 g, whereas we're talking about the strong motion that's  
13 relevant to the structure.

14                   I would continue analyzing this thing for 40  
15 seconds or 60 seconds, and it doesn't make any sense when my  
16 controlling response is being developed during the period of  
17 between 5 and 15, where all the strong motion is. The rest  
18 of it might be recorded on an instrument, but it's not really  
19 relevant as to how much stresses are going to develop in my  
20 structure. That's why we cut it off at 24, where, like I  
21 said, we have approximately .1 g in our time history.

22           Q           All right. Turning to page 17, line 17 --

23                   MR. NORTON: There is no page 17.

24                   MR. KRISTOVICH: Excuse me, page 7, line 17,  
25 beginning on line 16 and then going through 19.



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1 BY MR. KRISTOVICH:

2 Q There you state:

3 "This analysis, together with a more conventional  
4 analysis, which also yielded an adequate safety  
5 factor against overturning, demonstrated containment  
6 stability for the postulated seismic load combinations."

7 What did you mean by, "a more conventional  
8 analysis?"

9 A (Witness Hanusiak) The more conventional analysis  
10 would be just static stability analysis, where you compare  
11 the overturning moment to the stabilizing moment.

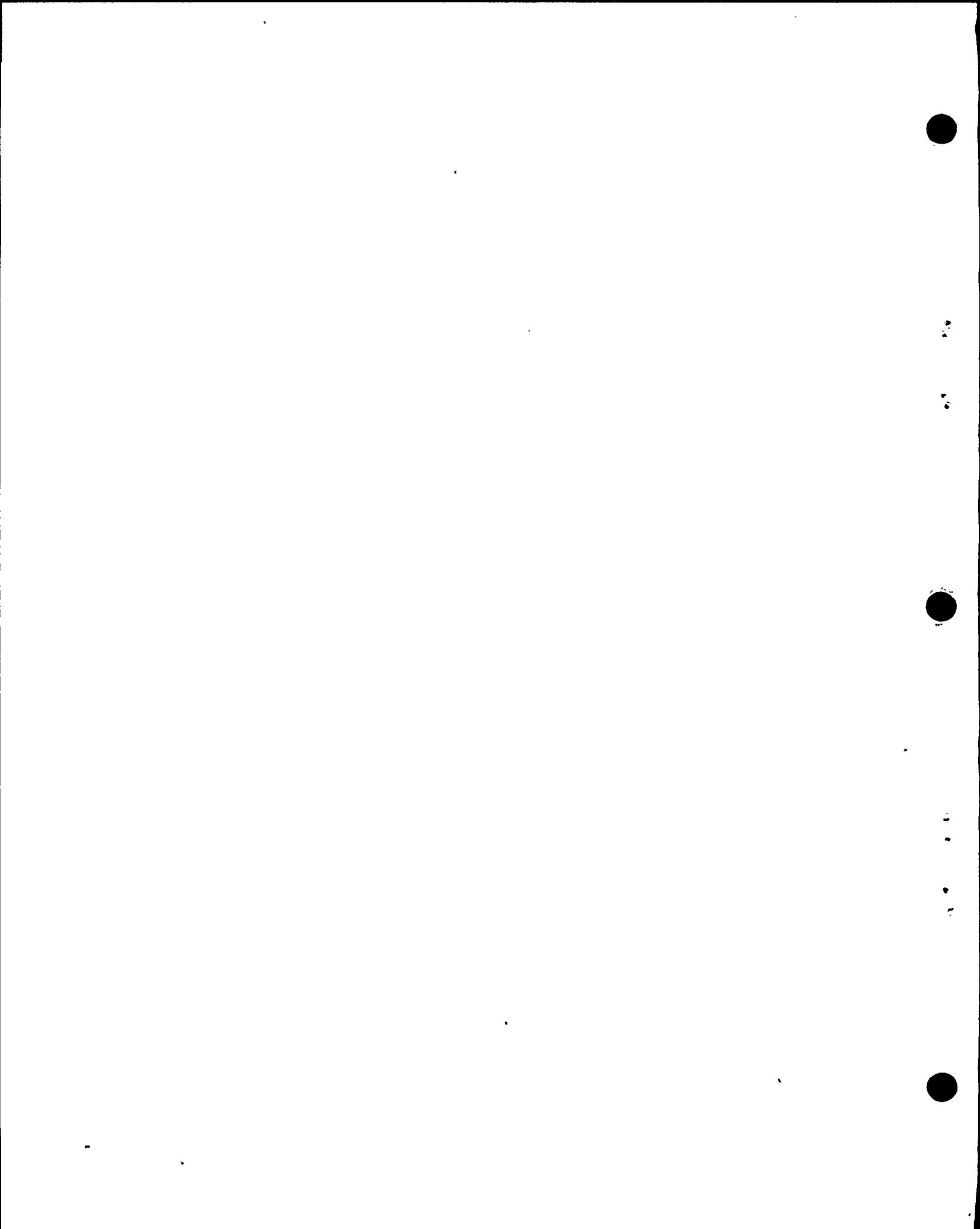
12 Q And what would the more conventional analysis  
13 have shown?

14 A This analysis was performed by Mr. Malik.

15 A (Witness Malik) When you're talking about  
16 stability, there are several ways of doing it. One of them,  
17 that's mentioned here, is the energy method. You find out  
18 how much energy is input into the structure and how much it  
19 would take to overturn it.

20 That was one way.

21 The other way is take all the forces due to  
22 seismic that are trying to overturn the structure, and then  
23 you say the only thing keeping it from overturning is its  
24 weight. And then you find out whether the weight is enough  
25 to keep it stable or not. And that is the more conventional



wei 9

1 approach that we did.

2 So we did it both ways, doing the energy input  
3 into it, and like it says, the energy that comes in from the  
4 Hosgri is less than one percent of what's needed to overturn  
5 the structure. And the other method, that's called the more  
6 conventional method, where you just take the weight, which is  
7 very, very conservative, still shows that the weight alone is  
8 more than enough to keep the structure stable from overturning.

9 Q All right.

10 Mr. Ghio, turning to page 8, with reference to  
11 the first paragraph, were you present when the containment  
12 structure was pressure tested?

13 A (Witness Ghio) No, I was not, but a member of this  
14 panel was, Mr. Hanusiak.

15 Q Mr. Hanusiak, were you present?

16 A (Witness Hanusiak) Yes, I was present.

17 Q Can you describe the technique that was used?

18 A The technique for doing what?

19 Q For pressure testing the containment structure.

20 A You mean for . . . okay.

21 The containment was being pressurized at stages.  
22 In other words, stages of pressure at several levels, 15 psi,  
23 25 psi, 47 psi -- up to maximum 54. And given that various  
24 measurements were taken, one of them was observation of cracks  
25 in the concrete. The other was measurements of deformations.



1 Then there were also some strain gauge measure-  
 2 ments taken.

3 Q Did you personally take the data?

4 A No.

5 Q Did you personally analyze the data?

6 A Yes. I was analyzing them after I received them,  
 7 yes.

8 Q Did any of the data indicate leakage in excess  
 9 of that allowed?

10 A No.

11 I should say that I wasn't analyzing the leakage.  
 12 This was a different person in the department doing that. But  
 13 I'm aware that he did not find any excessive leakage.

14 Q Do you know who analyzed the leakage?

15 A Mr. Rocha. He would be on one of the later  
 16 panels.

17 Q Okay. Mr. Chio, concerning containment leakage  
 18 has PG&E applied for an exemption for the requirements of  
 19 Appendix J to 10 CFR Part 50?

20 A (Witness Chio) I don't believe so.

21 Q Does PG&E intend to do so?

22 A I don't believe so.

23 MR. NORTON: May we have that Reg. Guide read,  
 24 instead of just a number, as to what it is you're talking  
 25 about?



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wel 11

1 MR. KRISTOVICH: It's a regulation.

2 MR. HORTON: Would you read it, as to what it  
3 requires?

4 MR. KRISTOVICH: Appendix J to 10 CFR Part 50?

5 MR. HORTON: You're asking if PG&E has applied for  
6 an exemption from that whole section?

7 MR. KRISTOVICH: Yes.

8 MR. HORTON: That's a regulation, huh?

9 (No response.)

10 BY MR. KRISTOVICH:

11 Q Okay, Mr. Ghio, did you evaluate containment  
12 stability against overturning and uplift?

13 A (Witness Ghio) No. I personally did not perform  
14 those calculations. However, members of this panel did. Both  
15 Mr. Hanusiak and Mr. Malik were involved, and have just  
16 answered some questions regarding those analyses.

17 Q Okay, Mr. Hanusiak, what is the maximum amount  
18 of uplift at the edge of the containment slab?

19 A (Witness Hanusiak) Three-quarters of an inch.

20 Q Would this result change if lower velocity numbers  
21 were used?

22 A This is outside of my expertise. I wonder if  
23 maybe some other --

24 A (Witness Malik) There is no way of knowing, unless  
25 you do the analyses.



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Q What would that analysis entail?

A Doing the . . . first you'd have to postulate the time history and do the whole dynamic analysis, and take the results and find out.

A (Witness Blume) Beyond that, if there were such hypothetical material, it would have different damping factors than have been used, even in the trial analyses.

So chances are that the results would be less, but, as has been said here, you'd have to go through a whole ritual to give a definite answer to your question.

Q Mr. Hanusiak, have you evaluated the adequacy of the piping supports for the three-quarters inch movement?

A (Witness Hanusiak) Well, I don't think it would be a subject of this panel.

MR. NORTON: This is structures, not piping.

BY MR. KRISTOVICH:

Q Okay, Mr. Hanusiak, what analysis of the foundation mat was conducted prior to November 8?

A (Witness Hanusiak) It was a finite element analysis performed for a condition that was determined to be the controlling one.

Q And what were the principal conclusions of that analysis?

A Well, this analysis actually determined -- you're talking about the Hosgri evaluation?

Q Yes.



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wel 13

1           A     Okay. The results were that the base level  
2 was adequate.

3           Q     Excuse me? I just didn't hear you.

4           A     The results indicated that the stresses are  
5 within allowable limits.

6           Q     Well, was a new approach or analysis presented  
7 to the Staff on November 8 with regard to the foundation  
8 mat?

9           A     Yes. We had originally evaluated the base slab  
10 by reviewing the original DDE analysis and stuff, and was not  
11 satisfied with it. So we supplied additional analysis.

12          Q     Can you describe the new analysis?

13          A     Well, it was also a finite element analysis with  
14 considering the soil properties represented by springs. . . I  
15 don't know how detailed or technical a description you want.

16          Q     Well, how did the new analysis differ from the  
17 old one?

18          A     Well, the original analysis used plate elements.  
19 The original analysis took a conservative assumption that the  
20 base slab actually is not held down by soil. In other words,  
21 the internal pressure would cause large moments in the base  
22 slab. And, of course, we felt that this would be the most  
23 conservative assumption.

24                 Now, the additional analysis didn't use those  
25 enveloping assumptions, but was more realistic a representation



1 of actual soil.

2 Q What were the properties of the actual soils?

3 A Well, those properties are reported in the  
4 FSAR. There's multiple elasticity and ratio given, which  
5 defines the soil properties.

6 Q And what were the principal conclusions using  
7 this new analysis?

8 A Well, the conclusion more or less corroborated  
9 our original analysis.

10 Q Is the new approach described in the FSAR?

11 A The new approach, no. This is more recent, so...

12 Q Are you going to provide a final report to the  
13 NRC on this new analysis?

14 MR. NORTON: It's been provided in an audit  
15 submittal. It's not part of the FSAR, but it was part of the  
16 audit submittal that was sent to Mr. Hubbard. Intervenors  
17 have had it.

18 MR. HUBBARD: No.

19 MR. NORTON: It's in the Public Document Room.  
20 There's one in Walnut Creek, too.

21 BY MR. KRISTOVICH:

22 Q Mr. Ghio, what relaxations to usual NRC methods  
23 of combining loads and responses was included in the diagonal  
24 reinforcement of the containment shell?

25 A (Witness Ghio) What relaxations in the usual



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wel 15

1 methods?

2 Q Correct.

3 A (Witness Hanusiak) I think this is my area, and  
4 the answer is none.

5 Q Well, was credit taken for concrete stiffness?

6 A No, it wasn't. Actually we have calculated the  
7 stresses by ignoring the concrete, and we have later on  
8 attempted to -- well, we had questions from NEC, like, well,  
9 would the concrete possibly add more stresses?

10 So we made also some additional analyses showing  
11 it wouldn't. So the numbers we have ignore concrete.

12 Q All right. Mr. Hanusiak, in your reevaluation of  
13 the containment structure did you include the masses of  
14 major equipment?

15 A Yes.

16 Q Did you ignore the stiffness of these items?

17 A I don't quite understand your question.

18 Q For example, in the steam generators did you  
19 ignore the stiffness?

20 A Well, as far as stiffness, I should refer you to  
21 Dr. Malik.

22 A (Witness Malik) Yes. That's what's meant by  
23 decoupled analysis.

24 Q What is the justification for decoupling with  
25 regard to the steam generator?



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wel 16.

1           A       I think we talked about that earlier. It started  
2 with a judgment thing, and then we did some analyses to  
3 justify that. And we found out that coupling did not change  
4 the responses. We did that for the pressure vessel.

5           Q       Okay, Dr. Malik, what do the studies done for the  
6 seismic research program show regarding the soil properties  
7 under the plant?

8           A       I don't know that we've finished that work yet.

9           Q       What were the preliminary results?

10          A       Well, what specifically about the soil properties  
11 do you want to know?

12          Q       Shear wave velocity.

13          A       I don't have it to memory. It's in the reports.  
14 What's more, that's not really -- I'm not the one you should  
15 be asking. You should be asking some geologist.

16                 MR. NORTON: Excuse me, Mrs. Bowers, I'm going to  
17 object. We've gone through this now, and we're going into  
18 it again. We went through it earlier this morning. And those  
19 questions were in fact asked of the panels that were on before,  
20 and those questions were answered.

21                 I believe Dr. Blume was one person that was asked  
22 and answered those questions. Dr. Smith was on that panel, and  
23 others.

24                 MR. KRISTOVICH: That's not my recollection.

25                 MR. NORTON: Well, Dr. Blume is here. He was the



wel 17

1 witness that I recollect was on the panel at that time. Maybe  
2 he can answer.

3 WITNESS BLUME: I recollect it, also.

4 BY MR. KRISTOVICH:

5 Q Dr. Blume, do you want to refresh my memory?

6 MR. NORTON: Object. This is not the panel.

7 This is a structural analysis panel. They have the right to  
8 go into the figures that were used, where those figures came  
9 from, and so on and so forth. They went into this question  
10 about new values. In fact, it was in line with the discussion  
11 of Q. Dr. Frazier was on the panel. And that's when we got  
12 the famous 16-digit figure from Dr. Frazier.

13 Does that refresh your recollection?

14 MR. KRISTOVICH: With regard to Q, yes.

15 MR. NORTON: And that evolved from the discussion  
16 that you are now talking about, or it followed that discussion.

17 MRS. BOWERS: Let's check with the Staff. Does  
18 the Staff have a position on this matter?

19 MR. NORTON: I don't believe Mr. Ketchen was  
20 here during that testimony.

21 MRS. BOWERS: Well, I think some of his  
22 technical advisors may have been.

23 MR. KETCHEN: Yes, Mrs. Bowers. Basically, as  
24 I understand the objection, it's one of relevancy, a question  
25 of whether this panel -- or whether it's within the scope of



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wel 18

1 the direct examination.

2 MRS. BOWERS: Pardon me, but I don't think it's  
3 relevancy, I thought it was because it was repetitive, and  
4 that prior panels testified on this.

5 MR. NORTON: My objection was that that question  
6 was asked of a prior panel, and it was answered in detail by  
7 that panel, regarding the values that were obtained in the  
8 SRP program.

9 Those questions were answered at length by the  
10 panel that Dr. Blume was on. This is not the panel that  
11 covers that material.

12 MR. KETCHEN: So it's repetitive, cumulative,  
13 and beyond the scope.

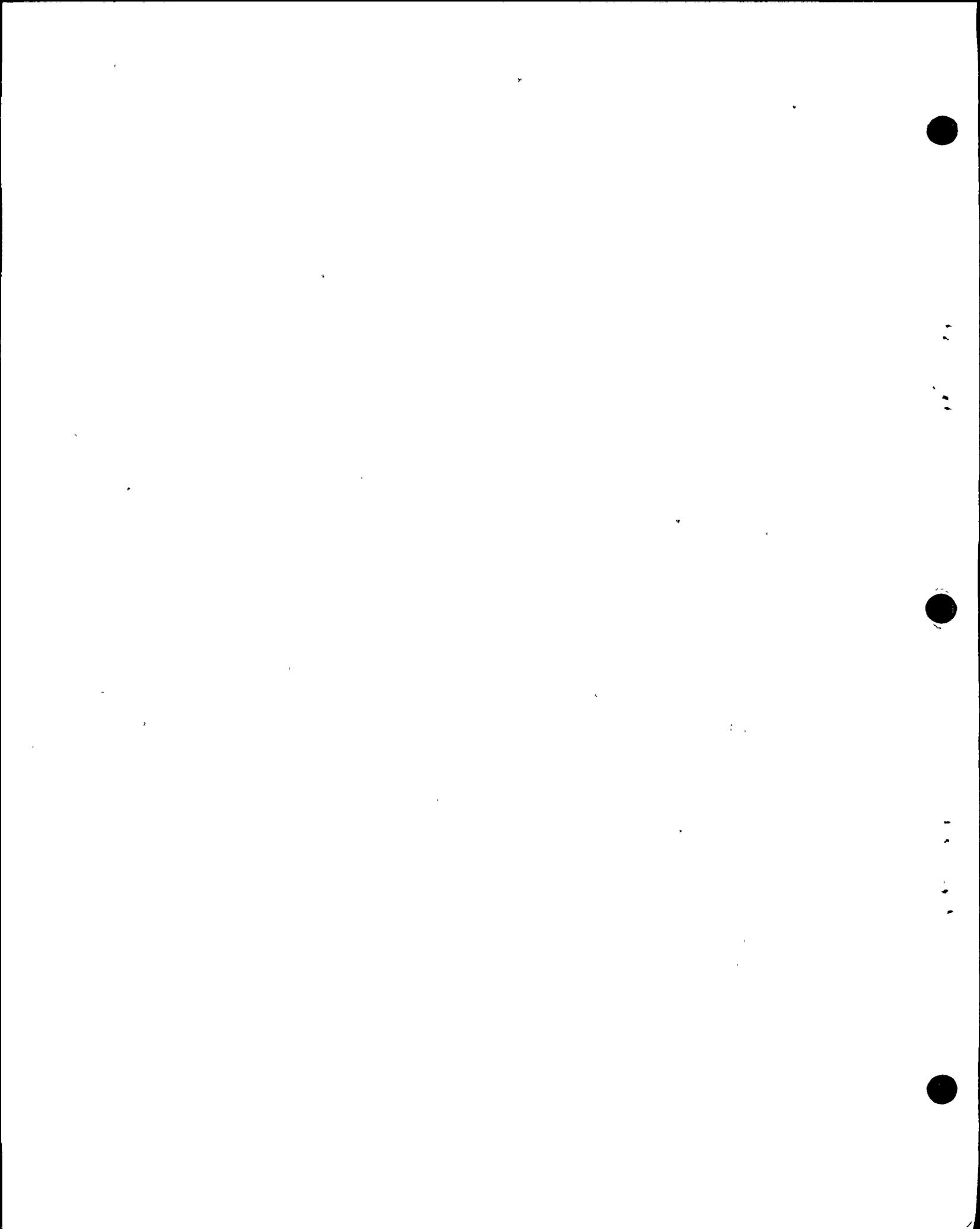
14 (Laughter.)

15 On that basis, I agree.

16 MR. KRISTOVICH: Mrs. Bowers, that's only if it  
17 is repetitive or cumulative, and I don't believe it is.

18 MR. KETCHEN: Well, Mrs. Bowers, I didn't mean  
19 to say that it was. I just wanted to understand Mr. Norton's  
20 objection, and on his explanation of what his objection is  
21 and the basis for his objection, we agree, the Staff would  
22 agree that -- and I am advised that is the case by my  
23 technical experts -- and we would support Mr. Norton's motion--  
24 I should say objection, I'm sorry.

25 MRS. BOWERS: Well, Dr. Blume has testified that



wel 19

1 it did happen.

2 MR. KRISTOVICH: With regard to soil structure?

3 WITNESS BLUME: With regard to shear wave  
4 velocities.

5 MRS. BOWERS: The objection is sustained. We  
6 certainly don't want to cover the same ground twice. We have  
7 enough before us to consider without repetitive testimony.

8 I know it's difficult when you have a number of  
9 panels, and they have very narrow responsibilities, to hold  
10 within that panel. But I'm sure other counsel will help you  
11 know if you stray beyond.

12 MR. KRISTOVICH: No further questions at this  
13 time.

14 MRS. BOWERS: Mr. Ketchen?

15 MR. KETCHEN: I have a few questions. If I may  
16 just take a couple of minutes to go back and get organized.

17 MRS. BOWERS: Why don't we take ten minutes?  
18 The rest of us will have a recess.

19 (Recess.)

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MRS. BOWERS: Mr. Ketchen, are you ready to proceed?

3

MR. KETCHEN: Yes, Ma'am.

4

BY MR. KETCHEN:

5

Q I'd like to go back to step one, the identification starting with Mr. Lang.

6

7

Is it Mr. Lang?

8

A (Witness Lang) Yes, Mr. Lang, Mister.

9

Q And you're with who?

10

A I'm with URS/Blume.

11

MRS. BOWERS: Mr. Ketchen, this is in their qualifications. Do you have a copy of that?

12

13

MR. KETCHEN: Yes, I do. It's easier if I get it in my notes here rather than just -- I want to talk to different people depending on who they work for.

14

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MRS. BOWERS: Well they're all with Blume except the two with PG&E.

17

18

MR. KETCHEN: Okay, let me try it that way.

19

BY MR. KETCHEN:

20

Q Who's with PG&E? I'm not straight.

21

(Show of hands, Ghio and Hanusiak.)

22

Mr. Ghio and is it Dr. Hanusiak?

23

A (Witness Hanusiak) Mister.

24

MRS. BOWERS: Before you start, I want to clarify something I said earlier. I don't consider it an interruption

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2 after one witness has concluded for someone else to volunteer  
3 something additional. And what we had earlier was when the  
4 witness was responding, another panel member jumped in.

5 BY MR. KETCHEN:

6 Q I'd like to refer you to Page Six of your direct  
7 testimony, again, lines 18 through 27.

8 The first question is, who wrote the first  
9 sentence of that paragraph starting: "A loss of coolant  
10 accident....?"

11 A (Witness Ghio) I did.

12 Q And can I assume that you wrote the second sentence  
13 as well?

14 A Yes.

15 Q Did you draft the whole paragraph?

16 A Yes.

17 Q Okay.

18 Is it your testimony that essentially -- let  
19 me strike the word "essentially."

20 Is it your testimony that the exact same para-  
21 graph has been submitted as part of the FSAR?

22 A I cannot testify that the FSAR contains the  
23 exact wording, but I believe it is very close if it is not  
24 exact.

25 MR. NORTON: Excuse me. Again, Mr. Ketchen, I  
don't think you were here last week, or the last week when



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1 we were in session when we had the discussion about the Hosgri  
2 evaluation as not actually part of the FSAR. It is an amend-  
3 ment in the application for the operating license, and it's  
4 not an FSAR amendment.

5 So when we say -- you have to be careful when  
6 you say it's part of the FSAR. All of us have fallen into  
7 that trap, but the Hosgri evaluation I think we decided was  
8 not part of the FSAR but an amendment to the operating license  
9 application.

10 MRS. BOWERS: But it is in evidence.

11 BY MR. KETCHEN:

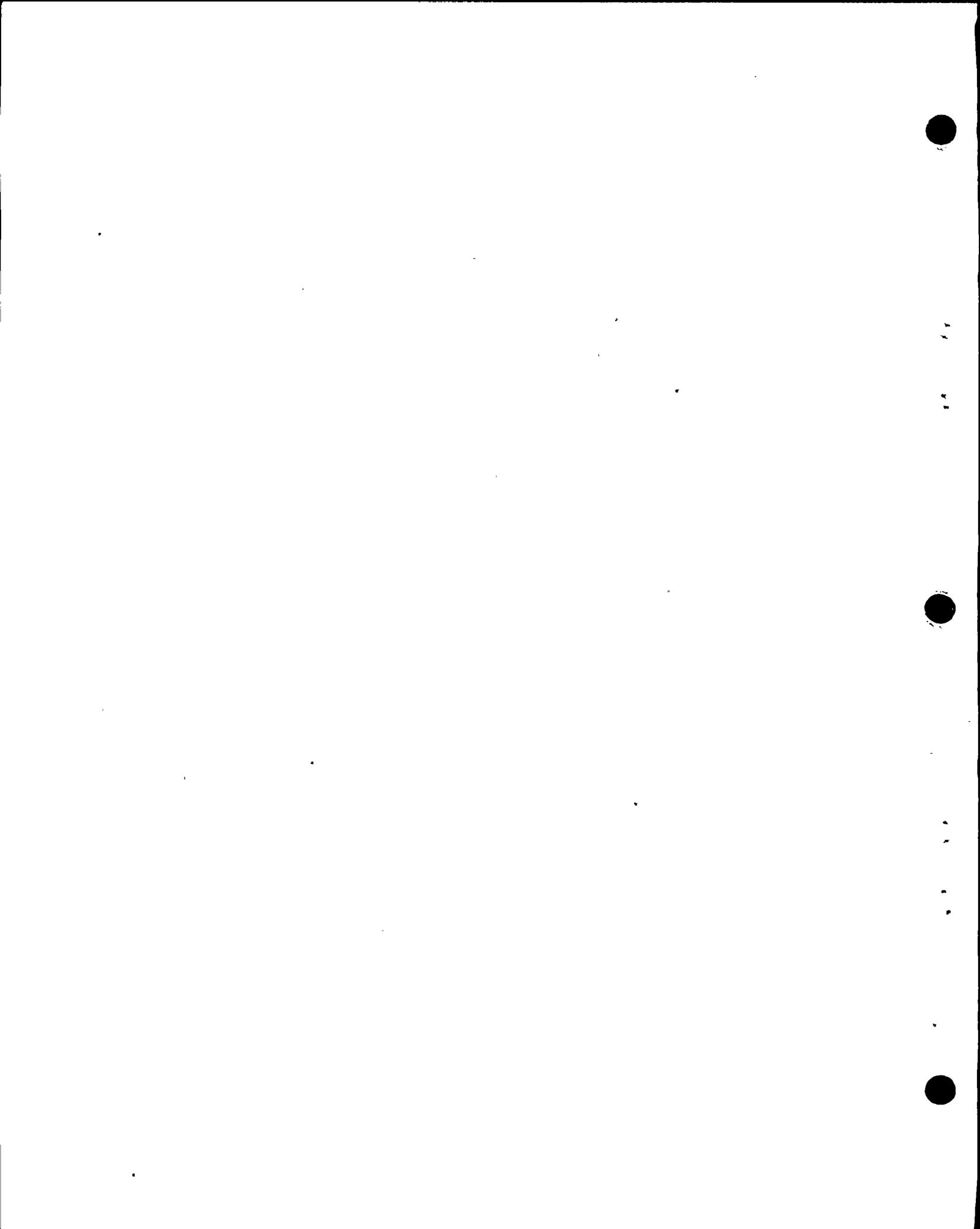
12 Q As part of the amendment to the application for  
13 the operating license, Mr. Ghio, did you also submit copies  
14 of WCAP reports?

15 A (Witness Ghio) Yes, I believe we did.

16 Q You were asked several questions, I believe,  
17 this morning about the basis for the two statements starting  
18 on Line 10, the first two sentences, Page Six. You referred  
19 to WCAP reports, is that correct?

20 A I don't believe I referred to the WCAP reports,  
21 it may have come up in the -- I don't recall even now that  
22 part of the testimony vividly, but I don't think I used the  
23 reference to the WCAP reports.

24 Q Then how do you respond, what is the basis for  
25 the statement in the first sentence?



1  
2 A Well it's either an exact duplicate or a para-  
3 phrasing of material that's in the Hoggri report, and I  
4 believe in there the reference to the WCAPs exists.

5 Q Let me direct your attention to the second  
6 sentence. There's a statement starting: "Seismic stresses  
7 alone are insufficient to initiate such an accident." What's  
8 the basis for that statement?

9 A Well it basically stems from analyses performed  
10 for the Diablo Canyon facility by the Westinghouse Electric  
11 Corporation, in which they evaluated the reactor coolant loop  
12 and the piping contained therein for a loss of coolant accident  
13 and for seismic loadings. And this was one of the conclusions  
14 of that work.

15 Q So it is not your conclusion, then?

16 A I would subscribe to it.

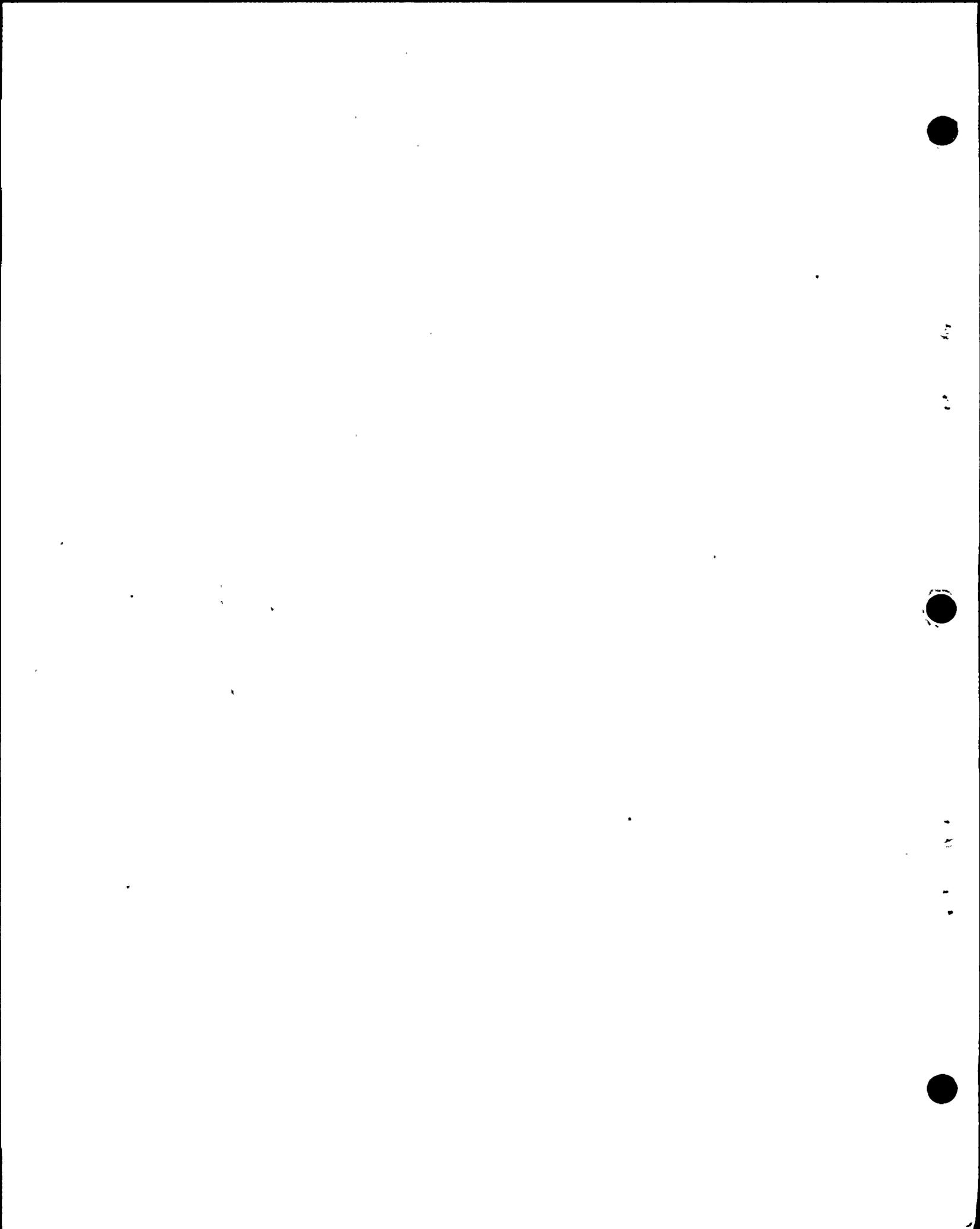
17 Q I understand you to say that you took the informa-  
18 tion from the Westinghouse analysis, you reviewed it and then  
19 you wrote this statement.

20 A That's essentially correct, yes.

21 Q Okay.

22 Can either you or -- well let me just ask you.  
23 Do you know whether or not the amendment to the application for  
24 the operating license included a submittal with that documenta-  
25 tion of the Westinghouse or WCAP reports?

A I believe it did, yes.



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1 Q Do you know the numbers of those?

2 A I'm afraid I can't cite the numbers at this point.  
3 without looking through the documents.

4 Q Maybe you can supply that after the break or  
5 by the end of the day.

6 A All right.

7 Q Now, do you know what the status of those WCAP  
8 reports are at this time before the Nuclear Regulatory  
9 Commission Staff?

10 A I believe they've been submitted and reviewed  
11 by the Staff and have been accepted. That's my understanding.

12 Q What's your understanding based on?

13 A Well you have to realize that when you're in-  
14 volved in a program like this, you either personally review  
15 stuff or are discussing these matters with people who have  
16 personally reviewed it. And as a consequence of those kinds  
17 of activities on my part, I've reached this understanding.

18 Q Let me go on to another sentence in that para-  
19 graph starting on line 13. It indicates starting out:

20 "Nevertheless, seismic stresses  
21 were combined with LOCA stresses on an absolute  
22 sum basis as part of the safety evaluation of  
23 the containment structure."

24 What is the basis for your choice of the word  
25 "nevertheless," in that sentence?



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Fig

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wrb/agh6

1 A Well, to put this in some perspective, really  
2 the intent of this entire paragraph was simply to portray the  
3 feeling that this particular combination of loads is very  
4 conservative.

5 Q Let me ask you again, what was the reason for  
6 your choice of the word "nevertheless," beginning as the first  
7 word of the sentence beginning on Line Two -- I'm sorry, Line  
8 13 of that paragraph?

9 A Well I could have used "however," but I used  
10 "nevertheless," and at the moment I can't tell you why I  
11 chose that word, I just think it logically follows from the  
12 sentences that precede it that make a couple of statements  
13 regarding the probability of the loss of coolant accident  
14 and the statement that the seismic stresses by themselves  
15 are insufficient in magnitude to cause a loss of coolant acci-  
16 dent.

17 MR. NORTON: Excuse me, Mr. Ketchen.

18 I have the references that you asked for earlier  
19 if you would like them, rather than numbers.

20 The WCAP reports are WCAP-9241 proprietary,  
21 and then WCAP-9242 non-proprietary submitted December of '77.  
22 9241 and 9242.

23 Then, in addition to that, Amendment 56 to the  
24 Hosgri Report which is entitled "Appendix B, Integrity of the  
25 Primary Piping Systems of the Diablo Canyon Nuclear Power



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"Plants During Postulated Seismic Events," is a part of the Hosgri Report. It is very lengthy. It is Appendix B to Volume 4, I believe, let me check the volume -- no, Volume 6, excuse me. Appendix B to Volume Six.

And it states under Conclusions on 8-1:

"These results lead directly to the conclusion that the primary piping system is extremely resistant to rupture and that a LOCA caused by a pipe rupture initiated by the seismic event is not an appropriate event combination for evaluations of Diablo Canyon Units 1 and 2."

That is quoting directly from that report. And that submittal was -- I think I may have just lost it. Hang on a minute.

(Pause.)

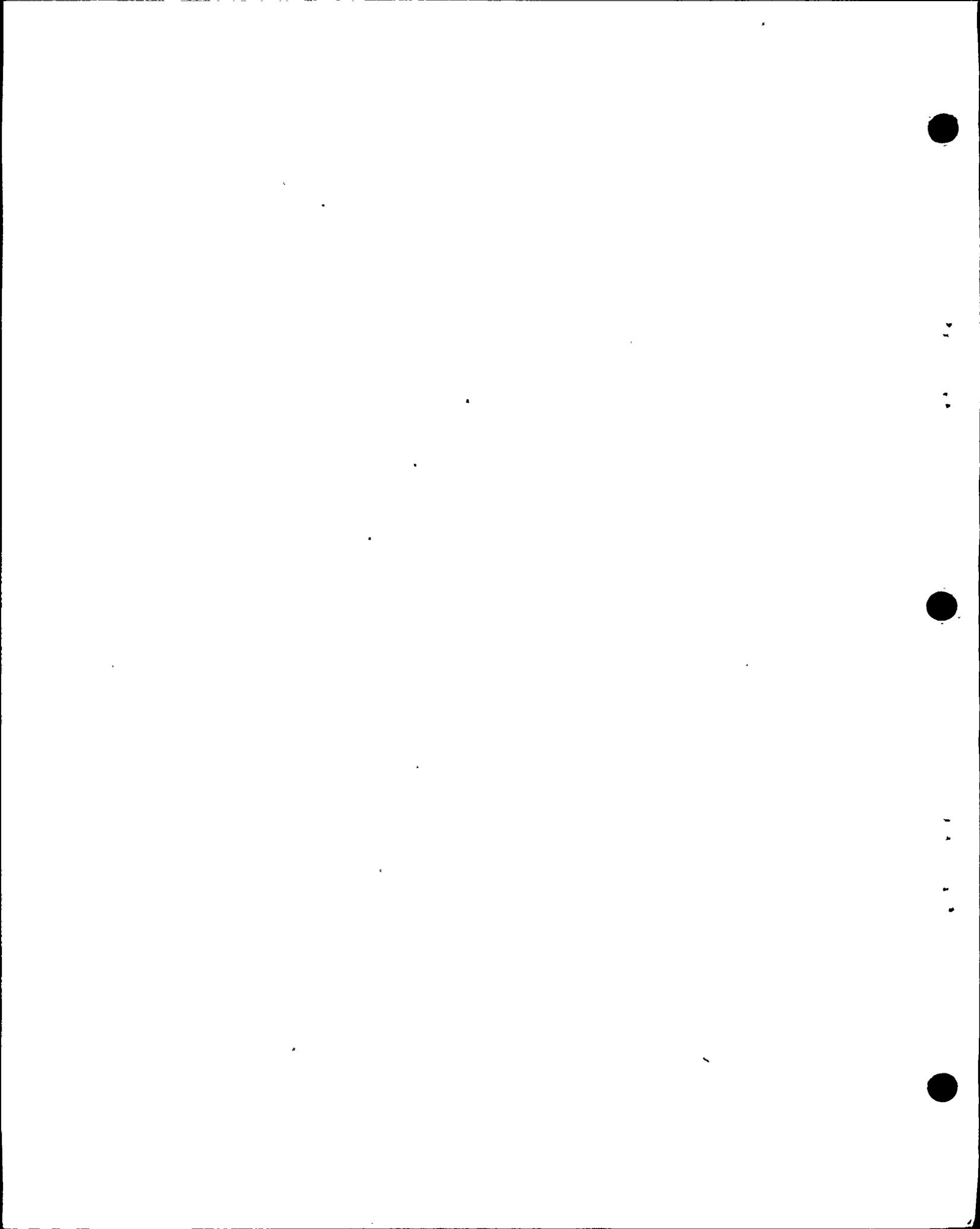
Here it is, November, 1977.

BY MR. KETCHEN:

Q Let me get your answer to this question one more time and straight out with it.

Isn't it true that the Staff has not accepted those NCAP reports at this time, they're still under review?

A (Witness Ohio) Quite frankly, I don't know the current status of the Staff's acceptance of the report. Apparently -- I may be somewhat mistaken as to how far along it's moved with the Staff. I thought that they had



wrb/agb8

1 reviewed it and accepted it.

2 Q All right. Let me then go to the other sentence  
3 I was talking about, the one with the "nevertheless."

4 Isn't it true that that statement results from  
5 the NRC Staff requiring the combination described in the  
6 sentence?

7 A I'm sorry, you're going to have to restate that  
8 for me.

9 Q In your opinion, this is a conservative statement,  
10 nevermind the "nevertheless," but:

11 "Seismic stresses were combined with LOCA  
12 stresses on an absolute sum basis as part of  
13 the safety evaluation of the containment structure."

14 If I didn't put that in the form of a question,  
15 the question is: It's your opinion that that's a conservative  
16 statement or a statement describing a conservative analysis?

17 A Yes, it's a statement describing a conservative  
18 combination of loads for which to perform the analysis and,  
19 in addition, yes, I believe that the -- I know that the Staff  
20 did require this combination to be employed in the Hosgri  
21 seismic evaluation of the facility.

22 Q Mr. Chio, can you state whether or not the facts  
23 and analysis in the WCAP report, and I say and/or including  
24 the description of the document by Mr. Norton a few moments  
25 ago, the Appendix B, isn't it true that the statement



1 beginning "nevertheless" stands alone without consideration  
2 of those WCAP reports? And, if the WCAP reports are described  
3 by Appendix B, that -- those reports?

4 Let me withdraw that and let me start all over  
5 again.

6 A Please do.

7 Q The sentence beginning: "Nevertheless, seismic  
8 stresses were combined..." and so forth and so on, to what  
9 extent does that sentence depend on the previous sentences,  
10 which I understand are based on the WCAP report analysis.

11 A Well to me, it depends on it in the sense of  
12 there's a logical flow there. However, I would agree that  
13 you could take out the preceding two sentences and formulate  
14 this paragraph to consist simply of the last two sentences  
15 and it still makes sense but it sort of doesn't tell you how --  
16 the ways and wherefores to things.

17 I tried to make a cohesive paragraph that told  
18 the whole story. The whole story simply being that this  
19 combination is very conservative.

20 MR. KETCHEN: No further questions.

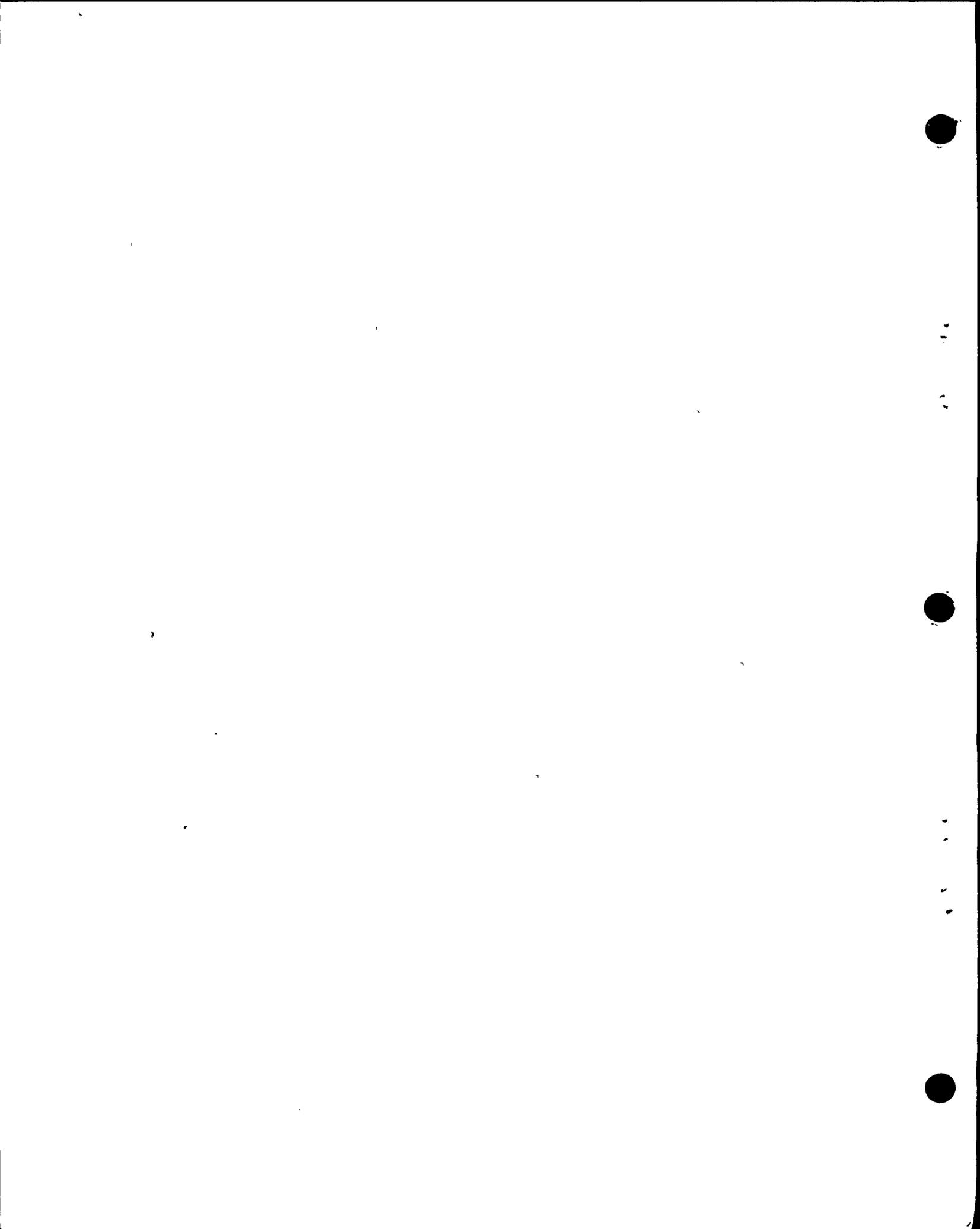
21 MRS. BOWERS: The Board has questions.

22 Shall we proceed, Mr. Norton, now?

23 EXAMINATION BY THE BOARD

24 BY MR. BRIGET:

25 Q I guess it would be for Mr. Chic. On the same line



wrb/agbl0

1 I'd like to ask the same question in a little different way  
2 or one of the same questions in a little different way.

3           You said the "seismic stresses are combined  
4 with LOCA stresses on an absolute sum basis as  
5 part of the safety evaluation of the containment  
6 structure."

7           All right.

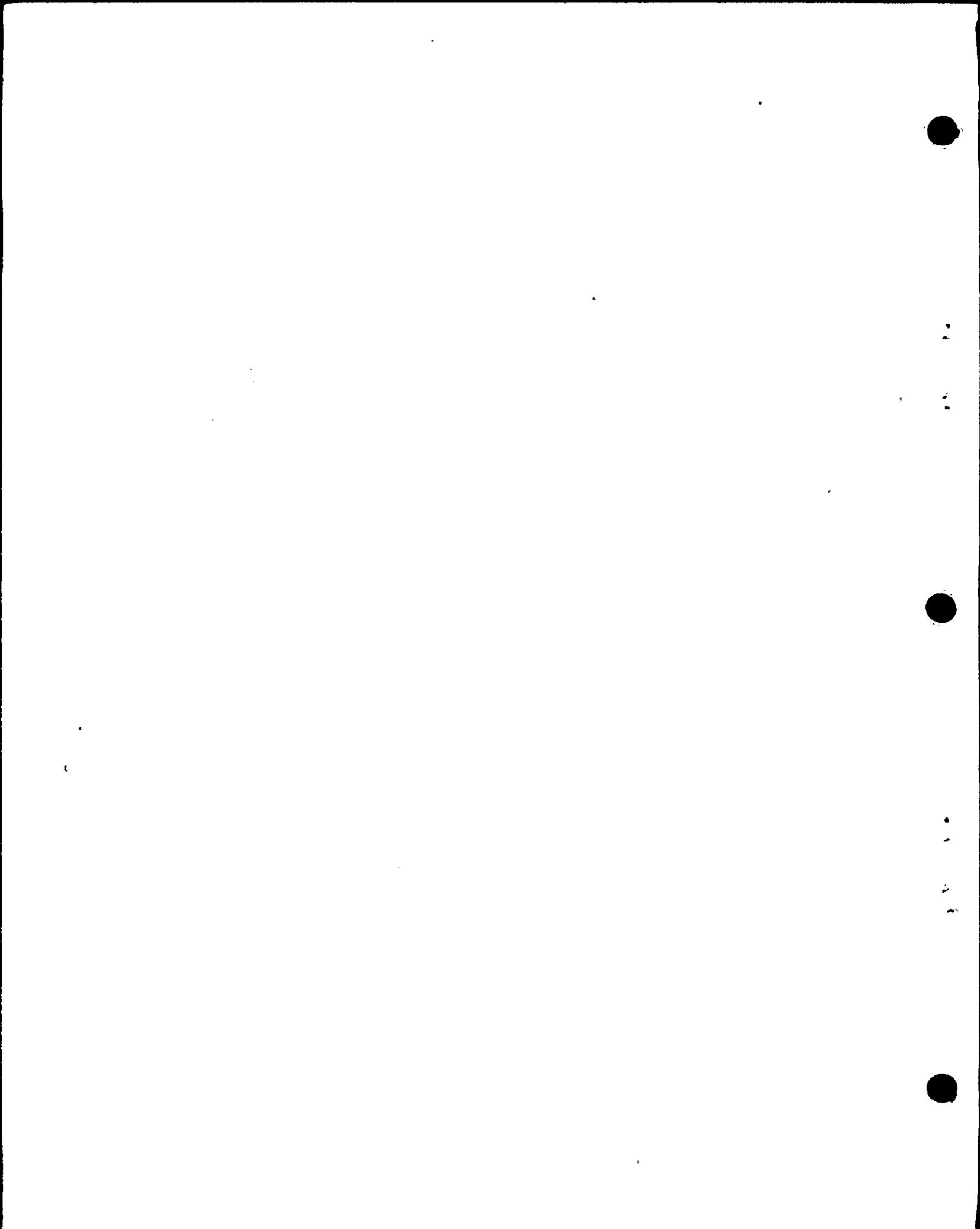
8           The components that go into making the summation  
9 values or whatever, do they depend upon the Westinghouse  
10 reports which there seems to be some doubt as to whether the  
11 Staff has accepted or not?

12           A           (Witness Ghio) Yes, they do.

13           For example, the pressure, internal pressure of  
14 the containment comes from work that Westinghouse performed  
15 for the loss of coolant accident.

16           Q           And the Board is to understand that these are  
17 currently under review by the Staff for the values that you are  
18 using?

19           A           I'm afraid I'm going to have to let the Staff  
20 state where they stand with the review of these documents.  
21 It is my understanding that the value, the specific value of  
22 47 pounds per square inch used in the derivation of the loss  
23 of coolant accident loads that were combined with the seismic  
24 loads both in the original seismic analysis for Diablo Canyon  
25 as well as the Hosgri evaluation, that number has been around



1 for several years.

2 And I'm quite frankly surprised to learn if  
3 that's what I'm doing here, and apparently I am, that the  
4 value is still open to question.

5 Q Well, Mr. Chio, it's a very strange surprise to  
6 me too, which is precisely why I'm asking. I'm not --

7 MR. NORTON: Excuse me, may I interject?

8 I don't think that's the case at all. I do not  
9 believe that is the case at all.

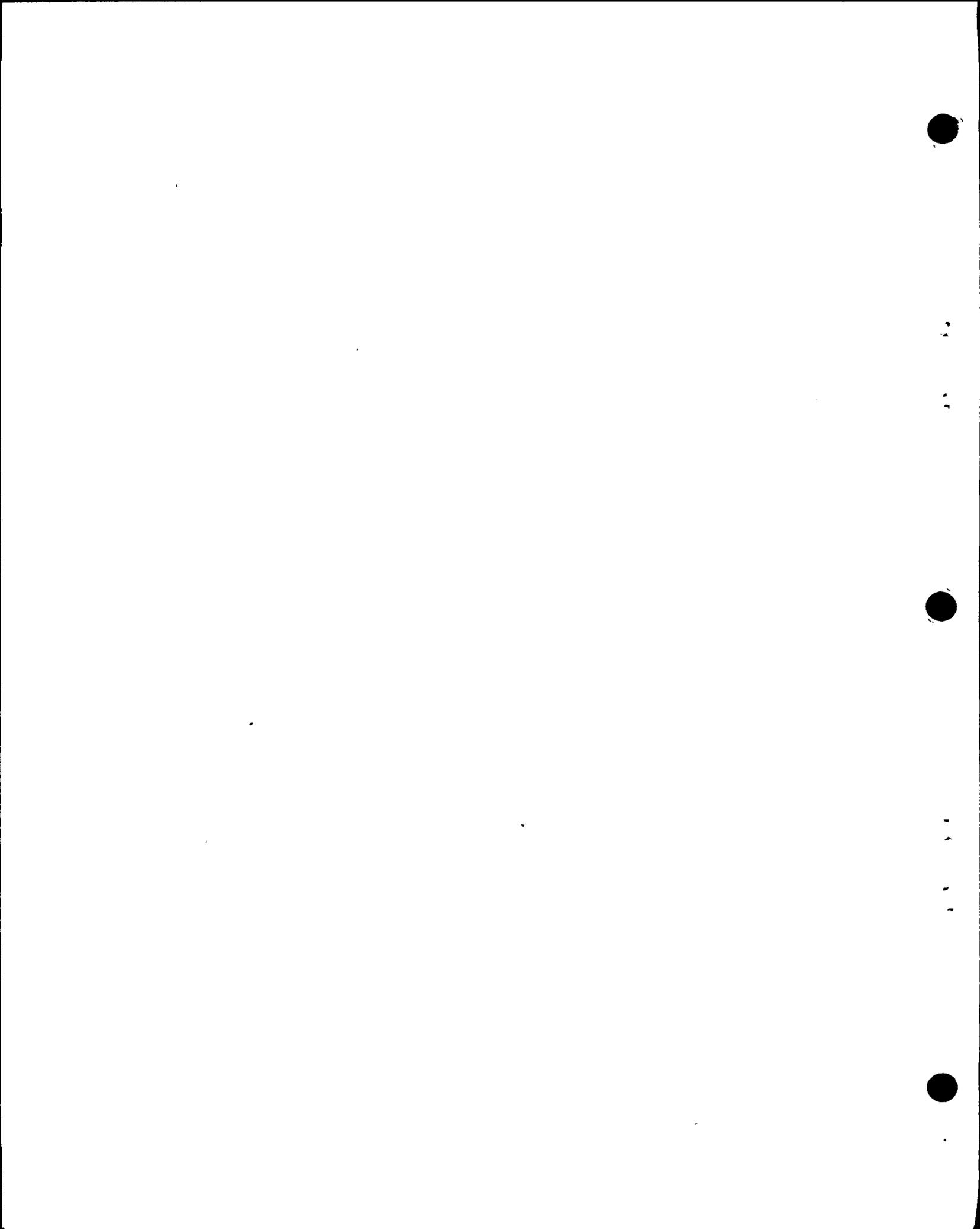
10 Mr. Knight is here of the Staff, and I think he  
11 could answer that very quickly. But you know, I hate to see  
12 us waste a half an hour or go down a garden path.

13 MR. BRIGHT: Very well.

14 Could we do this, when it comes time for the  
15 Staff to put on their case, could we be sure that some kind  
16 of answer to this question is addressed?

17 MR. NORTON: Could we do better than that,  
18 could we get an answer to the question right now, as long as  
19 the Staff member is here if no one has any objection? Because,  
20 you know, I don't think that's the case. I think we're just  
21 heading down a blind alley, I don't think that's the case at  
22 all. And if it is not, I would like to get it on the record.

23 MR. KETCHEN: Mrs. Dowds, I think that's a good  
24 suggestion. I prefer to have the information in the record  
25 at the same point where there is the confusion, so it can be



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2 dealt with and cleared up right away.

3 So I would suggest that if we could swear  
4 Mr. Knight for this very limited purpose to clarify the status  
5 of those reports and to answer any questions that might  
6 rectify this confusion, that that be done at this time rather  
7 than waiting a week or so or whenever Mr. Knight gets on to  
8 do that.

9 MRS. BOWERS: Mr. Kristovich, any objection?

10 MR. KRISTOVICH: No objection.

11 (Witness panel temporarily excused.)

12 MRS. BOWERS: Mr. Knight, raise your right hand,  
13 please.

14 Whereupon,

15 JAMES KNIGHT

16 was called as a witness on behalf of the Regulatory Staff and,  
17 having been first duly sworn, was examined and testified  
18 as follows:

19 MR. NORTON: When one gives an oath for limited  
20 testimony, does that mean he can lie about other testimony?

21 (Laughter.)

22 MR. KRISTOVICH: Is this a limited appearance  
23 for the next two days?

24 (Laughter.)

25 DIRECT TESTIMONY

WITNESS KNIGHT: My name is James Knight. I'm



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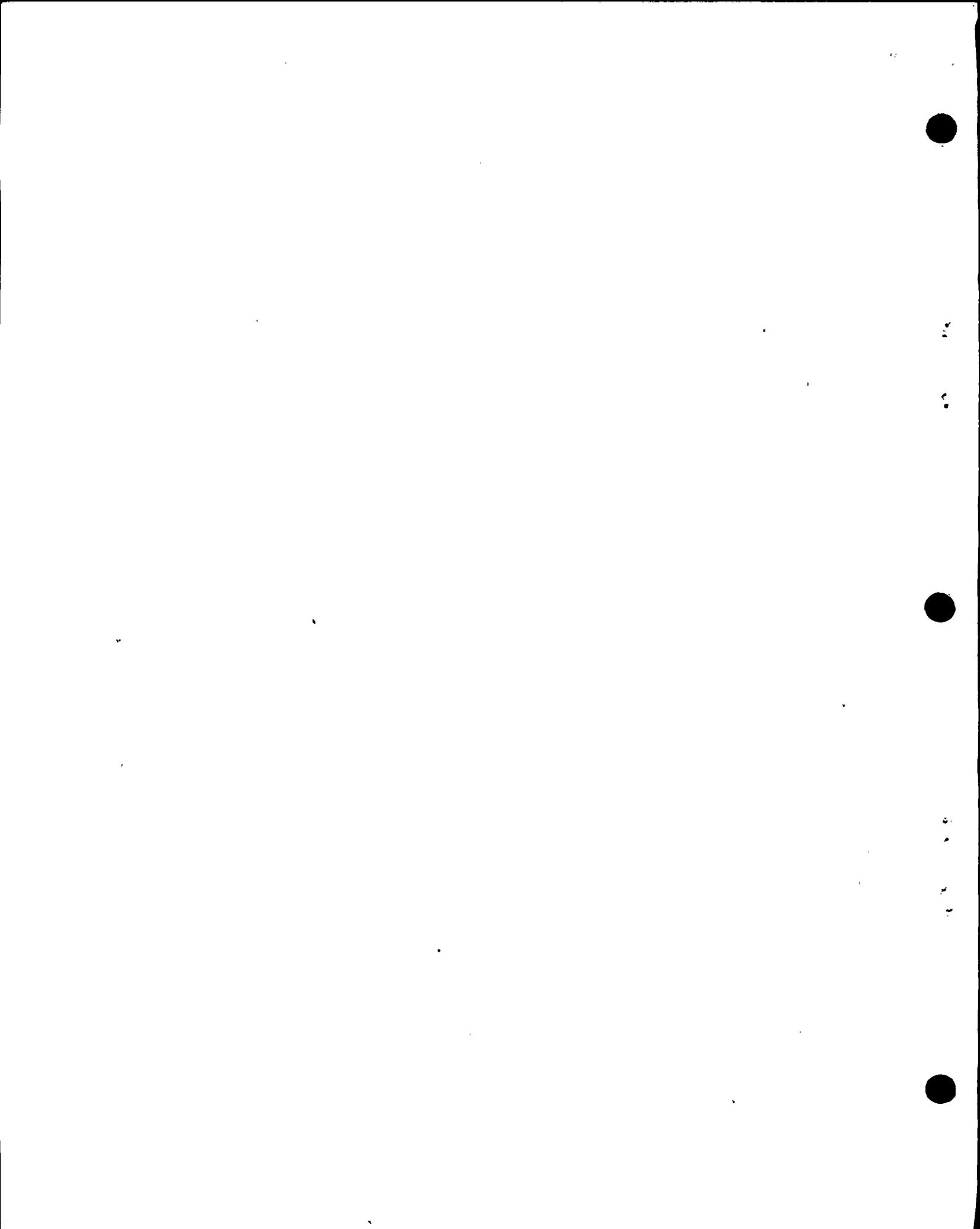
Assistant Director for Engineering in the Division of System Safety, NRC Staff.

If I may, let me try to reconstruct what I have heard here, and I think I'm only too well aware of the source of the confusion and hopefully in a matter of five minutes or so I can put it to rest.

Unfortunately, I don't have the documents and I don't want to fall into the trap of agreeing that the numbers I heard read out, the WCAP 9241 and 9242 are, in fact, the documents I have in mind. But there are, in fact, a series of WCAP reports the nature of which I can describe and I think we'll get general agreement that these are, in fact, the documents we're talking about.

The source of the statements we see here on Page Six of the testimony regarding the low probability of the loss of coolant accident and also the low probability of the combined loadings -- rather, the low probability of the loads combining absolutely, I believe are again in a WCAP. It may be 9241, I would have to look at it to be sure, but there was filed a WCAP whose principal, if not sole purpose was to examine this question of the likelihood of a large earthquake, the SSE in a generic sense, causing a loss of coolant accident.

The methodology used in that report postulates a flaw in the pipe and then proceeds to look at how large that



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flaw would have to be through the use of fracture mechanics and statistical methods to grow sufficiently during a seismic event that you would indeed cause a rupture of the pipe.

It's an extremely complex and extremely difficult subject. The whole field of fracture mechanics is somewhere between -- it is still somewhere between an art and a science.

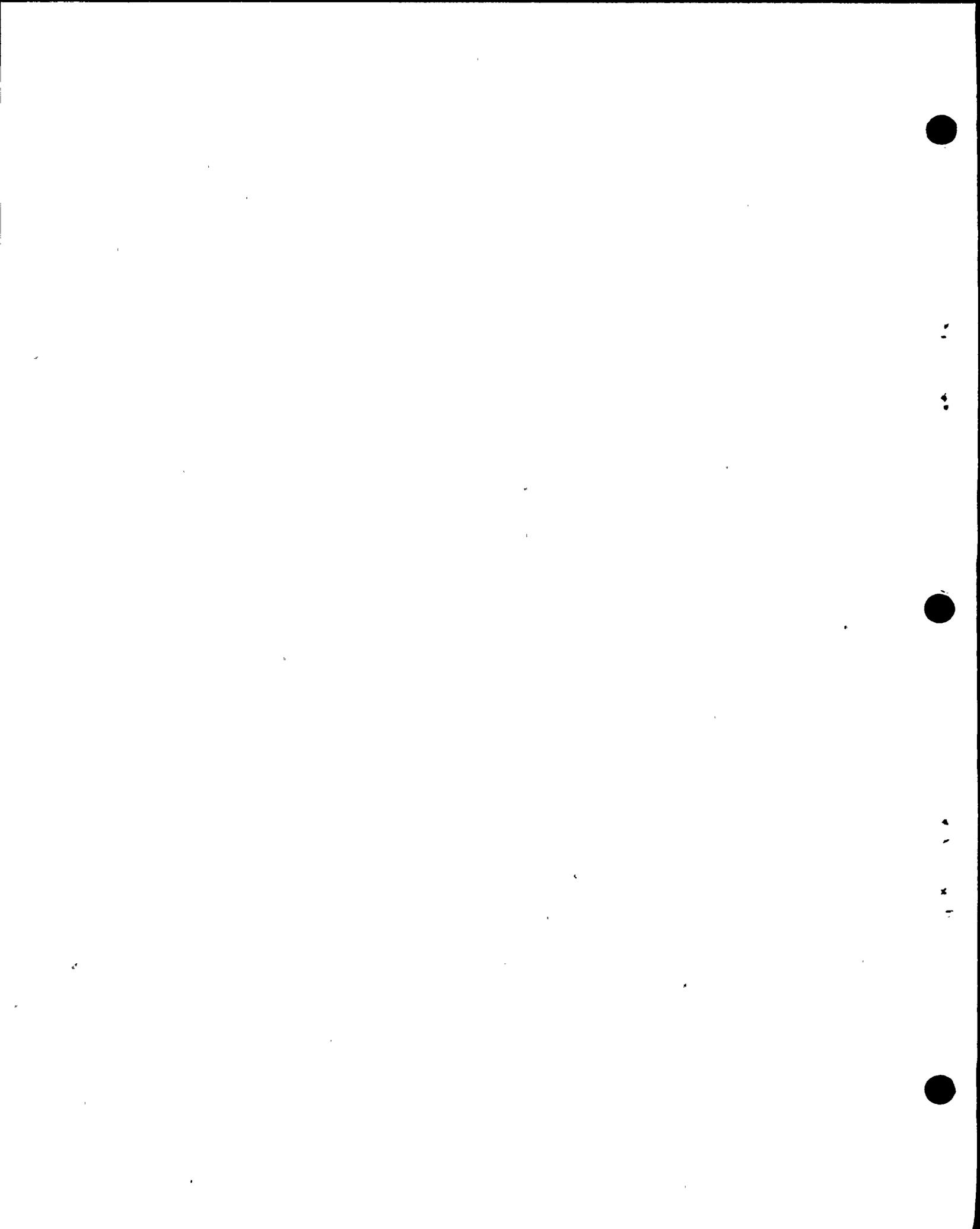
The Staff has that report under review, and it will be a somewhat protracted review.

Any other information that may have been in those reports, such as the containment pressure -- the number that may have been used for containment pressure or calculated stresses in the piping system, although they may have again appeared in those reports, they have appeared elsewhere.

For instance, the containment pressure is the subject of very definite, very specific Staff review. It's an organization other than mine that does this review, but we do an independent calculation of that containment pressure.

And I'm certain that that containment pressure has been verified and approved by the Staff, albeit the number may be in this other WCAP that is used for a different purpose.

Our remarks relating to that report not being accepted do not -- are not meant to reflect upon elements of information that might be in there that have, in fact, their source somewhere else and have been accepted somewhere else. Our review of these reports or our difficulty in acceptance at



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3 this point is related solely to this question of how large  
4 would a flaw have to be, how much could it grow, what type of  
5 statistical methods do you apply in coming to these conclusions.

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7 MR. BRIGHT: Fine. I think you answered my  
8 question.

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10 EXAMINATION BY THE BOARD

11  
12 BY MR. BRIGHT:

13 Q So if we went back to where Mr. Ketchen was  
14 beginning with "nevertheless," there is no problem with  
15 using this 47psi or whatever in determining the containment  
16 load from a loss of coolant accident in combination with the  
17 actual earthquake stresses on the building?

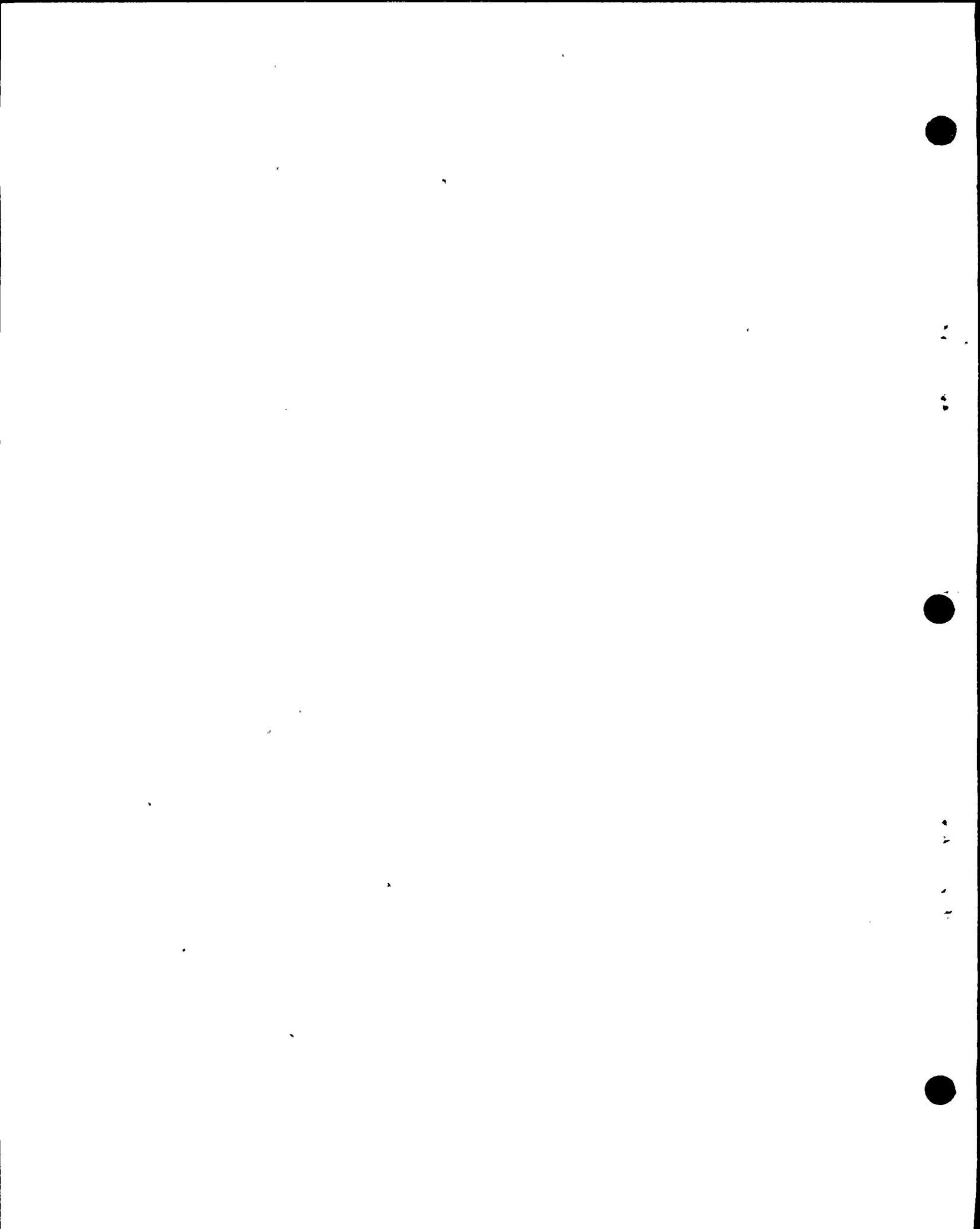
18 A No. To my knowledge, and I'm very certain of this,  
19 there is no question whatsoever with the components of those  
20 responses or loads that would have been used in this combination.  
21 It really goes far beyond -- I shouldn't say far beyond, but  
22 it goes to the side, if you will, to the more philosophical  
23 question of whether you ought to combine these loads or not  
24 directly or through some other methodology.

25 Q But the input, in case you want to do it, does  
appear to be soundly based?

A The input is soundly based, yes, sir.

BY MRS. BOWERS:

Q Now you made an assumption earlier, I believe  
you've been handed a document that may verify that or may



1 dispute it.

2 A Okay. Again I see, perhaps, where some of the  
3 confusion arose.

4 The WCAP 9241 which is entitled, "Evaluation of  
5 Reactor Coolant System for Postulated Loss of Coolant Accident  
6 from Diablo Canyon Nuclear Plant," is not the document we  
7 were referring to as still being under review. I believe this  
8 9241 has, in fact, been accepted.

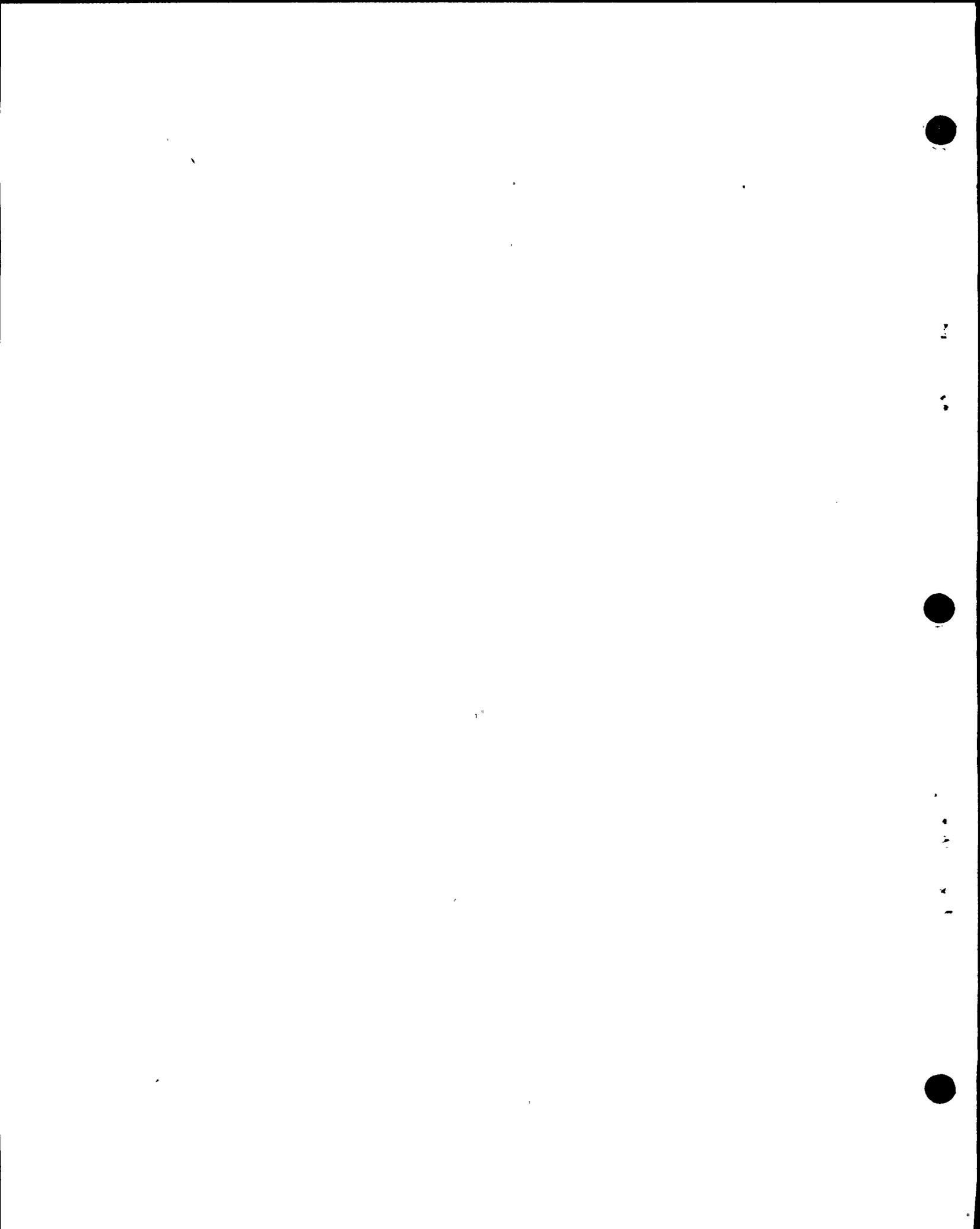
9 The document I was referring to, or the Staff  
10 was referring to as far as this question on how to combine  
11 these loads is another WCAP, the number of which I do not  
12 have available at the moment.

13 But when Mr. Ghio said some of these numbers  
14 were taken out of -- some of the elements of the input as  
15 you've put it out of 9241; then that would in fact be an  
16 accepted report.

17 MR. NORTON: Mrs. Bowers or Dr. Bright, so  
18 that I understand then we've gone full circle back to where  
19 we were, when Mr. Ghio originally said that as far as he  
20 knew those reports had been accepted, then that has now been  
21 proved up by the Staff as the case, is that correct, the  
22 WCAP 9241?

23 WITNESS KNIGHT: I heard the question and that  
24 is the case.

25 MR. KRISTOVICH: I would like to ask Mr. Knight



1 one question based on what he said.

2 CROSS-EXAMINATION

3 BY MR. KRISTOVICH:

4 Q Mr. Knight, I have just one question. Is the  
5 Staff's review of the probability of LOCA and seismic loads  
6 occurring simultaneously influenced by the NRC review of the  
7 conclusions of Dr. Lewis' Risk Assessment Review Group?

8 A No.

9 Q No, it is not influenced by Dr. Lewis' group?

10 A No.

11 Q Thank you.

12 Whereupon,

13 JOHN A. BLUME,

14 VINCENT J. GHIO,

15 DAVID A. LANG,

16 STANLEY A. HANUSIAK,

17 DILIP P. JHAVERI,

18 and

19 LINCOLN E. MALIK

20 resumed the stand as witnesses on behalf of the Applicant and,  
21 having been previously duly sworn, were examined and testified  
22 further as follows:

23 EXAMINATION BY THE BOARD (Resumed)

24 BY MR. BRIGHT:

25 Q Whoever is most knowledgeable about this, talking



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1  
2 wrb/agbl8 about a triangular geodesic pattern of reinforcing steel,  
3 and you're saying that this -- This is Page Six in the testi-  
4 mony -- and you talk about design innovations here.

5 Was this something, who designed this particular  
6 thing?

7 A (Witness Hanusiak) Our group.

8 Q PG&E did the design work on it?

9 A Yes.

10 Q I was wondering. I guess we're all familiar with  
11 Buckminster Fuller and the beautiful structures that he makes.

12 This is a means of using less steel with greater  
13 strength, the same amount of steel with more strength?

14 A Yes, in a way, yes, because now --

15 MR. NORTON: Excuse me. Mr. Hanusiak, don't  
16 forget your microphone.

17 WITNESS HANUSIAK: One of the things is that  
18 this pattern allows us continuous reinforcing bars, one welded  
19 by cad weld sleeve to another without any interruption.

20 In other words, we have a complete basket weave  
21 where we start in the containment base mat, go all over the  
22 structure and go back.

23 Now, many other containments -- well, I shouldn't  
24 say many other containments because there aren't that many --  
25 but containments that do not use that pattern, they have to  
interrupt bars because otherwise -- for instance, you have



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1 vertical bars in the containment structure. This would be  
2 all fine in the cylindrical portion, but when you get into  
3 the dome portion, they would all converge at the apex and you  
4 have to terminate them. And the predominant load is LOCA  
5 pressure, so it is really a pressure vessel.

6 So terminating reinforcing presents a problem  
7 because you have to develop the tensile strength of the bar.  
8 If you do not interrupt, if you have all things continuous,  
9 then this does present an efficient system.

10 Another thing is that the 60-degree diagonal  
11 pattern allows the bar to do a double function as far as  
12 seismic shear, because at 60 degrees, the same bar is able  
13 to take vertical tension in the shell almost as efficiently  
14 as a vertical bar, but at the same time, the same bar can  
15 take the seismic shear.

16 Q By 60 degrees, I mean you assume 30 degrees off  
17 the vertical?

18 A Right.

19 Another thing is that not having to terminate  
20 the bars and having them continuous allowed us to make it less  
21 congested, so consequently we could reduce the thickness, and  
22 reducing the thickness reduces the weight, and this reduces  
23 the seismic force.

24 Since we are not counting really on concrete  
25 strength, just the reinforcing strength, then eliminating the



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1 concrete is eliminating a course of loads without decreasing  
2 the strength.

3 Q I assume that this technique is well enough  
4 known, whether it is innovative or not, that we don't have  
5 any serious problems in whether it works or not.

6 A It's just a matter of physical ability to place  
7 the reinforcing bars where they are.

8 Q Now, I only have one other little thing:

9 When we were going through, or when Mr.  
10 Kristovich was doing the definitions, there was one word that  
11 kept coming out it appeared to be all the time, and that's  
12 called "response," and I just want to make it clear what  
13 response is.

14 Now, as I understand it, we have three different  
15 things that we worry about when we apply forces to an object,  
16 and one would be displacement, one would be velocity, the  
17 other would be acceleration, right or wrong?

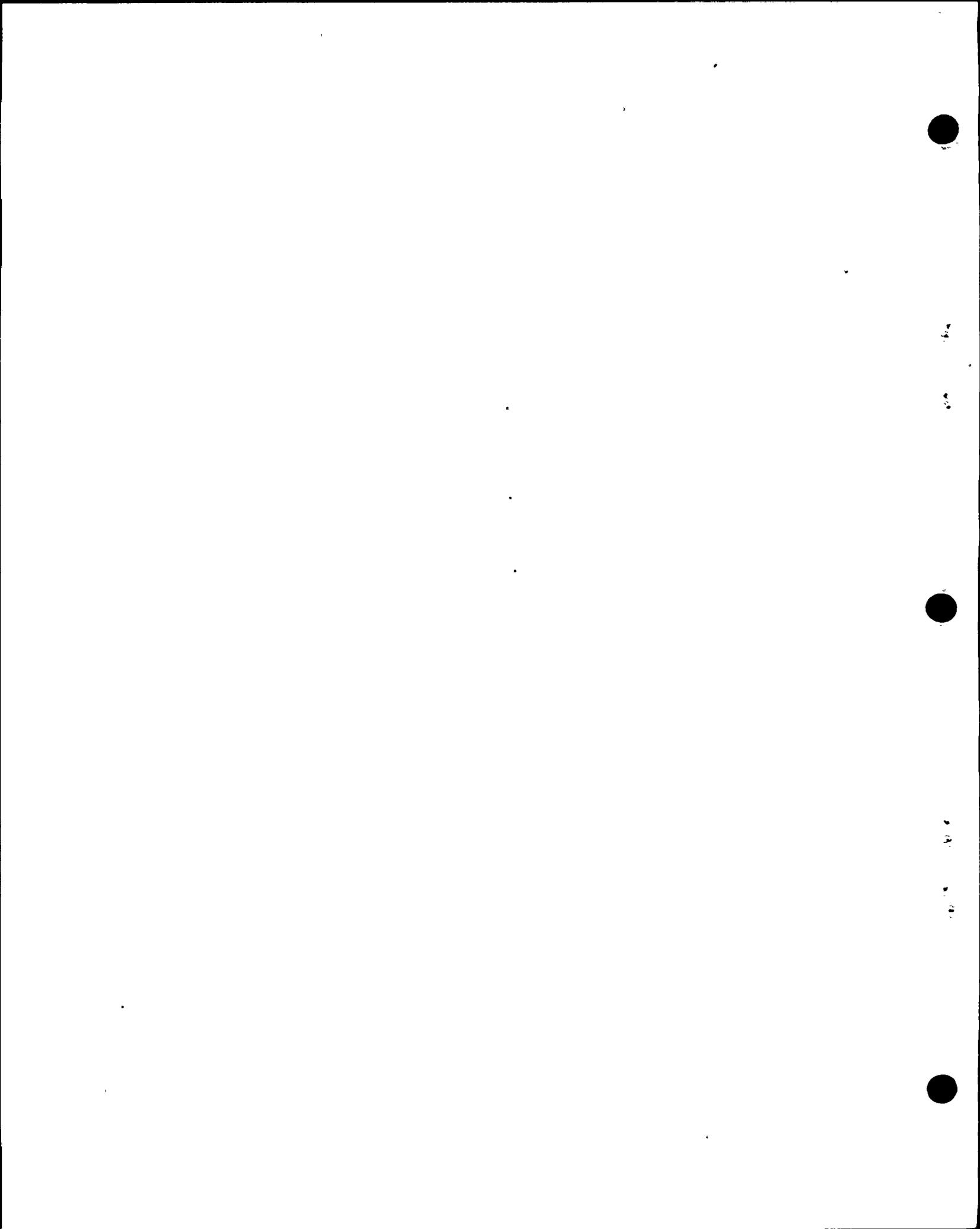
18 A (Witness Blume) Add another one and that's time.

19 Q Well I was thinking of -- well, no, I wouldn't  
20 be thinking of all of them as a function of time, would I?  
21 But you're quite right, Dr. Blume.

22 For example, on Page Two beginning with Line Six,  
23 you say:

24 "The response to the three components  
25 of ground motion..."

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The response were calculated separately.

Well now, does this response, is this a particular one of these three things or is it all of them or is it anything you want it to be?

A In the case at hand, we are dealing basically with response accelerations as a start. And the reason for that is that we use the response spectra, both the Newmark and the Blume sets of response spectra which are very important in the acceleration range because the structures under consideration have very short natural periods of vibration, so that they are very sensitive, most sensitive to acceleration.

Now having obtained an acceleration response in the structure, we then turn to displacement in the structure and finally to distortion because it's only distortion that causes stress. So we actually start with acceleration and the response spectra but finally wind up with displacements and distortion.

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2 Q So generally whenever you just say "response"  
3 you're talking about the acceleration, certainly primarily?

4 A Either the acceleration or the displacement. It  
5 would vary from case to case. But we start with acceleration.

6 We finally turned this into stresses. That's the  
7 bottom line, is to find out how the stresses are. Are they  
8 above or below the allowable limits. And if they are below,  
9 that solves the problem. If they're above, why, something has  
10 to be done.

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11 Q Fine. Thank you, gentleman.

12 BY MRS. BOWERS:

13 Q Well, I have some questions about Figure 5, and  
14 really it's a matter of trying to understand what it's supposed  
15 to depict. And this may be a matter of common usage.

16 But you've got the three vertical, the non-seismic,  
17 the DDE stresses, and the Hogri stresses, and did one of the  
18 panel do this?

19 A (Witness Hanusiak) Sure.

20 Q Well, can you tell me really what this means?  
21 What are you showing with this kind of an illustration?

22 For instance, you show an arrow with "Hogri"  
23 that includes the DOE, but it does not include the non-seismic,  
24 is that correct?

25 A Okay.

We had kind of a problem that was a purely



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1 draftsman problem. In the legend we show DDE stresses with  
2 vertical hatching, and Hosgri with the horizontal.

3 Now, I should really -- you can see the arrow  
4 actually shows Hosgri stresses all the way across through  
5 vertical lines and horizontal lines. If you are really  
6 completely logical, you would have little squares at the  
7 place where DDE stresses are because the horizontal lines  
8 would have to go clear to the diagonal lines where they are  
9 non-seismic loads. So this means that Hosgri is both the  
10 vertical and horizontal lines on the picture, while DDE are  
11 only vertical lines.

12 Q Well, I think what I'm trying to get at -- well,  
13 you have the containment on the left and then you depict the  
14 non-seismic because that's the lowest stress?

15 A No, we just are trying to provide a breakdown of  
16 how much load we have due to other loads non-seismic, which  
17 predominantly LOCA, and how much is due to seismic loads. And  
18 so if you want the total stress you would have to add all three  
19 areas.

20 Q But the way you show it here you just picked a  
21 method to show the extent of the various stresses, is that  
22 correct?

23 A Well, I'm attempting to show the variation of the  
24 stress.

25 Now, like, for instance, we start at the top of



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of the diagram. The stress is the lowest, and then increases as I go down. Then I come to Elevation 66 and I have a sudden decrease. Now the decrease is because we are adding another layer of reinforcing. So we have to simply divide the loads by a bigger reinforcing area.

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So they decrease, and they continue to increase toward the bottom. So the purpose of the diagram is really to show where we have to look for controlling stresses. And it's kind of obvious from this picture that what really controls is the little peak at elevation 166.

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A (Witness Blume) I think possibly there may be some confusion developing between the legend and the arrows on the figure.

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Now as I understand it, the arrows are correct. The Hogri stress is shown by that horizontal arrow. But the legend that says -- with the horizontal bars of hatching says Hogri stresses should really be Hogri stresses minus the DDE stresses.

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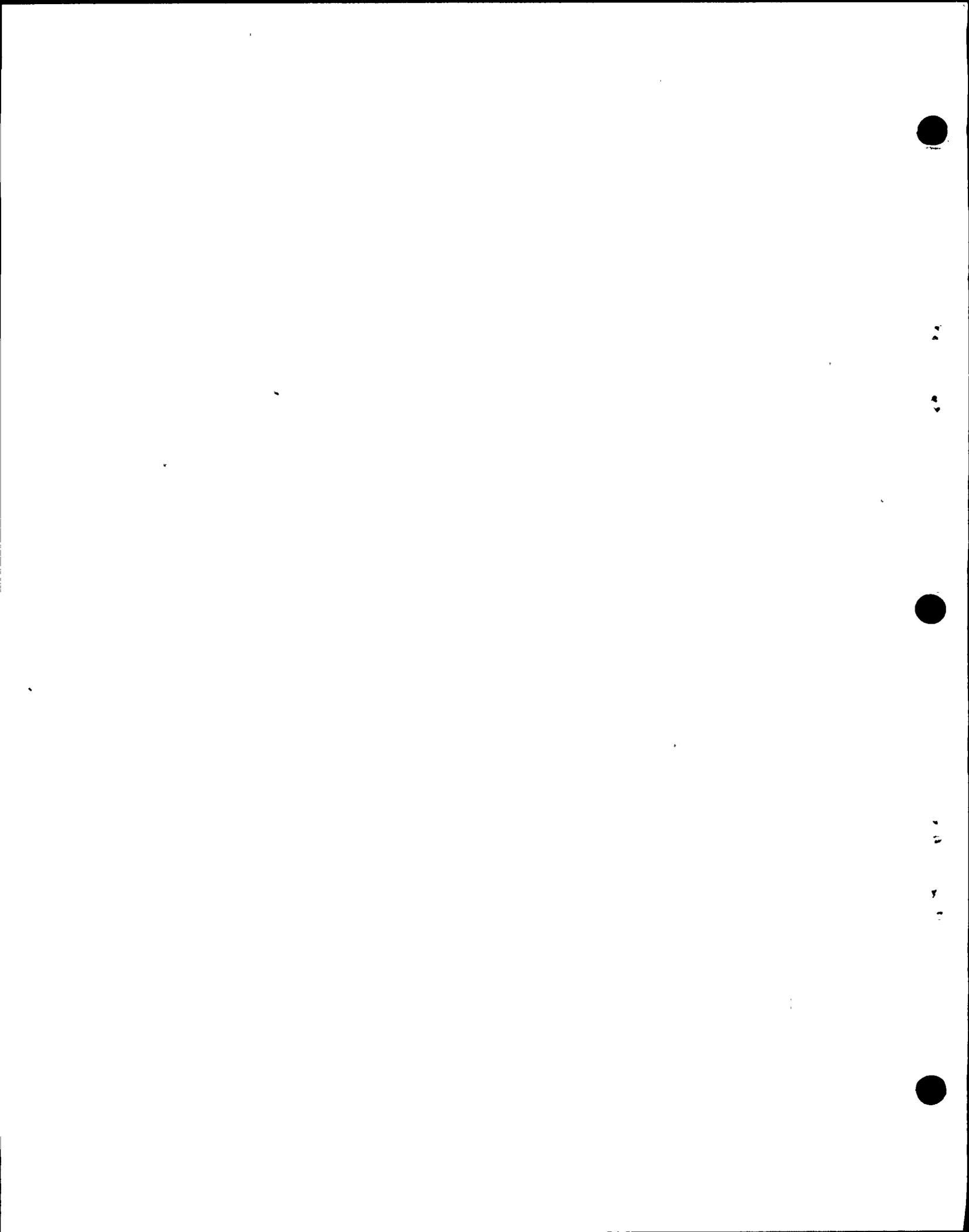
Am I not correct?

A (Witness Ghio) That's correct.

A (Witness Hanusiak) We actually asked the draftsmen to put the lines like the legend said, but then in the area where we have those vertical lines they wouldn't be criss-crossing.

25

A (Witness Blume) I realize that. But the arrows



1 that you show in the diagram are correct.

2 A (Witness Hanusiak) They are correct, right. In  
3 fact, this is why we put the arrows, because the picture was  
4 too confusing without them.

5 Q Fine. I understand now.

6 Well, and I assume you terminated the one layer  
7 of reinforcing because it was --

8 A The reinforcing continues to be the same while  
9 the load decreases toward the top, so it becomes just not very  
10 interesting.

11 Q So long as you were within the limits?

12 A Right.

13 MRS. BOWERS: Let me check with the parties and  
14 see if the Board's questions generated questions.

15 Mr. Norton?

16 MR. NORTON: We have a couple of questions on  
17 redirect. We'd like just a moment.

18 (Pause.)

19 MRS. BOWERS: I might mention one reason that I  
20 find some of these things have meaning is we have made many  
21 visits to the site in the various stages of construction, and  
22 we have seen the exposed rebars in there loop or whatever you  
23 call it. And so it's helpful, those site visits, in reading  
24 the testimony.

25 Mr. Norton?



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## REDIRECT EXAMINATION

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BY MR. NORTON:

Q Dr. Blume, I have just a couple of questions for you. I believe you were the one who responded to the questions of Intervenor's Counsel regarding whether or not the tau effect was called for in standard review plans or regulations or guidelines, and you answered no to each one of these questions.

That was yourself, wasn't it?

A (Witness Blume) Yes.

Q All right.

Do you know if the applicable regulations or standard review plans or guidelines require that an appropriate analysis be done?

A Yes. They do require an appropriate analysis.

Q All right.

My question for you is:

In this case do you feel that the use of the tau effect was an appropriate analysis?

A Yes.

MR. NORTON: That's all I have.

MRS. BOWERS: Mr. Kristovich?

MR. KRISTOVICH: I just have a couple of more questions.

MRS. BOWERS: Fine.



## RE-CROSS-EXAMINATION

BY MR. KRISTOVICH:

Q Mr. Ghio, directing your attention to page 6 of the written testimony again, lines 13 through 16, is it normal Staff practice to require the combination of seismic stresses with LOCA stresses on an absolute sum basis?

A (Witness Ghio) Yes, it is.

MR. NORTON: Excuse me.

I was going to object on lack of foundation as to whether or not this witness knows what normal Staff practice is, and I think that question ought to be asked first, because if he doesn't know then he shouldn't be answering the question.

MR. KRISTOVICH: I think the witness already answered the question.

MR. NORTON: I still would like the foundation question.

MRS. BOWERS: Well, the foundation question should have come first.

So will you back-up a little?

BY MR. KRISTOVICH:

Q Well, Mr. Ghio, to the best of your knowledge, is it normal Staff practice?

MR. NORTON: Object.

That does not ask the question of whether he knows



1 what the normal Staff practice is, which is the foundation  
2 necessary to answer such a question, whether it is to the  
3 best of his knowledge or otherwise.

4 BY MR. KRISTOVICH:

5 Q Mr. Ghio, do you know what the normal Staff  
6 practice is with regard to this?

7 A (Witness Ghio) Well, due to the fact that I  
8 have not reviewed either Staff-generated or other applicants'  
9 documents on how they handle their case in any detail, I  
10 guess I cannot claim to be an expert in normal Staff practice.

11 Q To the best of your knowledge, is it normal  
12 Staff practice?

13 MR. HORTON: Mrs. Bowers, that's exactly my  
14 objection. Normal Staff practice questions should be directed  
15 to the Staff, not to this panel.

16 These panel members are not Staff members and  
17 they do not know what normal Staff practice is except as it  
18 applies to Diablo Canyon.

19 And Mr. Ghio may think he knows, but in fact he  
20 may not know what normal Staff practice is. He may have  
21 heard, somebody may have told him something, and so he gives  
22 a response. But that's why the foundation question must be  
23 asked. And I think it's clear that he does not know what  
24 normal Staff practice is as respects other facilities.

25 MRS. BOWERS: Well, the witness has testified that



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1 he cannot say what normal Staff practice is.

2 MR. KRISTOVICH: I believe I limited it to the  
3 best of the witness's knowledge.

4 MRS. BOWERS: But he testified he doesn't know.

5 MR. KRISTOVICH: He also testified that yes that  
6 was.

7 MR. NORTON: And we are now moving to strike that  
8 answer for lack of foundation.

9 MRS. BOWERS: Well, just a minute. We have an  
10 objection pending.

11 The objection is sustained.

12 MR. NORTON: Now we are moving to strike Mr. Chio's  
13 response to the question when he responded before I had a  
14 chance to object for lack of foundation.

15 MRS. BOWERS: Mr. Kristovich?

16 MR. KRISTOVICH: I have nothing to say to that.

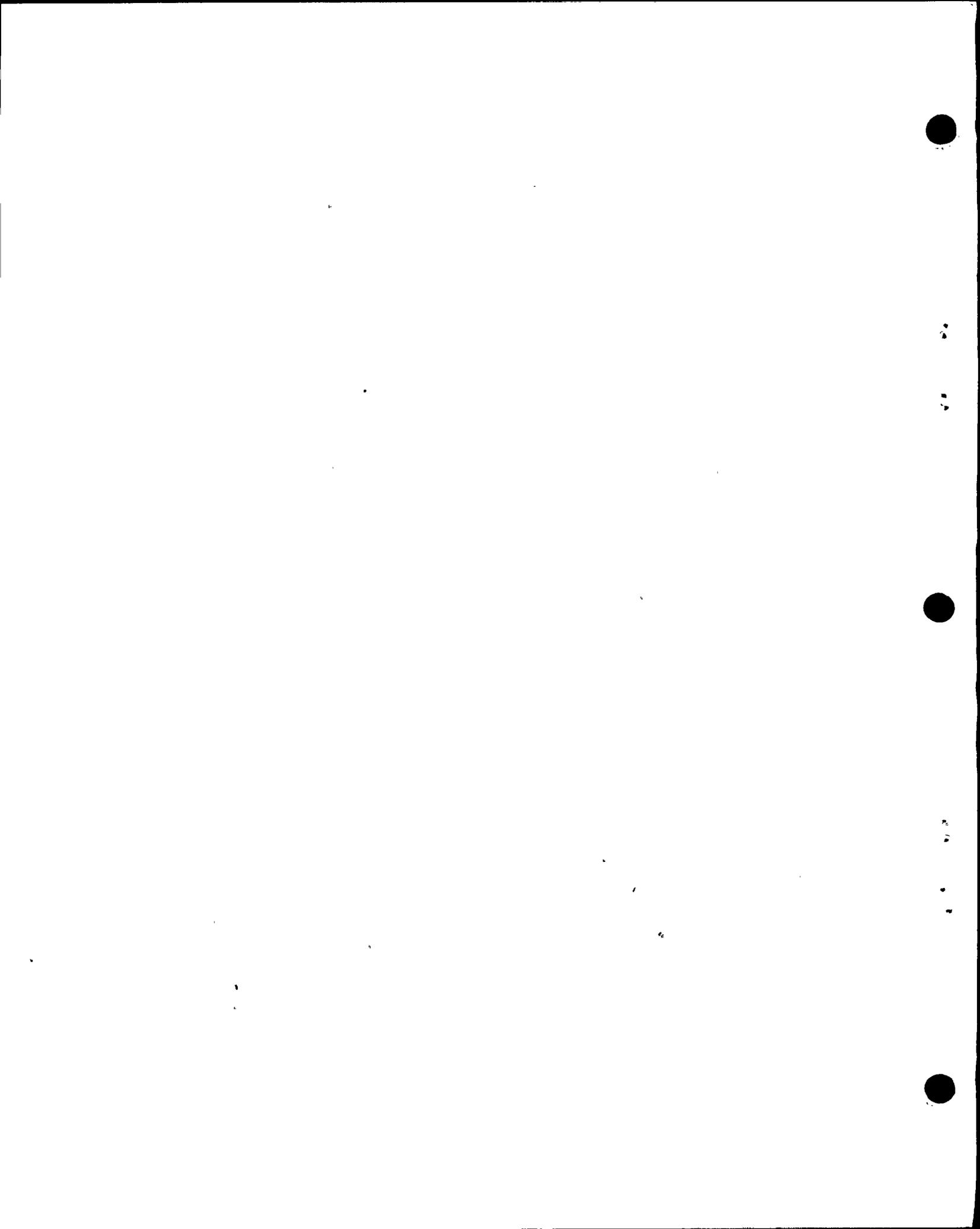
17 MRS. BOWERS: Well, does the Staff have a -- can  
18 the Staff tell us? I was delighted to hear there was normal  
19 Staff practice.

20 (Laughter.)

21 MR. NORTON: That's another foundation we need.

22 (Laughter.)

23 MRS. BOWERS: Do you have a position on the motion  
24 to strike the witness's answer before Counsel had an opportunity  
25 to object?



1 Let me review this, if you were conferring.

2 DR. MARTIN: Excuse me.

3 Does "normal" refer to practice or Staff?

4 (Laughter.)

5 MRS. BOWERS: There will be a motion to strike  
6 somebody.

7 (Laughter.)

8 MR. KETCHEN: Mrs. Bowers, I don't want to get  
9 into the practice of taking our witness out of turn and  
10 leaving him on the witness stand for any length of time.  
11 But I think the easy answer to that technical objection is  
12 just to get the answer. And we do have Mr. Knight here, and  
13 he can answer the question.

14 MR. NORTON: That doesn't address my objection,  
15 though. I want the answer from this witness struck.

16 If Mr. Knight wants to testify, that's fine. I  
17 have no objection to that, obviously. But I don't think  
18 this witness should be answering as to what is normal Staff  
19 practice.

20 MR. KETCHEN: I agree, Mrs. Bowers.

21 This witness is not qualified to testify as to  
22 what the normal Staff practice is.

23 MRS. BOWERS: Well, the motion to strike is  
24 granted.

25 For a very special reason, Mr. Ketchen, you had



1 Mr. Knight testify in an area. But aren't you getting into  
2 your basic case to have him proceed in other areas?

3 MR. KETCHEN: Yes, we are. That's why I had the  
4 premise. And if you like, I would defer and respond to that  
5 question when the Staff puts on its direct case, unless it  
6 would move things along to have the answer now.

7 MR. KRISTOVICH: It's a yes or no question.

8 MRS. BOWERS: Well, we would prefer to have the  
9 Staff proceed in the usual fashion rather than taking bits  
10 and pieces out of turn.

11 Do you want to go ahead, Mr. Kristovich?

12 BY MR. KRISTOVICH:

13 Q I just have one more, then.

14 Mr. Ghio, are you aware of any plant that has  
15 been granted an operating license without performing such  
16 an analysis described on lines 13 to 16 on page 6?

17 A (Witness Ghio) I'm not aware of any plants that  
18 have been or have not been granted a license.

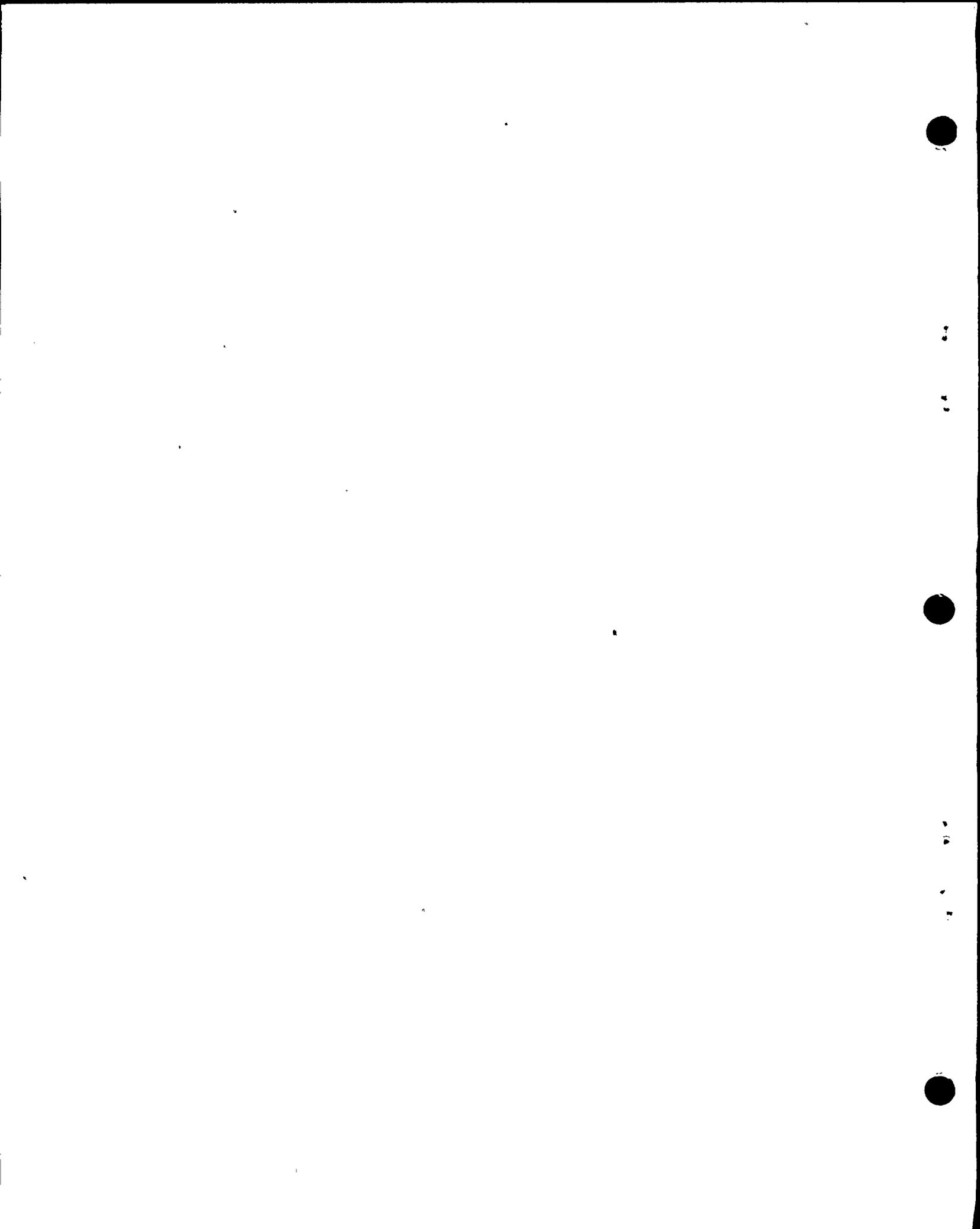
19 MR. KRISTOVICH: No further questions.

20 MRS. BOWERS: Mr. Katchen?

21 MR. KETCHEN: I have no questions, Mrs. Bowers.

22 MR. NORTON: No further questions.

23 We would ask that these witnesses not be excused.  
24 I think most of them are going to be on other panels. And I  
25 think Mr. Hanusiak is the only one that isn't slated to be on



WRB/  
mpb11

1 another panel. But a question may come up that does involve  
2 him. So we would ask that they not be excused, but that  
3 Mr. Hanusiak be allowed to step down and be replaced with  
4 someone else.

5 MRS. BOWERS: Fine.

6 (The panel temporarily excused.)

7 MRS. BOWERS: Now do you have another panel to go?

8 MR. NORTON: It's the same panel except we add  
9 Mr. Sokoloff.

10 MR. KETCHEN: Excuse me, Mr. Norton.

11 Mrs. Bowers, may I request the same accomodation  
12 for Mr. Knight? I would request that he be excused subject  
13 to recall when the Staff puts on its direct case. But I  
14 would like the record to reflect that he was released at  
15 this point.

16 MRS. BOWERS: Any objection, Mr. Norton?

17 MR. NORTON: No objection.

18 MRS. BOWERS: Mr. Kristovich?

19 MR. KRISTOVICH: No objection.

20 MRS. BOWERS: Mr. Knight, then, is excused, subject  
21 to recall.

22 (Witness Knight temporarily excused.)  
23  
24  
25



1 Whereupon,

2 JOHN A. BLUME

3 VINCENT J. GHIO

4 DILIP P. JHAVERI

5 DAVID A. LANG

6 LINCOLN E. MALIK

7 IGOR SOROLOFF

8 assumed the stand as witnesses for and on behalf of the  
9 Applicant and, having been previously duly sworn, were examined  
10 and testified as follows:

11 DIRECT EXAMINATION

12 BY MR. HORTON:

13 Q Mr. Ghio, I believe we are now to that portion  
14 of the testimony entitled Hoshri Analysis and Evaluation  
15 of the Auxiliary Building, which follows Figure No. 5 which  
16 we were just talking about.

17 Do you have any corrections to that testimony?

18 A (Witness Ghio) Yes, I do.

19 Q Could you make them at this time, please?

20 A On the first page, line 9, replace the words  
21 "Foundation filtering" with "spatial averaging of accelerations."

22 Q Or tau?

23 A On line 16, insert the word "spectra" before  
24 "basis." And on line 17 insert the word "spectra" before  
25 "basis."



1 On page 5, line 9, insert the words "for the  
2 Hosgri earthquake" after "margins."

3 On page 6, at line 25, which does not exist: there  
4 been an omission, and the following paragraph which consists  
5 of one sentence should be inserted:

6 "In conclusion the auxiliary building,  
7 with the modifications to the fuel handling area  
8 discussed above, is capable of resisting the Hosgri  
9 earthquake."

10 MR. BRIGHT: Would you repeat that, please,  
11 more slowly?

12 BY MR. NORTON:

13 Q Would you repeat the last sentence?

14 A (Witness Ghio) "In conclusion, the auxiliary  
15 building, with the modifications to the fuel handling  
16 area discussed above, is capable of resisting the  
17 Hosgri earthquake."

18 MRS. BOWERS: Hosgri earthquake of what magnitude?

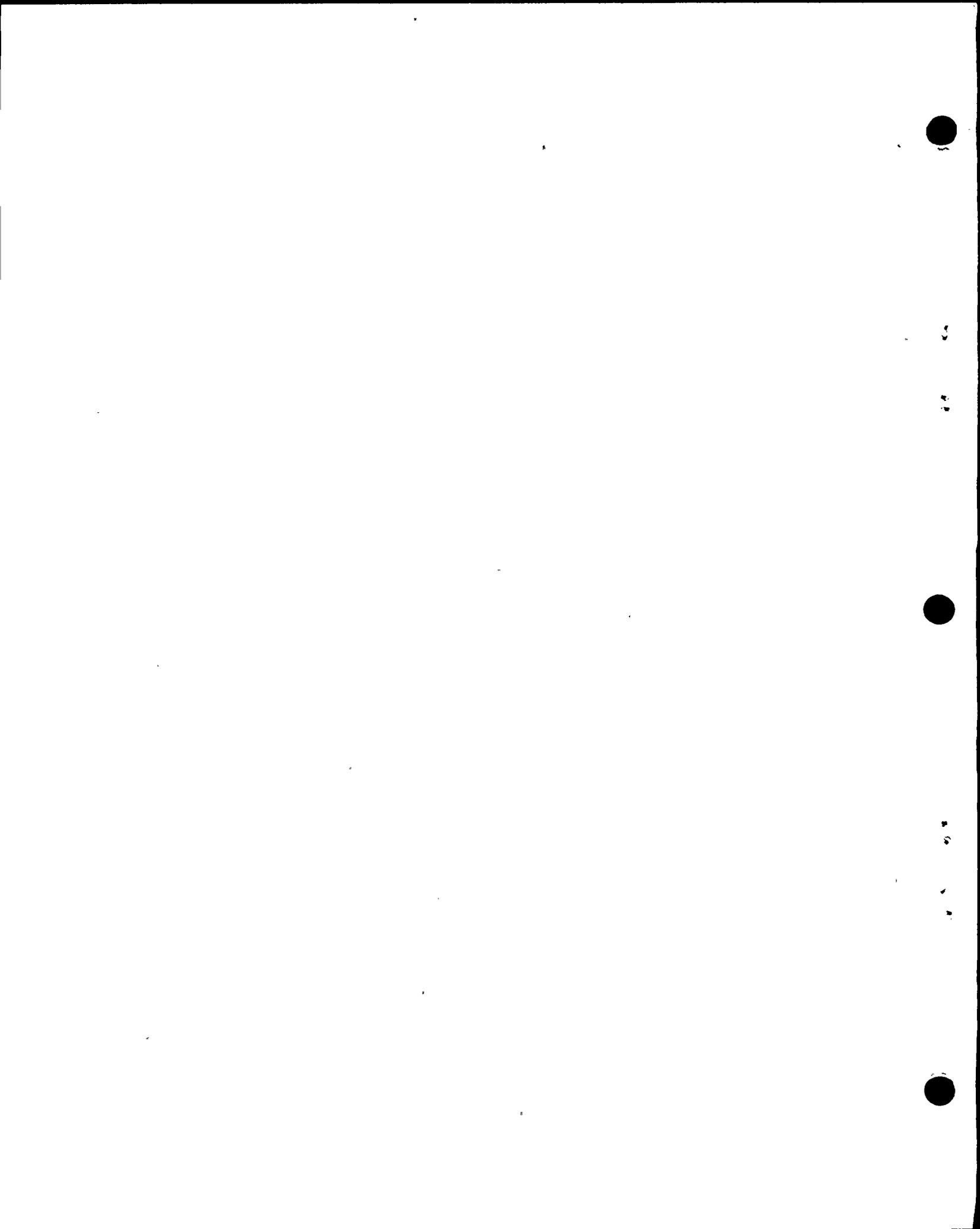
19 MR. NORTON: Excuse me, Mrs. Bowers; I believe  
20 any time that the Hosgri earthquake is ever referred to any  
21 testimony it is the postulated 7.5 magnitude earthquake in  
22 any testimony throughout the applicant's case at any time.

23 WITNESS GHIO: No further corrections.

24 BY MR. NORTON:

25 Q Mr. Ghio, at this time would you please briefly

WRB/wb2



ARB/wb3

1 summarize the six pages of testimony in a couple of minutes,  
2 if you could?

3 A (Witness Ghio) As was the case for the containment  
4 structure, the auxiliary building was evaluated utilizing  
5 structure-specific ground response spectra developed by  
6 both Drs. Blume and Newmark. Fixed base mathematical models  
7 were used in the analyses.

8 The testimony proceeds to describe the models  
9 and indicates that damping of 7 percent was utilized for the  
10 evaluation of the auxiliary building in accordance with NRC  
11 Regulatory Guide 1.61.

12 Three components of ground motion were combined  
13 on a square root of the sum of the squares basis. Torsional  
14 response was determined for both a 5 percent and 7 percent  
15 accidental eccentricity and combined with the horizontal  
16 translational response on an absolute sum and square root of  
17 the sum of the squares basis respectively.

18 The case with 5 percent eccentricity resulted in  
19 the controlling combination.

20 These methods of calculating torsion were compared  
21 with the results utilizing procedures embodied in the  
22 Uniform Building Code. The Uniform Building Code procedure  
23 consistently gave lower torsional responses.

24 The acceleration response time histories at  
25 appropriate locations in the auxiliary building were utilized



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1 to calculate floor response spectra which were, in turn,  
2 used in the seismic qualification of design Class I equipment  
3 and piping located in the auxiliary building.

4 The building has been evaluated to determine  
5 its capability to resist the revised seismic loads associated  
6 with the Hosgri dynamic analysis. The evaluation included  
7 the shear walls, floors and columns of the reinforced con-  
8 crete portion of the structure as well as the fuel handling  
9 building which is constructed of structural steel.

10 All parts of the structure were found capable  
11 of resisting the Hosgri earthquake. In addition, stability  
12 against sliding and overturning were found acceptable for  
13 the Hosgri input.

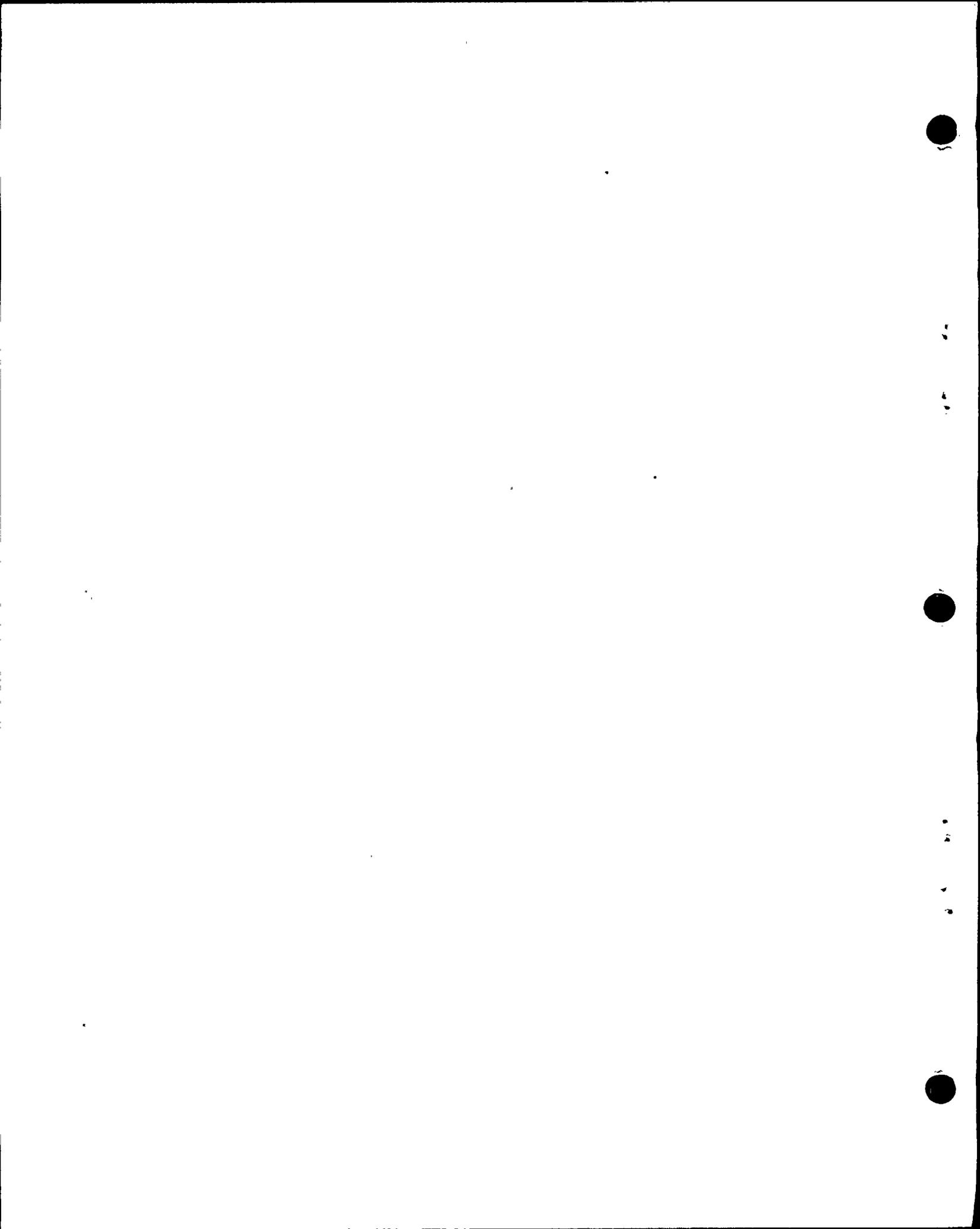
14 The evaluation of the fuel handling building for  
15 the Hosgri earthquake determined that some minor modifications  
16 would improve its seismic capability. These modifications  
17 have been implemented and the modified structure has been  
18 analyzed and found to meet the specified acceptance criteria.  
19 Minimum safety factors for significant elements of the  
20 building are shown in Tables 1 and 2 appended to the testimony.

21 That would conclude my summary.

22 Q All right.

23 Let me ask this question of all the members of  
24 the panel:

25 Do each and every one of the members of the



1 panel adopt this testimony as their own; and, if you do not,  
2 please somehow respond that you do not.

3 A (No response)

4 Q I take it by your silence, then, that you do.

5 MR. NORTON: Mrs. Bowers, at this time I would  
6 ask that this portion of the Structures Analysis, Hosgri  
7 Analysis, be placed in the record as though read.

8 MRS. BOWERS: Mr. Kristovich?

9 MR. KRISTOVICH: No objection.

10 MRS. BOWERS: Mr. Ketchen?

11 MR. KETCHEN: No objection.

12 MRS. BOWERS: Well the testimony identified,  
13 relating to the auxiliary building, will be physically inserted  
14 in the transcript as if read.

15 (Testimony on Auxiliary Building follows:)

16 INSERT  
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1 TESTIMONY OF  
2 VINCENT J. GHIO  
3 AND  
4 LINCOLN EDGAR MALIK  
5 ON BEHALF OF  
6 PACIFIC GAS AND ELECTRIC COMPANY  
7 DECEMBER 4, 1978  
8 DOCKET NOS. 50-275, 50-323

9 HOSGRI ANALYSIS AND EVALUATION OF THE AUXILIARY BUILDING

10 The horizontal seismic input to the Auxiliary  
11 Building was based on the Blume and Newmark free field  
12 ground spectra adjusted for foundation filtering. As was  
13 done for the analysis of the Containment, the horizontal  
14 components of the earthquake were conservatively taken as  
15 equal and the vertical spectrum was taken as two-thirds of  
16 the horizontal spectrum. These structure specific ground  
17 response spectra were used to derive equivalent horizontal  
18 acceleration time histories on both the Blume and the Newmark  
19 basis and an equivalent vertical acceleration time history  
20 on the Newmark basis.

21 The Auxiliary Building was analyzed using fixed  
22 base mathematical models in accordance with the current NRC  
23 Standard Review Plan. Two lumped-mass models, shown in  
24 Figures 1a and 1b, were used to analyze the building for the  
25 two horizontal components of ground motion. A lumped-mass  
26 model of the building and a finite-element model of the  
control room floor slab, shown in Figures 1c and 2, respec-  
tively, were used to analyze the building for the vertical  
components of ground motion.



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1           The mathematical models of the Auxiliary Building,  
2 as shown in Figure 1, had five lumped masses each, with two  
3 degrees of freedom at each mass point: one translational  
4 degree of freedom and one rotational degree of freedom. All  
5 degrees of freedom are defined at the center of mass.  
6 Masses 1 and 6 represent the control room concrete roof at  
7 elevation 163 ft. and the fuel-handling area steel roof at  
8 elevation 188 ft., respectively. Masses 2, 3 and 4 represent  
9 concrete floors of the Auxiliary Building at elevations 140  
10 ft., 115 ft. and 100 ft.

11           The Auxiliary Building was analyzed for damping  
12 equal to 7% according to the NRC Regulatory Guide 1.61. The  
13 concrete strength used was based on test values for the  
14 concrete taken during the construction of the Auxiliary  
15 Building with no allowance for the increase in strength  
16 associated with aging effects.

17           The translational (horizontal and vertical) masses  
18 used in the three lumped-mass models included the masses of  
19 cranes, storage tanks and other pieces of equipment as dead  
20 load and were added to the weight of the concrete floors and  
21 walls.

22           The response to the three components of ground  
23 motion was calculated separately and were combined on a  
24 square-root-sum-of-the-squares basis.

25           The torsional response due to an assumed "accidental  
26 eccentricity" was calculated from the mathematical models



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1 shown in Figures 1a and 1b. Two sets of models were developed  
2 for the north-south and east-west directions of the Auxiliary  
3 Building, one having an "accidental eccentricity" of 5% of  
4 the overall dimension of the structure, and the other a 7%  
5 "accidental eccentricity". In the case of the north-south  
6 model, shown in Figure 1a, the "accidental eccentricity" was  
7 added to the actual (geometric) eccentricity.

8           The torsional response from the 5% and 7% "accidental  
9 eccentricity" were combined with the horizontal translational  
10 response on an absolute sum and square-root-of-the-sum-of-  
11 the-squares-basis, respectively. The absolute sums of the  
12 torsional effects due to 5% eccentricity and the translational  
13 response were consistently the controlling combination. At  
14 the request of the NRC staff, the torsional responses thus  
15 determined were compared with responses using procedures  
16 outlined in the Uniform Building Code (UBC). The UBC  
17 procedure consistently gave lower torsional responses.

18           The lumped-mass model shown in Figure 1c was used  
19 to analyze the Auxiliary Building for the vertical component  
20 of the ground motion. This model is based on the assumption  
21 that the floor slabs are rigid which holds for all Auxiliary  
22 Building floor slabs except the floor of the control room.

23           The control room floor was modeled by finite  
24 elements as shown in Figure 2. The vertical input to this  
25 model was the acceleration time history determined from the  
26 lumped-mass model. This procedure gives conservative values



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1 for the responses of the control room floor slab because it  
2 uncouples the slab from the building in the analysis.

3 The acceleration response time histories at appro-  
4 priate locations in the Auxiliary Building were used to  
5 calculate floor response spectra at different elevations in  
6 the structure. These spectra were used as input motions in  
7 the analysis of Design Class I equipment and piping in the  
8 Auxiliary Building.

9 The Auxiliary Building has been evaluated to  
10 determine its capability to resist the revised seismic loads  
11 derived from the Hosgri dynamic analysis. The evaluation  
12 included the shear walls, floors and columns of the reinforced  
13 concrete portion of the structure, as well as the fuel  
14 handling building, which is constructed of structural steel.

15 A computer program was used to calculate the  
16 individual wall forces, shear stresses and areas of rein-  
17 forcing steel required for each wall.

18 Seismic input into the program were maximum absolute  
19 accelerations for each floor determined from the Hosgri  
20 dynamic analysis. In all cases, governing values from  
21 either the Newmark or Blume analysis were used. The program  
22 combines the effect of accidental eccentricity with that of  
23 actual geometric eccentricity. Accidental eccentricity as  
24 defined here is 5% of the maximum building dimension per-  
25 pendicular to direction of applied loads. Each wall was  
26 individually reviewed by comparing required reinforcing with



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1 actual in-place reinforcing and by analyzing the stress  
2 levels in the concrete. Walls that had the highest percentage  
3 of increase in response and the least reserve capacity were  
4 considered critical and were analyzed in detail.

5 No credit was taken in the original design, nor  
6 the Hosgri evaluation, for the additional structural capacity  
7 which could be obtained by considering the effects of embedded  
8 columns, the strengthening effect of perpendicular walls,  
9 and variable wall thickness. Adequate safety margins have  
10 been provided by consideration of the additional strength  
11 resulting from reinforcing quantities exceeding original  
12 design requirements and actual, rather than specified,  
13 values of material properties. Based on the findings of  
14 this review, it is concluded that the shear walls of the  
15 Auxiliary Building are adequately designed to withstand the  
16 postulated Hosgri 7.5M earthquake.

17 A comparison of the 7.5M Hosgri dynamic analysis  
18 with the DDE results was made to identify those floor slabs  
19 that have the highest percentage of increase in response and  
20 the least reserve capacity. A detailed re-evaluation showed  
21 that the slabs are adequate to withstand the 7.5M Hosgri  
22 earthquake.

23 Evaluation of all columns in the Auxiliary Building  
24 revealed that all have adequate capacity to withstand the  
25 7.5M Hosgri earthquake.

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1           In addition, stability against sliding and over-  
2 turning was found acceptable for the Hosgri input.

3           The evaluation of the Fuel Handling Building for  
4 the Hosgri earthquake determined that some minor modifications  
5 would improve its seismic capability. This structure, as  
6 originally constructed, has short, relatively rigid columns  
7 on one side and at both ends. The ends are quite heavily  
8 braced. These conditions cause an uneven distribution of  
9 seismic forces with a large portion of the earthquake load  
10 taken by the more rigid portion of the structure. To relieve  
11 these conditions, certain connections were modified by  
12 providing slotted holes which allow the structure to deflect  
13 uniformly throughout its length. These modifications,  
14 together with the addition of some bracing members, have  
15 been implemented. The modified structure has been analyzed  
16 and found to meet the specified acceptance criteria. Minimum  
17 safety factors for concrete and structural steel elements  
18 are shown in Tables 1 and 2, respectively. As used here,  
19 the term minimum applies to a singular element of each type  
20 listed, such as a wall, which exhibited the lowest factor of  
21 safety for that type element. For example, of the approxi-  
22 mately 170 walls in the auxiliary building only one has the  
23 factor of safety of 1.1 as listed in Table 1; the others  
24 have higher factors of safety.



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TABLE 1

**AUXILIARY BUILDING  
STRUCTURAL CONCRETE ELEMENTS  
MINIMUM FACTOR OF SAFETY**

<b>ELEMENT</b>	<b><u>MINIMUM</u> FACTOR OF SAFETY</b>
<b>Walls</b>	<b>1.1</b>
<b>Floors</b>	<b>1.5</b>
<b>Columns</b>	<b>1.5</b>
<b>Beams</b>	<b>1.4</b>
<b>Spent Fuel Pool</b>	<b>2.0</b>



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TABLE 2

**AUXILIARY BUILDING  
STRUCTURAL STEEL ELEMENTS  
MINIMUM FACTOR OF SAFETY**

ELEMENT	<u>MINIMUM</u> FACTOR OF SAFETY
Fuel Handling Crane Support Structure (MODIFIED)	1.3
Fuel Racks	1.2
Spent Fuel Pool Liner	2.0
Cable Tray Seismic Supports	1.1



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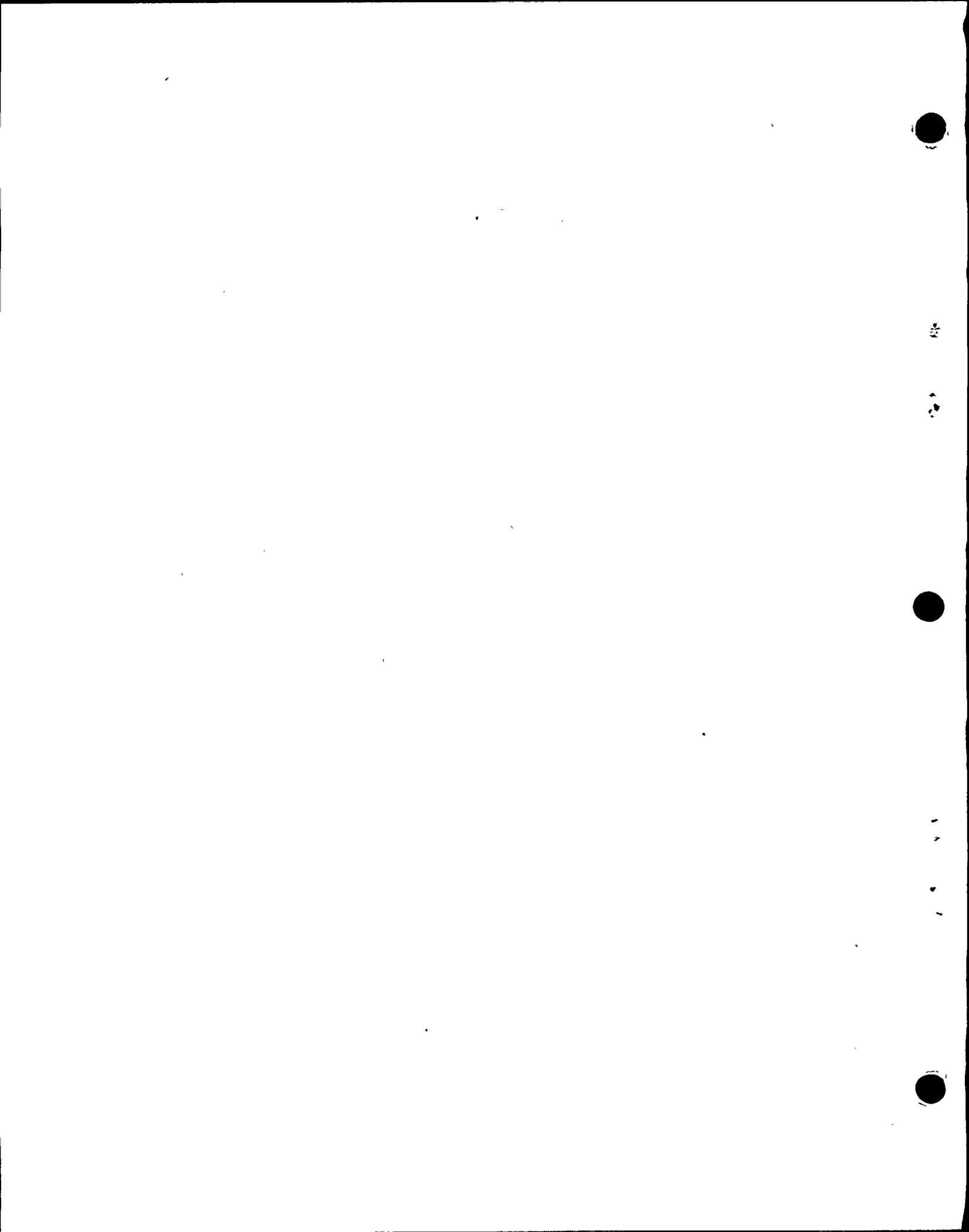
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**TABLE 3**

**AUXILIARY BUILDING  
OVERALL STABILITY  
FACTORS OF SAFETY**

<b>CONDITION</b>	<b>FACTOR OF SAFETY</b>
<b>Bearing</b>	<b>3.8</b>
<b>Sliding</b>	<b>1.5</b>
<b>Overturning</b>	<b>2.4</b>







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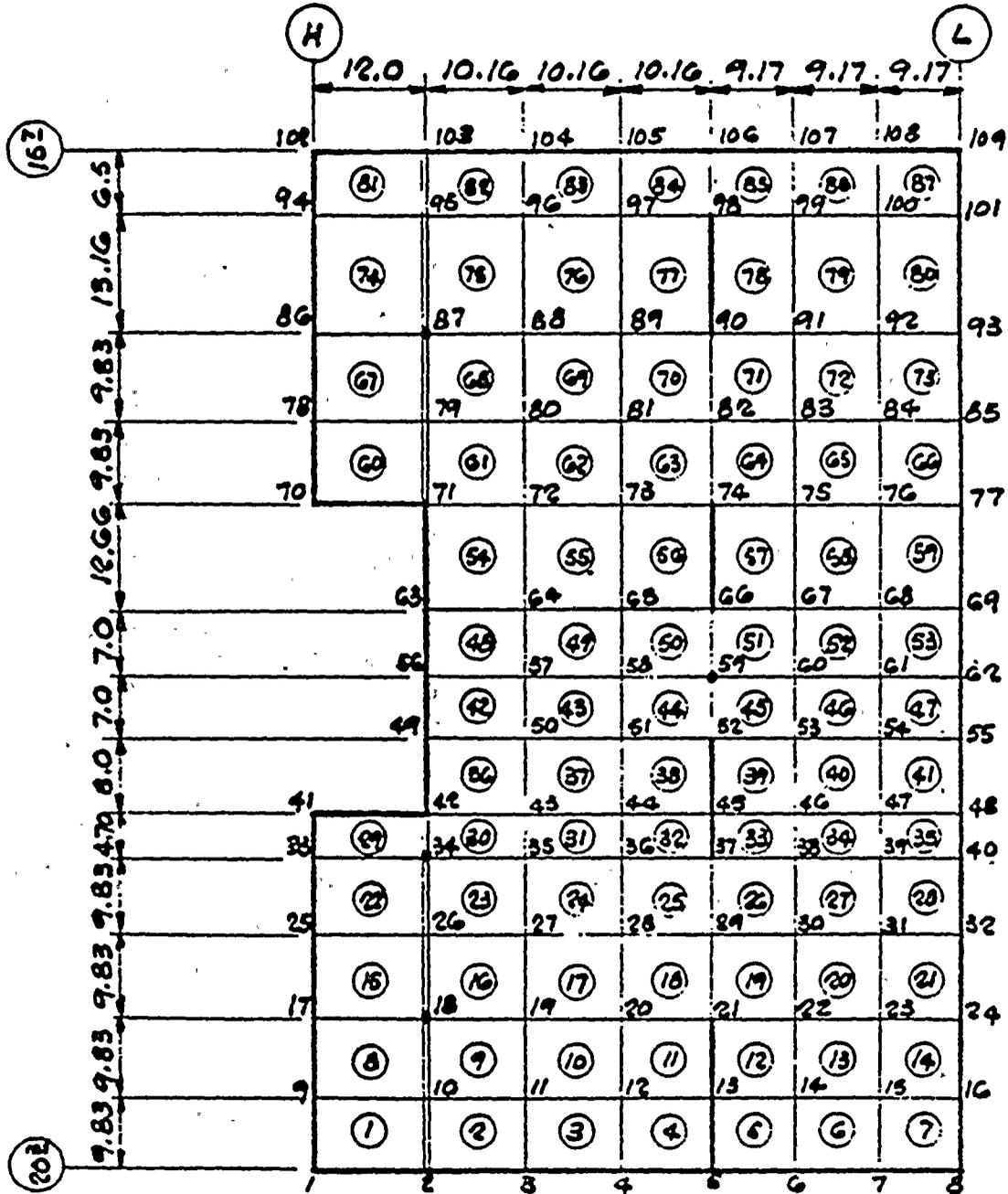
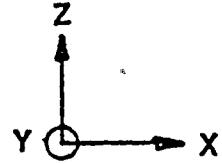
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LEGEND

- 72 NODE NUMBER
- (28) FINITE ELEMENT NUMBER
- WALL SUPPORT
- COLUMN SUPPORT
- STIFF BEAM



AUXILIARY BUILDING — FINITE ELEMENT MODEL OF CONTROL ROOM FLOOR SLAB

DIABLO CANYON NUCLEAR POWER PLANT

FIGURE NO. 2



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1 MR. NORTON: That concludes the direct, and we  
2 would pass the panel on for cross-examination.

3 MRS. BOWERS: Before we start with Mr. Kristovich's  
4 cross-examination we'll take a ten-minute recess.

5 (Recess)

6 MRS. BOWERS: Mr. Kristovich, are you ready to  
7 begin?

8 CROSS-EXAMINATION

9 BY MR. KRISTOVICH:

10 Q Dr. Malik, will you turn to page 1 of the written  
11 testimony, please, at line 9? --or Mr. Ghio.

12 By "spatial averaging of accelerations" do you  
13 mean the tau effect?

14 A (Witness Ghio) Yes.

15 Q And the adjustment for the tau effect after the  
16 peak acceleration of 1.15 had already been reduced to .75g?

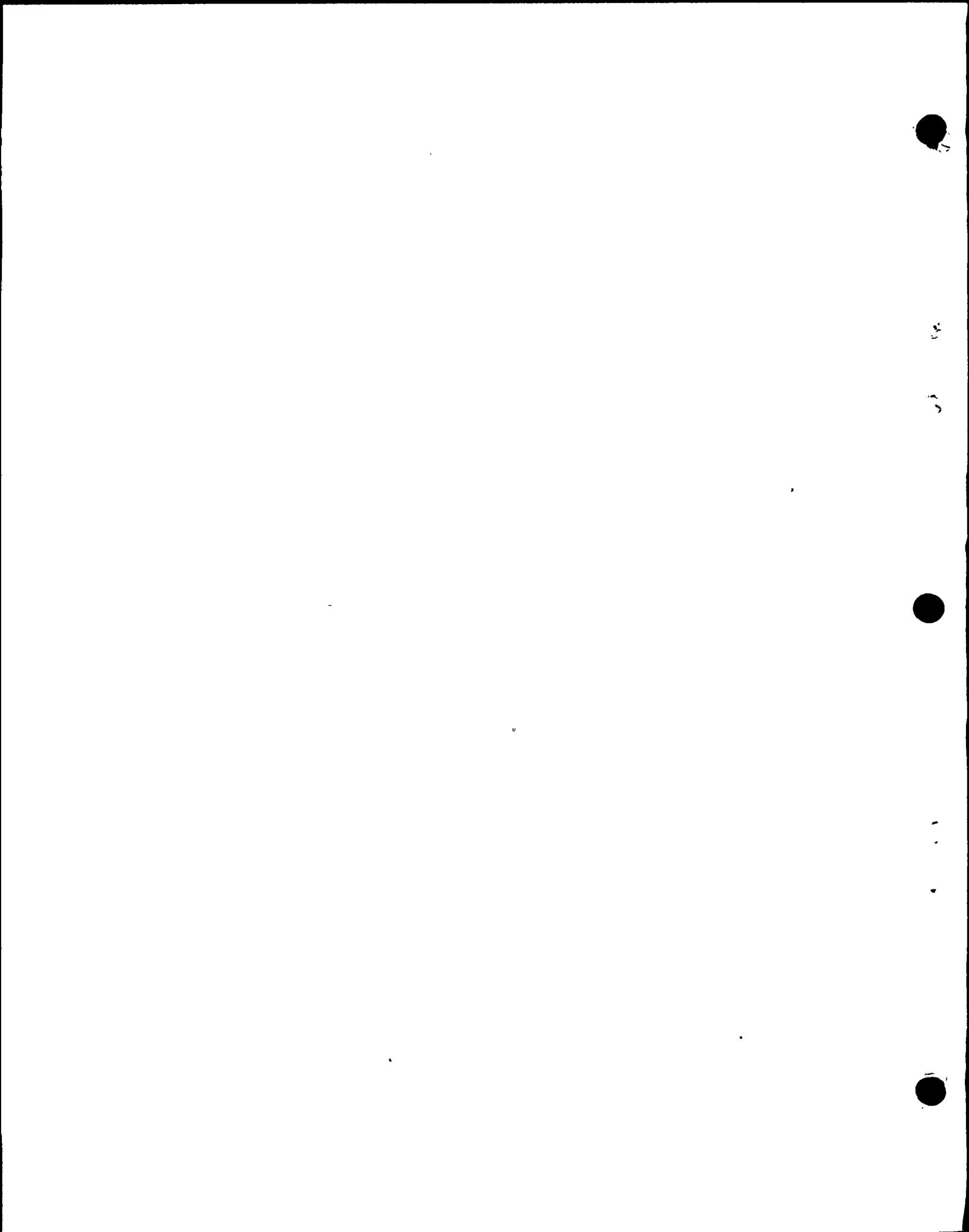
17 A Yes.

18 Q And what was the adjustment that was done for  
19 both the Blume spectra and the Newmark spectra?

20 A I happen to have it here for the Blume spectra,  
21 I believe, and it was -- the zero period acceleration is .63g.

22 Q So it was then reduced--

23 MR. NORTON: Excuse me, Mrs. Bowers. If we refer  
24 to the table on page 43 of Dr. Blume's testimony for the  
25 containment, all the buildings are listed there. I don't



1 understand why we have to ask and drag out each one, why it  
2 can't just be read in the record? I mean, they already are  
3 in the record.

4 If we're going to do this for each building like  
5 we just did, we're going to be here with this panel for  
6 another full day.

7 MR. KRISTOVICH: Mrs. Sowers, I'm just trying to  
8 make a tidy record. I only have two or three questions on  
9 this. It would take only two minutes.

10 MR. NORTON: I'll withdraw the objection. I would  
11 just like to speed things up.

12 BY MR. KRISTOVICH:

13 Q So, then, Mr. Ghio, the reduction for the Blume  
14 spectra was .12g, which was approximately 16 percent?

15 A (Witness Ghio) That's correct.

16 Q And do you have the reduction for the Newmark  
17 spectra?

18 A For the Newmark spectra the reduction was to .55g.

19 Q .75 was reduced to .55g?

20 A Correct.

21 Q So it was reduced approximately 27 percent?

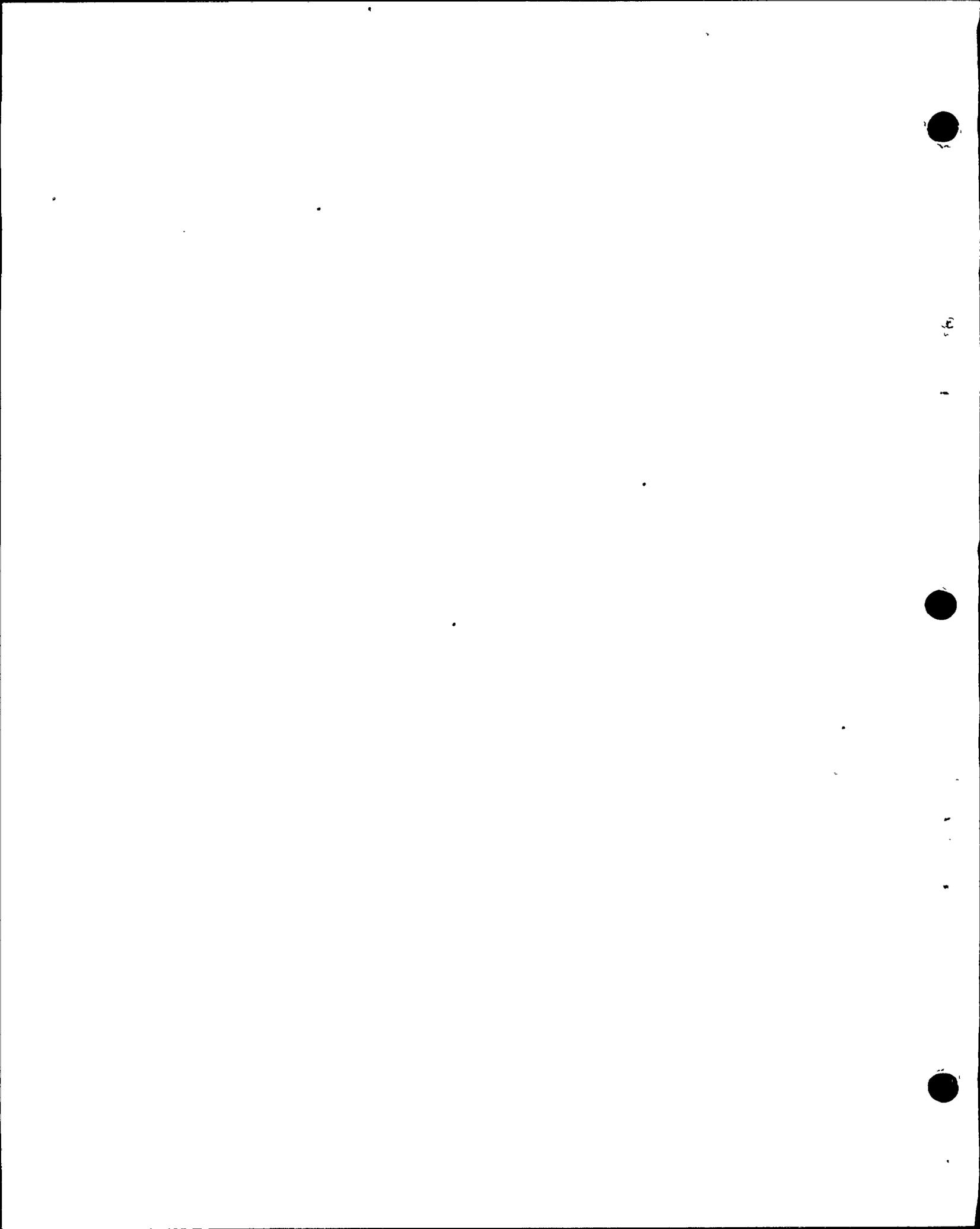
22 A (Witness Blume) Only at the zero period.

23 Q Correct.

24 Now, Dr. Malik, directing your attention to page 1,  
25 lines 22 and 23, how did the lumped-mass model account for the

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1 soil properties?

ARB/wb3

2 A (Witness Malik) It has nothing to do with  
3 the soil properties, the lumped-mass model or other model.  
4 It's a fixed base model anyway.

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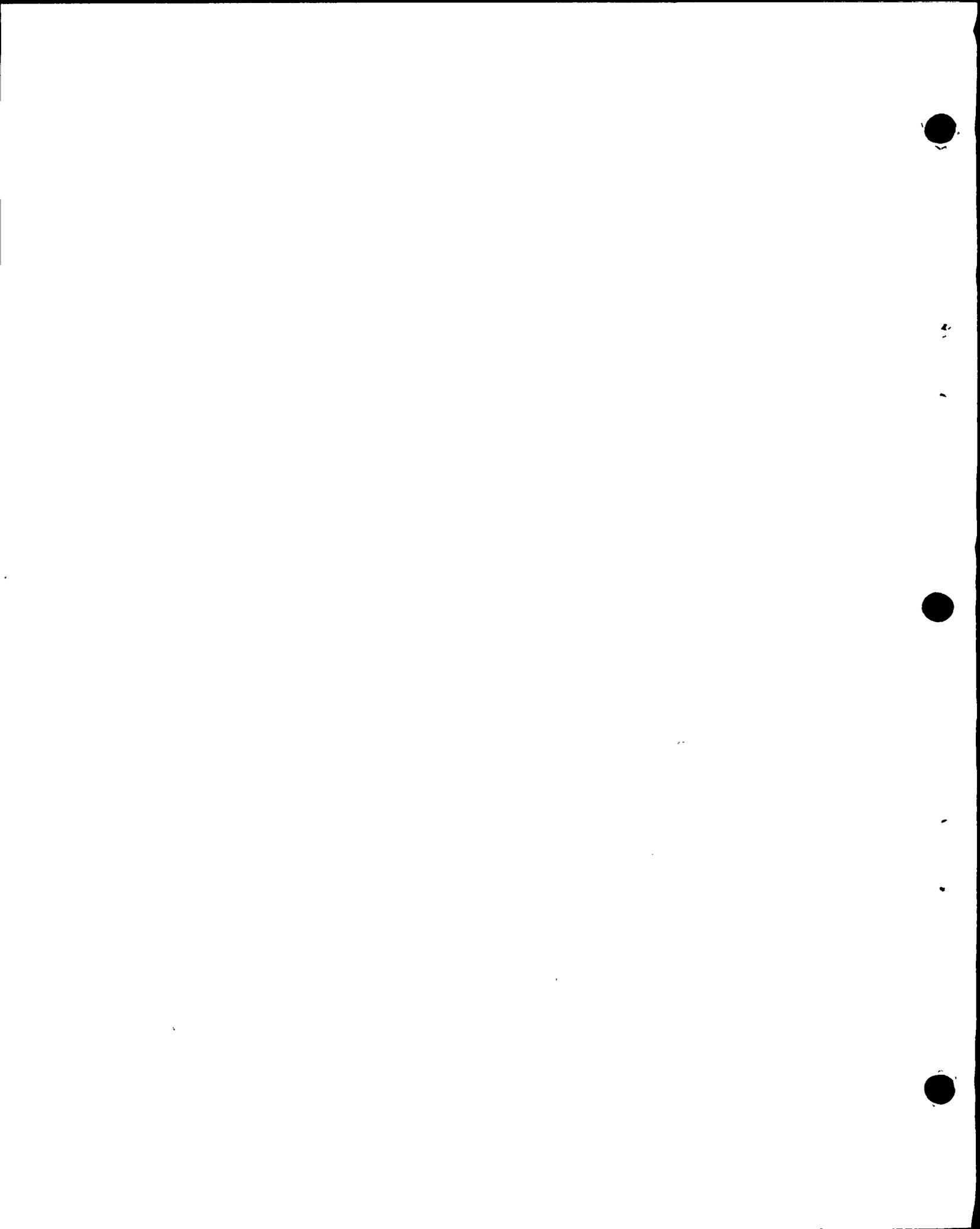
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1 Q . . . Could you define a lumped-mass model?

2 A Yes. This is where you select the loads -- the  
3 elevations through the building, at which point you lump all  
4 the tributary mass at that point. And between these masses  
5 you put massless elements; in this case they were beam  
6 elements that represent the stiffness of the building. So  
7 the mass of the building is concentrated at several nodes which  
8 are connected by elements that represent the stiffness of the  
9 building.

10 Q Mr. Sokoloff, did you do an OBE analysis for the  
11 auxiliary building?

12 A (Witness Sokoloff) I did not do it because OBE  
13 analysis was done before my responsibility for the auxiliary  
14 building.

15 Q Is any member of the panel familiar with the OBE  
16 analysis for the auxiliary building?

17 (No response.)

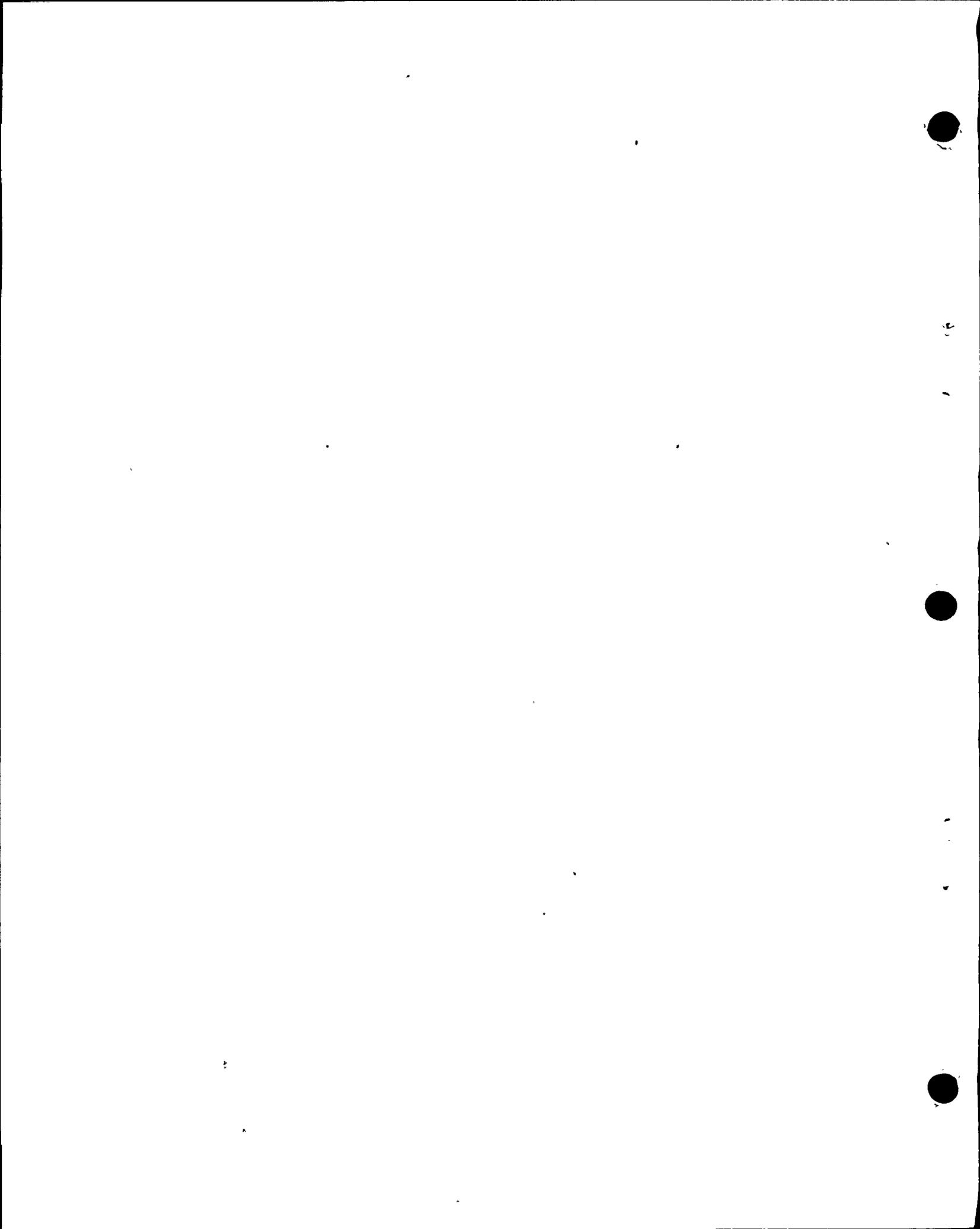
18 A (Witness Sokoloff) I am familiar with the OBE.  
19 I did not do it, but I am familiar with them.

20 Q Well, Mr. Sokoloff, do you know where the OBE  
21 analysis was limiting or controlling?

22 A In the auxiliary building, in row 30.

23 Q Was a vertical dynamic analysis made for the OBE?

24 A No, it was not made. However, in '71 was amplifi-  
25 cation factor used of 1.35.



WRB/mpbZ

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Q And what is the basis for the 1.35?

3

A Because previous response engineer decided it will be very proper to use amplification factor.

4

Q What was multiplied by 1.35?

5

A Usually if you have .2 multiplied by two-thirds, you get .13, right? In this case we use .18.

7

Q And why was that number used?

8

A Because that was the decision of the previous responsible engineer.

10

Q And do you know the basis of their judgment?

11

A Yes, I do. Because the expected amplification.

12

Q I'm sorry, the expected what?

13

A He expect amplification.

14

Q More amplification?

15

A Yes, amplification.

16

Q Mr. Ghio, directing your attention to page 3 of the written testimony, lines 20 through 22, you state:

18

"This modal is based on the assumption that the floor slabs are rigid which holds for all Auxiliary Building floor slabs except the floor of the control room."

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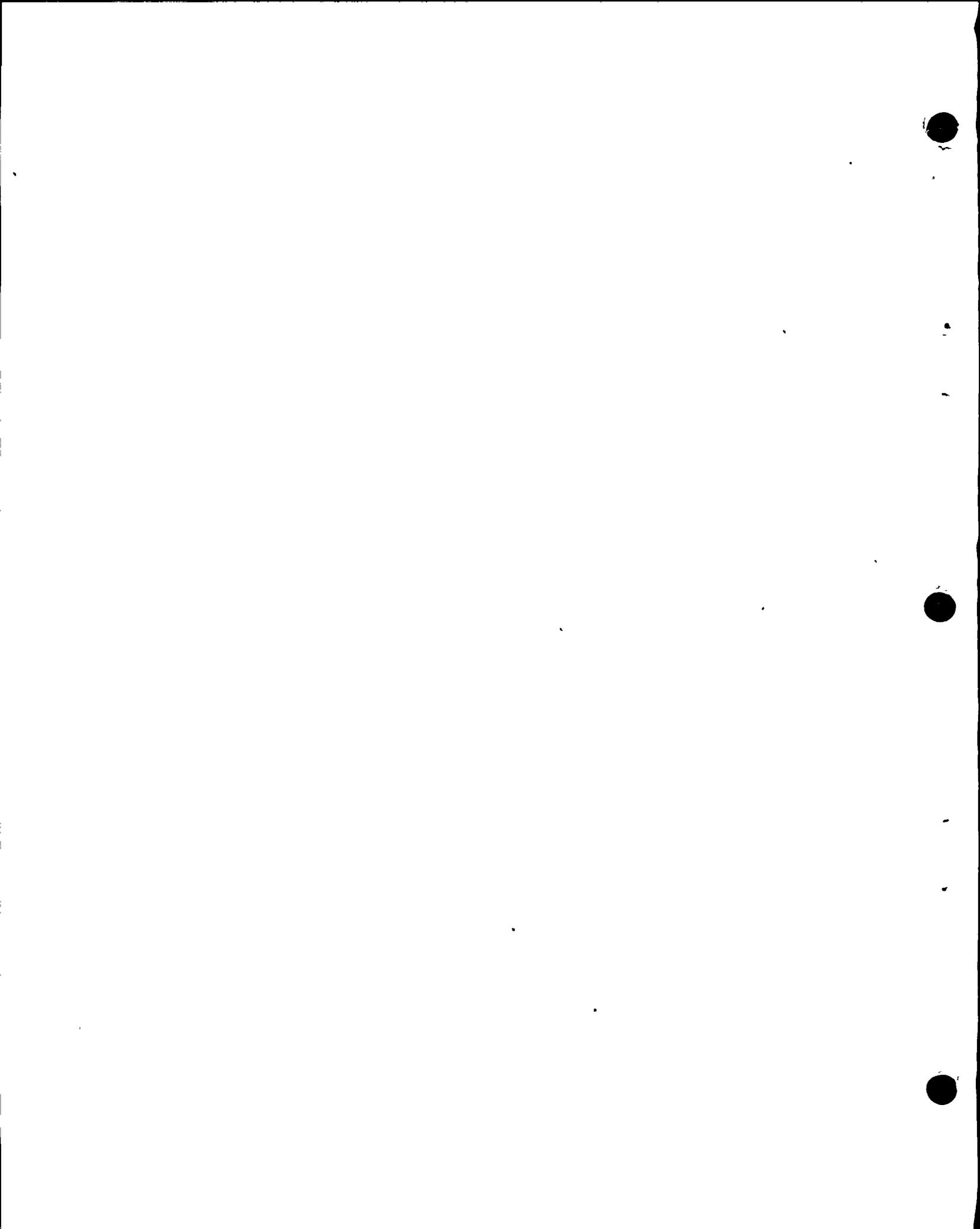
What's the basis for that assumption?

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A (Witness Ghio) Well, I think it may in fact be more than just an assumption. I believe we calculated the frequencies of the floor slabs in the building and found them



WRB/mpb3 1

2 to fall in the rigid category with the exception of the floor  
3 of the control room. And the testimony goes on to relate  
4 that we did a more refined analysis that incorporated the  
5 fact that the control room floor was determined not to be  
6 rigid.

7 Q So when you state "assumption" here, it was  
8 really based on analysis?

9 A (Witness Malik) I wrote that, and the reason I  
10 said "assumed" is because theoretically nothing is rigid  
11 unless it is infinite, as a frequency which approaches infinity.  
12 And the NRC guides say that anything over 33 hertz can be  
13 assumed to be rigid. And that's why I used the word "assumed"  
14 that it is rigid.

15 In reality there is nothing that is really  
16 absolutely rigid in the physical world.

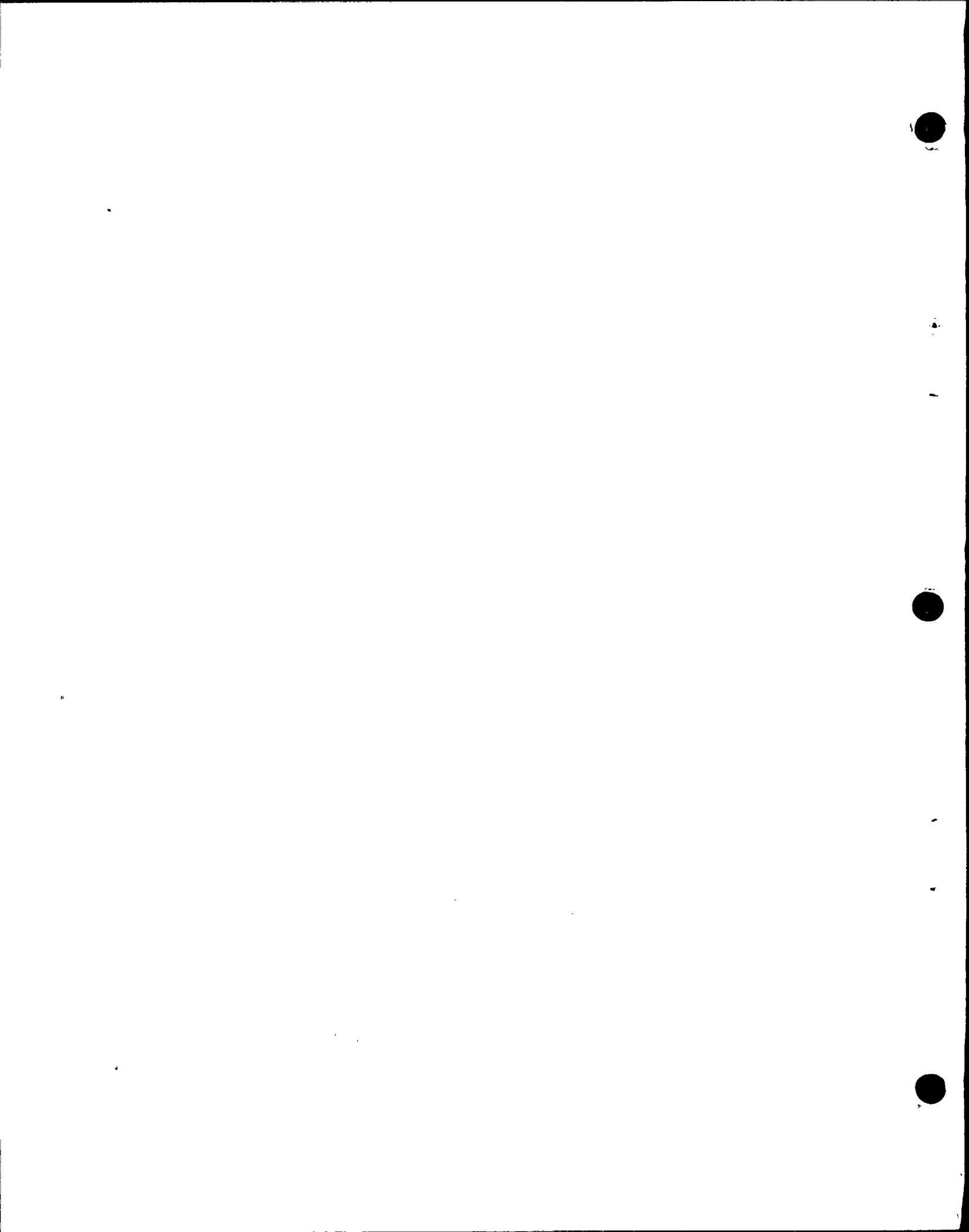
17 Q Mr. Ghio, turning to page 6 of the written testi-  
18 mony, at line 23 you used the term "factor of safety".

19 Could you define "factor of safety"?

20 A (Witness Ghio) Yes.

21 I think in this particular, we're referring to a  
22 Table 1 where these factors minimum, emphasize minimum factors  
23 of safety are delineated. And, as I recollect, that factor  
24 of safety was determined simply by dividing the allowable load  
25 or stress by the actual load or stress.

Q Well, is the yield stress you're using based on



WRB/mpb4 1

actual material stress?

2 A Yes.

3 As I believe I cited in the summary of my testimony,  
4 or if not, certainly it's within the prepared testimony,  
5 averages of actual material properties were utilized in deter-  
6 mining the allowable stresses in keeping with the specifica-  
7 tion that was formulated for the Hosgri evaluation.

8 Q Well, for the concrete used in Table 1, by how  
9 much did the actual allowable exceed the code allowable?

10 A (Witness Malik) I'll answer that.

11 Again, there is no such thing as a code allowable,  
12 a number that is code allowable. I don't really know what  
13 you're referring to.

14 Q Well, how are you using the term "allowable"?

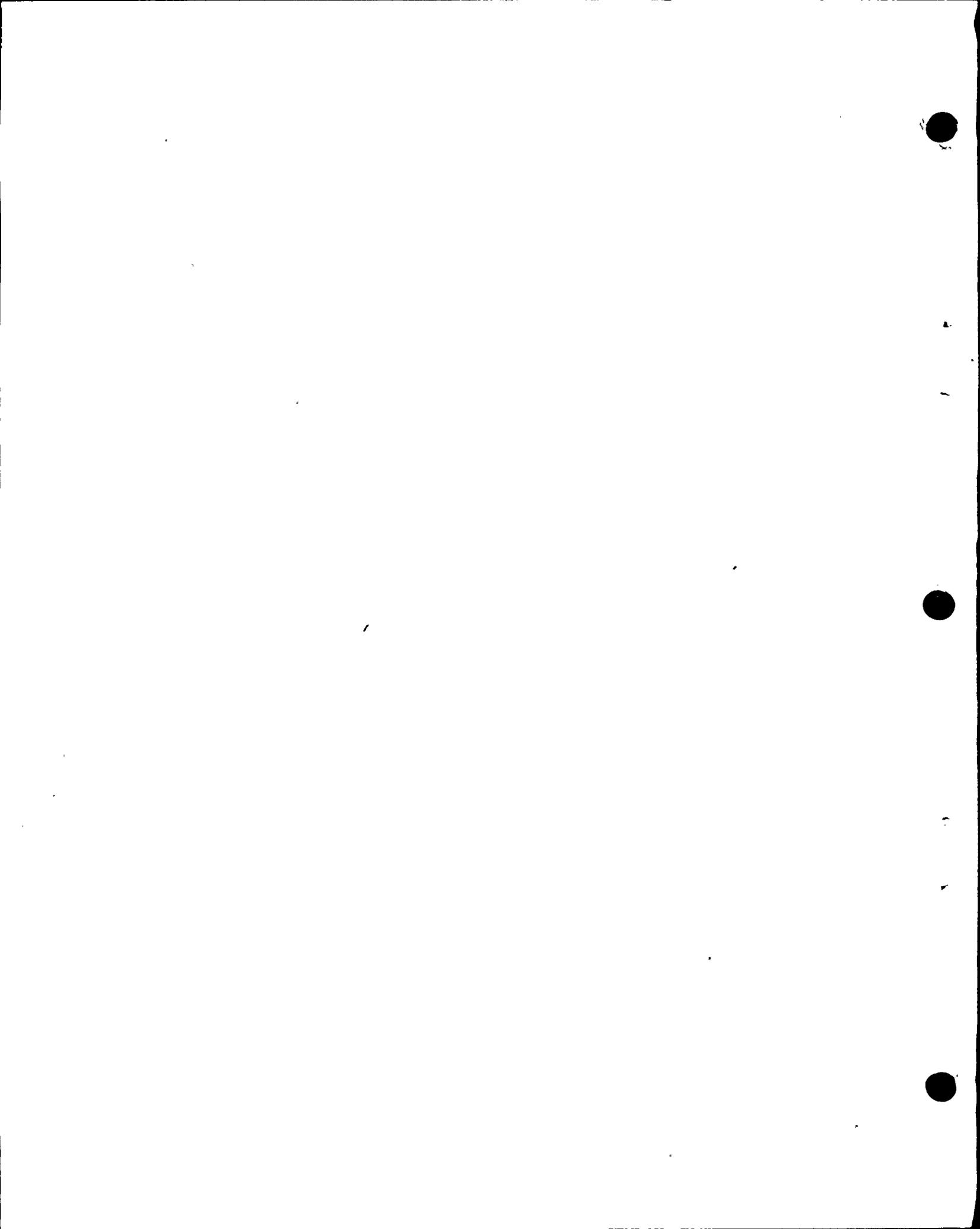
15 MR. NORTON: Object.

16 Mrs. Bowers, we went into the same thing with  
17 the prior panel when we got into his code numbers. Counsel  
18 keeps asking questions as if there were numbers in a code and  
19 the witness keeps telling him there are no numbers in the code  
20 as allowables. And until Counsel gets that straight, those  
21 questions are objectionable. They are misleading.

22 MRS. BOWERS: Mr. Kristovich, do you want to  
23 respond to that?

24 DR. MARTIN: The question was asked and answered.

25 MR. NORTON: Well, the second question wasn't



RB/mpb5 1 answered.

2 MR. KRISTOVICH: What is the second question?  
3 Do I want to respond, is that the second question?

4 MR. NORTON: No, the second question you asked  
5 was the one I objected to. Mr. Malik had not responded to  
6 that question.

7 MRS. BOWERS: There's an objection pending. Do  
8 you want to respond to the objection?

9 MR. KRISTOVICH: I'm contemplating a response.

10 (Pause.)

11 MR. KRISTOVICH: Well, Mrs. Bowers, as I under-  
12 stand it, in the codes there are definitions for minimum  
13 acceptable strengths for various materials such as concrete,  
14 and there are also factors given for yield, for example the  
15 .95 Mr. Hanusiak mentioned when he was on the stand. And  
16 also in Tables 1, 2 and 3 of the Chic and Lang testimony I  
17 believe factors are mentioned.

18 MR. NORTON: Are you referring to the tables  
19 concerning factors of safety?

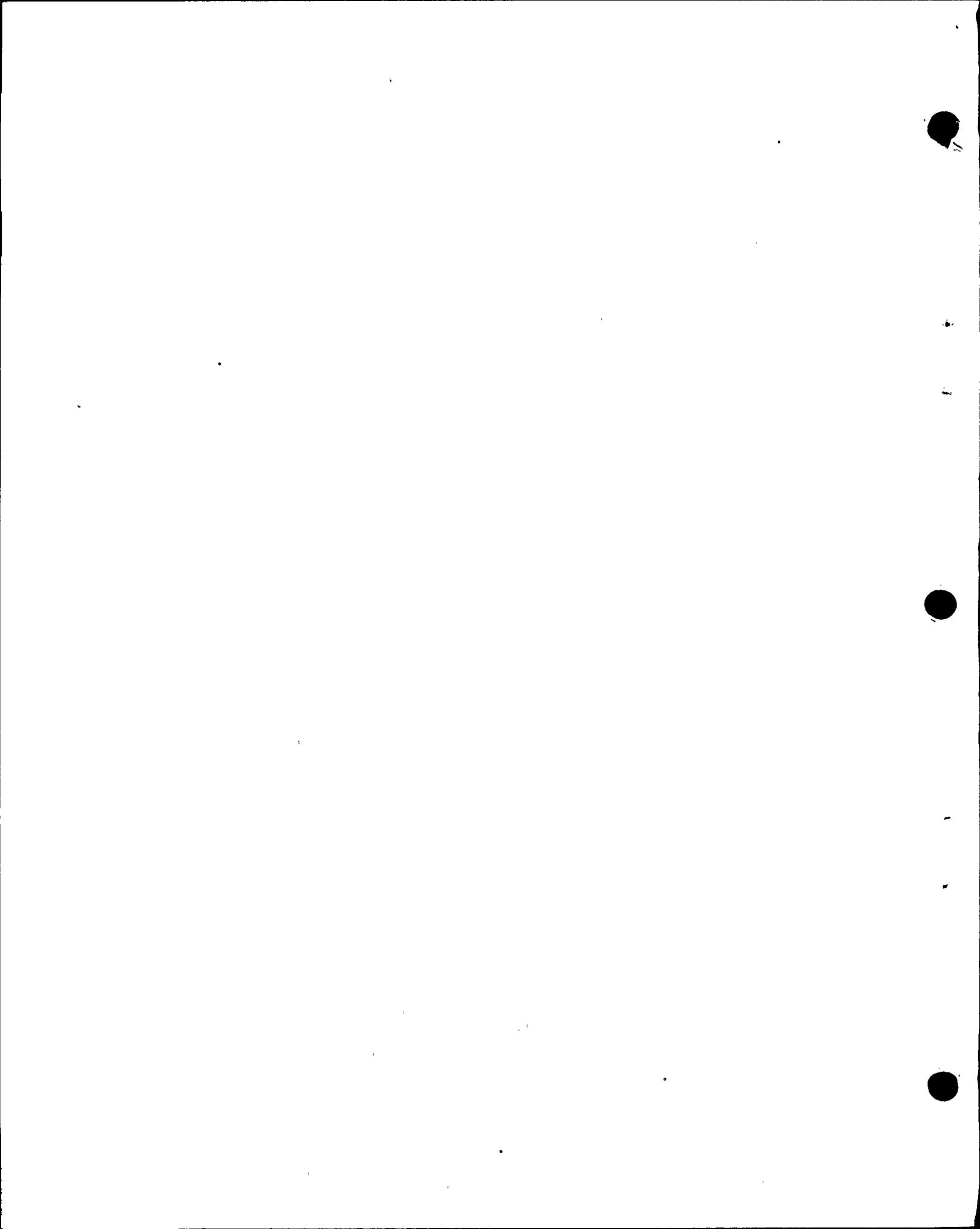
20 MR. KRISTOVICH: Calculating stresses.

21 MR. NORTON: What tables?

22 MR. KRISTOVICH: For the intake structure.

23 MR. NORTON: I'm sorry, I thought we were talking  
24 about the auxiliary building.

25 MR. KRISTOVICH: I'm responding to your objection.



RB/mpb6 1 MRS. BOWERS: Well, the objection was based on  
2 the use of the word "allowable". Does the code "allow"  
3 certain things.

4 MR. KRISTOVICH: What I'm saying, Mrs. Bowers,  
5 is....

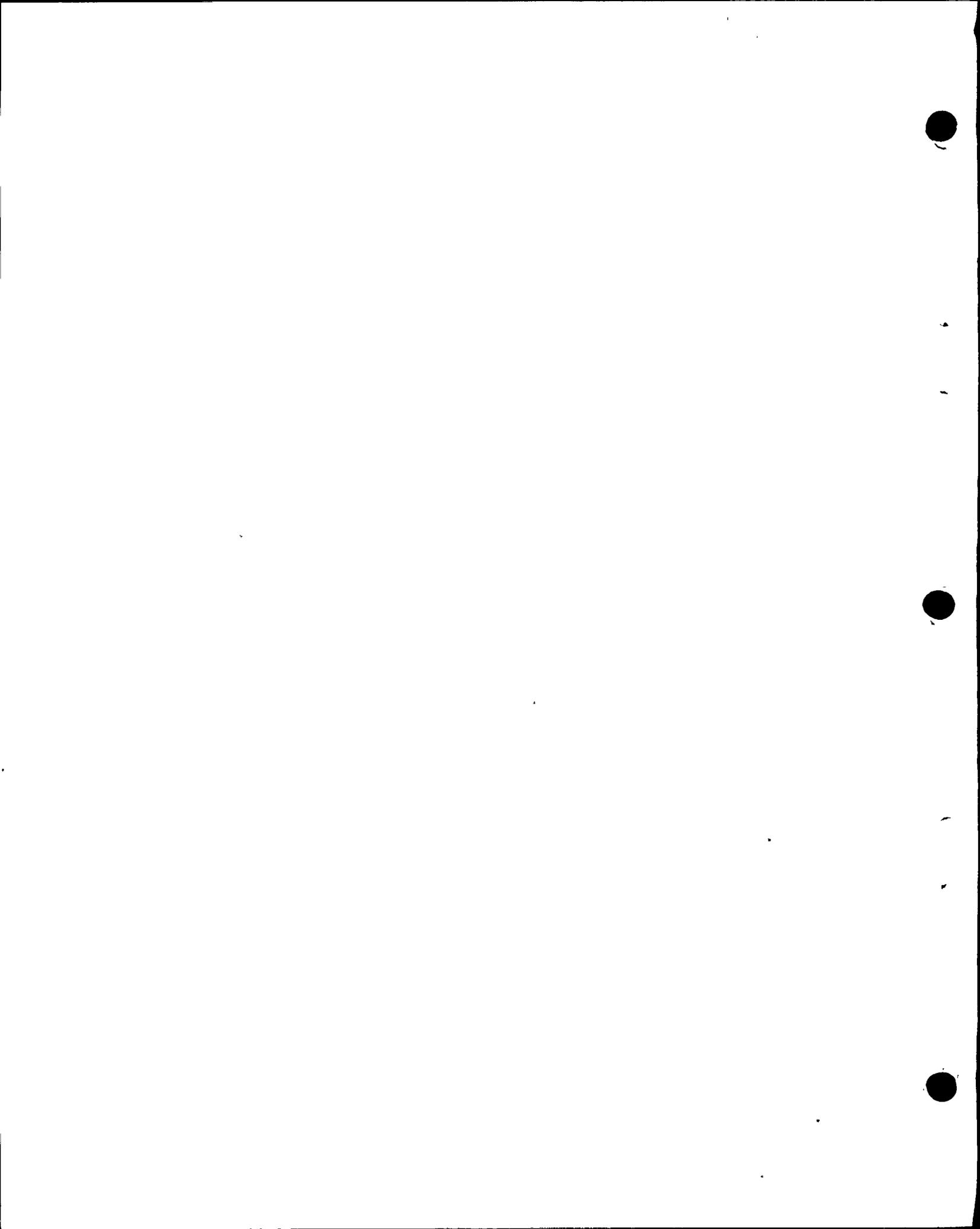
6 (The Board conferring.)

7 MR. NORTON: The problem is Mr. Kristovich's  
8 questions -- and he was corrected this morning by Mr. Malik --  
9 about code numbers, and Mr. Kristovich is again using code  
10 numbers. And Mr. Malik again corrected him. And as long as  
11 Mr. Kristovich is operating under the misconception that  
12 the code yields numbers like 60 or 67 or some of the numbers  
13 he was using this morning, or 57, and Mr. Malik says that's  
14 not the case. So those questions are misleading.

15 And he just keeps asking them about code numbers  
16 and I just think we ought to have that clear. I find it very  
17 confusing when he asks a question and he says a code number,  
18 and obviously the witness does too.

19 MRS. BOWERS: Well, but Mr. Kristovich, in argument  
20 on the objection, has stated there are minimum figures stated  
21 and then there are factors that can be applied to those.

22 MR. NORTON: Well, Mr. Kristovich is not a witness,  
23 and I don't think that's true. I disagree with what Mr.  
24 Kristovich is saying, and I think Mr. Malik can explain what  
25 the codes are.

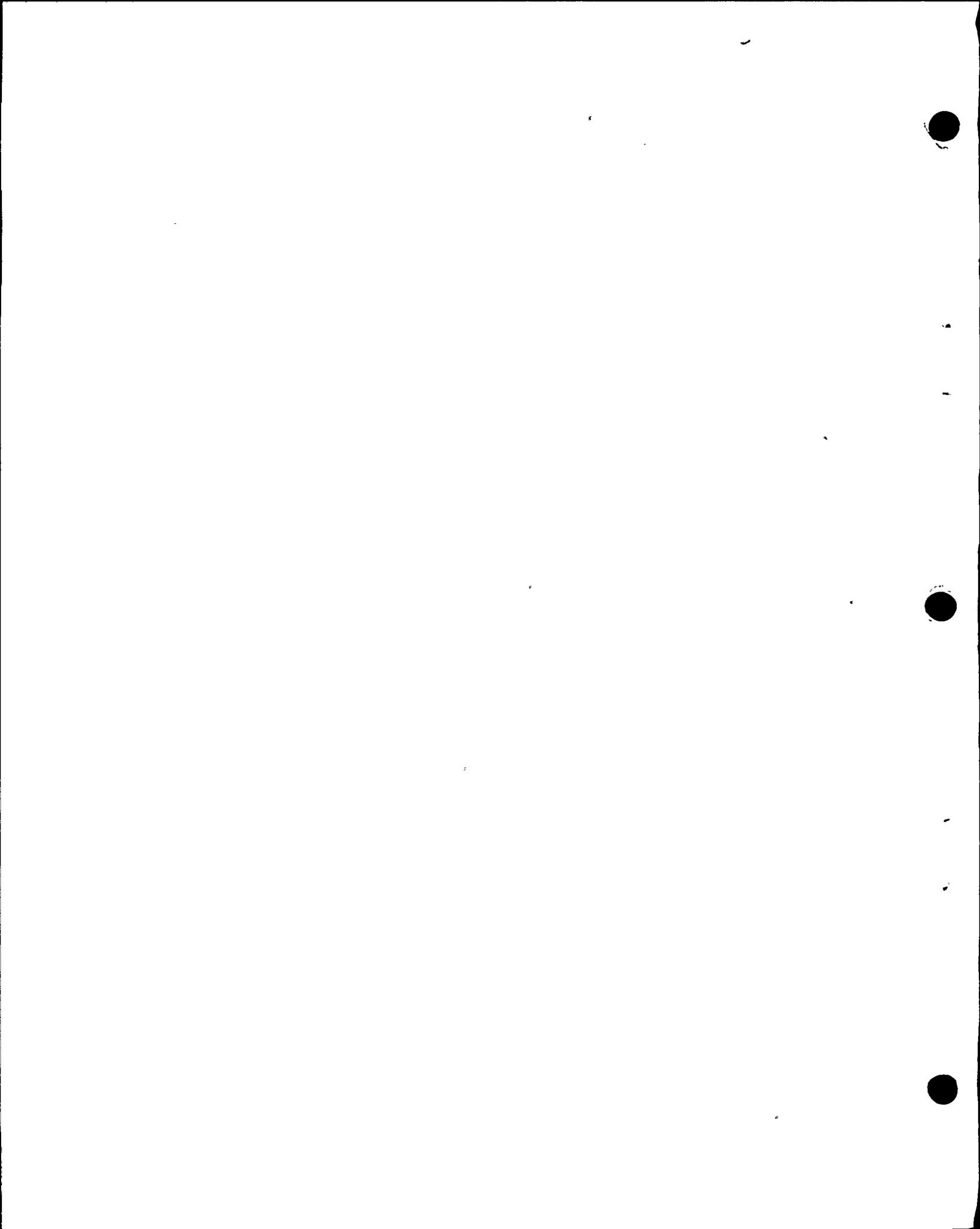


WRB/mpb7

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Maybe that's what wa ought to do, is to have the witness explain what the codes are instead of Mr. Kristovich.



WRB 1G -  
wel

1 MR. KRISTOVICH: Mrs. Bowers, on page 320 of  
2 SER 7 it states that:

3 "In the original analysis code specified  
4 minimum standards were used in accordance with  
5 standard practice."

6 And that's what we're getting at, what would the  
7 answers for these values be if they had used code specified  
8 minimum values in accordance with standard practice.

9 MRS. BOWERS: Does the Staff have a position in  
10 this matter?

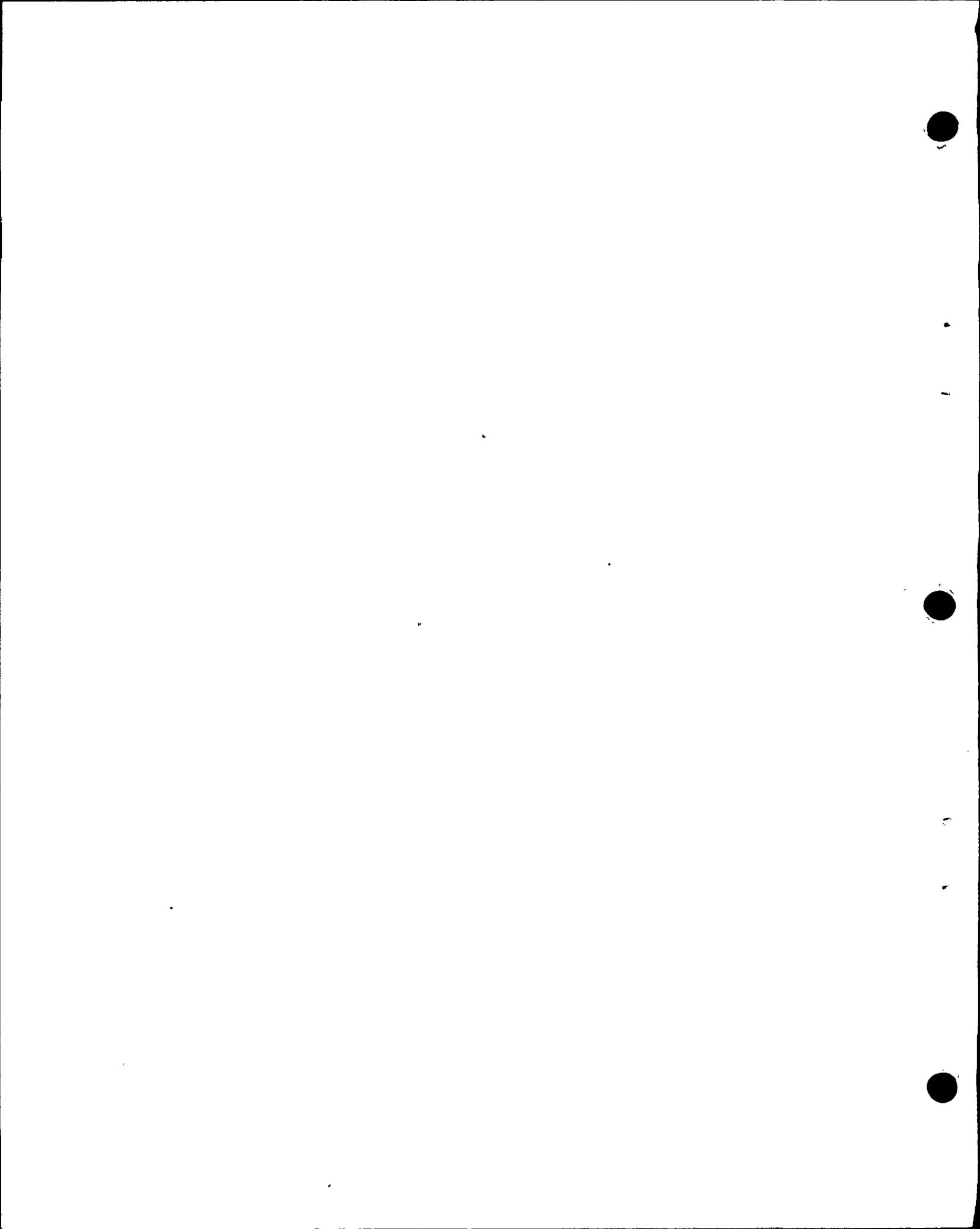
11 MR. NORTON: Mrs. Bowers, I'll withdraw the  
12 objection if the question will be asked to Mr. Malik to  
13 explain the codes, because I don't think Mr. Kristovich  
14 understands it, and I think the questions are misleading  
15 because of the misunderstanding.

16 MRS. BOWERS: Mr. Kristovich, will you proceed  
17 by asking the witness to explain the code, and then maybe  
18 we'll all understand it.

19 BY MR. KRISTOVICH:

20 Q Now, Dr. Malik, or Mr. Ghio, do you know what is  
21 meant by the statement in SER Number 7 on page 3-20 -- and I  
22 quote:

23 "In the original analysis code specified  
24 minimum values were used in accordance with standard  
25 practice."



wel 2

1 A (Witness Ghio) I can make my interpretation of  
2 what --

3 MRS. BOWERS: Is your microphone on?

4 WITNESS GHIO: I believe it is.

5 I believe that reference in the SER number 7 is  
6 talking about does specify minimum material strengths, and  
7 we have utilized the average actual material strengths based  
8 on tests.

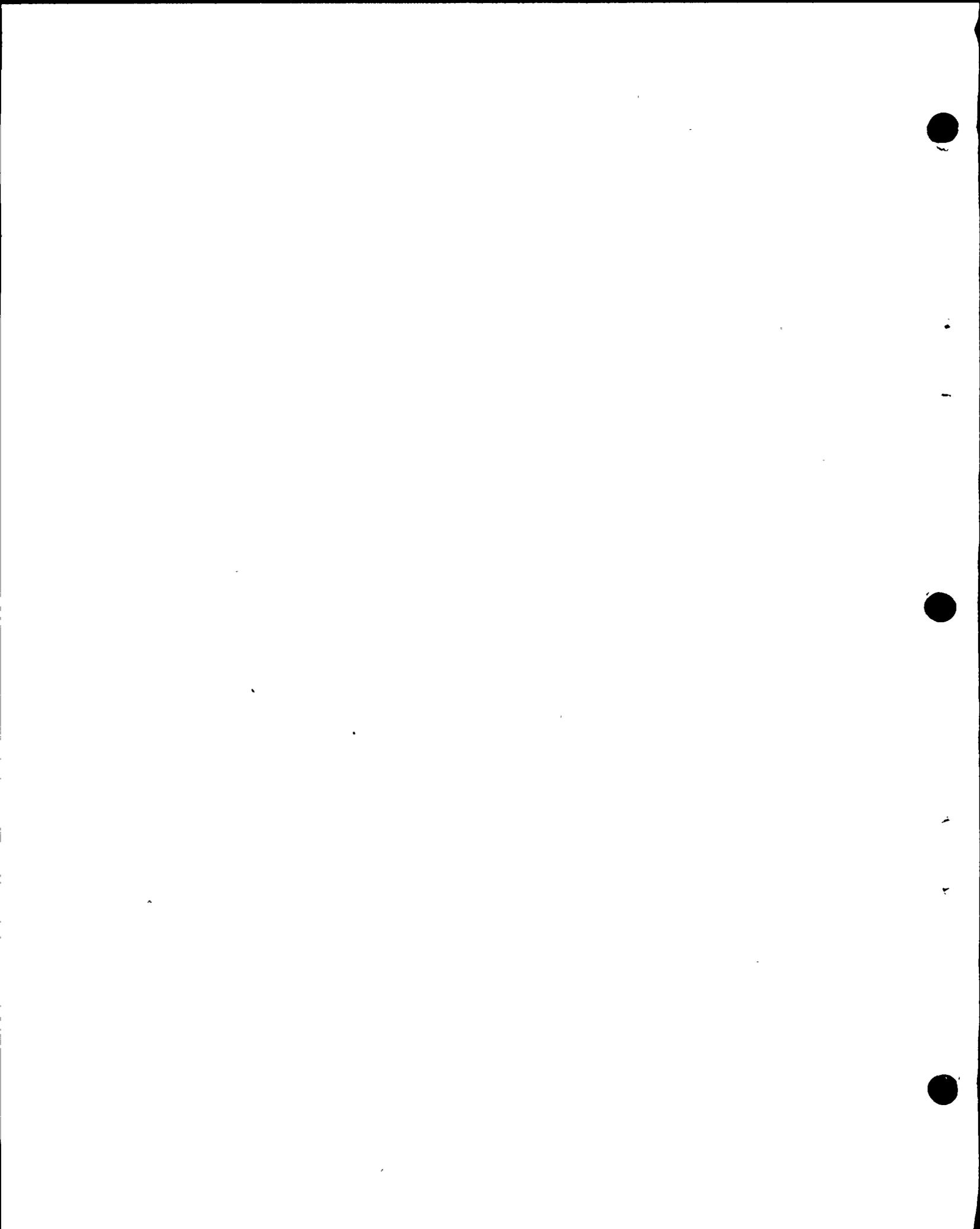
9 BY MR. KRISTOVICH:

10 Q So there are minimum specified material strengths  
11 in the code?

12 A (Witness Ghio) That's not in the code. That's  
13 in what I will call a standard. ASTM, American Society of  
14 Testing Material Standards, that cover such things as  
15 concrete and steel. And it's in those standards that are  
16 utilized when you specify the procurement of the material at  
17 the inception of the job that delineate minimum acceptable  
18 strengths, for example, of those materials.

19 A (Witness Malik) Let me explain one thing. You  
20 see, when you come up to design a structure the engineer  
21 before it's constructed will specify something like the  
22 concrete. You specify that I want 3,000 psi concrete or  
23 4,000 psi, or 5,000 psi. This is up to the discretion of the  
24 designer.

25 Now, during construction what that means is that



wel 3

1 the person who has supplied you the concrete has to supply  
2 concrete that at least has that strength. It can be more.

3 Now, the code then comes and says --

4 Q Which code?

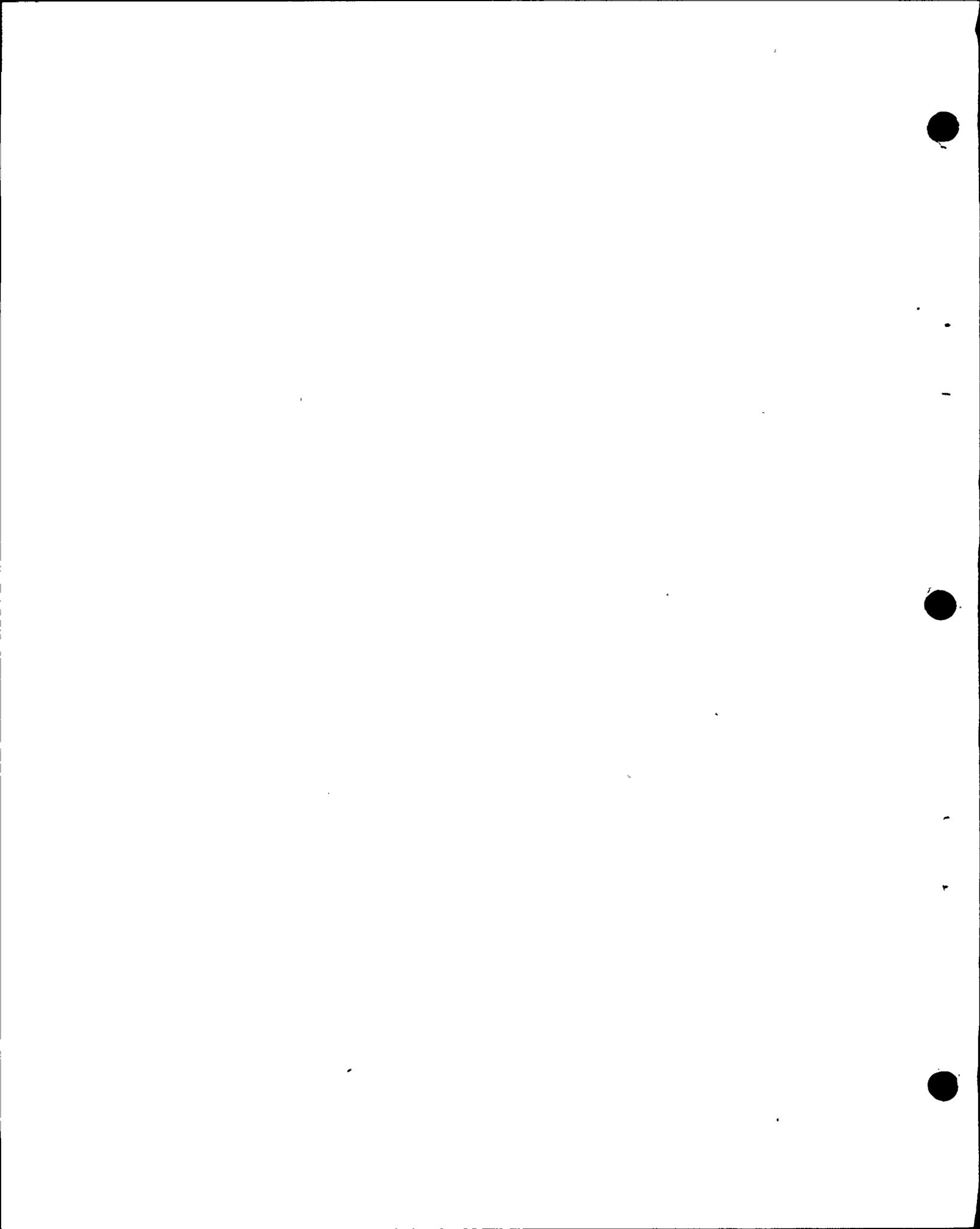
5 A The codes, whether you're talking about the ACI,  
6 the USC, the building code. They will come and say if you  
7 have specified 5000 psi concrete, then the allowable will be  
8 95 percent of that, and so on.

9 So the code does not give a number, because it  
10 doesn't know whether you're going to specify a 1000 psi  
11 concrete or a 5000 psi concrete. It just tells you once you  
12 have specified how much allowable you can use.

13 Now, in our case, since the structure has  
14 already been built we already know what the actual strength  
15 as supplied was. We don't have to go by the minimum that  
16 was specified.

17 And then once we take the actual strength,  
18 we still apply the code procedures. For instance, if you  
19 look in the table, the margins of elasticity, the way we  
20 calculate that is exactly as the code recommends they be  
21 calculated. We take the actual strength and from that we  
22 calculate the margins of elasticity, which is the primary  
23 factor that we need for our analysis.

24 So when you say a number, the code doesn't say  
25 concrete shall be 2500. It can't, because it can be any



wel 4

1 strength you design it to be.

2 A (Witness Blume) Let me add to that, and I think  
3 you will get a clarification.

4 I'm not changing what Lincoln said, I'm endorsing  
5 it. But I want to go a step further.

6 I think the words "code specified stresses,"  
7 or whatever were the words you quoted, have to do with the  
8 fact that whenever you select a basic stress or use a basic  
9 stress most normal building codes then tell you how you can  
10 use that particular material in the various types of stress,  
11 such as shear, compression, bending, and so on and so forth.  
12 So when they say code-related stress or code-specified stress,  
13 I am almost certain they are referring to the relationship  
14 of your prime stress and shear, bending, flexure, compression,  
15 whatever, all the details.

16 But you still have to start with the basic  
17 prime stress; in which case we have here the actual test  
18 stresses at age 28 or 60 days or whatever they happen to be.

19 Q Well, Mr. Ghio, mention has been made of .95.  
20 Are there are other standard factors that are used?

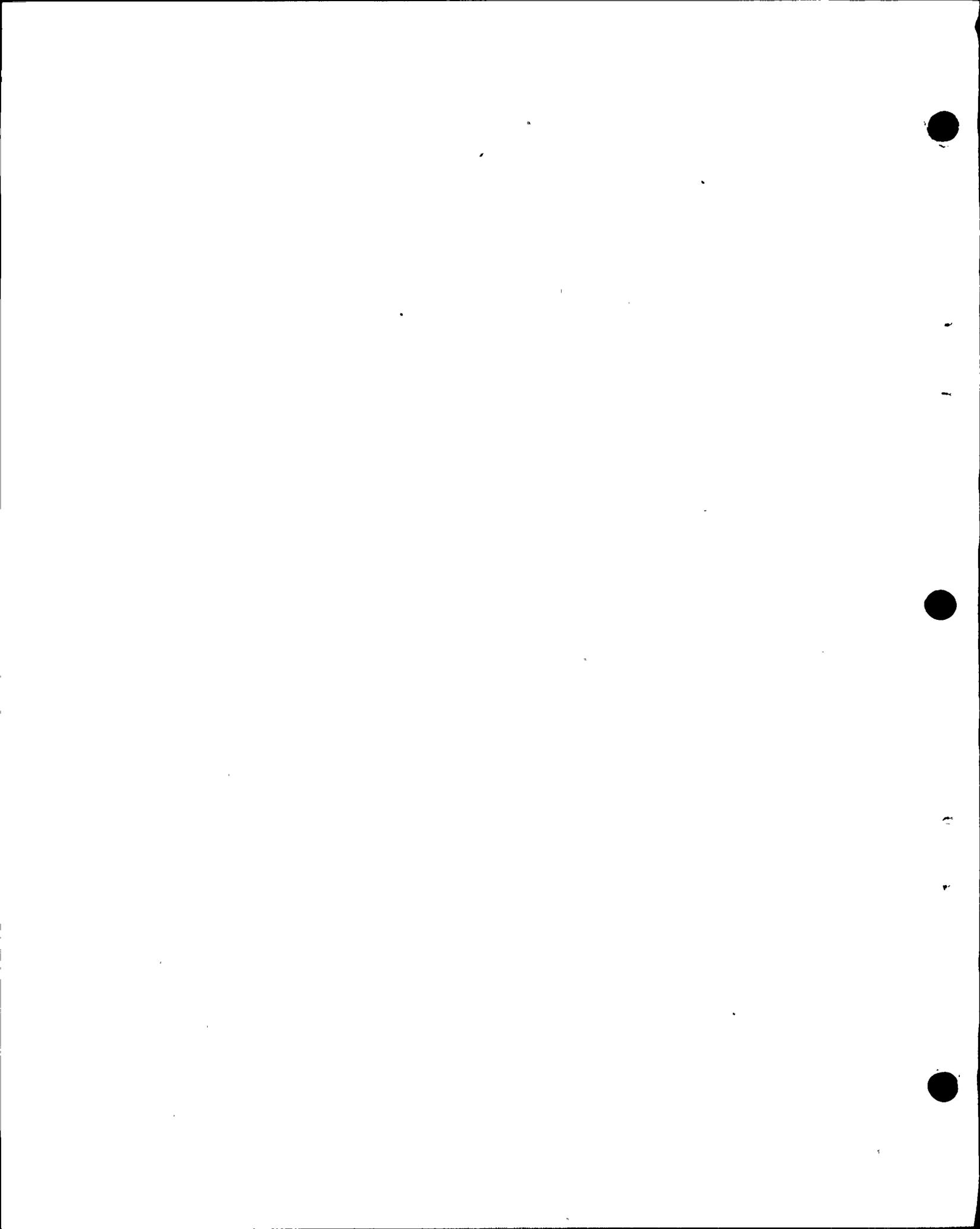
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1 A (Witness Ghio) Well I think we went over the  
2 facts of 0.95 and there are some other values similar to that  
3 in the code that's applicable to concrete design. That  
4 particular factor, as I think I stated earlier, relates to the  
5 fact that it's a design code, you don't know what variability  
6 you may get in your materials that you haven't purchased yet.

7 In this case that we're talking about here,  
8 specifically the Diablo Canyon Hosgri evaluation, we know the  
9 material values and we know their range and so it is in-  
10 appropriate to utilize this 0.95 type factor.

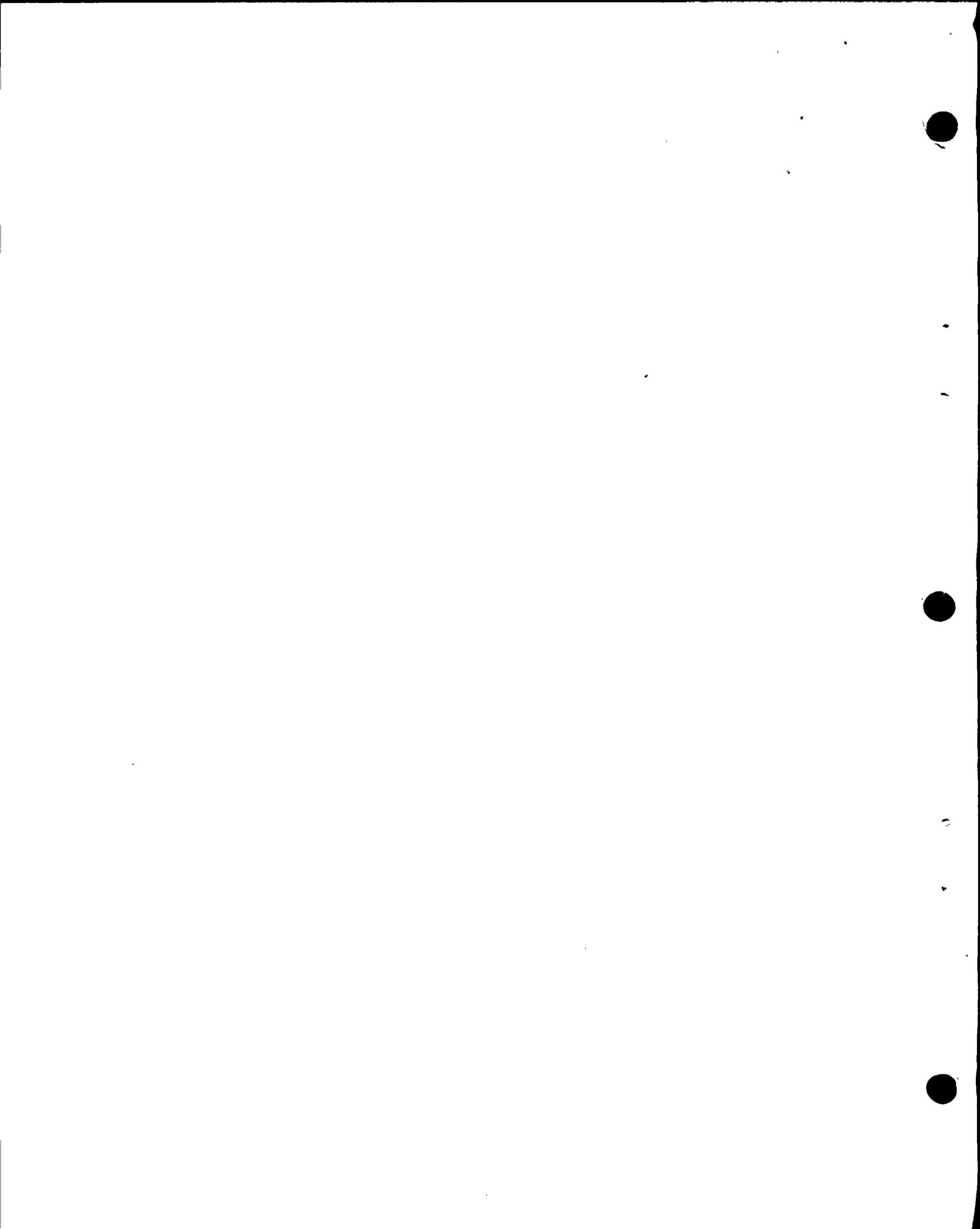
11 However, I think we have actually used this in  
12 the calculations that we're specifically talking about now,  
13 which led to the factors of safety.

14 Now beyond that, there are many other factors  
15 in the code that allow you to translate, if I may repeat  
16 to some degree what Dr. Blume has just said, to translate from  
17 a basic stress to a stress that's appropriate to the particular  
18 calculation you're doing.

19 If you're checking, determining the allowable  
20 shear stress in a concrete shear wall, you don't use 95 percent  
21 of the concrete strength. The code requires and we utilized  
22 a factored value for determining the concrete, the shear  
23 carrying capability of a concrete shear wall.

24 That's the best I can do.

25 Q Well turning to Table 1 in the testimony and



agb2

1. looking specifically at walls, which is the first item --  
2. was the minimum factor there based on a 3000 or a 5000 psi  
3. for concrete?

4. A I don't know the answer to that, but Mr. Sokoloff  
5. apparently does.

6. A (Witness Sokoloff) 5000, sir.

7. Q So in your calculations, Mr. Sokoloff, did you  
8. use 5,650 or 5000?

9. A I used 5,650, correct.

10. Q And did you reduce that by the factor 0.95?

11. A No.

12. Q Why not?

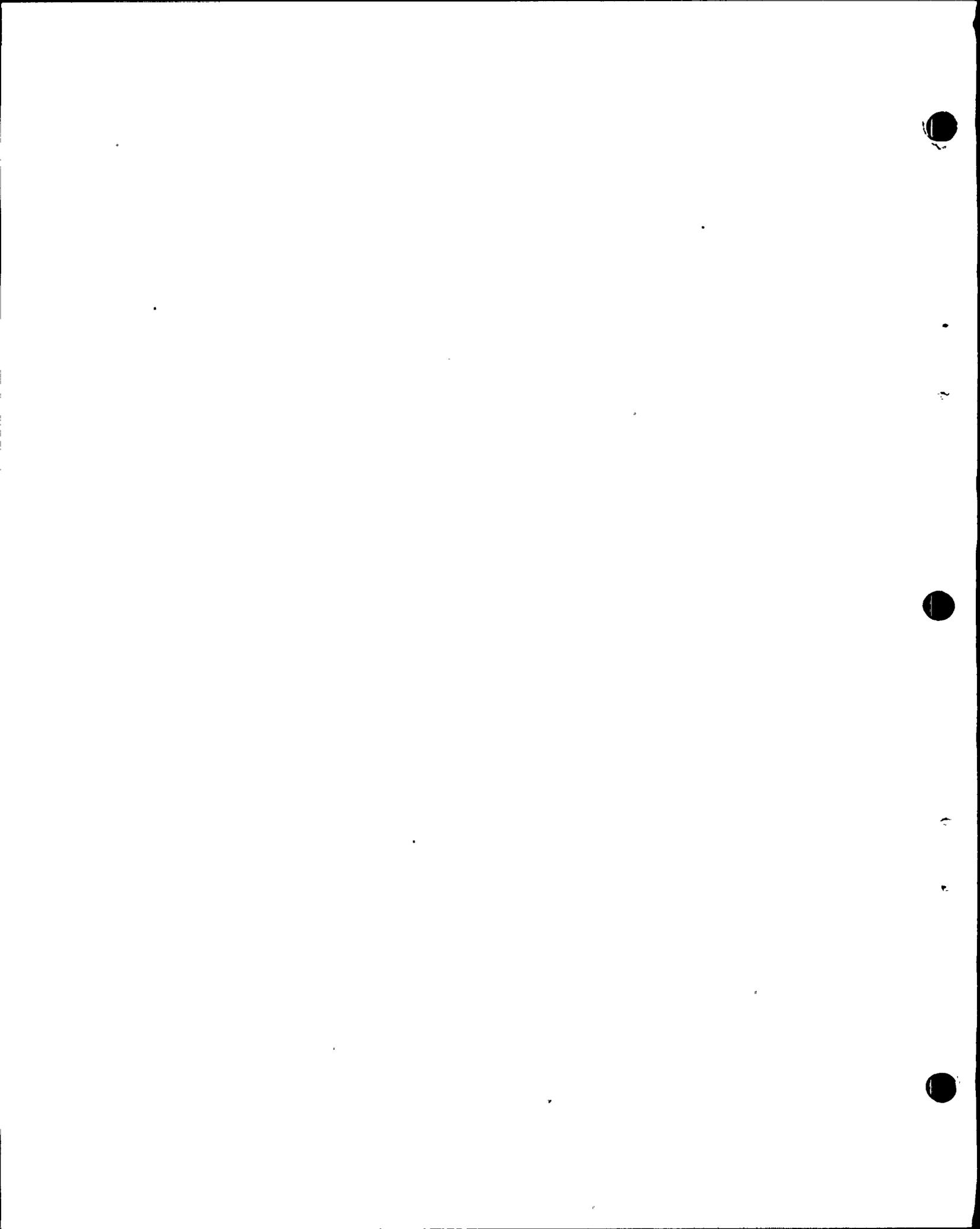
13. A Because it's governed by a different formula.

14. Q Which formula is that?

15. A It is ACI Code you take shear and look and this  
16. is the maximum 10 square root of F sub prime C.

17. A (Witness Ghio) If I may paraphrase that,  
18. what he's saying is, here's an example where he went into the  
19. American Concrete Institute Code which lays out factors for  
20. evaluating various structural elements, in this case, we're  
21. talking about a shear wall and he invoked the particular  
22. formulation applicable to a shear wall and he came up with a  
23. minimum factor of safety on that basis of 1.1.

24. This relates to one wall, a singular wall, out of  
25. a couple of hundred walls in the auxiliary building. This is



wrb/agb3

the lowest factor of safety.

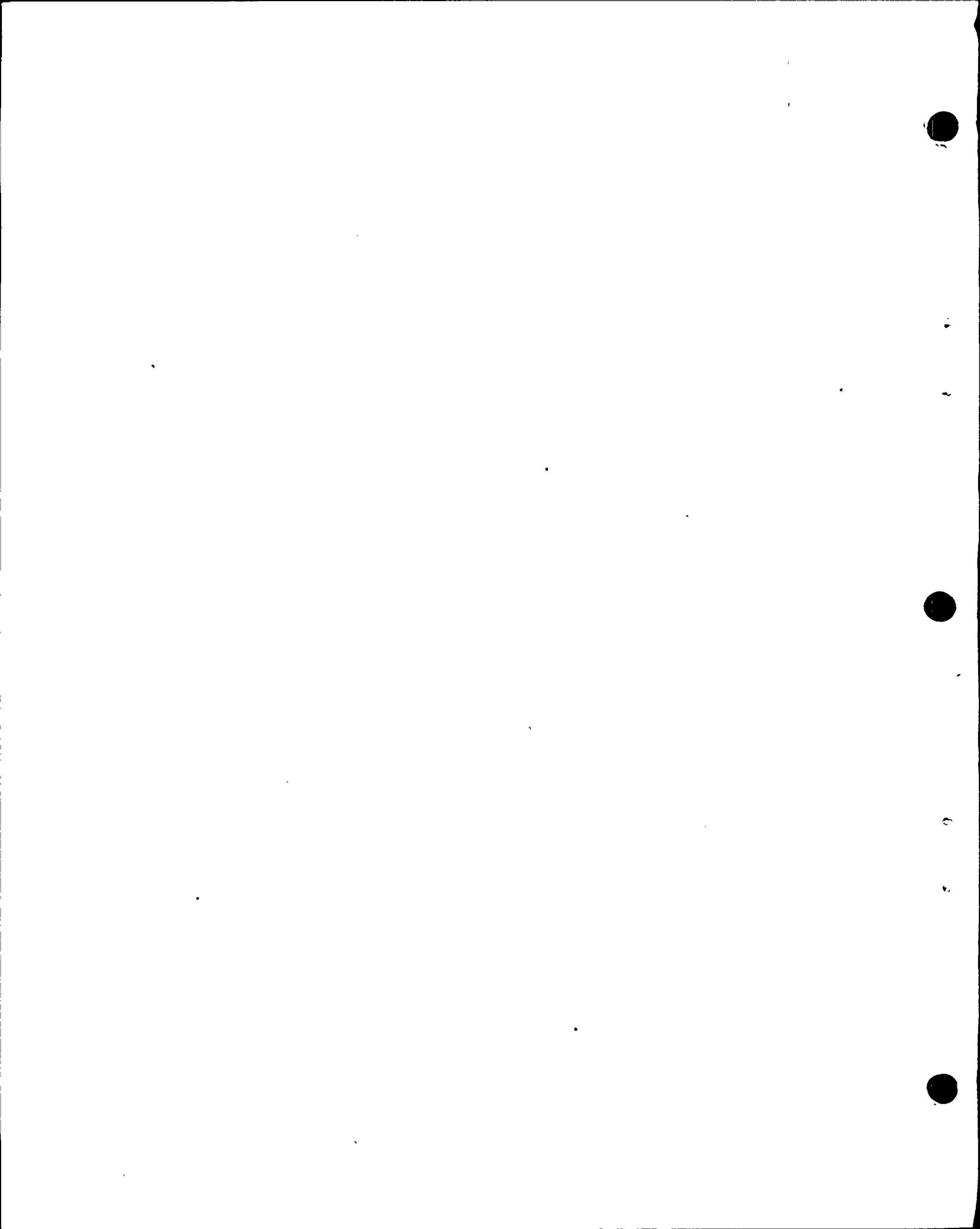
Q Well, Mr. Ghio, how many of the other walls were between the 1.2 and 1.2?

A (Witness Sokoloff) None. I will answer this question. The next one is 1.3.

MADELON  
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MADELON2 1

Q Mr. Sokoloff, what would be the answer in the event -- if 5000 other than 3000 had been used?

ci2 mpbl 2

A To my best knowledge, none.

3

4

Q It still would have been 1.1?

5

A Maybe .09.

6

MR. NORTON: Excuse me.

7

Would that be .09 instead of 1.1, or 1.09?

8

WITNESS SOKOLOFF: 1.09, I am sorry.

9

WITNESS BLUME: Many of these factors are not direct linear proportions. I think that's probably worrying people. They are often square root or sometimes cube root functions. So you can make a big change in a number like that and have very little change in the allowable stress.

10

11

12

13

14

BY MR. KRISTOVICH:

15

Q Dr. Blume, could you explain what root is used for walls?

16

17

A (Witness Blume) I believe the current shear value allowance is a square root function.

18

19

Am I correct in that?

20

A (Witness Sokoloff) Yes, sir.

21

Q Okay.

22

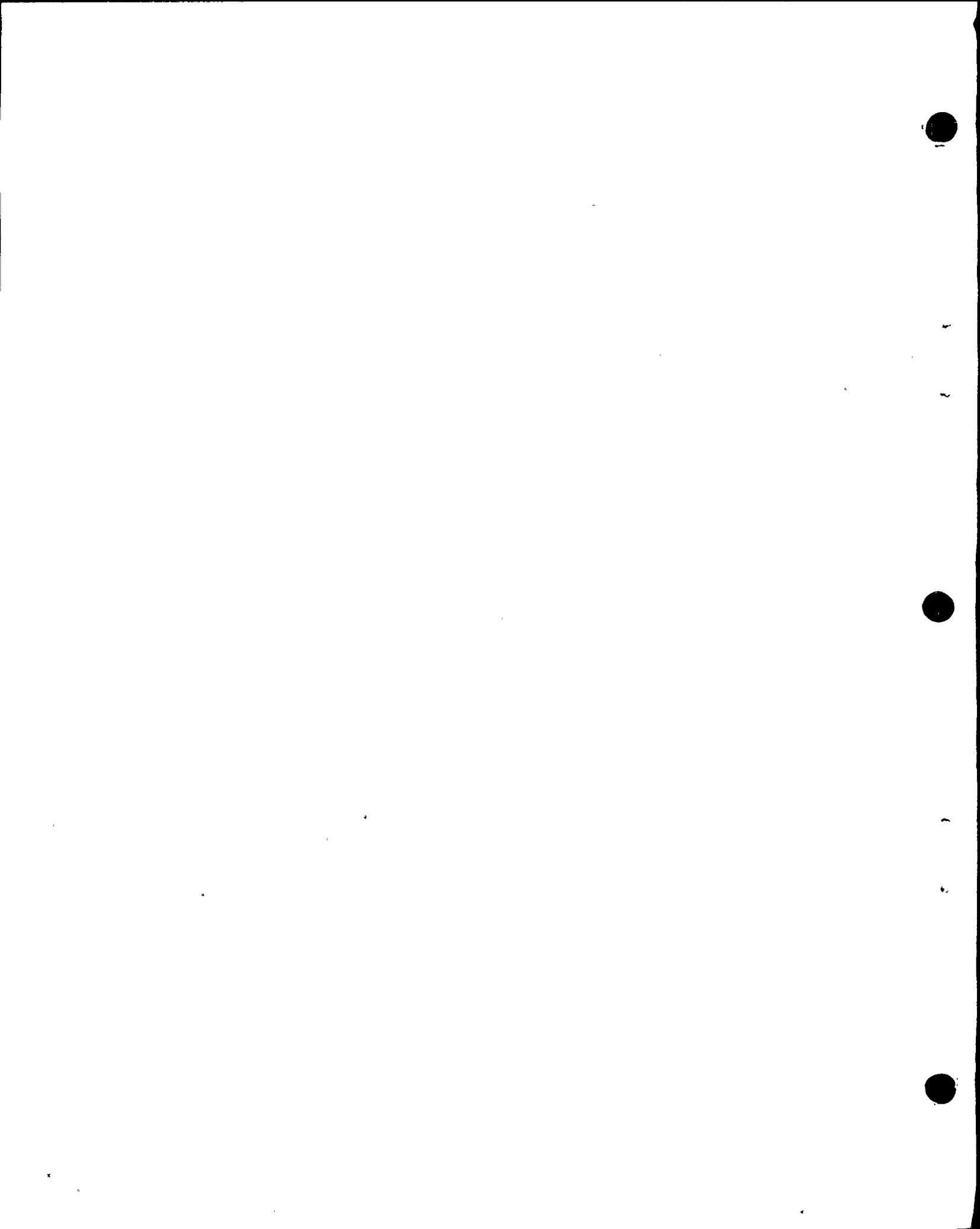
Mr. Sokoloff, on Table 2, which refers to structural steel elements, are those factors of safety square root or linear?

23

24

A Those are steel. In case of steel, it's not square

25



mpb2

1

root.

2

Q Is it linear, then?

3

A That's correct.

4

Q Okay.

5

Referring to page D-6B.3 in the Hongxi, which is

6

Table 5B.1, Steel Strength Data ---

7

MR. NORTON: Excuse me.

8

Could you give us time to get that out?

9

MR. KRISTOVICH: Yes.

10

(Pause.)

11

MR. NORTON: What was that number again, 6-B.1?

12

MR. KRISTOVICH: Table 6-B.1.

13

MR. NORTON: Okay. We have it.

14

BY MR. KRISTOVICH:

15

Q Mr. Sokoloff, do you have that table also?

16

A (Witness Sokoloff) Yes, I do.

17

Q For the cable tray seismic supports ---

18

A Yes.

19

Q --- which of the steel data on this page was

20

utilized?

21

A 836.

22

Q So did you use the average, then?

23

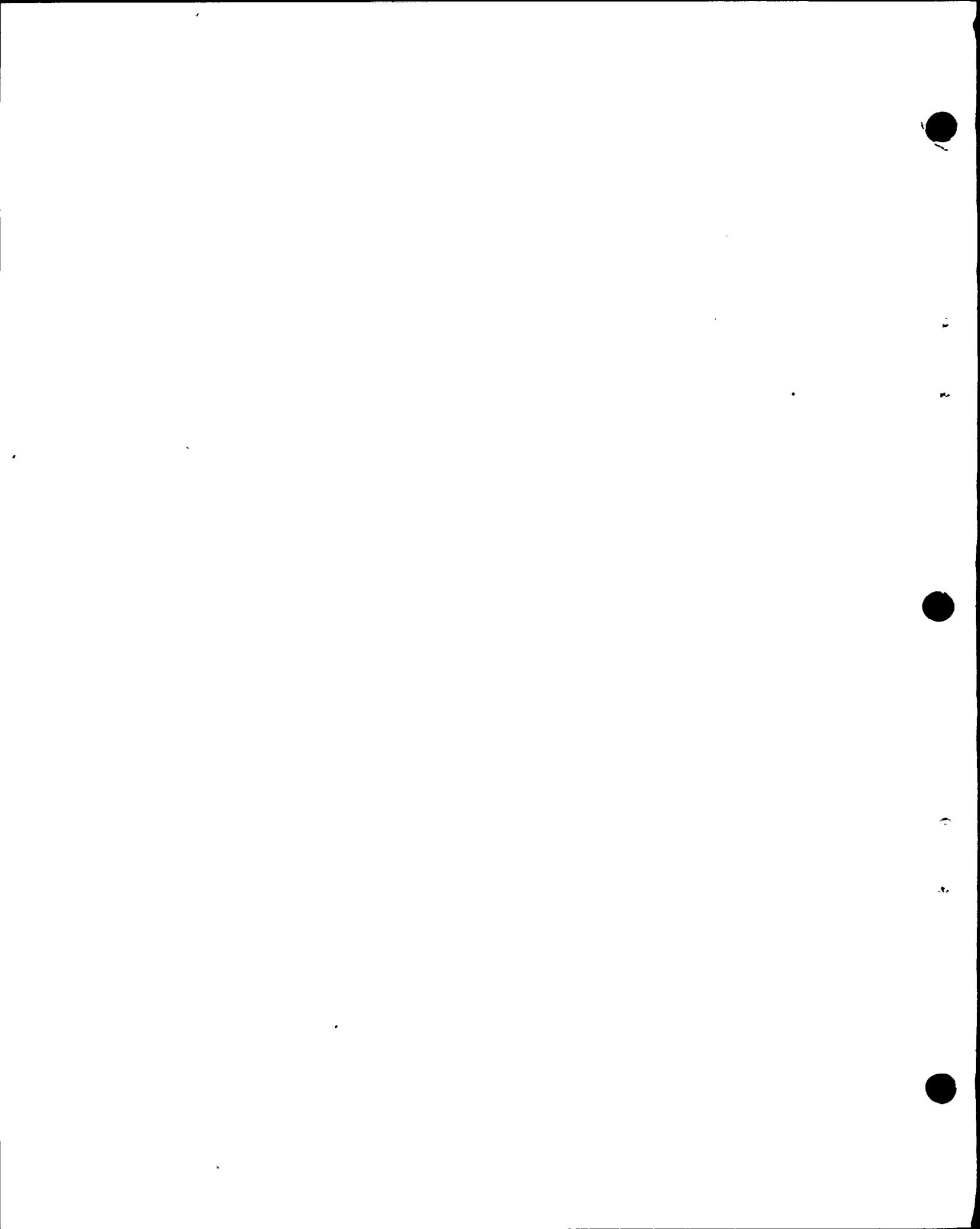
A Yes, we did.

24

Q The average of 43950?

25

A That's correct.



mpb3

1 Q And did you reduce that by any factor for allow-  
2 ables?

3 A Yes, by .9.

4 Q And where did you get .9?

5 A That's the same way like was reduced .95. At the  
6 earliest days we reduced by .9. We continued this way.

7 Q In the original analysis did you use 36,000 times  
8 9?

9 A In the original analysis I don't remember because  
10 it was done at the beginning of my responsibility. So I don't  
11 remember exactly. I hope we did, though.

12 Q Mr. Sokoloff, for fuel racks which materials  
13 apply?

14 A Can you rephrase this question? I didn't under-  
15 stand.

16 Q For fuel racks which of the data on Table 6-B.1 --

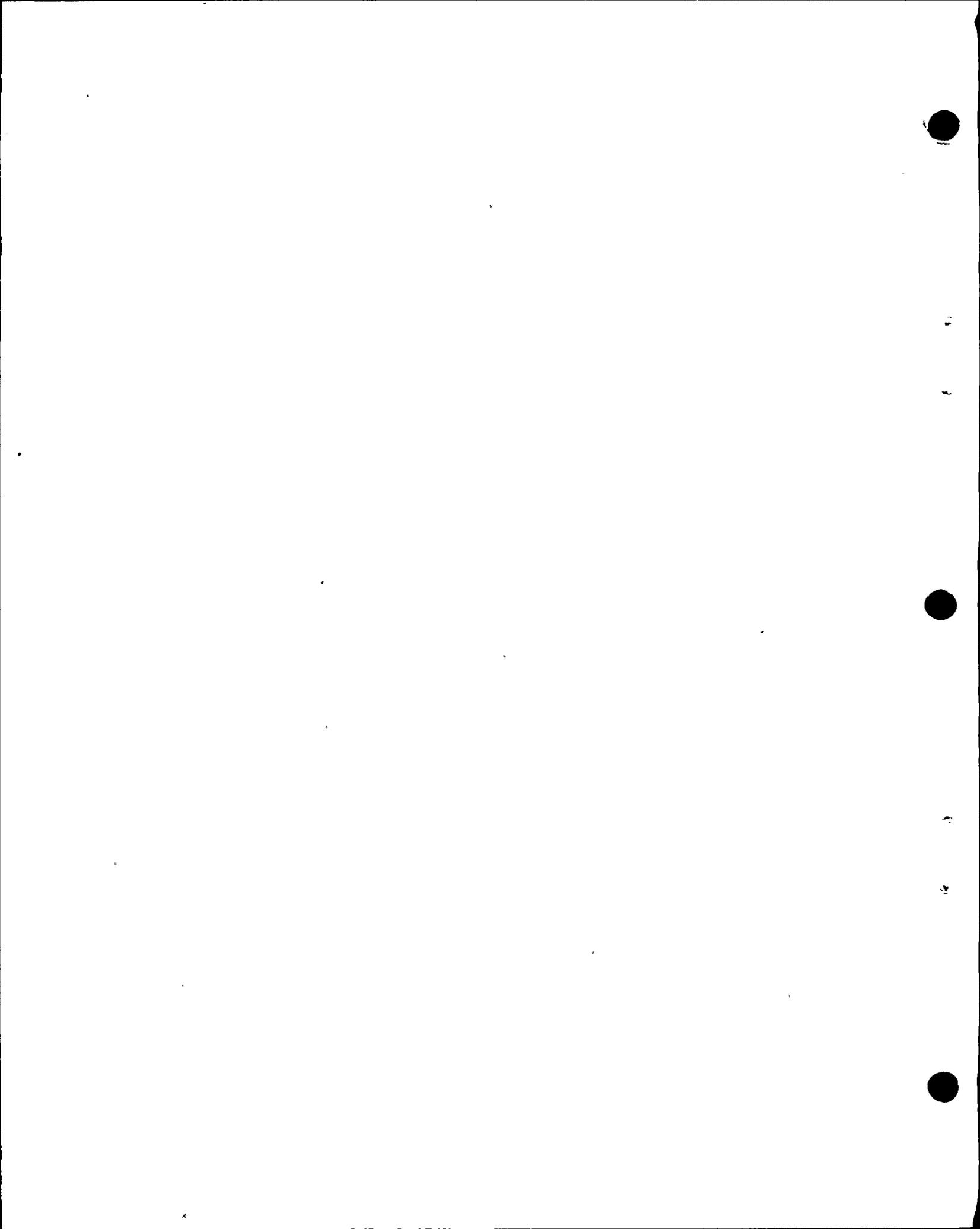
17 A Fuel racks are stainless steel, and this is  
18 completely different. Stainless steel is 8304. It's not in  
19 the table.

20 Q Do you know where it's listed, the stainless steel?  
21 Do you know where in the Hosgri reanalysis stainless steel is  
22 listed?

23 A I don't know.

24 Q Did you use actual values for stainless steel?

25 A I think we used reduced.



mpb4

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Q What do you mean "reduced"?

A Multiplied by a factor of .9 or something.

Q Mr. Sokoloff, what value did you use for stainless steel for the strength before reducing it by .9?

A I do not recall at this moment.

Q Do you have documents there that would have the data?

A No.

Q Dr. Bluma, is there a document there?

A (Witness Bluma) No, I don't have that here.

A (Witness Chio) We don't have the backup data here at this table that would enable us to answer your question, I'm afraid.

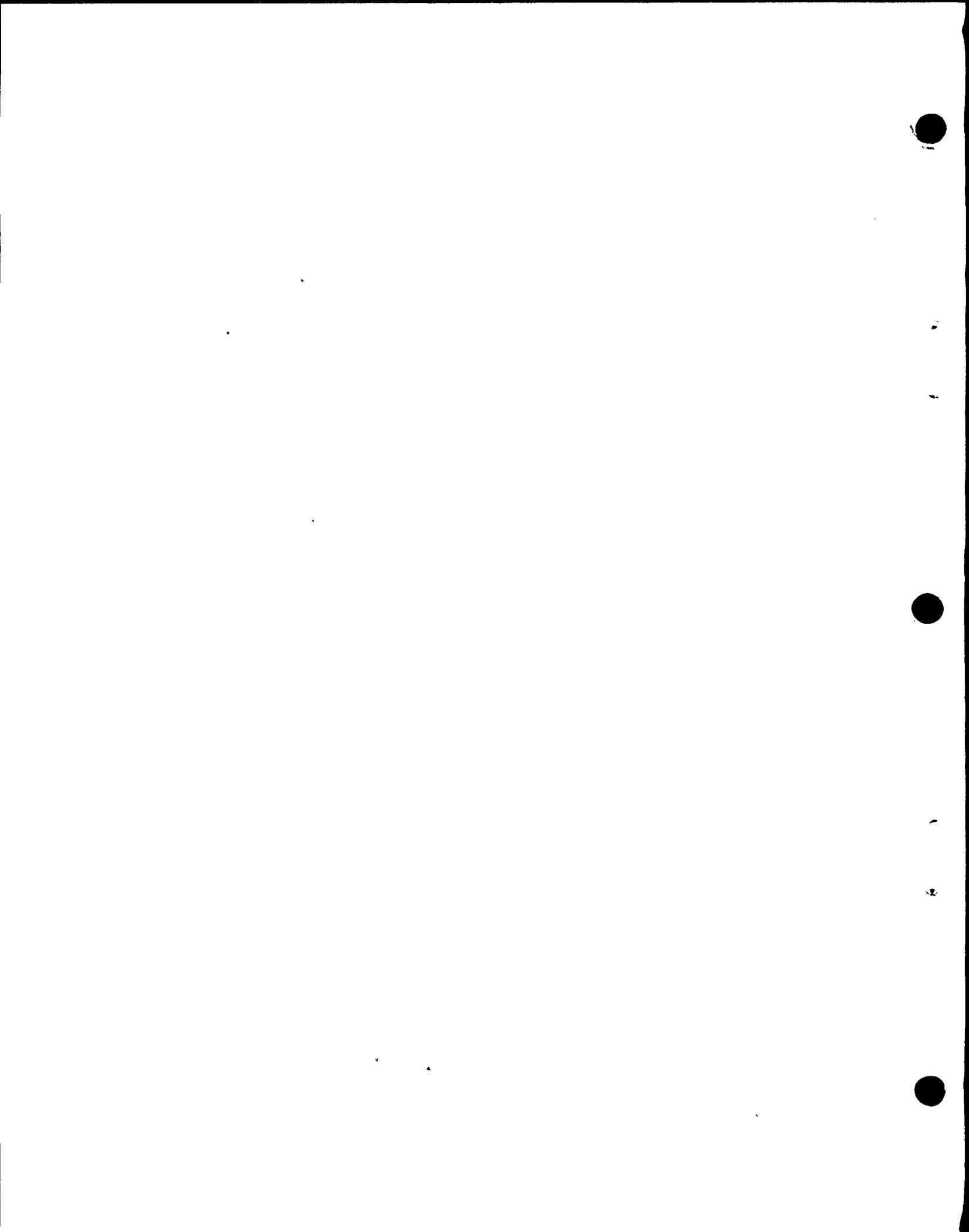
MR. NORTON: Mrs. Ewers, may we inquire where this is going?

I guess it's time for my afternoon lament.

(Laughter.)

But I don't see where we're going. The analysis has been done. They've told the way they've done the analysis, and now they're coming out and they want each and every individual number. And I deposed all of their witnesses and they don't have any numbers to counter those numbers, they don't have any testimony to counter those numbers. And I don't understand where all of this is going.

If they had a witness here that was going to say



mpb5

1 Your numbers are crazy, or Your numbers are wrong and we've  
2 got better numbers, then maybe all of this would have some  
3 meaning.

4 But to sit here and dig out papers and then recite  
5 a number, Yeah, here it is in the table 36,100, well, where  
6 do we go from there? I mean, there's nobody here to disputa  
7 that number in any event, and I just don't understand what  
8 the purpose of all of this is other than to take up time, which  
9 seems to be the purpose of cross-examination since we started  
10 these hearings.

11 MRS. BOWERS: Mr. Kristovich?

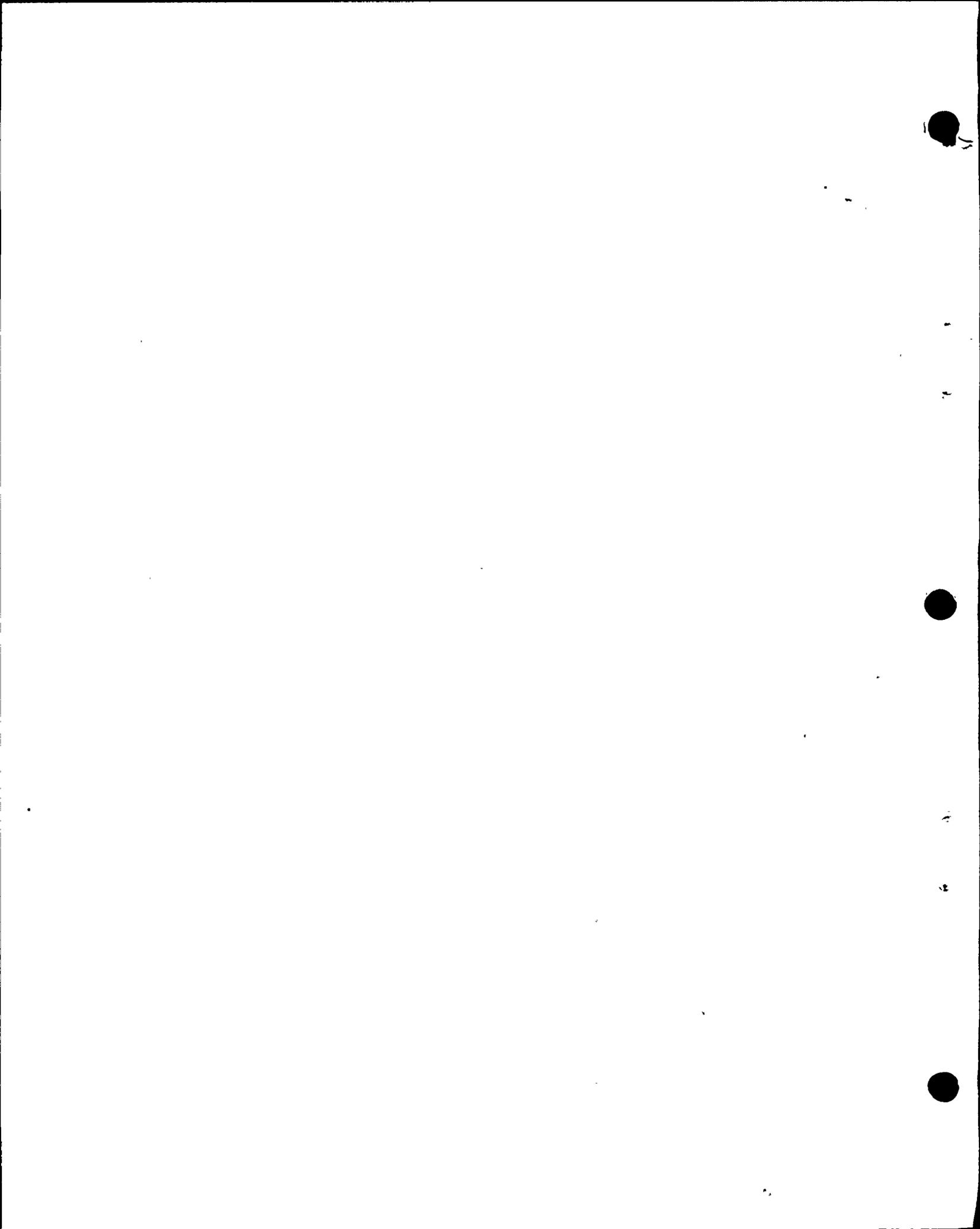
12 Well, let me ask Mr. Norton a couple of questions.

13 Mr. Norton, do you agree with the Board that the  
14 Joint Intervenors are not required to put on a direct case?

15 MR. NORTON: Well, they may not be required to put  
16 on a direct case, I would agree with that. They don't have to  
17 do anything, which is kind of what they're doing.

18 But to sit here and waste everybody's time by  
19 asking for numbers that don't have any meaning -- if they're  
20 not going to put on a case than pulling those numbers has no  
21 meaning. It's numbers out of the sky.

22 I mean, you know, they could say 36,000, or 50,000,  
23 or 100,000. Unless there is something to controvert those  
24 numbers or they can show that the analysis was flawed somehow,  
25 they did something wrong, it is meaningless. Numbers don't mean



mph6

1 anything to a reviewer of the record.

2 MRS. BOWERS: Well, but your direct testimony -- an  
3 I correct -- includes figures in Table 1 and Table 2, minimum  
4 factors?

5 MR. NORTON: Right, to show how those numbers were  
6 done and to show, you know, what was done.

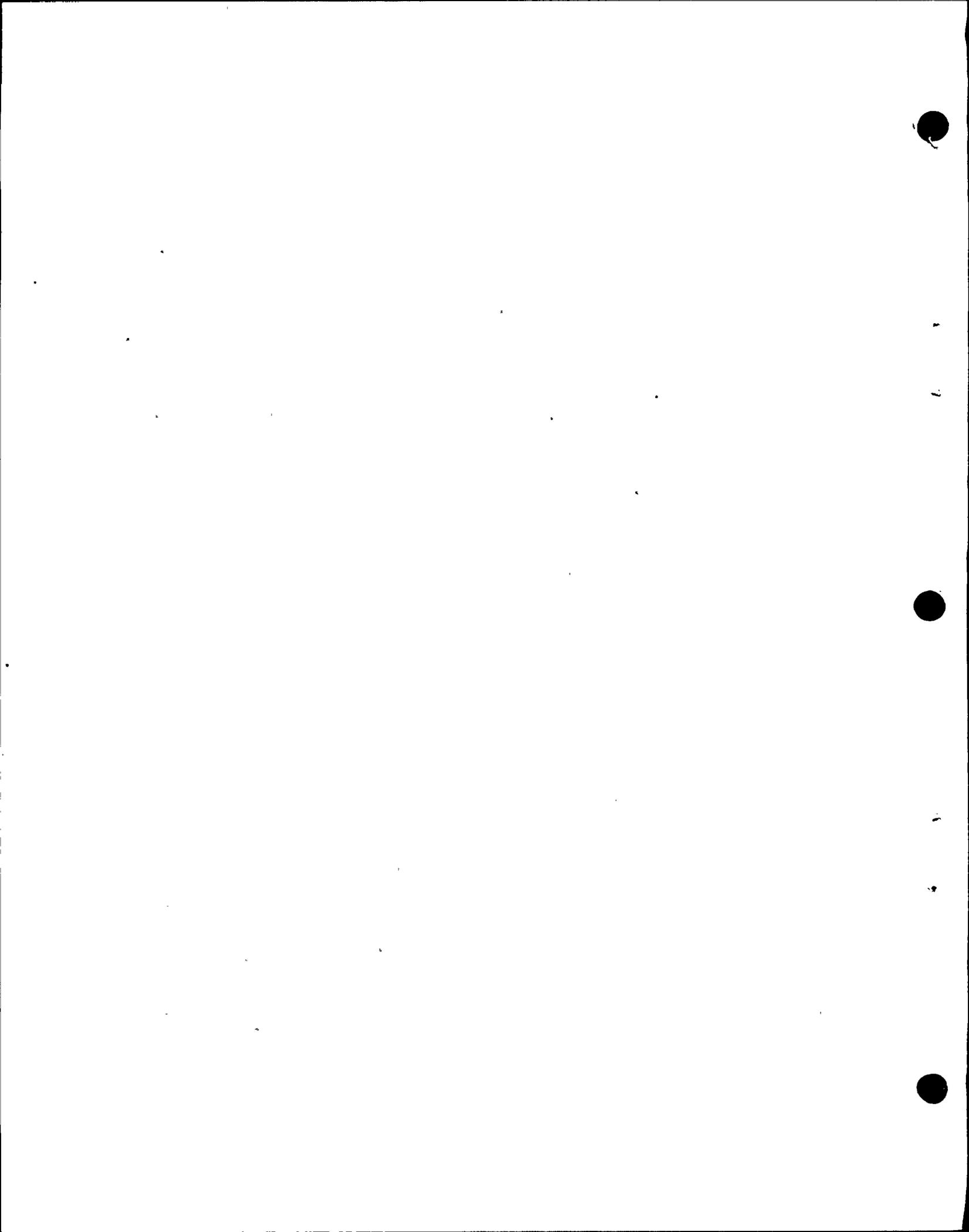
7 Now if they are trying to prove that it wasn't  
8 done -- and I don't think they're trying to prove that -- that's  
9 one thing.

10 What they're trying to infer is that somehow the  
11 numbers were wrong. I gather that's what they're trying to  
12 infer. I can't imagine any other purpose here. But I don't  
13 know how they're ever going to do that without a witness to  
14 say those numbers are wrong.

15 And I took Mr. Hubbard's deposition and he had  
16 no position on that, that those numbers were wrong.

17 MRS. BOWERS: Well, but if numbers are given like  
18 these minimum factor of safety numbers in your direct testimony,  
19 is it your position that unless they have witnesses of their  
20 own that they can't question how those numbers were arrived at?

21 MR. NORTON: No, they can question how they were  
22 arrived at. But how much depth is allowed and how much time  
23 should be spent on it -- I mean if we wanted to sit down and  
24 think up questions, I suspect I could keep this panel on there  
25 for a year about the derivation of these numbers. I really



mpb7

1 think I could. If I wanted to do it and someone were willing  
2 to pay me, I think I could keep them here a year asking them  
3 questions.

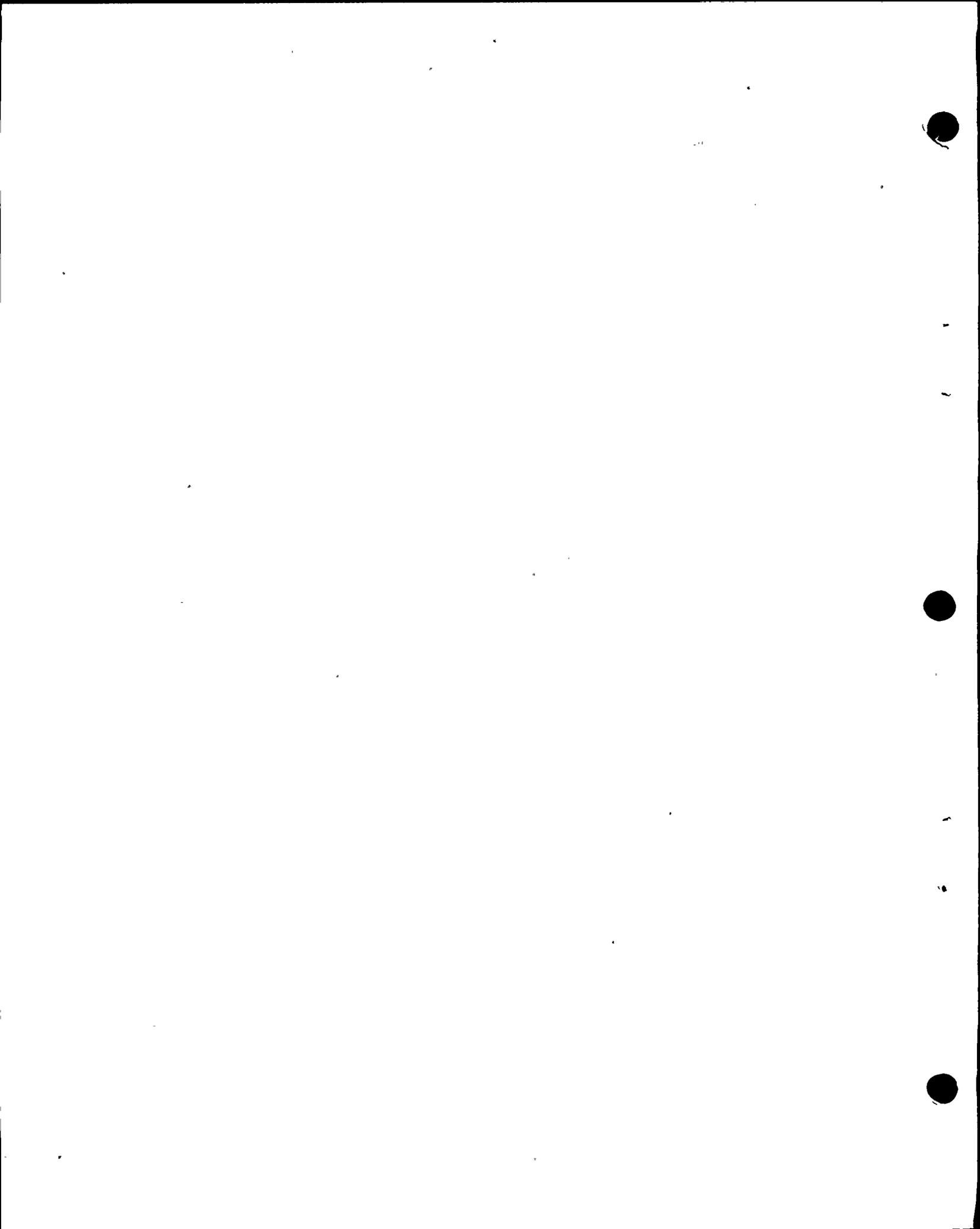
4 But I don't think that's the purpose of these  
5 hearings. I don't think that's what the Congress had in mind  
6 when they established the NRC, and I don't think it's what  
7 the NRC had in mind when they established these hearing pro-  
8 cedures.

9 MRS. BOWERS: Well, if I was following the ques-  
10 tions, I thought the questions went to right now the fuel  
11 racks, as to how the Figure 1.2 was arrived at.

12 MR. NORTON: I agree, but what's the purpose of it?  
13 Once you've established how these things were arrived at, what  
14 is the purpose of digging up the backup numbers? Where does  
15 that go? That's all my -- you know, it just takes tremendous  
16 time and it doesn't get us anyplace.

17 Once the analysis, the way this was done is  
18 explored, what's the sense of going back into the background  
19 numbers? I mean, it can be done. I suspect they can go get  
20 those backup numbers, but I don't understand where that gets  
21 us. I don't know how that advances this hearing.

22 MRS. BOWERS: Well, I think the Interveners had  
23 in mind trying to get -- and correct me if I'm wrong --  
24 trying to get the backup figures for these things and then  
25 doing computations to see if it all adds up.



mpb8 1

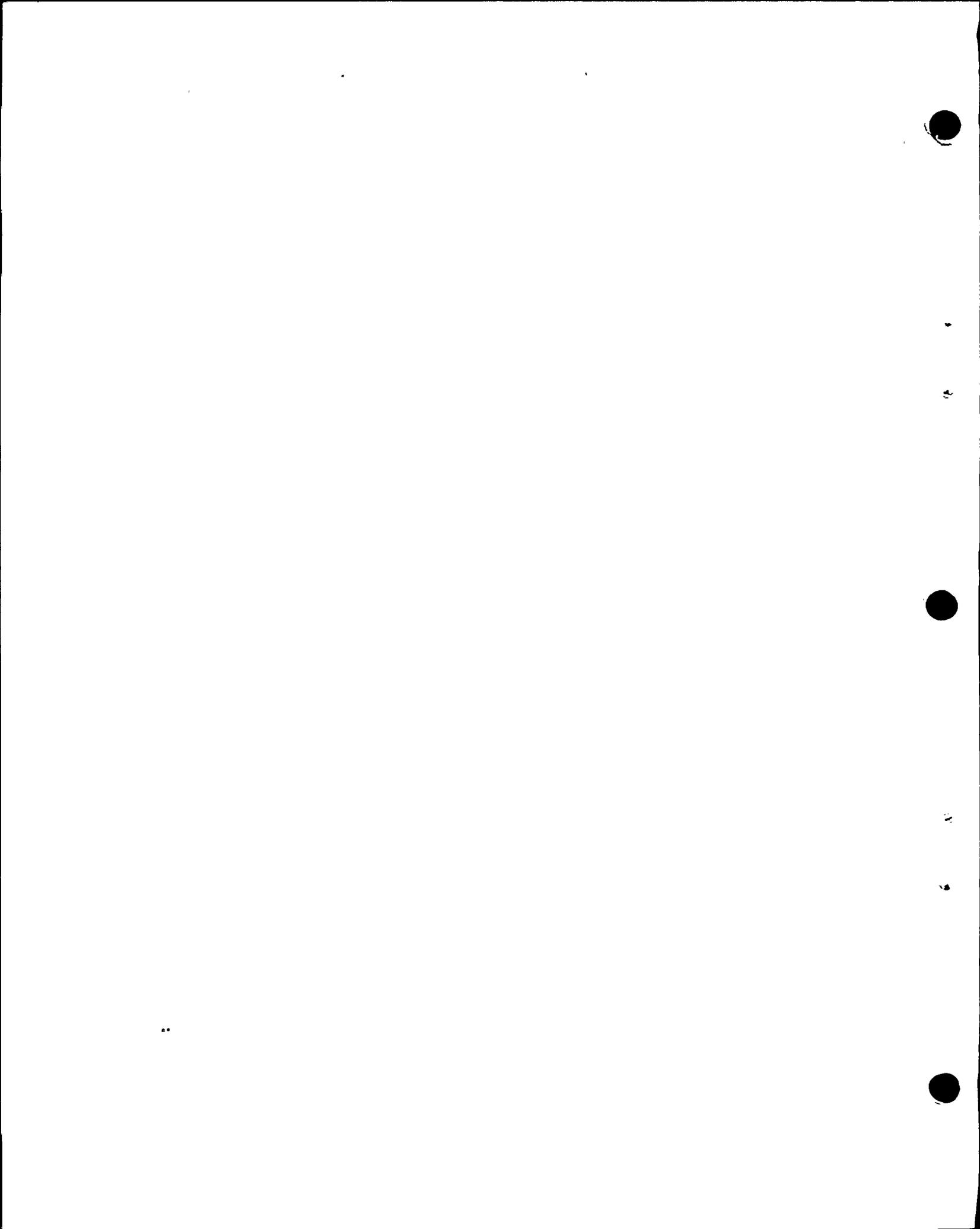
2 MR. NORTON: Well, I would suggest that should  
3 have been done in discovery. I mean that's exactly why you  
4 have discovery. If you suspect somebody's numbers are wrong,  
5 then you prepare your case through discovery; you ask for  
6 those figures and answers to interrogatories and requests for  
7 production of documents or some other way. And if you think  
8 the calculations are wrong, then you do your preparation and  
9 you put on your case.

10 But to do your discovery during the hearing process  
11 to then go out and check the numbers is not the way trials  
12 are conducted. No judge would allow that to be done in a  
13 trial; that he would allow the discovery of some expert  
14 witnesses, all the numbers and everything, and then allow  
15 somebody to go out to do that during discovery.

16 MRS. BOWERS: Are you saying these numbers have  
17 been available to the intervenors --

18 MR. NORTON: This table, 6B.1, has been out for  
19 at least a year, if not two. And they've had it. And the  
20 witnesses are shaking their heads. These tables have been in  
21 their hands for a long time.

22 And now to be going through each and every number  
23 and checking out the math and so on -- if there's an error, I  
24 mean I could understand that procedure. But there's been no  
25 error as yet. We've been doing this for weeks and we haven't  
come up with any errors, or come up with Oh, you've made a



mpb9 1 mistake in your calculations, and that's not where they're  
2 headed now. I don't believe they're headed in that direction  
3 at all.

4 I believe they know there's no error in these  
5 numbers if they've checked it.

6 MRS. BOWERS: Does the Staff have a position on  
7 this matter, Mr. Ketchen?

8 MR. KETCHEN: No, ma'am.

9 MR. KRISTOVICH: Well, Mrs. Bowers.

10 MRS. BOWERS: Yes.

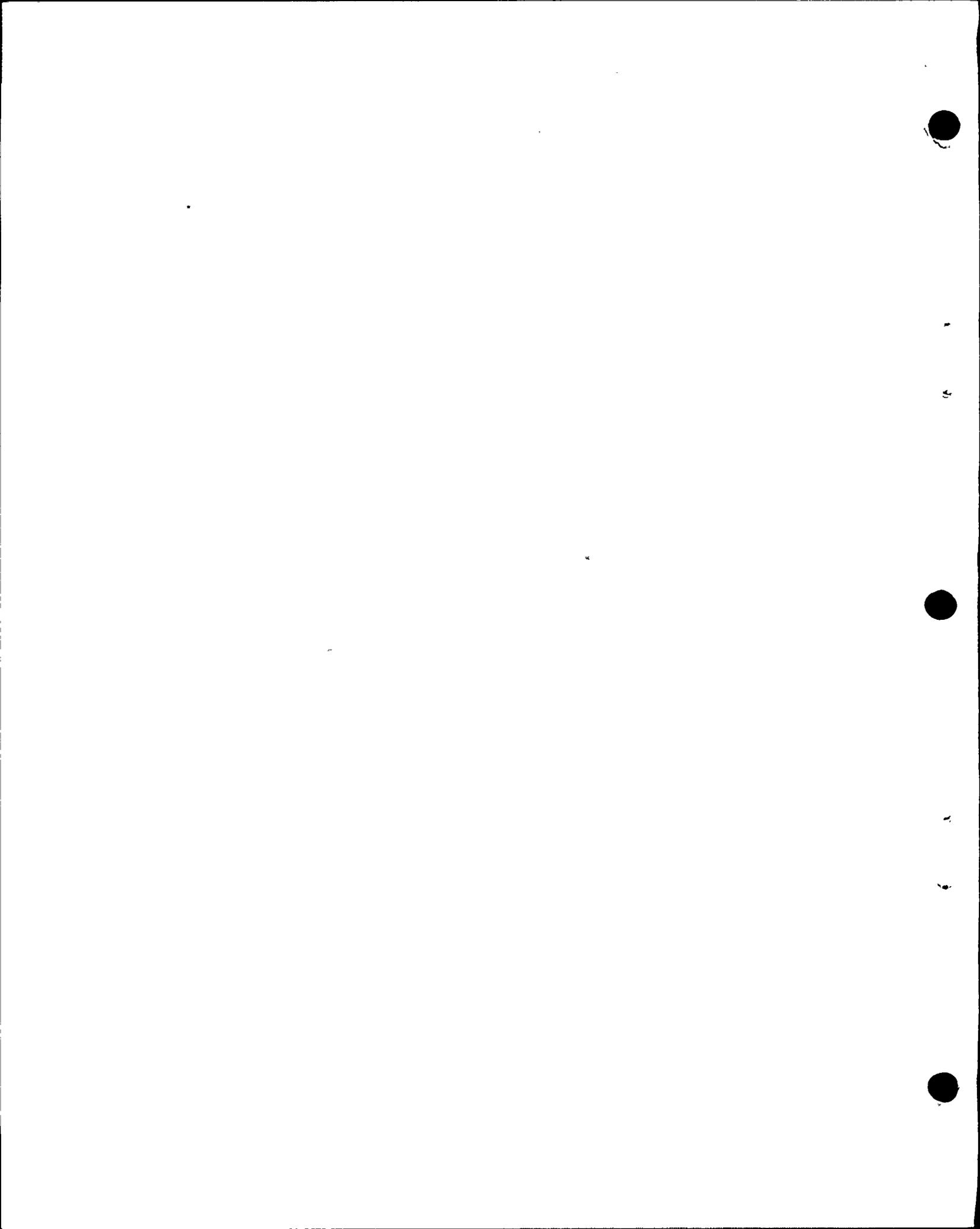
11 MR. KRISTOVICH: I'd really like to point out  
12 that we haven't taken a year in cross-examining these panels.  
13 I believe it's been more along the lines of 40 minutes. And  
14 we do appreciate Counsel for the Staff taking the time out to  
15 help us conduct our case -- Counsel for PG&E, excuse me.

16 And I believe we are trying to get behind the  
17 analysis, the way they were arriving at these figures in the  
18 cross-examination. I believe that's a proper line of cross-  
19 examination.

20 MRS. BOWERS: Well, the Board would like to confer  
21 on this matter. I think we have your positions.

22 MR. NORTON: Mrs. Bowers, it's not an improper  
23 line of cross-examination if carried to a reasonable extent.  
24 It's just that I don't see where it's going.

25 We went through the cable tray, now we're going to



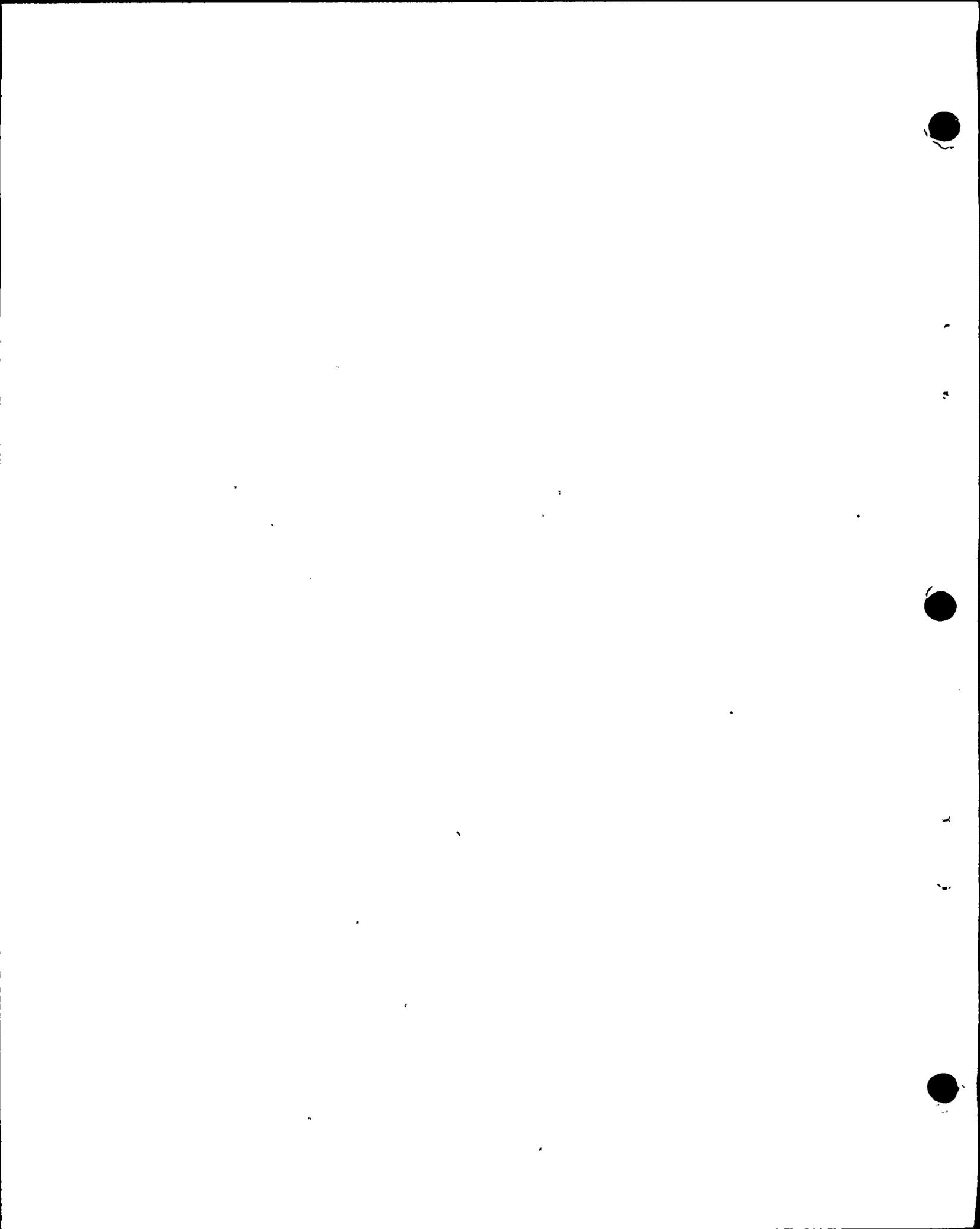
mpbl0 1 the fuel racks and the different kinds of materials and so on.  
2 And now they're asking for detailed numbers that aren't  
3 available. I just don't know where we're going with it; that's  
4 all.

5 It's relevant. There's no way I can argue that  
6 it's not relevant. It's just how necessary is it and what  
7 does it do to further these hearings, and that's my basis.  
8 You know, one can try to some period of time -- and when I  
9 said a year I was saying that one could dream up questions  
10 that were somehow relevant for a year. I didn't mean to imply  
11 that he was going to. I certainly hope he isn't.

12 MR. KRISTOVICH: Mrs. Bowers, it seems that what  
13 we're trying to get at is that Applicant has reduced the  
14 spectra by using various factors such as tau, effective  
15 acceleration, and damping. And they've also upped the accept-  
16 able yield points by using actual material values, and we're  
17 just trying to get behind this approach and see what the  
18 assumptions are underlying it, and see if those assumptions  
19 are valid.

20 MR. NORTON: That's all well and good, but I  
21 don't know what pulling numbers after numbers after numbers  
22 would do. The same kind of an analysis was used for all of  
23 it.

24 And if that's their objective, then why don't  
25 they take one thing and zero in on it, and then ask if that



mpb11

1 same approach was used for the other things. But to pick  
2 the numbers from each and every one doesn't accomplish their  
3 purpose.

4 If that's their stated purpose, then what they're  
5 asking doesn't accomplish that.

6 (The Board conferring.)

7 MRS. BOWERS: Well, the Board overruled your  
8 objection.

9 We do think that it's a proper line of question-  
10 ing. However, we would encourage intervenors to try to focus  
11 in on numbers that they may think are suspect rather than  
12 feeling it's necessary to consider each and every number.

13 BY MR. KRISTOVICH:

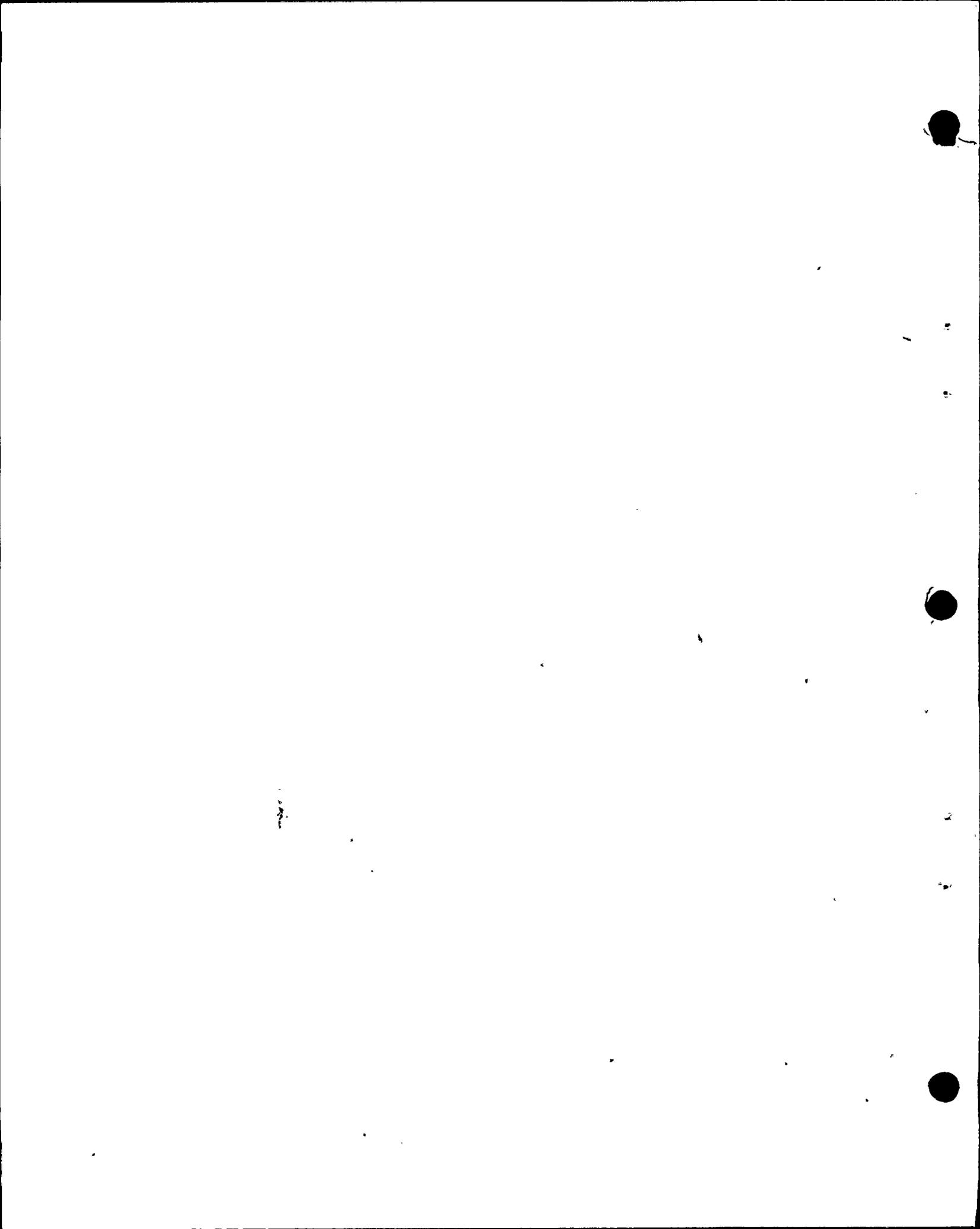
14 Q Well, does any member of this panel have the  
15 actual values for stainless steel that were used in the fuel  
16 racks?

17 A (Witness Chic) I think you asked that earlier,  
18 and I believe we responded that we didn't. We don't have it  
19 available at this table at this time.

20 We did use the actual values to formulate the  
21 top side of the equation that was used to calculate the factor  
22 of safety.

23 Q Do you know if these actual values are listed any-  
24 place in the FSAR?

25 A I do not believe that they are listed in the FSAR.



mpb12 1 We've attempted to provide the vast majority of the actual  
2 material strength data that we have utilized in the evaluation  
3 for the major structures, the concrete and structural steel  
4 therein.

5 We have not attempted to include certifications  
6 for every piece of material utilized in the job. I believe  
7 we can find the values related to these particular elements,  
8 specifically the fuel racks, given enough time. We simply  
9 don't have them with us right here.

10 MRS. BOWERS: Well, but you said you don't have  
11 them at the table.

12 Now do you have them in Avila Beach?

13 WITNESS GHIO: I'm not even sure we have them in  
14 Avila Beach. It's possible they may reside at the site or in  
15 San Francisco.

16 BY MR. KRISTOVICH:

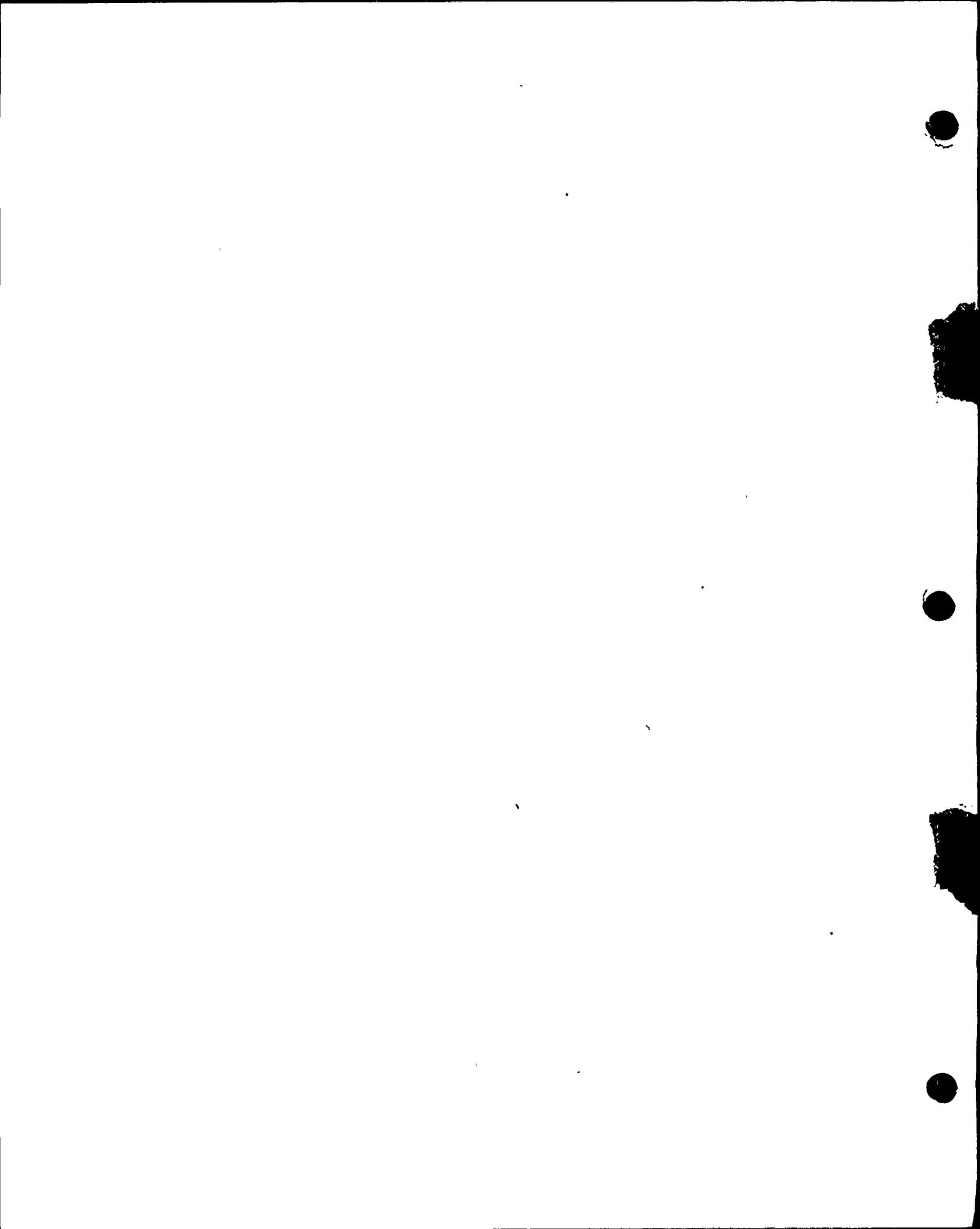
17 Q Well, since the information is not available, we  
18 will just move on.

19 Mr. Ghio, how did you account for torsional effects  
20 in the roof of fuel handling?

21 A (Witness Ghio) I would like to have Dr. Malik  
22 answer that question. He did the analysis.

23 Q Fine.

24 A (Witness Malik) Well, initially we took the res-  
25 ponses of the roof of the fuel building due to horizontal



mpb13

1 earthquake and increased it by ten percent to account for the  
2 torsion. Later on the NRC Staff asked us to compare that ten  
3 percent with actually doing the same thing that we did with  
4 the rest of the structure, by adding a five percent or a  
5 seven percent eccentricity going through the whole procedure  
6 and comparing, and we found out that what we had done by in-  
7 creasing it by ten percent was conservative, meaning that if  
8 we did the eccentricity we got less increase in the results  
9 than ten percent.

10 So we did it both ways. In fact, we did it  
11 three ways. Another way was doing it the UBC method.

12 Q What's the UBC method?

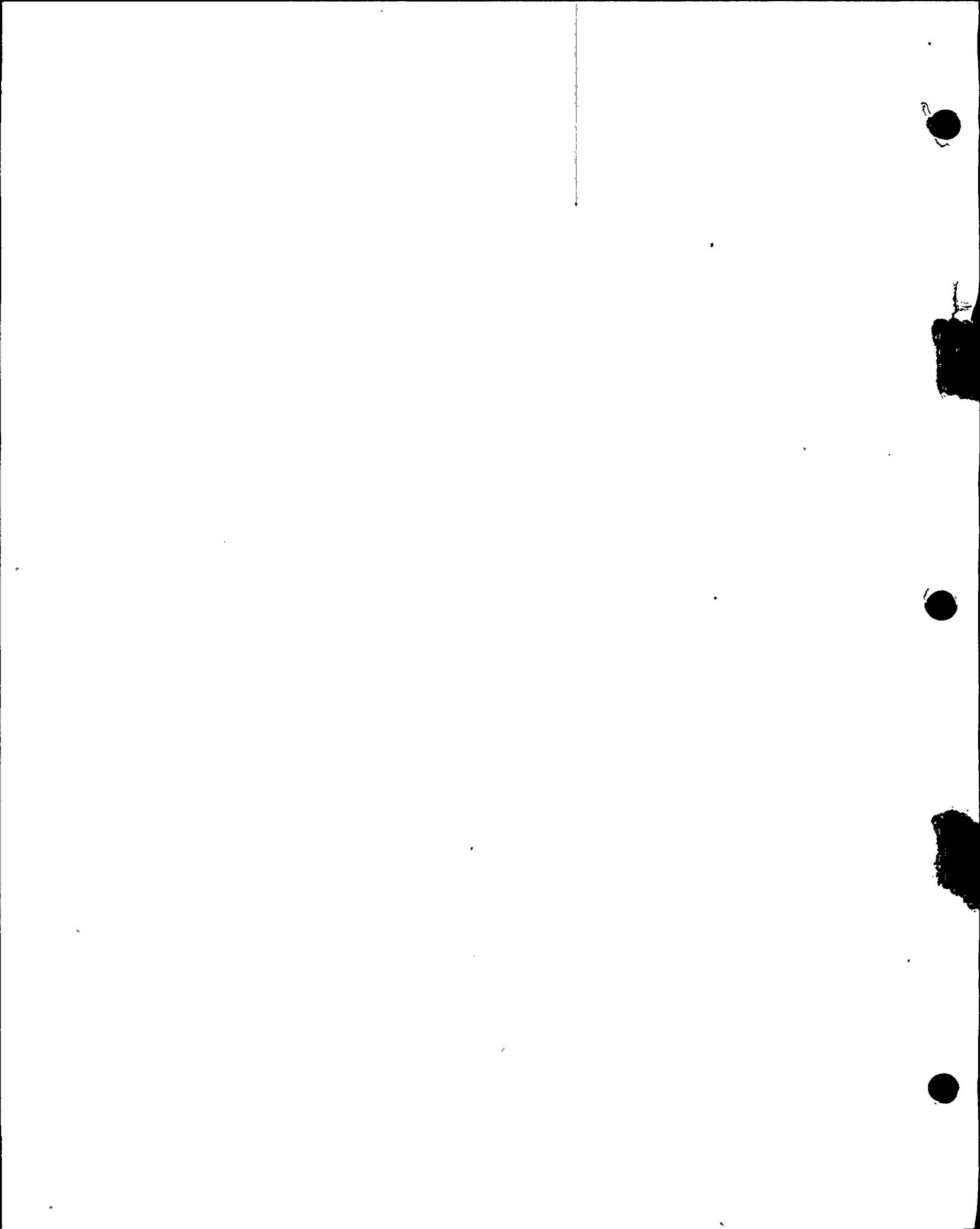
13 A It is an equivalent static method where you take  
14 the shear that's developed, and then you -- instead of doing  
15 a dynamic -- moving the mass, making the mass eccentric and  
16 doing a dynamic analysis, you leave the mass where it is.  
17 You get the floor shears, then you move the shears five  
18 percent off and multiply it by the moment, and get the torsion,  
19 if you follow that.

20 (Laughter.)

21 Q Well, Dr. Malik, what is the physical basis of the  
22 assumption of ten percent?

23 A Well, again it was a judgment factor.

24 The reason that we didn't do the eccentric mass  
25 for the fuel handling building is because it's not a rigid



mpb14

1 floor, it's a steel floor as compared with the concrete  
2 floors in the rest of the building. So the whole idea from  
3 eccentric mass isn't really appropriate. And we decided that  
4 ten percent would be sufficient to take care of that.

5 But, like I said, we compared it to what we  
6 would have if we applied the same criteria as for the concrete  
7 floors, and we found out that ten percent was certainly con-  
8 servative.

9 Q Is there anything in the Standard Review Plan  
10 that says what you should have used?

11 A No.

12 MR. KRISTOVICH: No further questions at this time.

13 MRS. BOWERS: Mr. Ketchen?

14 MR. KETCHEN: Mrs. Bowers, the Staff has no ques-  
15 tions.

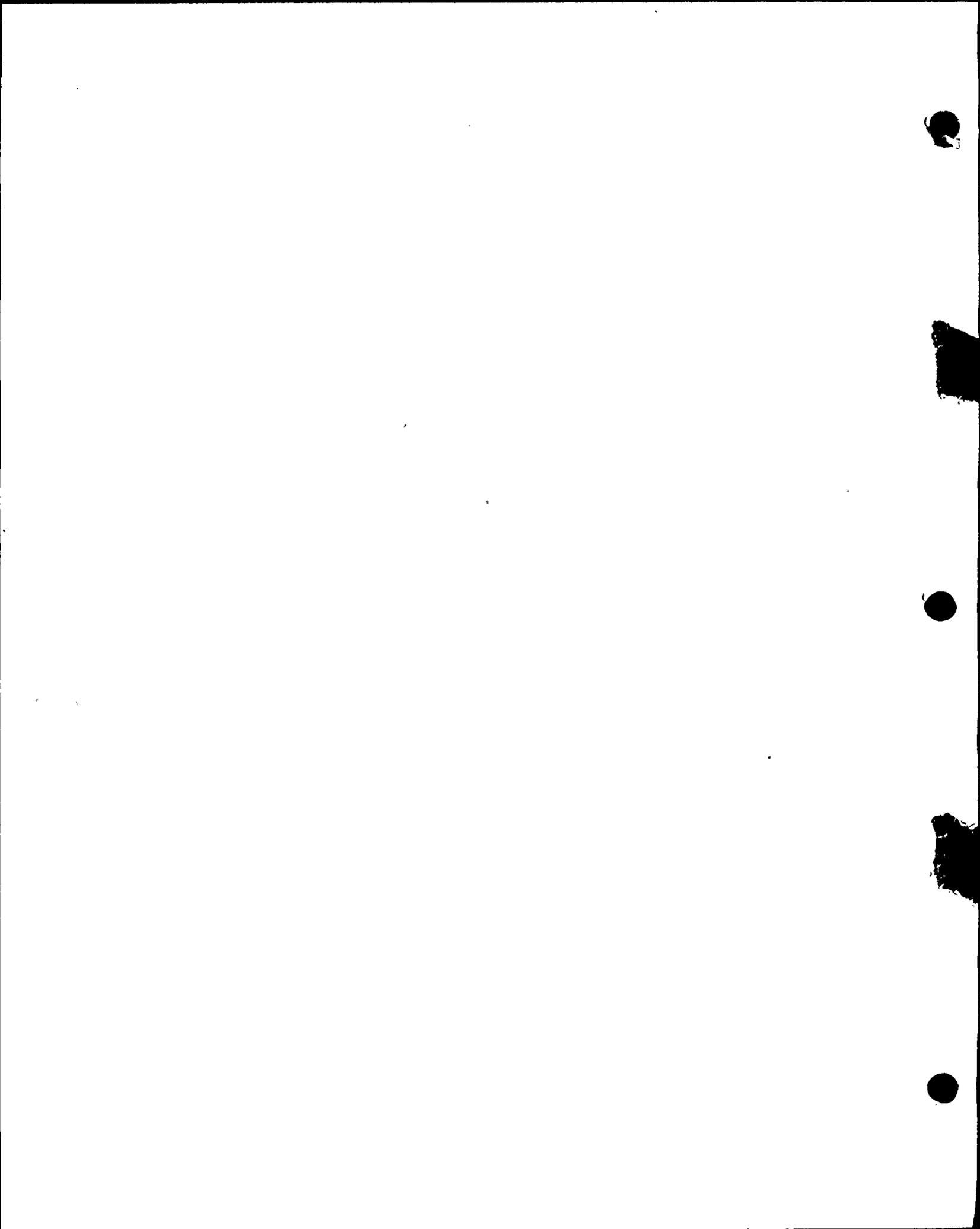
16 MRS. BOWERS: Well, I have some questions.

17 EXAMINATION BY THE BOARD

18 BY MRS. BOWERS:

19 Q I noticed in the direct testimony a reference to  
20 both five percent and seven percent torsion, and that's on  
21 page 3.

22 Dr. Bluma, didn't you tell us several weeks ago  
23 -- and it may have absolutely nothing to do with this -- that  
24 the Staff determined that you have used seven percent torsion.  
25 Was that in an entirely different matter?



mpb15

1 A (Witness Blume) It might have been a different  
2 matter.

3 We used seven percent damping.

4 Q I thought you also used it in relation to torsion.

5 A We used the same damping in relation to torsion.

6 Now I might explain this five and seven -- and  
7 please correct me if I'm wrong.

8 With a five percent assumption, three components  
9 were -- SRSS, which is square root of the sum of the squares --  
10 no, pardon me, that should have been the seven percent.

11 But with the five percent it was the absolute  
12 sum of two components. So there were two separate operations  
13 that had to be gone through there in order to find out which  
14 one would govern in each case. And this was specified or  
15 agreed to with the Staff some time ago.

16 In other words, there was a question as to which  
17 might produce the greatest stresses, and so we had to do it  
18 both ways, take three components and take the square root of  
19 the sum of the squares on the seven; and with the five we just  
20 took the two components and took the absolute sum.

21 Have I got it backward?

22 A (Witness Malik) What we did is just for the  
23 combination of the torsion and the horizontal translation,  
24 just for those two, we took either seven percent or we took  
25 the effect of the torsion and combined it with the effective



mpb16

1 translation in the horizontal direction on SRSS, or we took  
2 five percent eccentricity and combined it with the same  
3 horizontal translation on absolute sum. And we took which-  
4 ever one was greater.

5 And it turned out that adding absolute sum of  
6 five percent eccentricity was the greater consistently, and  
7 that was what we ended up using. But on the three components  
8 we used SRSS all across the board.

9 A (Witness Blume) That was what I was trying to say.

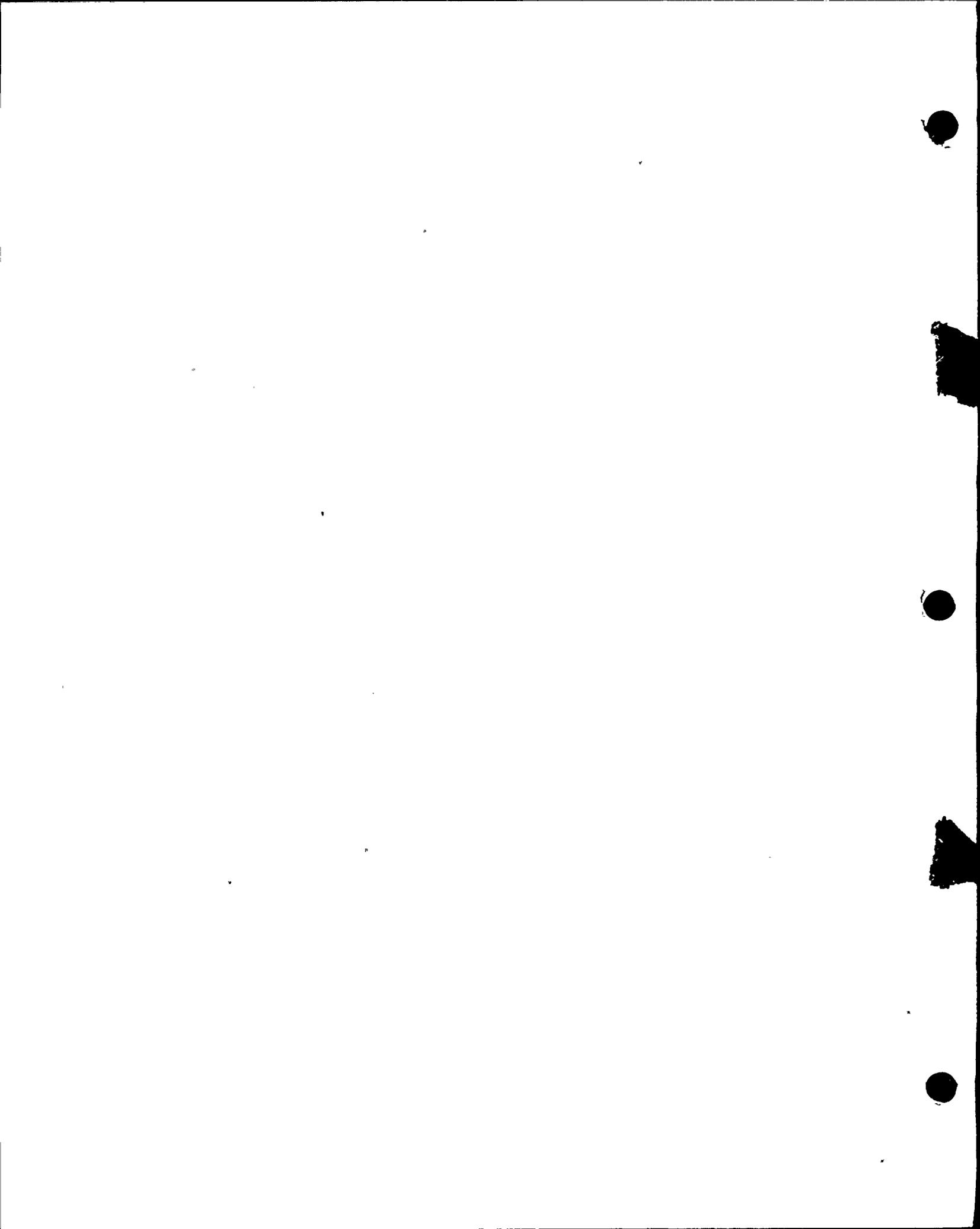
10 (Laughter.)

11 Q Well, then, I have another question that goes to  
12 Table 1 and Table 2.

13 In looking through your direct testimony time  
14 after time you say the minimum safety factor will withstand  
15 the 7.5 magnitude earthquake.

16 But really, what do these figures mean? 1.1  
17 compared to what?

18 A (Witness Ghio) Well, Mrs. Eowers, those factors  
19 of safety I think I stated earlier were calculated by simply  
20 dividing the allowable stress or load in the element using as  
21 a basis the average of the actual material properties of the  
22 material used in the construction. We divided that by the  
23 calculated stress or load based on the seismic dynamic analy-  
24 sis. And in that process we made literally hundreds or  
25 thousands of these types of calculations. And what we're



mpb17

1 attempting to do here is list out the worst cases, the singular  
2 point somewhere in the system that had the lowest value.

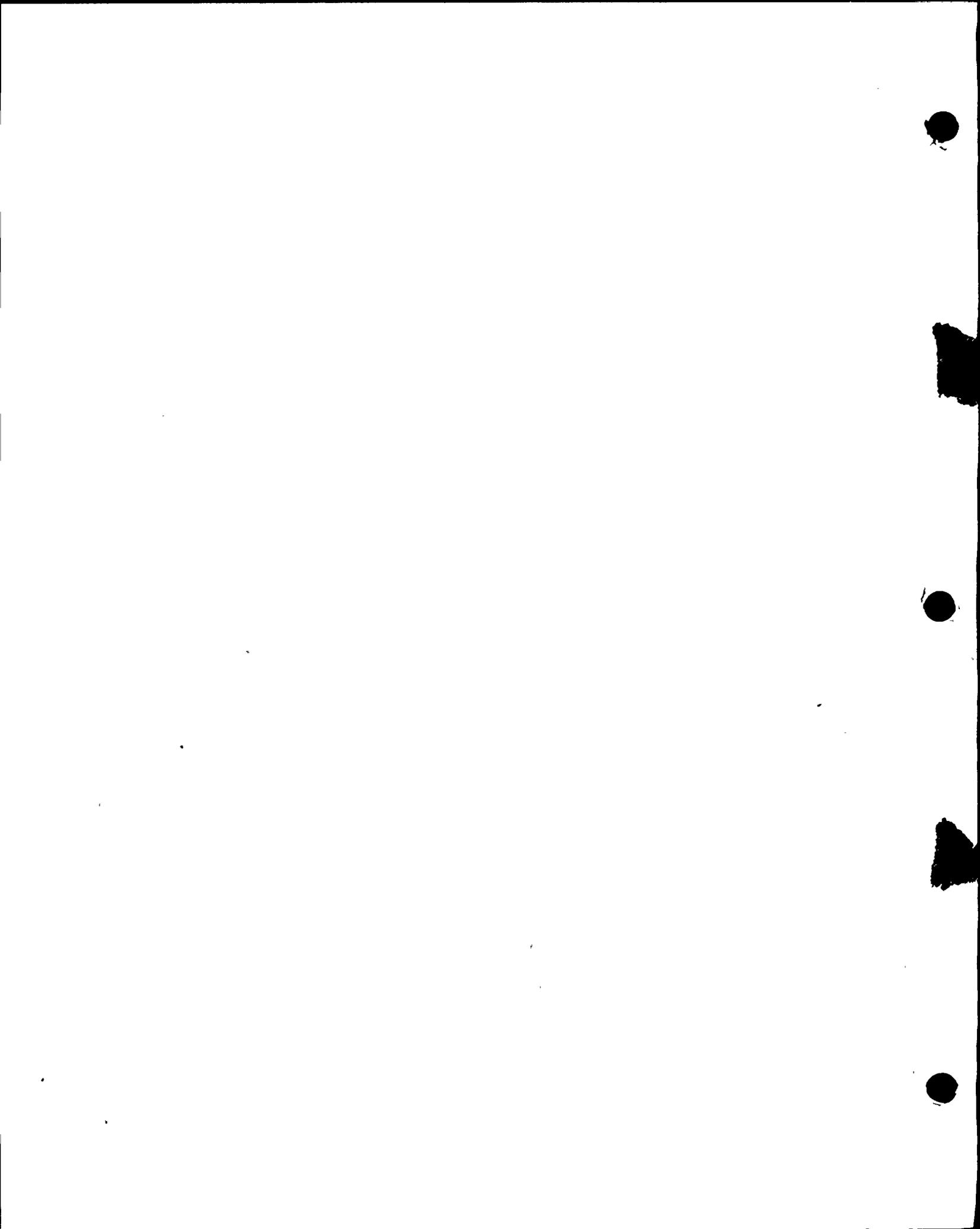
3 And under that kind of a presentation anything  
4 that is equal to one or greater is deemed adequate.

5 Q Fine. You've answered my question.

6 A (Witness Blume) May I add to his answer that  
7 we're dealing here with the worst possible 7.5 magnitude,  
8 the 115 instrumental, the .75g effective, all of these things,  
9 and going through this whole very very conservative approach  
10 we wind up with the -- still having a margin of ten percent  
11 on one member out of 200 or so.

12 In other words, there is a safety margin even  
13 after going through these very rigorous and conservative  
14 procedures that we've been talking about for the whole two  
15 weeks.

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1 MRS. BOWERS: Let me check and see if the Board's  
2 questions stimulated any questions on the part of the parties.

3 Mr. Norton?

4 MR. NORTON: Just one.

5 CROSS-EXAMINATION ON BOARD QUESTIONS

6 BY MR. NORTON:

7 Q When Dr. Blume just said that you go through and  
8 you find one of 200 having a margin of safety of 10 percent,  
9 that's the lowest of the 200 pieces?

10 A (Witness Blume) Oh, yes. The others are all  
11 higher. These are the very lowest listed here.

12 Q In other words, the worst case?

13 A Worst case.

14 MRS. BOWERS: Didn't the direct testimony say  
15 170 walls, approximately 170 walls? Now you're saying 200?

16 WITNESS SOKOLOFF: In the case of the walls  
17 there were approximately 170 walls. The point of elevation,  
18 at some elevation we have 200. But we took the least amount,  
19 or least wall elevation, yes.

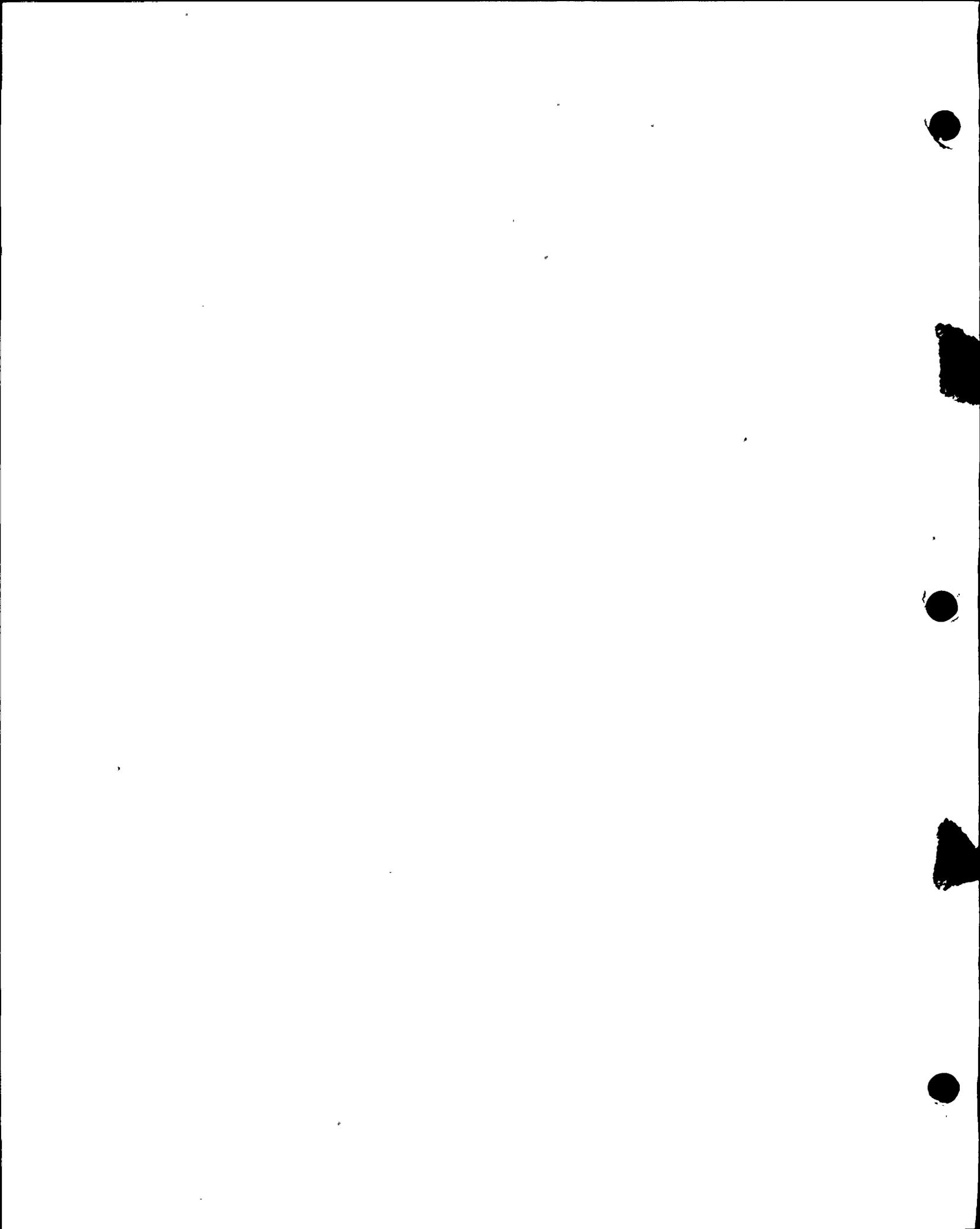
20 MRS. BOWERS: Do you have anything further, Mr.  
21 Norton?

22 MR. NORTON: Yes, I do. Just a moment.

23 (Pause.)

24 BY MR. NORTON:

25 Q Dr. Blume, if you would turn to page 43 of your



1 testimony, the table on tau and PGA values --

2 A (Witness Blume) Yes, I have it.

3 Q Under the Blume criteria auxiliary buildings,  
4 you have a tau of .052, and a PGA of .36 g. What is PGA?

5 A Peak ground acceleration, meaning here effective.

6 Q Okay. And that was a reduction from .75, I  
7 believe -- the testimony was -- I forget what the percentage  
8 was, but it didn't make any mathematical sense to me, and I  
9 forget what the question was from the attorney, counsel for  
10 Intervenors. But he asked you whether or not that's a  
11 reduction of "X" percent, and I think you said yes.

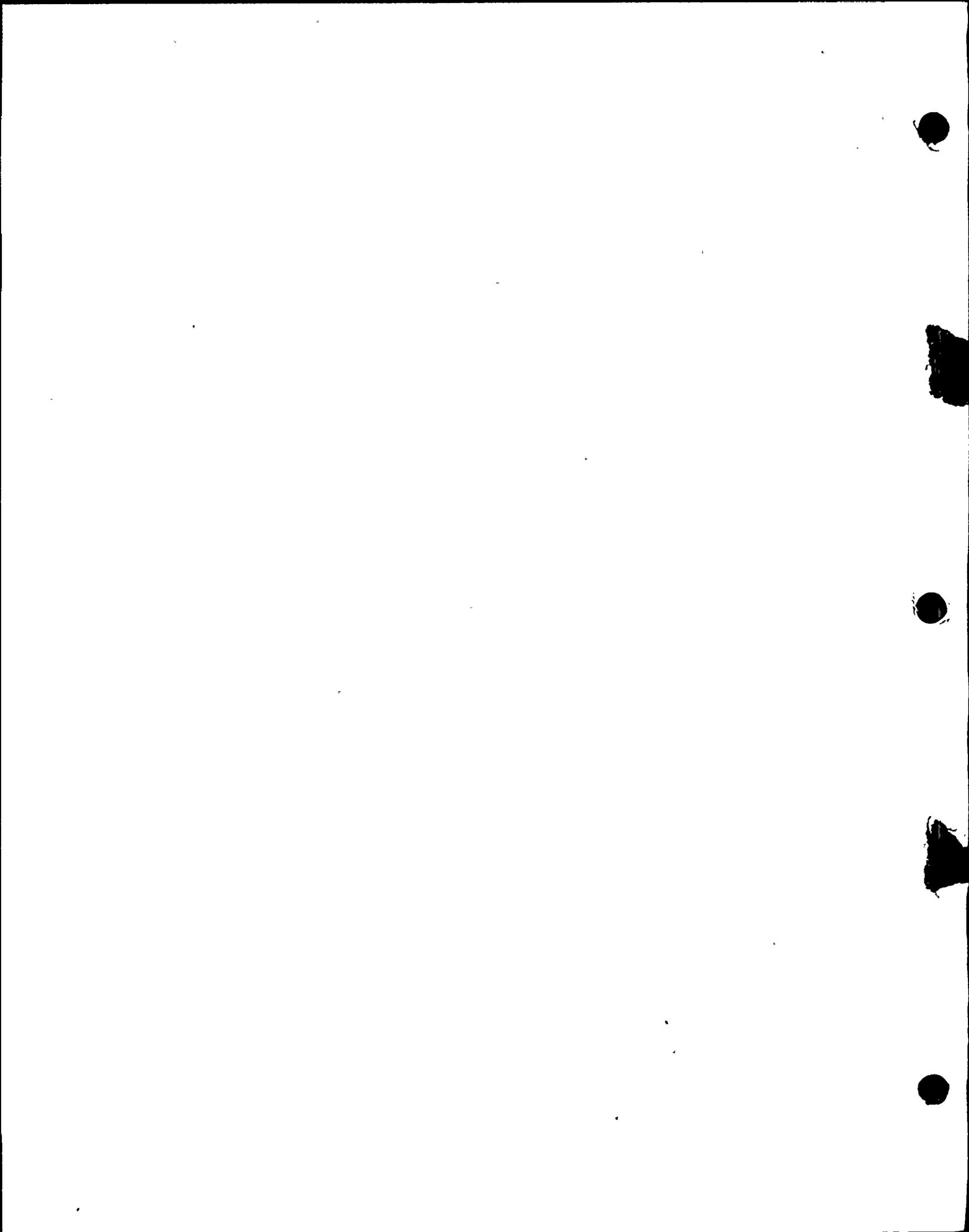
12 A I think he asked Mr. Chic, and they agreed on  
13 the percentage. And I objected because that applies only to  
14 the zero period.

15 Q Well, that was when we got to the Newmark  
16 criteria, which is the next one, when you objected and said  
17 it applied to --

18 A Well, it applies to both of them.

19 Q Okay. But what I want to do is establish what  
20 that reduction is in terms of percentage, because are we  
21 talking about a reduction in terms of percent of gravity?  
22 Is that the percentage reduction we're talking about, or are  
23 we talking about the percentage of reduction of the number,  
24 which is not the same as reduction of the percent of gravity?

25 A It's of the number, the latter.



1 Q All right, I just wanted to get that clear on  
2 the record.

3 How does one compute that? You go from .75, you  
4 take away .63, and you get 12, a reduction of 12. And you  
5 divide that by what?

6 A .75.

7 Q All right. And that gives you the percentage?

8 A Yes.

9 Q Now, I didn't see anybody doing those mathematical  
10 calculations, and I frankly can't do that in my head very  
11 well. How did you people get those numbers so quickly and  
12 agree to them so quickly?

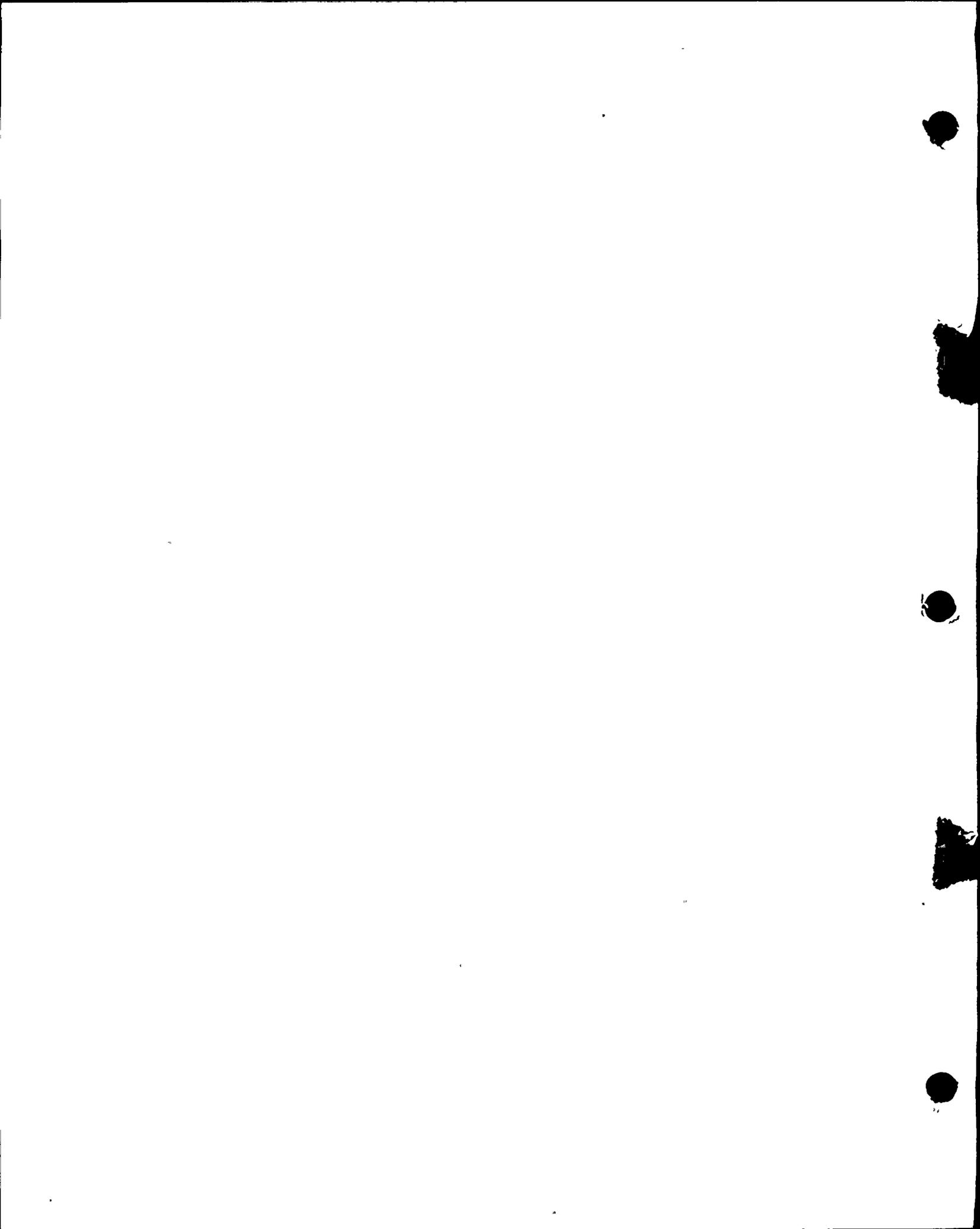
13 (Laughter.)

14 You see, that's what concerns me a little bit.  
15 I wonder if counsel for Intervenor was't just subtracting  
16 and using that as the percentage, or if he had actually  
17 calculated those, if he'd taken 12 and divided it by 65 to  
18 come up with a percent, and if you did so in response to the  
19 questions?

20 A Well, in your head you'd get about one-seventh  
21 or one-sixth, and, of course, that can easily be done. But  
22 it's really meaningless because it applies only to the zero  
23 period.

24 Q Okay. That's the next part I want to go into.

25 Now, there was -- this was also gone into in the



1 previous panel with the containment structures, about the  
2 percentage reduction because of the tau factor, and now with  
3 the auxiliary building. And both times you stated, well,  
4 that's at the zero period.

5 What's the significance of that statement?

6 A Well, at the zero period there are no structures  
7 or equipment of absolutely zero period. Everything, as has  
8 been pointed out, has some flexibility, even though it may be  
9 fairly rigid. It still has some flexibility.

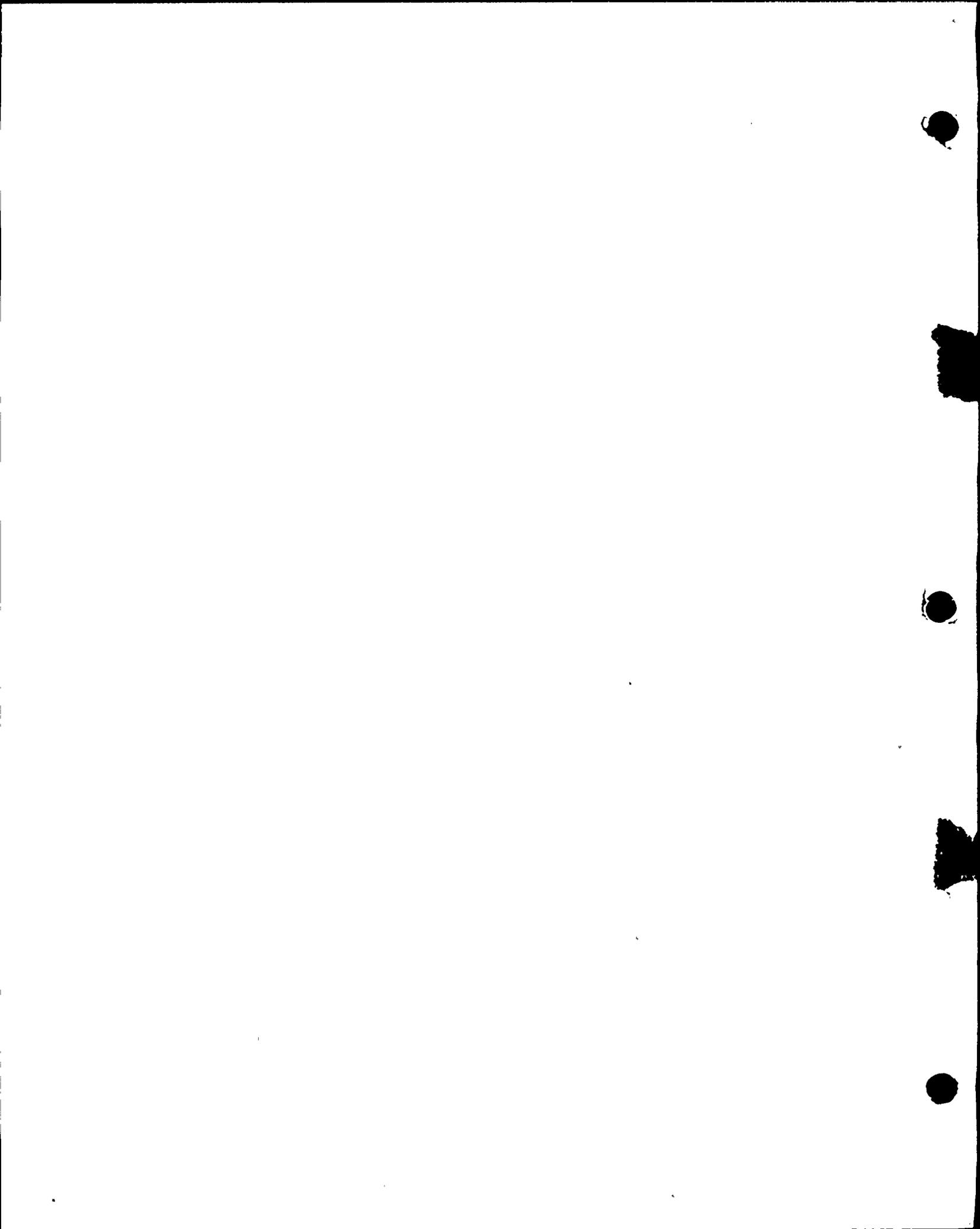
10 As you get out into the spectral curves which  
11 are shown in the latter part of my direct testimony of two  
12 weeks ago, you'll see that the amount varies with period, the  
13 amount of the reduction, the so-called tau reduction, and as  
14 you approach four-tenths and five-tenths seconds it disappears,  
15 it vanishes, there is no more reduction in our curve.

16 Q All right. And is that at the period at which  
17 buildings start becoming affected?

18 A Yes, the auxiliary building that we've been  
19 talking about has a fundamental mode of the superstructure,  
20 in right about four-tenths of a second. Is that about --

21 A (Witness Sokoloff) For the steel, .434, I think.

22 A (Witness Blume) .43 for the steel superstructure  
23 of the auxiliary building, which this panel is talking about,  
24 which means that on the Blume curve there's no reduction  
25 whatsoever for tau at that period.



1 Q So, in other words, where it's of concern to the  
 2 building, or where you have concern about the building, what  
 3 the building is seeing, you are not taking any reductions for  
 4 tau, is that correct?

5 A That's correct, for the fundamental mode of the  
 6 superstructure of this building.

7 Q Is the same thing true with the containment  
 8 building? The same general conclusion, is that true of the  
 9 containment building, where you're not taking significant  
 10 reduction for tau in the period in question?

11 A I think to answer that I should look at the  
 12 curve.

13 Q All right.

14 (Pause.)

15 A In the case of the containment structure, there  
 16 is some reduction at the period of the fundamental mode.

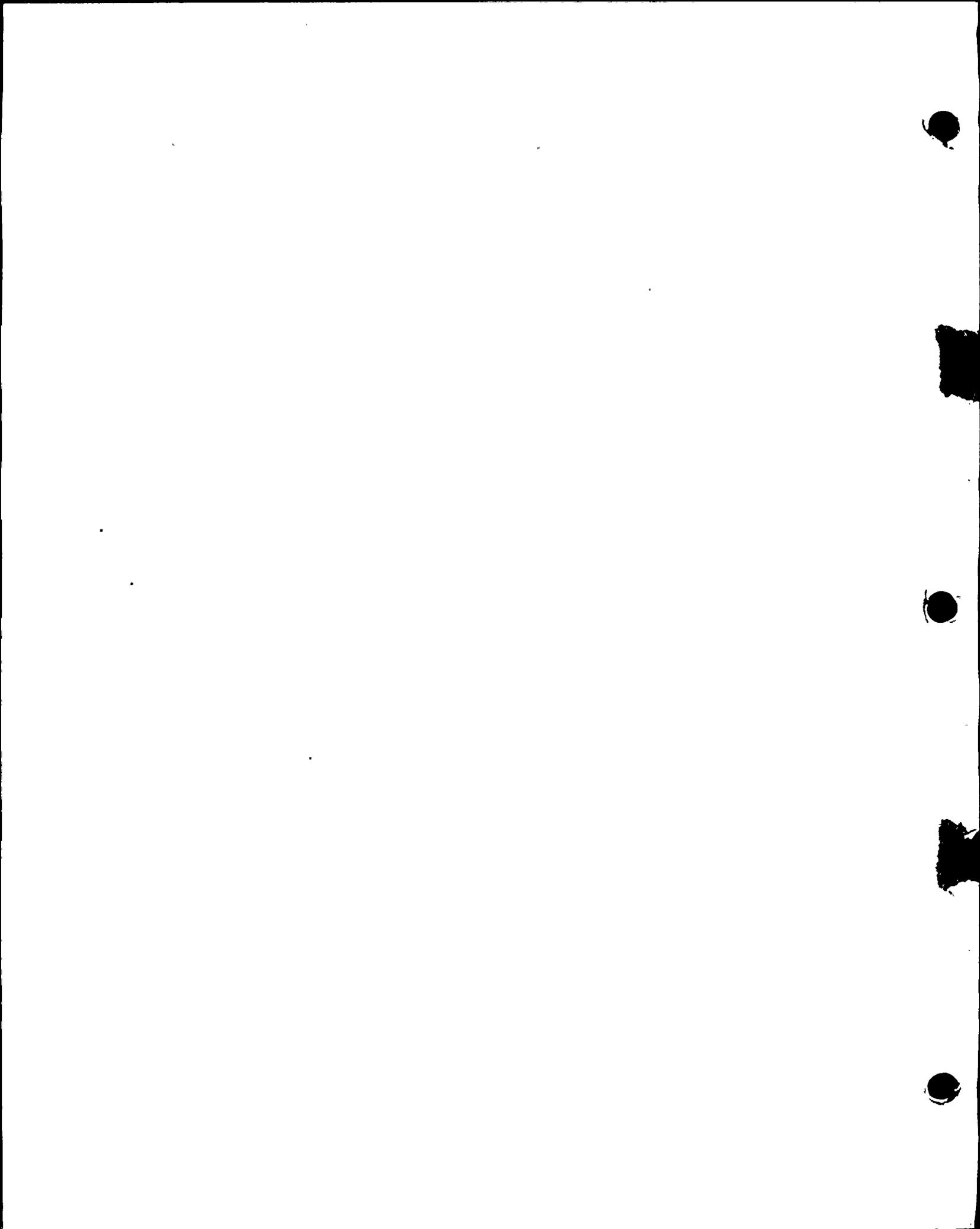
17 Q All right, but it's not as great as it would be  
 18 at the zero period?

19 A That is correct.

20 Q In no case would it be as great as it would be at  
 21 the zero period, is that correct?

22 A Well, -it would only be true if we were dealing  
 23 with a very, very rigid system.

24 Q All right, but when I said in no case, I'm  
 25 talking about --



1 A For the building, that's correct.

2 MR. NORTON: That's all I have.

3 MRS. BOWERS: Mr. Kristovich?

4 BY MR. KRISTOVICH:

5 Q Mr. Blume, I have a couple of questions.

6 What is the reduction at the fundamental mode?

7 What is the fundamental mode for the containment?

8 A (Witness Blume) It's about a fifth of a second,  
9 the exterior shell is about .21 seconds -- I think .22 seconds.  
10 Yes, .22.

11 Q How much would the reduction be, then, at the  
12 fundamental mode in the containment?

13 A Well, we have to find the right curves to go  
14 through that exercise.

15 Q Figures 12 and 13, I believe.

16 (Pause.)

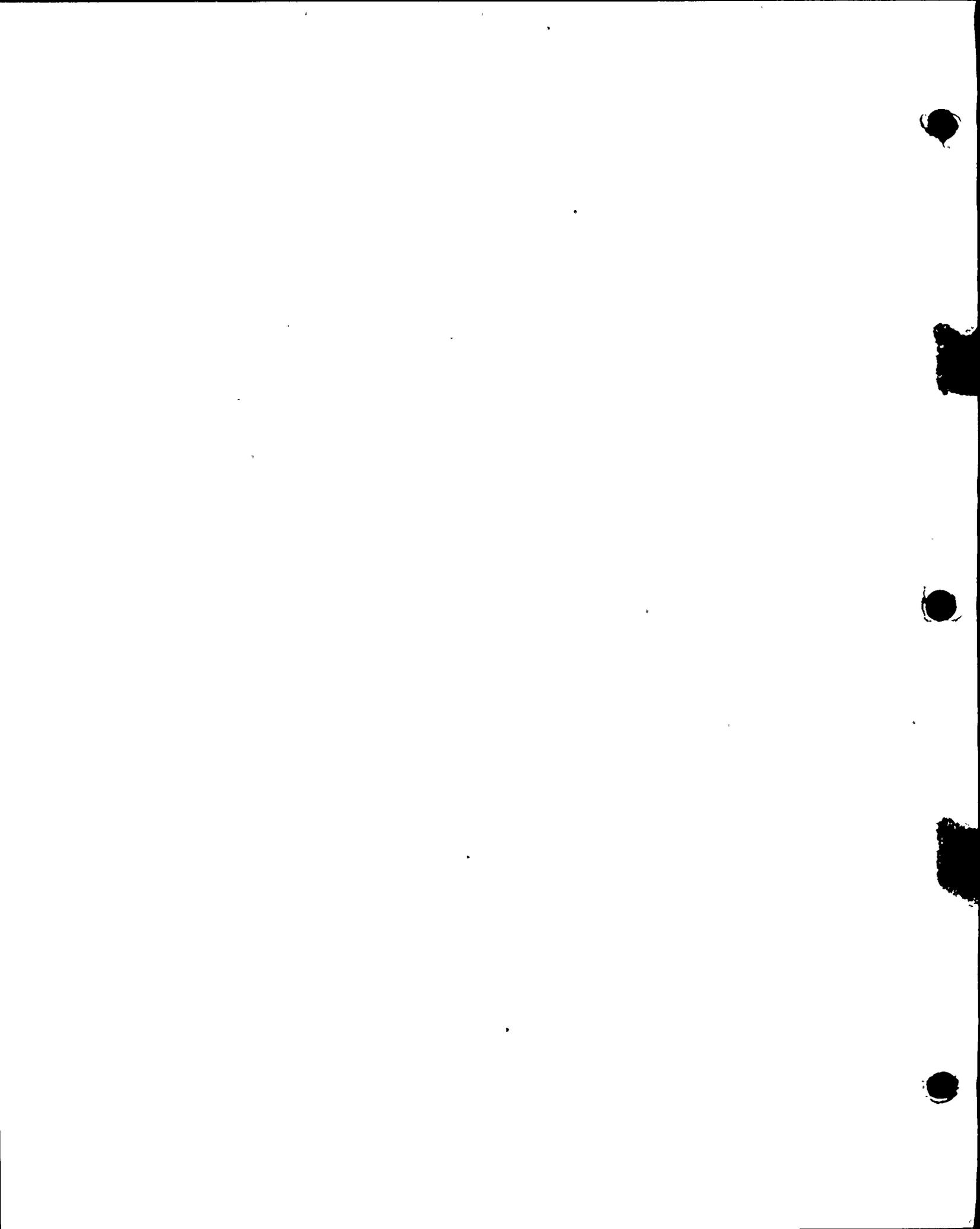
17 A It seems to be about 12 percent at that point.

18 MR. NORTON: And how much was it at the zero  
19 period?

20 WITNESS BLUME: They tell me 11 percent. About  
21 the same.

22 WITNESS MALIK: I volunteered this, by the way.  
23 We don't have a scale --

24 WITNESS BLUME: This is not the way to do it.  
25 It should be done very carefully, using both the Newmark and



1 the Blume figures, and go through this. If it's an important  
2 issue it should be done more carefully.

3 But these are about what the reductions are.  
4 And I say reductions from a very, very high point to start  
5 with.

6 BY MR. KRISTOVICH:

7 Q Well, did you use actual material strength to  
8 come up with the fundamental mode?

9 A (Witness Blume) Yes. The modulus of elasticity  
10 that was finally used was the actual test value, is that  
11 correct?

12 A (Witness Malik) Yes. And may I add, if we had  
13 used the specified material properties the structures would  
14 be more flexible, and in that case it would help us. We'd  
15 be coming down on the curve.

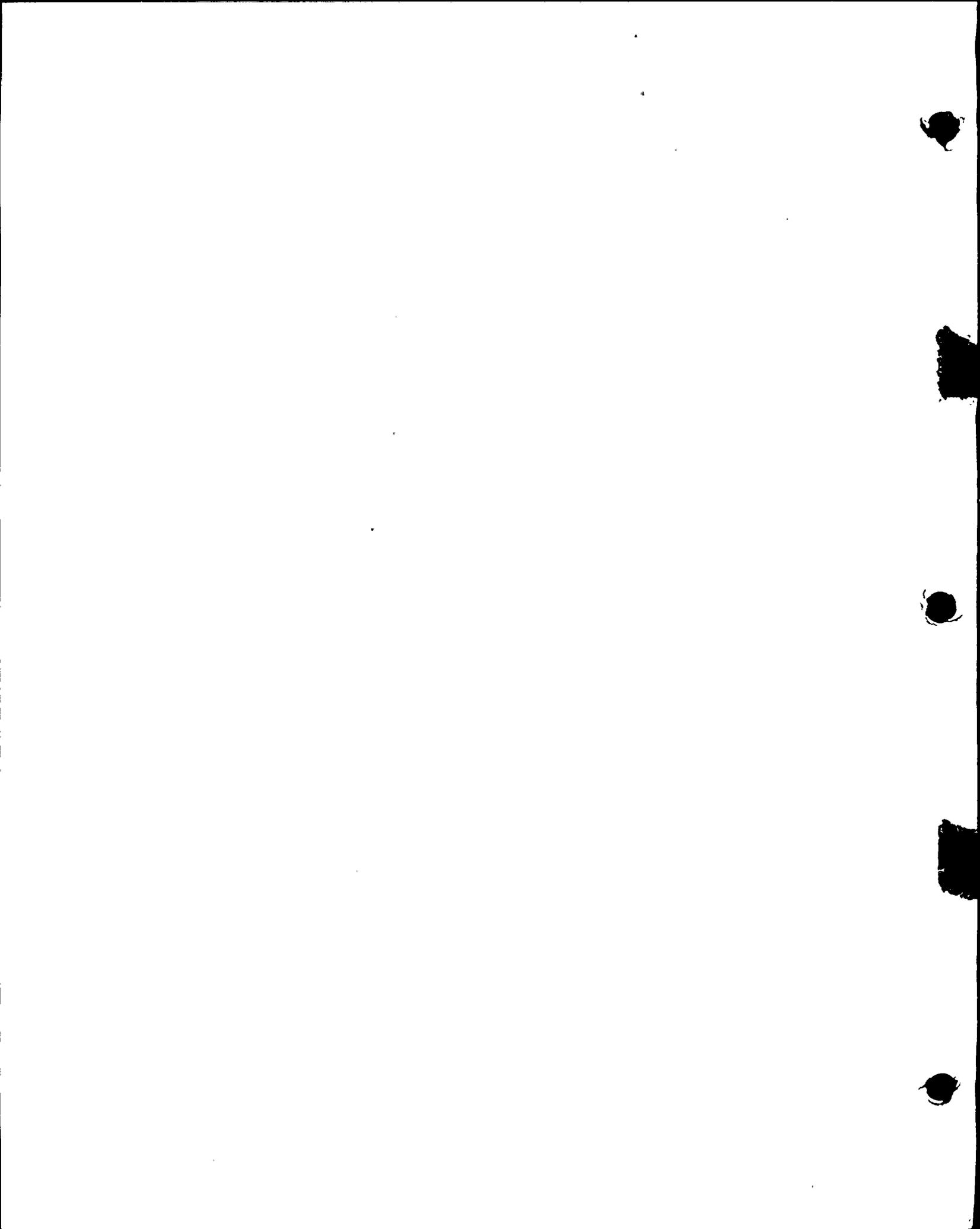
16 Q But there would then be a larger difference  
17 between the Newmark and the Blume spectra, would there not?

18 A (Witness Blume) No, not necessarily.

19 Q Why not?

20 A In fact, I think there'd be a lesser difference  
21 if we lengthened the period hypothetically. We're close to  
22 the hump on both curves. And frankly it wouldn't make much  
23 difference one way or the other in that particular point.

24 Q Dr. Blume, I may have not heard what you said,  
25 but did you say in response to a question from Mr. Norton the



1 tau factor does not affect the structural analysis?

2 A I don't think I said that. I'm curious as to  
3 what the basis for that question is.

4 MR. KRISTOVICK: No further questions.

5 MRS. BOWERS: Mr. Ketchen?

6 MR. KETCHEN: Yes, Ma'am.

7 BY MR. KETCHEN:

8 Q I do have a question, and it's based on Mr.  
9 Kristovich's last question, which I think was based on a  
10 question asked by Mr. Norton.

11 You testified in response to the question -- at  
12 least my notes show -- that there is no tau effect taken for  
13 the auxiliary building.

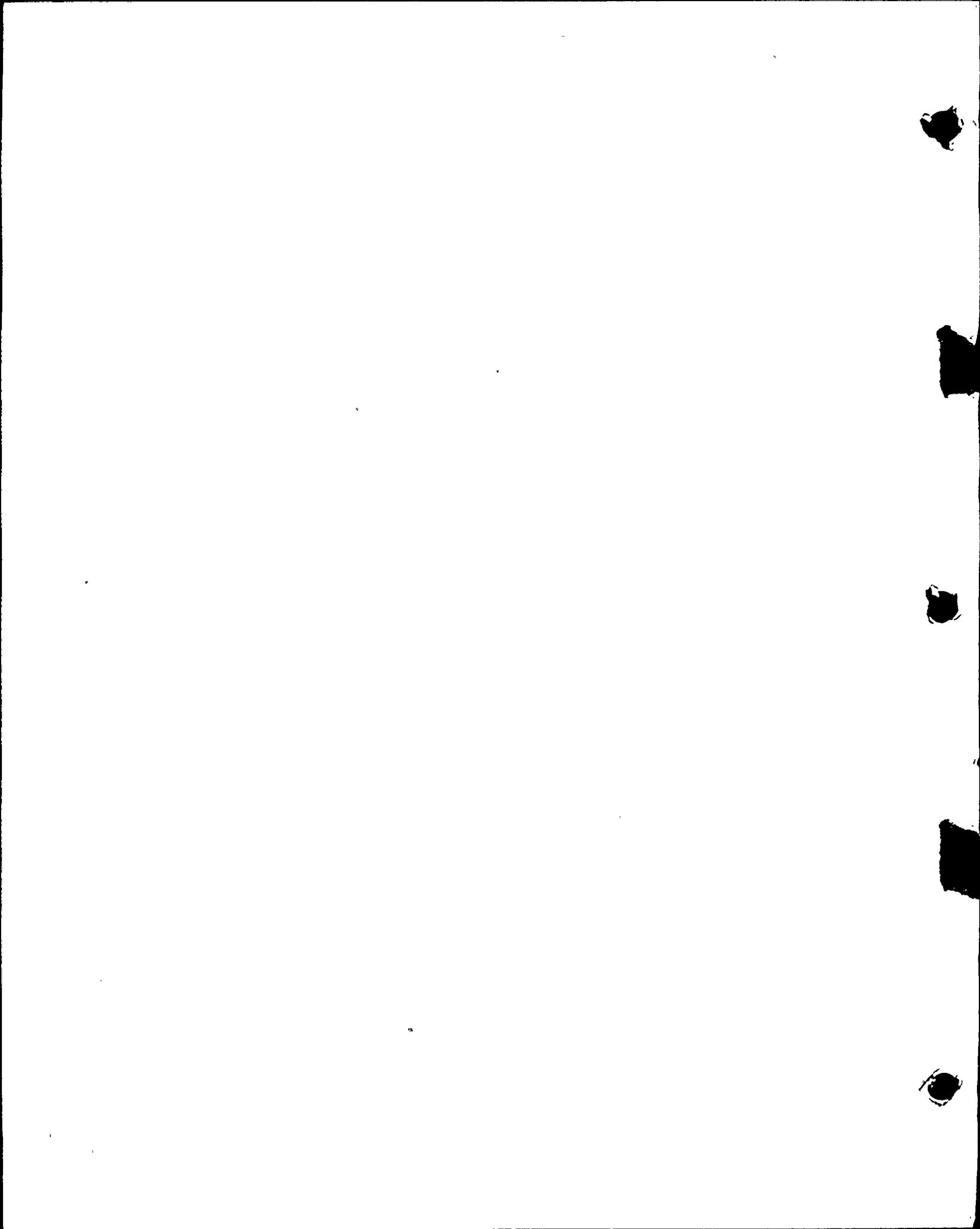
14 Is that correct?

15 A (Witness Blume) That is correct, for the  
16 fundamental mode of the auxiliary building. Maybe that was  
17 the basis for counsel's previous question.

18 Due to the fundamental mode period being in the  
19 order of four-tenths to forty-five hundredths seconds, we are  
20 reaching the point in the spectral diagram where the tau  
21 reduction no longer is there. It just vanishes.

22 Q Are you talking about structural steel, or  
23 concrete, or both?

24 A The superstructure of the auxiliary is structural  
25 steel.



1 Q What would your answer be with respect to the  
2 concrete portion of the building?

3 A There we're coming down into a much more rigid  
4 mode, and we would be reaching a point where there would be  
5 some tan reduction.

6 MR. KETCHEN: Thank you, sir.

7 MRS. BOWERS: Does that end your cross-examina-  
8 tion, Mr. Ketchen?

9 MR. KETCHEN: Yes, Ma'am, thank you.

10 MRS. BOWERS: My notes show on Wednesday a.m.,  
11 Dr. Blume, December 20, you talked about NRC considering a  
12 five percent and a seven percent torsion, and the seven  
13 percent was selected.

14 WITNESS BLUME: Well, actually, both were  
15 selected. Both the five and the seven. And we were obliged  
16 to treat both of them, but in different ways, and to use  
17 whichever result turned out to be the most critical.

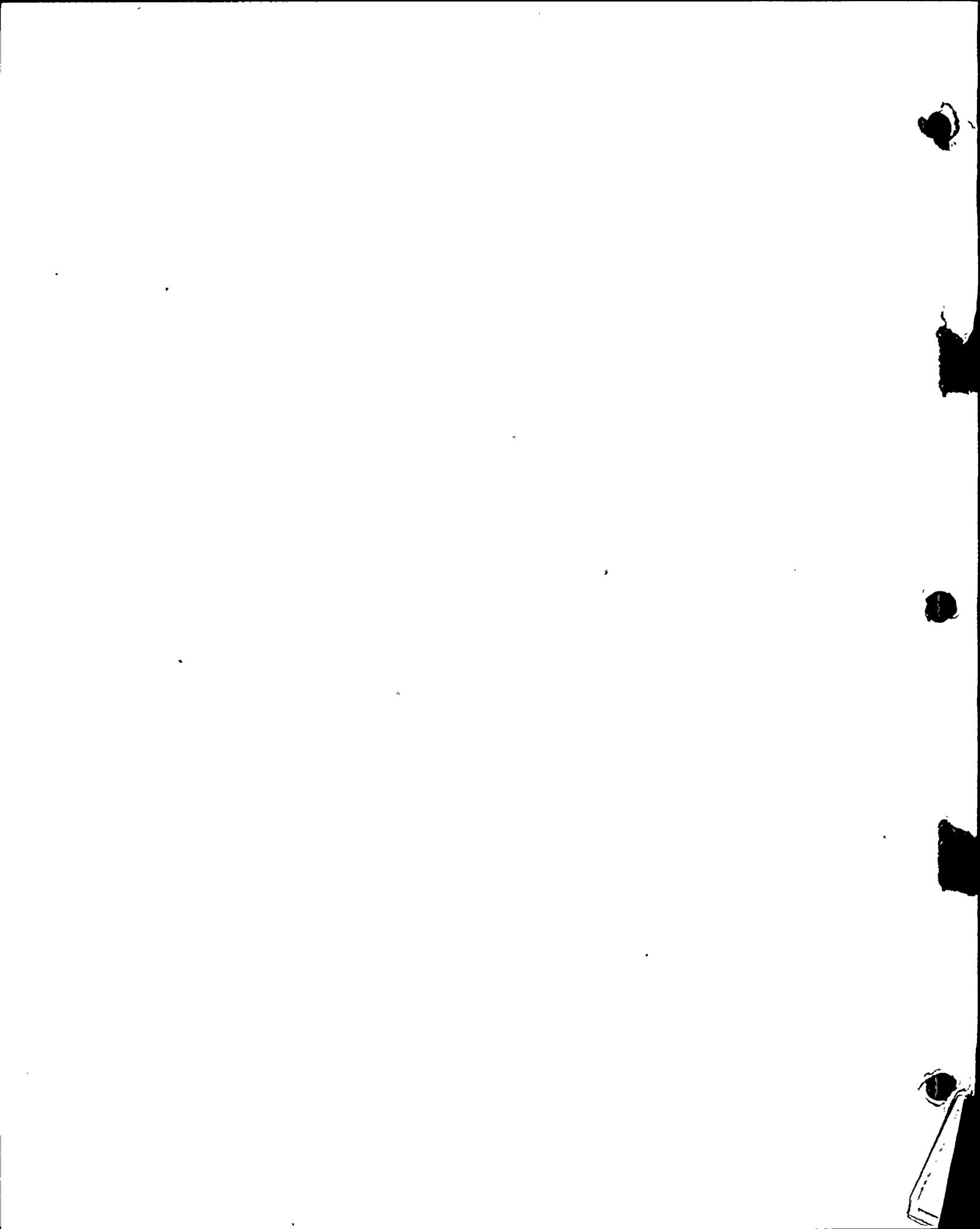
18 So all the way through there has been both a  
19 five percent eccentricity and a seven percent eccentricity  
20 tried. It so happens that the five on the absolute sum  
21 basis generally governed.

22 MRS. BOWERS: Thank you.

23 If there's nothing further, it's 5:00 o'clock.

24 (Laughter.)

25 The alarm just went off. Are these witnesses



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to be -- are they going to put on another set of hats for tomorrow morning?

MR. NORTON: Yes, except for Mr. Skoloff, and I guess Mr. Malik disappears off of this panel for awhile, and Mr. Jhavari.

My gosh, we're going to have almost a new case of characters.

MRS. BOWERS: So how do you want these witnesses --

MR. NORTON: They will all be here throughout. I think there's three more panels, and they could be called back for any one of those panels, perhaps.

MRS. BOWERS: All right.

We will recess for the evening, and meet at 8:30 tomorrow morning.

(Whereupon, at 5:00 p.m., the hearing was recessed, to reconvene at 8:30 a.m., Thursday, 4 January 1979.)

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