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Official Transcript of Proceedings

NUCLEAR REGULATORY COMMISSION

Title: Private Fuel Storage, LLC

Docket Number: 72-22-ISFSI; ASLBP No. 97-732-02-ISFSI

Location: Rockville, Maryland

Date: Wednesday, June 19, 2002

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

In the Matter of:	)	
	)	
PRIVATE FUEL STORAGE, LLC,	)	Docket No. 72-22
(Independent Spent Fuel	)	ASLBP No.
Storage Installation)	)	97-732-02-ISFSI
	)	

ASLBP Hearing Room
Third Floor
Two White Flint North Building
11545 Rockville Pike
Rockville, Maryland

June 19, 2002

The above-entitled matter came on for hearing, pursuant to notice, at 10:00 a.m. before:

MICHAEL C. FARRAR, CHAIRMAN
Administrative Judge
U. S. Nuclear Regulatory Commission

THE HONORABLE G. PAUL BOLLWERK, III
Administrative Judge
U. S. Nuclear Regulatory Commission

DR. JERRY R. KLINE
Administrative Judge
U. S. Nuclear Regulatory Commission

DR. PETER S. LAM
Administrative Judge
U. S. Nuclear Regulatory Commission

A P P E A R A N C E S

FOR THE STATE OF UTAH:
Denise Chancellor, Esq.
Connie Nakahara, Esq.
ASSISTANT ATTORNEY GENERAL
Office of the Attorney General
160 East 300 South, 5th Floor
P. O. Box 140873
Salt Lake City, Utah 84114

FOR PRIVATE FUEL STORAGE, LLC:
Paul Gaukler, Esq.
Blake Nelson, Esq.
SHAW PITTMAN
Attorneys at Law
2300 N Street, N.W.
Washington, D.C. 20037

FOR THE U.S. NUCLEAR REGULATORY COMMISSION:
Sherwin E. Turk, Esq.
Martin O'Neill, Esq.
Office of the General Counsel
Mail Stop - 0-15 B18
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

I-N-D-E-X

WITNESS	DIRECT	CROSS	REDIRECT	RECROSS
STEVEN BARTLETT				
By Mr. Turk		11377		11502
By Ms. Chancellor			11496	
By Mr. Gaukler		11474		11503
VINCENT LUK				
By Mr. Turk	11507			
By Mr. Gaukler		11573		
By Ms. Nakahara		11582		

E-X-H-I-B-I-T-S

EXHIBITS

NUMBER	DESCRIPTION	MARK	RECD
Staff			
XX	Soil Mechanics by Wu	11391	11397
YY	Cask and Pad Sketch	11520	11539

1 P-R-O-C-E-E-D-I-N-G-S

2 (10:01 a.m.)

3 CHAIRMAN FARRAR: Good morning, everyone.
4 We're starting an hour later than contemplated. We
5 were advised last night by staff counsel that Dr. Luk
6 had arrived somewhat late and that the parties would
7 prefer to start with him at 10:00 rather than to try
8 to do Plan B and do some soils testimony from 9:00 to
9 10:00. So that's fine with us.

10 Just a word to all the witnesses and
11 counsel in terms of the microphone system: You need
12 to speak directly into it, not too close or we get
13 static, not too far away or the court reporter's
14 system doesn't pick it up. But sometimes even if
15 their system picks it up, we're advised that the
16 people in the audience cannot hear. So if you would
17 do about six inches away, and if the audience can't
18 hear, someone put their hand to their ear and we'll
19 ask the witness to change.

20 Are there any preliminary matters?

21 (No response.)

22 Dr. Luk, the last we saw you, we had
23 called on you so often, you said you were going to
24 move the hotel so we couldn't get you again.

25 (Laughter.)

1 But somehow we've tracked you down, and
2 here we are. So we are ready to proceed with Dr. Luk
3 present.
4 The order of proceeding is staff will be
5 cross examining, with Dr. Luk's assistance, Dr.
6 Bartlett, who's rebuttal testimony to the Luk Report.
7 So, Dr. Bartlett, if you would take again your
8 familiar seat over there?
9 MR. TURK: Before we begin, Your Honor,
10 may I just note my thanks to the Board for agreeing to
11 the 10:00 a.m. start this morning. It gave us a
12 little bit more time. As you noted before, we were
13 working fairly late last night. So it was helpful.
14 CHAIRMAN FARRAR: And we appreciate the
15 indulgence of all of counsel for the other parties in,
16 again, accommodating each other's needs.
17 Dr. Bartlett, of course, you've been
18 previously sworn and you're still under oath.
19 DR. BARTLETT: Yes, Your Honor.
20 WHEREUPON,
21 STEVEN BARTLETT
22 having been previously duly sworn, resumed the witness
23 stand, was examined and testified as follows:
24 CHAIRMAN FARRAR: All right, Mr. Turk,
25 whenever you're ready.

1 Just so the record will be clear, Dr.
2 Bartlett's direct rebuttal testimony on which he's now
3 going to be cross examined appeared in the transcript
4 on June 7th, beginning at page 10,530 and concluding
5 on 10,535.
6 MS. CHANCELLOR: Your Honor, that was only
7 part of the transcript. I gave you those page numbers
8 yesterday, and the other parties may like to confirm.
9 It's also at 10,344 through 10,352 and 10,374 through
10 10,397.
11 If you'll recall, the testimony, rebuttal
12 testimony, was given. It was stricken; it was
13 unstricken, and then we came back for some redirect.
14 So that is what those page numbers reference. I
15 didn't discover that until last night.
16 CHAIRMAN FARRAR: All right, thank you for
17 that. Was that all on June 7th? That was all about
18 the same day?
19 MS. CHANCELLOR: That's correct.
20 CHAIRMAN FARRAR: Okay, hold on.
21 MR. TURK: We're going to make a
22 distribution, Your Honor. We'll get you the pages.
23 In fact, I think we'll do that now.
24 CHAIRMAN FARRAR: All right, go ahead.
25 MR. TURK: For the record, let me note

1 that we're distributing pages from the transcript of
2 June 7 in which Dr. Bartlett presented his oral
3 rebuttal to Dr. Luk. The handout that we are
4 distributing also includes some other pages that are
5 not part of the rebuttal. But I won't be asking
6 questions about matters that are not part of the
7 rebuttal. That's not my intention. They just happen
8 to be as part of this handout.
9 May we go off the record for a moment?
10 CHAIRMAN FARRAR: Yes.
11 (Whereupon, the foregoing matter went off
12 the record at 10:06 a.m. and went back on the record
13 at 10:07 a.m.)
14 CROSS EXAMINATION BY MR. TURK
15 MR. TURK: Dr. Bartlett, before we begin
16 questions with respect to the testimony you gave, I
17 would like to ask you something a little bit more
18 about your personal background, your professional
19 background.
20 DR. BARTLETT: Yes.
21 MR. TURK: You are currently an Assistant
22 Professor of Civil and Environmental Engineering at
23 the University of Utah?
24 DR. BARTLETT: That's correct.
25 MR. TURK: Is that a full-time job or a

1 part-time job?

2 DR. BARTLETT: Full-time.

3 MR. TURK: In addition, you also serve as

4 a consultant to various construction projects within

5 the State of Utah? Or is that --

6 DR. BARTLETT: That was primarily, I

7 think, previous experience with Woodward-Clyde.

8 MR. TURK: Okay. In your work at the

9 University of Utah, could you describe the courses

10 that you teach?

11 DR. BARTLETT: The courses that I teach or

12 have taught are the undergraduate geotechnical

13 courses; geotechnical course 1, we call it,

14 geotechnical course 2. I've also taught field and

15 laboratory testing of soils, earthquake geotechnical

16 engineering. I believe that's all I've taught thus

17 far.

18 MR. TURK: Have you taught courses in

19 conducting finite element analysis?

20 DR. BARTLETT: No.

21 MR. TURK: Have you taught any courses in

22 structural mechanics?

23 DR. BARTLETT: No, I'm a geotechnical

24 engineer.

25 MR. TURK: Have you ever conducted a

1 finite element analysis?

2 DR. BARTLETT: Yes.

3 MR. TURK: Where was that?

4 DR. BARTLETT: I have run finite element

5 code for seepage analysis, finite element code to

6 develop to measure stress, to estimate stresses and

7 strains in soils. I think those are the two codes

8 that I've run.

9 MR. TURK: You've indicated that you've

10 run code. Have you ever designed a model, a finite

11 element analysis model?

12 DR. BARTLETT: No, I've just run previous

13 models that were developed by others.

14 MS. CHANCELLOR: Your Honor, could I --

15 I'm sorry to interrupt, Mr. Turk. Could I just make

16 an inquiry, is this handout also for Dr. Luk's

17 rebuttal? Because there's a whole chunk in here of

18 the transcript you handed out from 10,411 through

19 10,469 that has nothing to do with Dr. Bartlett's

20 testimony on rebuttal. There is a lot of this with

21 Dr. Ostadan.

22 But if this courtesy copy is for purposes

23 of examining Dr. Bartlett as well as what you may use

24 with Dr. Luk, that's fine, but if it deals with Dr.

25 Bartlett's rebuttal, then the pages I mentioned,

1 10,411 through 10,469, are not what -- if you
2 remember, Your Honor, we kept on taking hats on and
3 off. I just want to make sure before the questioning
4 starts that we don't get into those areas.
5 MR. TURK: Your Honor, when I distributed
6 the pages, I indicated there was material in the
7 handout that went beyond the cross examination I was
8 going to conduct. I can't sit down now and explain to
9 Ms. Chancellor why different pages are found in this
10 handout. When I conduct rebuttal examination of Dr.
11 Luk, if you believe that I am straining beyond, if Ms.
12 Chancellor believes that, she can raise that objection
13 then.
14 CHAIRMAN FARRAR: Mr. Turk, the extra
15 pages are in here just because of a copying error
16 or --
17 MR. TURK: No, Your Honor. When I
18 assembled these pages, I was taking everything out of
19 the transcript that referred to Dr. Luk, regardless of
20 whether it would be cross examination or rebuttal.
21 MS. CHANCELLOR: Okay, so this handout is
22 also relevant to rebuttal that you're going to be
23 conducting with Dr. Luk?
24 MR. TURK: What I said is exactly opposite
25 of what you just stated. There are materials in the

1 handout that relate to Dr. Luk, regardless of whether
2 it's going to be examined upon now or in rebuttal
3 testimony by Dr. Luk. It goes beyond.
4 CHAIRMAN FARRAR: But, in any event, is
5 this is nothing but a courtesy copy of a prior
6 transcript. So, in a sense, it doesn't matter what's
7 in it; we will deal with it as we go along, I think.
8 MR. TURK: I would agree with that, Mr.
9 Chairman.
10 CHAIRMAN FARRAR: Okay.
11 JUDGE LAM: Mr. Turk, are the corrections
12 to the transcript made by you?
13 MR. TURK: There are no corrections that
14 I have made. I think I had marked in some circles at
15 different places. Oh, there was one correction that
16 I had put in. That's not an intention to correct the
17 transcript. I noted that as I was reading it and
18 happened to make that stray mark. But the transcript,
19 except for the hand notations that you will see in
20 there, is the same transcript that is part of the
21 official record of this proceeding.
22 JUDGE LAM: Perhaps with one minor
23 exception. On page 10,465, on line 1, I'm glad
24 somebody corrected that part of the transcript. The
25 court reporter reported a question about "end-house

1 loading", corrected to "in-house loading," which is
2 exactly right. I'm glad that correction was made.
3 MR. TURK: Thank you. In fact, when the
4 parties propose their transcript corrections, I think
5 we'll include that one to make sure that the official
6 transcript bears that same correction.
7 May we proceed?
8 CHAIRMAN FARRAR: Yes, go ahead.
9 MR. TURK: Okay.
10 Apart from your critique of Dr. Luk's
11 finite element analysis in this proceeding, have you
12 ever critiqued a finite element analysis involving the
13 placement of a structure on soils or cement-treated
14 soils?
15 DR. BARTLETT: I'm not sure it's fair to
16 characterize that I've critiqued the finite element
17 model used by Dr. Luk. I think what I was reviewing
18 was how the soil properties were used in the model.
19 MR. TURK: Have you ever provided an
20 evaluation of how interfaces have been modeled in a
21 finite element analysis, apart from your evaluation of
22 Dr. Luk's?
23 DR. BARTLETT: I typically provide
24 geotechnical properties to models for use in the
25 models, whether they be finite element or finite

1 difference.

2 MR. TURK: When you do that, are you

3 essentially providing geotechnical properties of the

4 materials used?

5 DR. BARTLETT: The soils.

6 MR. TURK: The soils?

7 DR. BARTLETT: Yes.

8 MR. TURK: Have you ever evaluated how

9 interfaces are modeled in a finite element analysis

10 other than this proceeding?

11 DR. BARTLETT: Are you speaking from a

12 modeling sense or from a property sense?

13 MR. TURK: Well, let's take them both.

14 DR. BARTLETT: Like I said before, I

15 provide, quite often, products of materials that could

16 be interpreted as what is used at the interfaces.

17 Have I reviewed how interfaces are actually modeled by

18 a finite element program? No.

19 MR. TURK: I would like to begin examining

20 on your rebuttal testimony at page 10,347.

21 DR. BARTLETT: Yes.

22 MR. TURK: In your answer, beginning at

23 line 9 and continuing on to line 20 --

24 DR. BARTLETT: Yes, I see that.

25 MR. TURK: Okay. The last sentence of

1 that paragraph states that, quote, "My understanding
2 is that table 8 of the Luk report summarizes the
3 interface conditions that he used in his modeling."
4 DR. BARTLETT: Uh-hum.
5 MR. TURK: When you made that --
6 DR. BARTLETT: Yes, I see that.
7 MR. TURK: When you provided that
8 response, were you referring to the mu factors, mu1
9 and mu2?
10 DR. BARTLETT: Yes, the coefficients
11 friction that were used at those interfaces?
12 MR. TURK: In fact, the top of page
13 10,348, you explain that what you are referring to are
14 the interfacial coefficients of friction?
15 DR. BARTLETT: That's correct.
16 MR. TURK: Then at line 15 on page 10,348,
17 you indicated that your approach was to see if the
18 coefficients of friction represented the intent of the
19 PFS design as well as site-specific conditions at the
20 PFS site?
21 DR. BARTLETT: Yes, that's correct.
22 MR. TURK: So, in doing that, you were
23 looking to see if the various factors of mu, either mu
24 equal .31 or mu equal .10, or other statements of the
25 coefficient of friction, whether those represented the

1 intent of PFS and the site conditions?

2 DR. BARTLETT: No, I wouldn't characterize

3 it that way.

4 MR. TURK: What am I misunderstanding

5 there?

6 DR. BARTLETT: Whether what was assumed at

7 those values as far as the properties, whether it

8 represented what the actual conditions were and the

9 intent of PFS's design. My review wasn't solely to

10 see if the coefficients of friction were correct, but

11 also to see if the proper cohesion had been included

12 at those interfaces. Though not knowing exactly how

13 modelers do interfaces, but there is significant

14 cohesion that is supposed to be existing at these

15 interfaces.

16 MR. TURK: As I understand your answer, I

17 think what you perceive that Dr. Luk was trying to do

18 was to model the material properties --

19 DR. BARTLETT: As frictional materials,

20 and they're not all frictional materials. Or at least

21 some of their strength is not all friction.

22 MR. TURK: In that regard, when Dr. Luk

23 was applying different coefficients of friction, it is

24 your believe that what he was doing was trying to

25 represent the material properties at the interface

1 between the two different layers --

2 DR. BARTLETT: Yes, a frictional

3 materials, yes.

4 MR. TURK: Such as the soil as it comes up

5 against the cement-treated soil and then higher up the

6 cement-treated soil as it interfaces with the

7 concrete?

8 DR. BARTLETT: Right, those were the two

9 interfaces that I understand, and those were both

10 represented in the model as this mu2 coefficient.

11 MR. TURK: As testimony has indicated

12 already, the mu2 factor is that same coefficient of

13 friction that would be applied both between the soil

14 and the cement-treated soil, as well as between the

15 cement-treated soil and the concrete pad?

16 DR. BARTLETT: That's my understanding of

17 the two interfaces, yes.

18 MR. TURK: You understand that it is

19 possible in finite element analysis to model the

20 interface rather than the materials that abut that

21 interface?

22 DR. BARTLETT: So what you are telling me

23 is that it is possible to model the interface and not

24 consider the materials in between? Is that --

25 MR. TURK: Well, I'm asking if your

1 understanding of finite element analysis modeling is
2 that you must model the materials that abut at that
3 interface rather than model the actual interface
4 condition? You understand that --
5 DR. BARTLETT: That abut the interface?
6 So you're telling me that you model the properties
7 that are on either side of the interface, top or
8 bottom?
9 MR. TURK: No, I'm not suggesting that to
10 you. I'm asking about your understanding of how FEA
11 -- and by the way, if I use FEA, that in my mind is
12 finite element analysis.
13 DR. BARTLETT: Uh-hum.
14 MR. TURK: In case I use an acronym that
15 you're not familiar with, that would be what I intend.
16 If I state "CTS" at some time, that to me would be
17 cement-treated soil. So as long as we're clear, in
18 case an acronym slips here or there.
19 DR. BARTLETT: It's my understanding that
20 the interface knows this to capture the properties at
21 those interfaces of the soils, or in this case also
22 the cement-treated soil and the concrete path.
23 MR. TURK: When you say, "capture the
24 properties," you mean capture the material
25 properties --

1 DR. BARTLETT: The strength properties.

2 MR. TURK: Of the materials that abut at

3 that interface?

4 DR. BARTLETT: Yes.

5 MR. TURK: Are you aware whether it is

6 possible in finite element analysis modeling to

7 disregard material properties, but instead to model

8 simply the interface conditions?

9 DR. BARTLETT: Yes, I believe that's also

10 possible.

11 MR. TURK: But you believe that Dr. Luk,

12 instead, here was attempting to model the material

13 properties?

14 DR. BARTLETT: No, I think he was trying

15 to model the interfaces.

16 MR. TURK: And when you say that, you mean

17 the interface or the --

18 DR. BARTLETT: The internal angle of

19 sliding of friction between two interfaces. But

20 regardless whether it's an interface or a property of

21 the soil not at the interface, I don't think it makes

22 any difference from what we're trying to discuss here.

23 MR. TURK: When you talk about the

24 internal angle of sliding of friction, are you

25 referring to a well-known formula or theory?

1 DR. BARTLETT: The internal angle of
2 friction is the ratio of the shear stress to the
3 normal stress at the time when sliding is initiated.
4 In soil mechanics we use what's called a phi angle,
5 which is the arctangent of the internal angle of
6 friction.
7 MR. TURK: Is the symbol the Greek symbol
8 phi, P-H-I?
9 DR. BARTLETT: "Phi" or "Phe."
10 MR. TURK: That's the angle of internal
11 friction?
12 DR. BARTLETT: That is the angle of the
13 internal friction, yes.
14 MR. TURK: When you say "phi" or "phe,"
15 it's pronounced either way?
16 DR. BARTLETT: I use "phe," but maybe it's
17 "phi." P-H-I.
18 JUDGE LAM: Is that the same Greek symbol
19 as "Phi Beta Kappa"?
20 (Laughter.)
21 DR. BARTLETT: Yes, P-H-I.
22 MR. TURK: Dr. Bartlett, are you familiar
23 with the Mohr-Coulomb theory of failure?
24 DR. BARTLETT: I am.
25 MR. TURK: You are?

1 DR. BARTLETT: I am.

2 MR. TURK: For the reporter, that's

3 M-O-H-R dash C-O-U-L-O-M-B.

4 Is that, in effect, the formula that

5 you're discussing here?

6 DR. BARTLETT: Yes, it would be the angle

7 of that failure envelope.

8 MR. TURK: At various times in your

9 testimony, both in the rebuttal testimony and, again,

10 in fact, yesterday afternoon, you referred to the same

11 concept. For instance, if I look at yesterday's

12 transcript, at page 11,353, I ask you, "Could you

13 explain the 45-degree angle minus phi?" And your

14 answer is, "Phi is the friction angle."?

15 DR. BARTLETT: Yes.

16 MR. TURK: Do you recall that testimony?

17 DR. BARTLETT: Yes.

18 MR. TURK: And you're referring again to

19 the same theory when you made that statement

20 DR. BARTLETT: The same theory, the same

21 angle.

22 MR. TURK: Okay, I would like to

23 distribute a document. Your Honor, I would ask to

24 have this document marked as Staff Exhibit XX for

25 identification.

1 CHAIRMAN FARRAR: The reporter will do
2 that.
3 [Whereupon, the above-referred-
4 to document was marked as Staff
5 Exhibit XX for identification.]
6 MR. TURK: For the record, let me identify
7 this document as follows: It is the cover page and
8 addition page, followed by pages 170 and 171, of a
9 textbook entitled, "Soil Mechanics," by Tien Hsing Wu.
10 I believe we have given the appropriate number of
11 copies to the court reporter.
12 Dr. Bartlett, I would ask you to take a
13 look at this document. You may not have seen this
14 particular document before, or have you?
15 DR. BARTLETT: I'm well familiar with this
16 theory and this formula. So proceed.
17 MR. TURK: Okay. At page 170, Section 7.2
18 discusses the Mohr-Coulomb Theory of Failure.
19 DR. BARTLETT: Yes, I see it.
20 MR. TURK: And this is the theory that you
21 have been describing?
22 DR. BARTLETT: Yes.
23 MR. TURK: The formula that you have been
24 describing, if I am not mistaken, also appears on page
25 171 of the document?

1 DR. BARTLETT: Yes.

2 MR. TURK: Just to the record is clear, I

3 believe what we are talking about is the formula

4 represented by the equation S equals C plus --

5 DR. BARTLETT: Sigma.

6 MR. TURK: -- sigma tan phi. Is that the

7 formula that you're referring to?

8 DR. BARTLETT: Yes.

9 MR. TURK: Okay. So that the record is

10 also clear, what that means is that shear stress is

11 equal to --

12 DR. BARTLETT: Shear strength.

13 MR. TURK: Shear strain?

14 DR. BARTLETT: Strength.

15 MR. TURK: Strength, okay. Shear strength

16 is equal to cohesion plus normal stress --

17 DR. BARTLETT: Yes, normal stress.

18 MR. TURK: -- times the tangent of the

19 angle of internal friction?

20 DR. BARTLETT: That's correct.

21 MR. TURK: That is shown in Figure 7.1b,

22 correct?

23 DR. BARTLETT: Yes, for a linear failure

24 envelope, that's correct.

25 MR. TURK: In that chart, it may be a

1 little bit difficult to read from the printing here,
2 Figure 7.1b has as the X or the horizontal axis normal
3 stress. That's sigma, right?
4 DR. BARTLETT: Correct, that's the normal
5 stress applied to the potential failure claim.
6 MR. TURK: And the vertical axis is
7 represented by --
8 DR. BARTLETT: Is cohesion or shear
9 strength.
10 MR. TURK: Then there's a diagonal line
11 that begins at the Y axis and extends out. Do you see
12 that, the diagonal line?
13 DR. BARTLETT: The diagonal line, the
14 failure envelope?
15 MR. TURK: Well, that would essentially be
16 the bound of the failure envelope?
17 DR. BARTLETT: Yes, that's the defined
18 state of failure. According to this theory, when you
19 have a state of stress that's on that envelope, you
20 have reached failure and you can't have state of
21 stresses above that envelope.
22 MR. TURK: Okay. Just below that diagonal
23 line, do you see there's a horizontal line that
24 extends to the right?
25 DR. BARTLETT: Right.

1 MR. TURK: The angle that's represented by
2 the intersection of the diagonal line with that
3 horizontal line --
4 DR. BARTLETT: Is the internal angle of
5 friction, sometimes we're showing it to the angle of
6 friction.
7 MR. TURK: And that's phi?
8 DR. BARTLETT: Yes.
9 MR. TURK: Just so we understand this
10 chart a little bit better, is it correct that any
11 strain that would lie above that diagonal line --
12 DR. BARTLETT: Any state of stress; we're
13 not talking about strain.
14 MR. TURK: Any state of stress that lies
15 above that diagonal line --
16 DR. BARTLETT: Would have reached failure.
17 MR. TURK: In contrast, if there was a
18 state of stress, you said?
19 DR. BARTLETT: State of stress, yes.
20 Below the failure envelope you would not be at a state
21 of failure.
22 MR. TURK: The formula that you're
23 referring to when you are looking to Dr. Luk's report
24 to see how he was modeling --
25 DR. BARTLETT: It's a generally-accepted,

1 simplified formula describing the two components of
2 the shear strength of a soil, one part being C, or the
3 cohesion, the other part being the slope of this line,
4 or phi.
5 MR. TURK: At the bottom of page 170, the
6 very first sentence in Section 7.2 states that the
7 Mohr-Coulomb failure theory has been found to be very
8 successful in defining failure in soils.
9 DR. BARTLETT: Yes, we generally use it.
10 MR. TURK: And you agree with that
11 statement?
12 DR. BARTLETT: It will define the point at
13 which you reach failure, yes. It doesn't describe the
14 strain behavior. It just describes when you reach
15 failure.
16 MR. TURK: And that's failure of the
17 materials?
18 DR. BARTLETT: Yes.
19 MR. TURK: In this case soils?
20 DR. BARTLETT: Yes.
21 MR. TURK: Just so that we are clear on
22 this document, just below the Figure 7.1 there's a
23 statement that reads, "The quantities C and phi are
24 material properties frequently called cohesion and
25 angle of internal friction, respectively."

1 DR. BARTLETT: Yes.

2 MR. TURK: That's correct?

3 DR. BARTLETT: Yes.

4 MR. TURK: In your testimony yesterday,

5 again at page 11,353, at line 18, you stated, quote,

6 "Geotechnical engineers don't usually use coefficients

7 of friction, so what we do is take, let's see, the

8 coefficient of friction is equal to the tangent of the

9 phi angle."

10 DR. BARTLETT: Uh-hum.

11 MR. TURK: So it is your understanding

12 that in applying mu or the coefficient of friction,

13 that what one is doing is applying the tangent of the

14 phi angle?

15 DR. BARTLETT: Yes, that's correct. Most

16 of the time we talk about the phi angle or "phe"

17 angle. It's the property most of us have a sense for,

18 and it's quite simple. In soil mechanics we can often

19 measure the angle, repose of the slope, and that angle

20 of repose of the slope is a rough estimate of the phi

21 angle. It is just differences in terminology, but if

22 one just remembers the math, you can convert between

23 the two systems.

24 MR. TURK: So it is your understanding,

25 then, that coefficient of friction or mu is defined by

1 this formula that appears at Figure 7.1b?

2 DR. BARTLETT: Yes, mu is equal to the

3 arctangent of phi.

4 MR. TURK: Your Honor, I would like to ask

5 that Staff Exhibit XX for identification be admitted

6 into the record.

7 CHAIRMAN FARRAR: Any objection?

8 MR. NELSON: No objection.

9 MS. CHANCELLOR: No objection, Your Honor.

10 CHAIRMAN FARRAR: Then it will be

11 admitted.

12 [Whereupon, the above-referred-

13 to document marked as Staff

14 Exhibit XX for identification

15 was received in evidence.]

16 MR. TURK: Incidentally, I owe Dr. Luk an

17 apology. I asked him to bring a textbook with him,

18 but he was at home at the time and all he had was what

19 apparently is his college text -- undergraduate, his

20 undergraduate text from 30 years ago. He assures me

21 that he has others in the office that are more recent

22 than this.

23 CHAIRMAN FARRAR: That's fine. I don't

24 think the theories changed.

25 (Laughter.)

1 JUDGE LAM: I happen to know Dr. Wu, who
2 wrote this textbook. So I can testify to the
3 authenticity here.
4 (Laughter.)
5 MR. TURK: Again, at page 10,349 of your
6 rebuttal testimony, I think what you state, starting
7 at line 6 and continuing through the end of that
8 paragraph, you're describing pretty much the same
9 concept, that coefficient of friction is equal to the
10 arctan of phi?
11 DR. BARTLETT: Yes, I think I just used an
12 example that, if we had a mu of 1, we would then apply
13 the phi angle of 45 degrees.
14 MR. TURK: Is that the same thing as
15 saying that the tangent of a 45-degree angle is equal
16 to 1?
17 DR. BARTLETT: Yes.
18 MR. TURK: Both at line 10 to 11 of this
19 page, as well as in your testimony yesterday, you
20 referred to practices common among geotechnical
21 engineers. Could you explain what you mean when you
22 describe what geotechnical engineers do when they use
23 this arctan of phi?
24 DR. BARTLETT: When we use the arctan of
25 phi, we're describing the portion of shear strength of

1 the soil that is derived from friction.

2 MR. TURK: And why do you do that?

3 DR. BARTLETT: Because shear strength to

4 the geotechnical engineers is everything, because most

5 of the failures that we analyze are in shear failure.

6 So it is a fundamental and important property to us.

7 MR. TURK: That would be shear failure of

8 the material?

9 DR. BARTLETT: Yes.

10 MR. TURK: When you use that concept, are

11 you talking about elastic or plastic behavior of the

12 material?

13 DR. BARTLETT: It defines a state of

14 stress at which we reach failure. Generally, before

15 failure, soils still may not be in an elastic range,

16 but their deformations are relatively small. Once we

17 reach that state, we go into a post-failure mechanism,

18 which may or may not be plastic. It can be quite

19 different depending on the material. Sometimes it may

20 be somewhat of a plastic failure; sometimes it may be

21 a brittle failure, or somewhere in between.

22 MR. TURK: Is this the small deformation

23 theory? Are you familiar with that concept?

24 DR. BARTLETT: Small deformation theory?

25 I'm confused. We're talking about shear strength, and

1 now we've added a Mohr-Coulomb envelope which defines
2 failure. Deformation is really now getting into
3 stress/strain behavior. So maybe you could refine
4 your question.
5 MR. TURK: All right, I think I will just
6 pass it for now.
7 DR. BARTLETT: Okay.
8 MR. TURK: At the top of page 10,349, just
9 for clarification, you describe that the first line --
10 and this would be of, I believe it's Table 8 of Dr.
11 Luk's report -- you state that on that first line, mu
12 equal to 1.0 represents the first case for soil type
13 1. What you are referring to there is model type 1
14 rather than soil type 1?
15 DR. BARTLETT: I've lost a line.
16 MR. TURK: Okay.
17 DR. BARTLETT: Which page and line, again,
18 are we on?
19 MR. TURK: I'm looking at page 10,349 --
20 DR. BARTLETT: Okay.
21 MR. TURK: -- lines 1 to 3.
22 DR. BARTLETT: One to three.
23 MR. TURK: And for context, you may need
24 to look at the prior page also. What you're doing is
25 you're describing that you looked at a table in Dr.

1 Luk's report. The actual table, actually, you refer
2 to it specifically on page 10,347, at line 18, as
3 Table 8 of the Luk report.
4 DR. BARTLETT: Right.
5 MR. TURK: Do you have Dr. Luk's report
6 with you?
7 DR. BARTLETT: I do.
8 MR. TURK: Okay. This is just for
9 clarification. I want to make sure I understand.
10 DR. BARTLETT: Let me read it here and
11 see.
12 (Pause.)
13 So for the first case on the first line,
14 there is a mu1 of .2 and a mu2 of 1.0, I see from the
15 table.
16 MR. TURK: Okay, and what's your --
17 DR. BARTLETT: So maybe if I said
18 something wrong here, that might clarify it.
19 MR. TURK: Well, just for clarification,
20 I understand what you're referring to as being the
21 best estimate soil for model type 1?
22 DR. BARTLETT: Correct.
23 MR. TURK: Okay.
24 DR. BARTLETT: And these are the interface
25 coefficients of friction used.

1 MR. TURK: Okay. Then, again, as you
2 continue down that page, this is what we discussed
3 previously. This is your understanding that what was
4 being modeled, what was being represented was this
5 formula that we discussed previously?
6 DR. BARTLETT: Yes.
7 MR. TURK: Okay. Then if you continue on
8 to the bottom of page 10,349 and onto page 10,350, you
9 are describing other examples of mu2 --
10 DR. BARTLETT: Yes.
11 MR. TURK: -- used in Table 8?
12 DR. BARTLETT: Yes.
13 MR. TURK: And at line 24 you state, what
14 this is really modeling in simple terms is really a
15 sliding on a granular material. Ms. Chancellor asked
16 you on page 10,350, "Such as sand," and you responded,
17 quote, "Such as a sand or gravel where there is no
18 cohesion present."
19 DR. BARTLETT: Right. Friction materials
20 for geotechnical engineers are those without any
21 cohesion, and generally sands and gravels are
22 considered frictional materials if they don't have any
23 large component of clay in them, and perhaps some
24 silts, too.
25 MR. TURK: So it is your understanding

1 that when Dr. Luk utilized the coefficient of friction
2 of 1, he was modeling granular material?
3 DR. BARTLETT: No, I'm not necessarily
4 implying that. I am just drawing an analogy back to
5 my own discipline that it is being treated as a
6 frictional material. I was just stating that
7 frictional materials that we study would be sands and
8 gravels. But I'm not trying to do any more than that.
9 MR. TURK: Well, your statement is that,
10 quote, "What this is really modeling in simple terms
11 is really a sliding on a granular material."
12 DR. BARTLETT: Well, a frictional
13 material.
14 MR. TURK: Again, it is your understanding
15 that Dr. Luk was trying to model, in his use of a
16 coefficient of friction of mu2 equals 1.0, he was, in
17 essence, modeling sliding on granular material?
18 DR. BARTLETT: Sliding on a granular
19 friction material, yes. Or a material that does not
20 have a large component of cohesion.
21 MR. TURK: On the next page, page 10,350,
22 you go on to state, commencing at line 4, that when
23 Dr. Luk used this coefficient of friction of mu2 equal
24 1.0, he was, quote, "relying on the sliding friction
25 to resist sliding." Then you go on to say, quote,

1 "That's not consistent with the PFS design intent. It
2 is my understanding at least for the design basis
3 earthquake that PFS is proposing that there will be no
4 sliding at these interfaces."
5 DR. BARTLETT: Yes, that's correct.
6 MR. TURK: So your criticism of Dr. Luk
7 here is that he was not properly modeling the PFS
8 intent?
9 DR. BARTLETT: Yes, as we heard yesterday,
10 the intent of PFS's design is to assure that there's
11 enough cohesion or bonding at these interfaces that
12 precludes sliding, and they would develop a testing
13 program to demonstrate it.
14 MR. TURK: Is it your belief that in
15 choosing a mu2 of 1.0, that Dr. Luk was specifically
16 considering the nature of the materials found at the
17 interface between the CTS and the soil, and between
18 the CTS and the pad?
19 DR. BARTLETT: It is my understanding that
20 that was modeling the internal angle of friction or
21 the interfacial friction between those two materials,
22 yes.
23 MR. TURK: Now, out of curiosity, if you
24 were going to model that interface, what coefficient
25 of friction would you use?

1 DR. BARTLETT: Which interface?

2 MR. TURK: Either the interface between

3 the CTS and the soil or between the CTS and the pad.

4 DR. BARTLETT: There would be no

5 interfaces.

6 MR. TURK: Could you explain that?

7 DR. BARTLETT: Because PFS's design intent

8 is not to allow sliding along those interfaces.

9 MR. TURK: So you would model the cement-

10 treated soil and the soil as if they had the same

11 properties and they were not rubbing up against each

12 other; they were not in contact with each other --

13 DR. BARTLETT: PF -- excuse me.

14 MR. TURK: -- or if they were a single

15 block?

16 DR. BARTLETT: What I'm trying to say is

17 that PFS's design intent is not to allow any sliding

18 at these interfaces. They have promised to develop

19 enough cohesion or bonding at these interfaces so

20 there cannot be sliding.

21 MR. TURK: And, in your opinion, would it

22 be proper to conduct finite element analysis and to

23 construct a model for that FEA by depicting the soils,

24 the cement-treated soil, and the pad as a single block

25 with no interfaces?

1 DR. BARTLETT: Well, not being a modeler,
2 I think we have to remember that they vary in their
3 dynamic properties. They have different stiffnesses.
4 But in the model, I wouldn't allow a sliding interface
5 at those boundaries.
6 MR. TURK: Do you know how you would do
7 that?
8 DR. BARTLETT: No, I'm not a modeler. I'm
9 just telling you what the intent of the design is is
10 to not allow any sliding at those interfaces.
11 Now do you want to talk about what the
12 real properties may be?
13 MR. TURK: Not at the moment.
14 DR. BARTLETT: Okay.
15 MR. TURK: Are you familiar with any other
16 formulas that may be applicable to defining a
17 coefficient of friction? Other than the Mohr-Coulomb
18 failure theory that we discussed before?
19 DR. BARTLETT: At this moment I can't say
20 I am.
21 MR. TURK: Have you ever heard of
22 something called the Coulomb Law of Friction?
23 DR. BARTLETT: Coulomb Law of Friction?
24 Not put in that context.
25 MR. TURK: Are you familiar with an

1 equation which reads f=mu N?

2 DR. BARTLETT: No, but if you define the

3 terms, maybe it might be just differences in

4 disciplines and their nomenclature.

5 MR. TURK: F, frictional resistance.

6 DR. BARTLETT: Yes.

7 MR. TURK: Mu is the same mu that we are

8 describing now.

9 DR. BARTLETT: Yes, and N is the normal

10 stress?

11 MR. TURK: N is the normal load.

12 DR. BARTLETT: Normal stress?

13 MR. TURK: Normal stress or -- yes.

14 DR. BARTLETT: Normal stress? It would be

15 a formula appropriate for a frictional material, but

16 not for a clay or a soil cement.

17 MR. TURK: That's your opinion?

18 DR. BARTLETT: Sure.

19 MR. TURK: Have you ever heard that

20 expressed by other people?

21 DR. BARTLETT: Well, we spent about a day

22 and a half talking about "cohesiving" and bonding. So

23 I'm in pretty good company, but go ahead please.

24 MR. TURK: Well, I'm talking about this

25 particular formula.

1 DR. BARTLETT: Again, I'm stating that the
2 strengths of clays and the soil cement derive their
3 primary resistance to shear from cohesion, not from
4 the formula you gave me. But I will admit that any
5 material that is not purely a clay or purely a sand or
6 a frictional material has components of both.
7 MR. TURK: Do you believe that the
8 equation I gave you would apply to any material?
9 DR. BARTLETT: Oh, it would apply to a
10 purely frictional material, sure.
11 MR. TURK: Well, my question is any
12 material, apply to any material.
13 DR. BARTLETT: It applies to frictional
14 material, but it doesn't apply to all materials, no.
15 MR. TURK: Coulomb, by the way, is a
16 scientist who lived approximately two centuries ago?
17 DR. BARTLETT: About that, yes.
18 MR. TURK: And he was a well-known,
19 perhaps a seminal figure in defining concepts of
20 friction and formulas for friction?
21 DR. BARTLETT: Yes, sure. That's fine.
22 MR. TURK: That's your understanding?
23 DR. BARTLETT: That's fine.
24 MR. TURK: Have you ever used this formula
25 before?

1 DR. BARTLETT: Yes. Not quite in that
2 form, but, yes, I calculate the shear resistance of a
3 frictional or granular material all the time using
4 that formula, not quite in that form, but I understand
5 what it is saying.
6 MR. TURK: Well, when you say, "not quite
7 in that form," are you now saying that you use --
8 DR. BARTLETT: In geotechnical engineering
9 we would replace some of those symbols, but I think
10 the concepts are pretty much the same.
11 MR. TURK: Okay. What you would use,
12 then, would be the Mohr-Coulomb failure theory that we
13 discussed before?
14 DR. BARTLETT: Yes, because I've tried to
15 explain before that soils also have a cohesion
16 component to them.
17 MR. TURK: Okay. So it is your
18 understanding that the two formulas are equivalent?
19 Is that your statement?
20 DR. BARTLETT: No.
21 MR. TURK: All right, let me come back to
22 the question I asked you then, which was, have you
23 ever used this formula, f equals mu N, previously? My
24 understanding would be that you have not, or you
25 indicated you weren't familiar with the terms.

1 DR. BARTLETT: Well, not in the formula
2 that you gave it. I think it is just a difference in
3 disciplines, but, as you defined it to me, you said f
4 is some frictional resistance, is a function of a
5 coefficient times a normal stress. I understand that
6 concept, use it. Now maybe there's variations on how
7 we calculate those parameters between two different
8 disciplines, but the general concept I understand.
9 MR. TURK: Do you understand that this
10 formula is used, or can be used, to model the
11 interface condition between two different objects?
12 DR. BARTLETT: If they purely frictional,
13 maybe if they're not. I don't know, but I'm just
14 saying that it doesn't capture what the interface
15 conditions I believe are. We're not dealing with
16 purely frictional materials.
17 MR. TURK: In Dr. Luk's finite element
18 analysis model, you understand he was not attempting
19 to model soil failure mechanisms? Or do you not know?
20 DR. BARTLETT: I'm not sure what we're
21 trying to get at. I don't think he was trying to
22 model the stress/strain behavior of the soil. I
23 understand that this interfacial coefficient of
24 friction is used to define the shear resistance at an
25 interface. I think I understand that.

1 MR. TURK: Which formula? The one that I
2 gave you --
3 DR. BARTLETT: Yes, the one you just gave
4 me. I'm just saying that is incorrect.
5 MR. TURK: What's incorrect?
6 DR. BARTLETT: For use at this particular
7 interface.
8 MR. TURK: So your belief is that use of
9 the formula f equals mu N is not appropriate in
10 attempting to model the interface between the CTS and
11 the soil and between the CTS and the pad?
12 DR. BARTLETT: Yes, because they derive
13 their strength from cohesion, not from friction --
14 mainly.
15 MR. TURK: Let's take a little closer look
16 at the formula. If mu friction is used to define the
17 shear resistance at an interface. I think I
18 understand that.
19 Can you explain your understanding of what
20 the frictional resistance would be equal to?
21 DR. BARTLETT: Would you please give me
22 normal stress? And then I will be able to.
23 MR. TURK: When you say normal stress do
24 you mean the normal stress of the materials?
25 DR. BARTLETT: No, the normal stress that

1 is acting at that point.

2 MR. TURK: Would the normal stress be the

3 inertial load?

4 DR. BARTLETT: No, in this case the normal

5 stress would, maybe, if we want to do a simple case

6 before we go into dynamics, let's just consider the

7 normal stress equal to the weight of gravity.

8 The normal stress at the base of the pads,

9 in this case, is about 2 KSF, two kips per square

10 foot. Do you want to use that in determining sliding

11 resistance for a static case?

12 MR. TURK: Okay.

13 DR. BARTLETT: What was the Mu?

14 MR. TURK: 1.0.

15 DR. BARTLETT: It is 2 KSF sliding

16 resistance.

17 MR. TURK: What would be the frictional

18 resistance?

19 DR. BARTLETT: Two KSF.

20 MR. TURK: KSF would mean what?

21 DR. BARTLETT: Kips per square foot.

22 MR. TURK: And in turn, if one was to use

23 a Mu of .31?

24 DR. BARTLETT: .31 KSF.

25 MR. TURK: .31 KSF would be the frictional

1 resistance?

2 DR. BARTLETT: Correct.

3 MR. TURK: Now, if one was to use, as a

4 hypothetical, a Mu 2 factor of .31, represent the

5 interface between the cement treated soil and the pad

6 that lies above it, would that imply that the

7 frictional resistance would be less than the inertial

8 load, or less than the weight of gravity of the load

9 above that interface?

10 DR. BARTLETT: I'm not sure I understand

11 the question. We were talking about a static case,

12 and now we've introduced an inertial term, so please

13 redefine it.

14 MR. TURK: Taking the static case, the

15 normal stress, as you described it before, would be

16 the weight of gravity?

17 DR. BARTLETT: Yes, the weight of -- well,

18 it is the weight of the pad and overlying casks,

19 together, at the base of the pads.

20 MR. TURK: Isn't that the same thing as

21 describing it as an inertial load?

22 DR. BARTLETT: When I generally speak of

23 inertial loads I'm into the dynamic case, but --

24 MR. TURK: Well, let's not stray there,

25 just in the static case.

1 DR. BARTLETT: Let's just call it the
2 weight of gravity acting on the system, the weight of
3 the casks and the pads is about 2KSF at the base of
4 the concrete slab.
5 MR. TURK: And, in essence, that is the
6 inertial load, isn't, in a static case?
7 DR. BARTLETT: I don't use inertial loads
8 in the static case, but maybe differences in
9 disciplines. Inertial load, to me, is some
10 acceleration times the mass. I guess if you want to
11 say we are accelerating downward, with the weight of
12 gravity, I will give you it is an inertial --
13 MR. TURK: If your weight of gravity, or
14 inertial load, if you would humor me --
15 DR. BARTLETT: Yes.
16 MR. TURK: -- is 2KSF, if you have a phi
17 Mu2.31 --
18 DR. BARTLETT: Correct.
19 MR. TURK: That would mean you would
20 obtain sliding with a force less than equivalent of
21 the 2 KSF?
22 DR. BARTLETT: You would obtain sliding at
23 a force of .31 KSF. Excuse me I can't even do the
24 math now.
25 MR. TURK: I think Counsel for PSF is

1 wrong on it, too. Is that .62?

2 DR. BARTLETT: It is .62.

3 MR. TURK: We are all wrong, but I think

4 we understand what we are talking about.

5 So essentially sliding would commence

6 before you reach the 2 KSF, well before in that case?

7 DR. BARTLETT: Yes, at .62 KSF if you

8 apply the horizontal load something would start to

9 slide, yes.

10 MR. TURK: Okay. And that would be the

11 reaction, I'm sorry, the sliding would be the reaction

12 to the force that is applied --

13 DR. BARTLETT: Yes, that would -- there

14 would be another force resisting that sliding, but it

15 is the sliding resistance applied at the base of the

16 block.

17 MR. TURK: In contrast, if Mu2 was 1.0 --

18 DR. BARTLETT: Correct.

19 MR. TURK: -- you would have had to have

20 much larger seismic forces acting in order to induce

21 sliding?

22 DR. BARTLETT: Yes, you would have to have

23 some force of about 2 KSF.

24 MR. TURK: So that if you use a Mu2 of 1.0

25 in effect you are requiring a much greater seismic

1 force to induce sliding than if you use .31?

2 DR. BARTLETT: That is correct.

3 MR. TURK: Now, that would be true

4 regardless of the materials involved in the underlying

5 soils, or whatever is underlying the cement treated

6 soil, correct?

7 DR. BARTLETT: No, that is not true.

8 MR. TURK: It is not true. Regardless of

9 the type of material that one --

10 DR. BARTLETT: No, it is highly dependent

11 on the type of material, whether the material derives

12 its strength from cohesion, or from friction.

13 At that interface if we have two cohesive

14 materials, that sliding along that interface may not

15 have anything to do with the normal stress, and it has

16 everything to do with the cohesion that has developed

17 along the bond.

18 MR. TURK: And when you say that the

19 cohesion that has developed along the bond, what you

20 are describing is a surficial condition, correct?

21 DR. BARTLETT: No.

22 MR. TURK: The surface of the materials as

23 they interface with the structure, CTS above it?

24 DR. BARTLETT: To be pure, when you talk

25 about the conditions between two dissimilar materials

1 we use the word adhesion. When we talk about failure
2 within a material itself, then it would be cohesion.
3 MR. TURK: In sum, with respect to Mu2
4 equals 1.0, it is your belief that Dr. Luk introduced
5 sliding into his model in contrast to the -- sliding
6 of the pad on the cement treated soil, and the cement
7 treated soil on the underlying soils, in contrast to
8 the PFS design intent of no sliding; that is the
9 summary of your view of what Dr. Luk did his use of
10 1.0 Mu2?
11 DR. BARTLETT: Well, let me show if I can
12 capture it this way. At these interfaces that were
13 considered, they were modeled as frictional materials
14 with a coefficient of friction, or internal angle of
15 friction, or a Mu, whichever you prefer.
16 And these interfaces don't derive their
17 strength from friction, they derive it from cohesion.
18 Does that help?
19 MR. TURK: It is a start.
20 DR. BARTLETT: Okay.
21 MR. TURK: But your bottom line is that
22 when Dr. Luk used a Mu2 of 1.0, he is introducing
23 sliding between the pad and the CTS, and between the
24 CTS and the underlying soils?
25 DR. BARTLETT: I'm not sure he is

1 introducing sliding, he is just modeling it as a
2 frictional material, and if the horizontal forces are
3 large enough, then sliding would occur in the model,
4 when that condition is reached.
5 MR. TURK: Do you know whether Dr. Luk's
6 model, or his analytical results, found sliding of the
7 pad on the CTS, or the CTS on top of the soil?
8 DR. BARTLETT: That I'm not sure. I
9 believe we asked those questions. There was sliding
10 for some cases, but I can't remember how much, and at
11 what particular interfaces.
12 MR. TURK: And when you say there was some
13 sliding, do you believe that was of the pad, rather
14 than of the casks?
15 DR. BARTLETT: Those details I really
16 can't remember. I know there was sliding of the casks
17 on top of the pads, that is given. But whether we
18 talked about sliding of the pads atop the soil cement,
19 and sliding of the soil cement atop the native soils,
20 I don't remember that detail of discussion.
21 MR. TURK: If Dr. Luk is able to show
22 that, in fact, his results show negligible, either no
23 sliding of the pad on the CTS, or virtually none that
24 is noticeable, would that satisfy your concern about -
25 -

1 DR. BARTLETT: The sliding of the pads
2 atop the soil?
3 MR. TURK: Sliding of the pads in the
4 model, relative to the cement treated soil below it.
5 DR. BARTLETT: I'm not sure.
6 MR. TURK: You don't know if that would
7 satisfy your concern?
8 DR. BARTLETT: I'm not sure. Again,
9 sliding, if it is initiated, can be a mechanism of
10 dissipating energy.
11 MR. TURK: Well, I'm not sure that is
12 responsive to my question.
13 DR. BARTLETT: Yes, it is. I'm just
14 saying that sliding initiates at any of these
15 interfaces, then -- excuse me, the Mu2 interfaces, we
16 should restrict ourselves to the Mu2 interfaces, then
17 sliding is being used as a mechanism to dissipate
18 energy.
19 MR. TURK: And my question to you is, that
20 if Dr. Luk shows that there was no relative
21 displacement of the pad, relative to the cement
22 treated soil below it, would that satisfy your concern
23 that Dr. Luk has --
24 DR. BARTLETT: I guess there are two
25 interfaces I would like to make sure there is no

1 sliding at either of these interfaCes, the Mu2
2 interfaces.
3 MR. TURK: What if he was able to show you
4 that there was no relative displacement between either
5 the pad and the CTS, as well as the CTS relative to
6 the soils, would that satisfy your concern?
7 DR. BARTLETT: For all cases, yes. I also
8 would not have to remember that there was beyond
9 design basis earthquake cases run, also.
10 MR. TURK: In other words, you would be
11 interested to see the results for something larger
12 than the 2000 year --
13 DR. BARTLETT: I would like to see the
14 correct conditions modeled at all interfaces, yes.
15 MR. TURK: And my question to you is, if
16 Dr. Luk shows you that for something substantially in
17 excess of the 2000 year earthquake, such as the 10,000
18 year return period earthquake, his model obtained
19 virtually no, or no sliding --
20 DR. BARTLETT: I have trouble with
21 virtually no sliding. I have no way of knowing how
22 much this could dissipate energy. You are getting
23 into an area that is difficult for me to guess what
24 the results for a dynamic model may be.
25 MR. TURK: At this point you are not

1 prepared to state whether your concerns --

2 DR. BARTLETT: I would have to look at it

3 and review it, yes.

4 MS. CHANCELLOR: Instruct the witness not

5 to guess.

6 MR. TURK: I'm sorry?

7 MS. CHANCELLOR: I said I instruct the

8 witness not to guess.

9 THE WITNESS: I'll never guess at the

10 results of the dynamic model.

11 BY MR. TURK:

12 MR. TURK: Again, at page 10351 there is

13 the same type of discussion, commencing at line 2.

14 You indicate that the Mu2 values tend to overemphasize

15 sliding.

16 DR. BARTLETT: Well, I was just trying to

17 do some simple calculations in my mind. For example,

18 if we went back to a Mu2 value that you gave

19 previously, of .31 with a normal stress of about 2

20 KSF, that would imply sliding would begin when the

21 horizontal stress of about .62 KSF was applied.

22 The cohesion of some of these interfaCes

23 could be as high as -- well, the compressive strengths

24 are designed to be about 100 PSI, which would be an

25 undrained shear strength of about 50 PSI.

1 Excuse me for a moment, I have to grab my
2 calculator. 50 PSI would be the shear strength at
3 these interfaces. I'm going to convert that to PSF,
4 pounds per square foot. And KSF, the sliding
5 resistance would be as high as 7.2 KSF at some of
6 these interfaces if they could reach failure.
7 So I see quite a difference in what the
8 design is, and what these interfaces, what were used
9 at these interfaces.
10 MR. TURK: When you do this calculation,
11 again going back to the Mohr-Coulomb failure theory?
12 DR. BARTLETT: I'm using cohesion. Yes,
13 I'm using the cohesion component.
14 MS. CHANCELLOR: Just for point of
15 clarification, the 7.2 KSF, that is your rough
16 calculation for the PFS site soils?
17 THE WITNESS: Well, I was just grabbing
18 the upper bound strength of the cement treated soil,
19 and estimating what would be the shear resistance.
20 BY MR. TURK:
21 MR. TURK: And that is within the
22 material, within the soils?
23 DR. BARTLETT: No, it is a bond. It is a
24 bond between two materials.
25 MR. TURK: Just for the clarification of

1 the record, the .72 KSF was just solely based upon
2 cohesion, and no frictional resistance?
3 DR. BARTLETT: Yes, that is what I was
4 doing. You could add the frictional resistance to it
5 if you wanted to. It would actually be somewhat
6 higher than that.
7 MR. TURK: I'm sorry, did you say 7.2, or
8 .72?
9 DR. BARTLETT: 7.2.
10 MR. TURK: Excuse me.
11 DR. BARTLETT: These are bond strengths at
12 the interfaces that were talked about yesterday. I
13 think we used the analogy of mustard. So I'm talking
14 about the mustard now. There would have to be at
15 least that, or higher, because PFS' intent is to not
16 allow any sliding along these interfaces.
17 So they would have to be, at least, higher
18 than the strength of the soil, or the cement treated
19 soil.
20 MR. TURK: When you refer to C, that is
21 the C component in the Mohr-Coulomb --
22 DR. BARTLETT: That is correct.
23 MR. TURK: -- failure theory, correct?
24 DR. BARTLETT: That is correct. It is the
25 cement that holds the glue together. I mean, the soil

1 together.

2 MR. TURK: If you believe that Dr. Luk's

3 use of the 1.0 Mu, the Mu2, tends to overemphasize

4 sliding, as you state in your testimony --

5 DR. BARTLETT: I'm just saying --

6 MR. TURK: Let me finish the question.

7 DR. BARTLETT: Sure, go ahead.

8 MR. TURK: Would that mean that you would

9 expect to see sliding of the pad under design basis

10 earthquake conditions?

11 DR. BARTLETT: No, I'm just looking at it

12 from the material properties standpoint and saying

13 that, for example, if we use the Mu2 of .31 and

14 calculated a resistance to a sliding of .62 KSF, when

15 in fact the actual resistance, if we look at PFS'

16 design intent, may be as high 7.2 KSF, then the

17 numerical model may allow sliding to occur before --

18 the numerical model that Dr. Luk used may allow

19 sliding to occur before the PFS model, if we put

20 different properties.

21 MR. TURK: And my question to you is,

22 based on Dr. Luk's use of the 1.0 for Mu2, would you

23 expect, then that you would see sliding of the pad, or

24 of the cement treated soil as part of his analytical

25 results?

1 DR. BARTLETT: That I can't say because,
2 again, I didn't look at whether there was sliding at
3 these different interfACes.
4 MR. TURK: But the logical conclusion to
5 your statement that Dr. Luk is overemphasizing sliding
6 by use of the 1.0 Mu2 --
7 DR. BARTLETT: Was not based on looking at
8 his analytical results, it was just looking at the
9 properties, just thinking it through, which would
10 allow sliding first.
11 MR. TURK: So you don't have a position,
12 right now, on whether Dr. Luk's use of 1.0 for Mu2
13 would result in sliding of the pads in his model; you
14 don't have a position?
15 DR. BARTLETT: No, I haven't looked at the
16 conditions of those interfaces, and the time history,
17 whether there is sliding occurring, or not.
18 MR. TURK: Would it then be appropriate to
19 look at the time histories to see if sliding resulted
20 at the interfaCes?
21 DR. BARTLETT: That would be an approach,
22 yes.
23 MR. TURK: An acceptable approach?
24 DR. BARTLETT: No, not completely. We
25 have other issues with the model.

1 MR. TURK: I understand. But with respect
2 to this issue, do you believe it would be an
3 acceptable way to determine if there was sliding, if
4 we look at the time histories and see if, in fact,
5 sliding of the pad resulted? That would be how you
6 would find whether or not there --
7 DR. BARTLETT: Sliding at the two
8 interfaces we've been talking about, yes.
9 MR. TURK: That is correct?
10 DR. BARTLETT: Yes.
11 MR. TURK: I'd like to turn to page 10352
12 of your testimony. Commencing at line 12, you discuss
13 the Young's modulus. This is another one of the
14 issues that you raised.
15 DR. BARTLETT: Yes, okay.
16 MR. TURK: With respect to Dr. Luk's
17 report.
18 DR. BARTLETT: I'm on page 10 of the
19 report now.
20 MR. TURK: Okay. In your testimony you
21 state, commencing at line 13, on page 10352, that "the
22 design as we understand it thus far is to limit the
23 Young's modulus of the cement treated soil under the
24 pads, to 75,000 PSI".
25 DR. BARTLETT: Correct.

1 MR. TURK: And you go on to state: "And
2 when they look at what Dr. Luk has used in his report
3 the soil cement underneath the pads has been assigned
4 270,000 PSI".
5 DR. BARTLETT: Yes.
6 MR. TURK: And you go on to say, which
7 overestimates what the design requirements that PFS
8 has put on the cement treated soil.
9 DR. BARTLETT: That is correct.
10 MR. TURK: Okay. And in doing this, as
11 you mentioned, you are looking at page 10 of Dr. Luk's
12 report?
13 DR. BARTLETT: Yes, table 2. And I'm
14 looking at the Young's modulus assigned to the soil
15 cement two foot thick underneath the pad.
16 MR. TURK: Okay. And you believe, and in
17 the third vertical column you see the figure 270,000
18 PSI?
19 DR. BARTLETT: Yes.
20 MR. TURK: If one was to input into an
21 analytical model a Young's modulus for the cement
22 treated soil under the pad of 270,000 PSI, in contrast
23 to the design intent of no more than 75,000 --
24 DR. BARTLETT: Maximum, yes.
25 MR. TURK: -- maximum.

1 DR. BARTLETT: Okay.

2 MR. TURK: Would that in effect be

3 modeling the cement treated soil as stiffer material

4 than it actually would be?

5 DR. BARTLETT: Yes.

6 MR. TURK: And in modeling it as a stiffer

7 material, would that tend to transfer a greater load

8 through that material up into the pads, and the casks

9 above the pads?

10 DR. BARTLETT: It would tend, maybe, to

11 transfer high frequency motions.

12 MR. TURK: Only high frequency motions?

13 DR. BARTLETT: Well, I guess if we are

14 talking about peak forces, I usually think of those as

15 high frequency effects.

16 MR. TURK: If that is your belief then it

17 really shouldn't matter whether PFS uses a 75,000 PSI

18 Young's modulus or 270,000?

19 DR. BARTLETT: It matters a great deal.

20 MR. TURK: All right. Let's come back to

21 the --

22 DR. BARTLETT: I guess what I'm trying to

23 imply is why do we have to second guess, why don't we

24 just model this correctly and get the right

25 properties? Why do we have to guess what is going to

1 happen in the dynamic sense? It is that simple.

2 MR. TURK: And to model it correctly you

3 would use a 75,000 PSI maximum?

4 DR. BARTLETT: Yes, but one might consider

5 the range, because we discussed yesterday that that

6 modulus may increase with time.

7 MR. TURK: Is it your view that when you

8 model the Young's modulus of the CTS, at 270,000 PSI,

9 that you are, in effect, transferring the same loads

10 to the casks, than you would be if you --

11 DR. BARTLETT: I think --

12 MR. TURK: Let me finish the question.

13 Would you be, in effect, transferring the same loads

14 to the casks that you would be transferring to those

15 casks if you use a 75,000 PSI?

16 DR. BARTLETT: Again, why do I have to

17 second guess the results of the dynamic model? Let's

18 just model it correctly.

19 MR. TURK: Could you answer the question

20 I asked you, though?

21 DR. BARTLETT: I'm not going to make a

22 supposition.

23 MR. TURK: You don't know?

24 DR. BARTLETT: I'm not going to make a

25 supposition.

1 MR. TURK: Why is that?

2 DR. BARTLETT: Because I'm not going to

3 guess the results of the dynamic model.

4 MR. TURK: Have you ever built a dynamic

5 model?

6 DR. BARTLETT: Yes, I have.

7 MR. TURK: Including Young's modulus?

8 DR. BARTLETT: Well, shear modulus in

9 soils, but yes.

10 MR. TURK: Is the shear modulus in the

11 soil something that would transfer a load through

12 shear stress?

13 DR. BARTLETT: Yes.

14 MR. TURK: In your work with dynamic

15 models, if you put in a larger shear modulus than

16 actually existed in the material, would you not, in

17 effect, be causing that material to be stiffer?

18 DR. BARTLETT: The shear modulus soil is

19 highly non-linear so it is strain dependent. We don't

20 use one property, one value. At high strains

21 interesting things can happen, yes. But I'm not going

22 to second guess the results of the dynamic model.

23 My position is that it should be modeled

24 correctly.

25 MR. TURK: If Dr. Luk was able to

1 demonstrate, or to explain that using a Young's
2 modulus of 270,000 PSI for the CTS, in effect builds
3 a conservativism into his model, thereby greater
4 forces are transmitted to the casks, in order to
5 maximize cask displacement, or cask rotation, would
6 that, to you, be an acceptable understanding, or would
7 that provide understanding to you as to the propriety
8 of using 270,000 PSI here?
9 DR. BARTLETT: Possibly.
10 MR. TURK: You are not sure?
11 DR. BARTLETT: Well, another effect is
12 that it affects the stiffness in the vertical
13 direction. So, again, my position is, why don't we
14 just model it correctly instead of trying to retrofit
15 results back.
16 MR. TURK: You understand, however, that
17 when engineers perform analyses sometimes they build
18 conservativisms into the analysis, in order to
19 maximize the effect upon the element of interest, the
20 structure of interest?
21 DR. BARTLETT: At times, yes.
22 MR. TURK: Now, do you know if that is
23 also done in finite element analysis modeling?
24 DR. BARTLETT: Sure, one could put in
25 conservative estimates. But, again, I'm not going to

1 second guess what is going to happen in a dynamic
2 sense by using this soil cement that is obviously
3 stiffer than what PFS intends to use.
4 Because there could be, also, things
5 happening at these interfaces. Again, I'm just not
6 going to guess at what is going to happen in the
7 dynamic sense, as we soften it in one part, or stiffen
8 it in another part.
9 It is a simple thing, I just don't
10 understand why he didn't capture it properly the first
11 time.
12 MR. TURK: Okay.
13 DR. BARTLETT: It is not that it has been
14 a big secret.
15 MR. TURK: In general, though, if you use
16 a stiffer Young's modulus --
17 DR. BARTLETT: I'm not going to suppose
18 what is going to happen in the dynamic case, I've
19 already gone there.
20 MR. TURK: Can you talk about a static
21 case?
22 DR. BARTLETT: Static linear case?
23 MR. TURK: Yes.
24 DR. BARTLETT: Fine.
25 MR. TURK: If one was to use a stiffer

1 Young's modulus, a larger Young's modulus for the
2 cement treated soil, would that have the effect of
3 transferring greater forces to the cask than if one
4 had used a lower Young's modulus for that cement
5 treated soil?
6 DR. BARTLETT: I can't understand your
7 analogy, because our casks, and the movement of the
8 casks, is really a dynamic case. When the Young's
9 modulus is stiffer it will strain less at a higher
10 load. That is simply all it means.
11 MR. TURK: And when you say it will strain
12 less, do you mean that material will strain less?
13 DR. BARTLETT: For the same load it will
14 have a less axial strength.
15 MR. TURK: And we are talking about the
16 cement treated soil?
17 DR. BARTLETT: Whatever. I thought we
18 were going to a generic case, talking about modulus.
19 MR. TURK: I'm trying to keep this as
20 understandable as possible. If one used a larger
21 Young's modulus for the cement treated soil, that
22 would, as you stated, make that material stiffer, and
23 therefore it would strain less?
24 DR. BARTLETT: It would strain less for
25 the same amount of load, yes.

1 MR. TURK: But if the force is the same --
2 DR. BARTLETT: Correct.
3 MR. TURK: -- then that force, instead of
4 being dissipated in the cement treated soil, would be
5 transferred to whatever structures are above the
6 cement treated soil?
7 DR. BARTLETT: Again, we've gone from a
8 simple discussion about Young's modulus to a case of
9 casks and pads, and I'm not going to go there.
10 MR. TURK: Commencing at page 374 --
11 CHAIRMAN FARRAR: Mr. Turk, before we go
12 on start thinking about breaks, and lunch, and the
13 time. Given the late start we don't have a cross
14 examination plan on this, do we?
15 How much longer do you think the whole
16 examination, cross examination will be?
17 MR. TURK: I would say about an hour and
18 a half. Essentially, as I understand the presentation
19 of the rebuttal testimony, it appears to be
20 duplicative.
21 There were, essentially, three times which
22 appears to me to be the same theories and statements
23 were made. So we may be able to gloss through a lot
24 of that fairly quickly if, in fact, I'm right that
25 those are just restatements of what we are discussing

1 now.

2 If Your Honors would like a break this

3 would be an acceptable time.

4 CHAIRMAN FARRAR: Yes, why don't we -- it

5 is 27 after, let's be back at 20 of. We will do part

6 of what you have left, and then take a lunch break.

7 Unless it gets shorter than you think, in which case

8 we could go straight through, and I will let you

9 finish before lunch. But we will just see how that

10 comes out.

11 MR. GAULKER: I will have some cross

12 examination, not that much, but I will have some.

13 CHAIRMAN FARRAR: All right. Let's come

14 back at 20 of.

15 (Whereupon, the above-entitled matter

16 went off the record at 11:27 a.m. and

17 went back on the record at 11:40 a.m.)

18 CHAIRMAN FARRAR: On the record. Mr.

19 Turk, are you would resume?

20 MR. TURK: Thank you.

21 BY MR. TURK:

22 Q Let me ask you one follow-up question that

23 I should have asked you before when we were talking

24 about the 2.1 kips per square foot. Is that what it

25 was? The KSF.

1 A Yes.

2 Q If the -- are you familiar with the

3 analysis that PFS conducted with respect to cask

4 stability, did you review those?

5 A These are the Holtec analyses?

6 Q Yes.

7 A Yes, I'm generally familiar with them.

8 I'm not sure about specific details, but --

9 Q There was a Stone and Webster calculation,

10 GB-04.

11 A Yes.

12 Q Which was a stability analysis of cask

13 storage pads?

14 A Yes.

15 Q Do you recall, in that calculation, what

16 the frictional resistance to sliding, KSF, was used?

17 A What frictional resistance to sliding? My

18 recollection that the sliding calculations used

19 cohesion, not friction.

20 Q I'm sorry, the cohesion factor, that was

21 a 2.1 KSF.

22 A 2.1 KSF is the cohesional resistance to

23 sliding, yes.

24 Q And that is the same factor, the 2.1, as

25 in MU2 equals 1.0, if the stresses are 2.1 KSF,

1 correct, the normal stress?

2 A Could you please repeat that? I got lost.

3 Q In this calculation Stone and Webster used

4 C=2.1KSF?

5 A Correct, that is the cohesive strength of

6 the clay, the Bonneville clay, for a sample that was

7 consolidated to a normal stress of about 2 KSF.

8 Q Is it correct that the PFS analysis, for

9 this bonded case, in which there is no sliding of the

10 pad, on the cement treated soil, uses a shear

11 resistance of this 2.1KSF?

12 A As a cohesion, yes. And that is shear

13 resistance of the Bonneville clay, it is the shear

14 strength, also.

15 Q So that is the bond they are inputting as

16 resistant to the sliding?

17 A Well, the intent of PFS is to develop a

18 bond between the cement treated soil, and the soil

19 cement, such that it forces the failure plane into the

20 Bonneville clay, which has an undrained shear strength

21 of 2.1KSF, approximately, in that calculation.

22 Q That was undrained?

23 A Undrained shear strength, yes.

24 Q In an essence that is a description of the

25 bond that PSF postulates between the pad and the

1 cement treated soil?

2 A The bond between -- no, that interface

3 would be the -- well, let's back up and make sure we

4 are clear. The 2.1 kips per square foot, or the

5 cohesion that you referred to is the undrained shear

6 strength of the clay.

7 The intent of PSF's design is to develop

8 a bond between the clay, and the base of the cement

9 treated soil, such that that bond would be higher than

10 the undrained shear strength of the clay, forcing the

11 failure into the clay.

12 That is my understanding of what they are

13 trying to do with the design for the sliding

14 calculation.

15 So the bond that they have to develop from

16 the test program would be higher than that value, at

17 least.

18 Q That is very close to what Dr. Luk used,

19 where Mu 2 equals to 1.0, correct?

20 A No, that is not correct.

21 Q The value is not correct?

22 A Could you repeat the question?

23 Q If we used the formula F=Mu N, F the

24 frictional resistance --

25 A Correct.

1 Q -- would be equal to Mu1.0 times the
2 normal stress, normal stress is 2.1, then F equals
3 2.1, correct?
4 A I agree thus far. Now, what was the --
5 Q And that value is pretty much the same as
6 the value represented by the PFS bonded condition that
7 is inputted into their cask stability analysis?
8 A No.
9 Q It is not?
10 A No.
11 Q How are they different?
12 A Because the cohesion is not dependent on
13 the normal stress. In a dynamic case the normal
14 stress may be varied because of the accelerations in
15 the vertical direction.
16 Q Okay.
17 JUDGE LAM: If I may interrupt, Mr. Turk?
18 MR. TURK: Yes.
19 JUDGE LAM: Now, this cohesion issue here,
20 are you saying that this is an inherent deficiency in
21 Dr. Luk's model, or Dr. Luk had misused his input?
22 THE WITNESS: I think it is an inherent
23 deficiency in the description of the properties in the
24 model. Does that help?
25 Maybe I could tell you why a little bit.

1 But in the dynamic case the friction materials derive,
2 obviously, some of their shear resistance, or derive
3 all of their shear resistance from the normal
4 stresses.
5 In the case of an earthquake we have to
6 also remember we have things moving up and down, we've
7 talked somewhat about an effective way, things are
8 becoming effectively, have less weight as the
9 accelerations change, or we have kind of an unloading
10 going on, because we have this vertical direction that
11 is also occurring during the earthquake.
12 So when you look at a friction material,
13 since it is dependent upon that normal stress, if you
14 plot it at a certain interface you will probably see
15 its shear resistance decreasing and increasing by a
16 certain ratio, this MU coefficient that we have been
17 describing.
18 Cohesion doesn't, at least the way we are
19 thinking of it, in a pure sense, doesn't rely anything
20 on the normal stresses. It is always there, it is --
21 I think we described in Salt Lake City, the super glue
22 that holds things together, but doesn't depend upon
23 the normal stresses.
24 So I think that is one of the areas we are
25 discussing, is this dependency on the normal stresses,

1 and how this internal linear friction models that
2 versus cohesion which doesn't depend on the normal
3 stresses.
4 In fact, when Private Fuel Storage
5 initially started the analysis of this system, they
6 looked at placing the pads directly on a granular
7 frictional material, gravel. And found that when they
8 did their analysis for sliding they didn't have
9 adequate resistance for sliding, simply because when
10 the accelerations downward become quite large, the
11 effective weight of the pad decreases.
12 And if we applied an inertial force in
13 this direction, the pad would slide and I recall the
14 factor of safety around .4 or .5. And I think those
15 are even somewhat carried on in the present
16 calculations to show that there is inadequate
17 resistance for sliding when you put on a frictional or
18 a granular material.
19 So then the design concept evolved to,
20 well, could we somehow develop a bond between the
21 cement, excuse me, the base of the concrete pad, and
22 the top of the because, and rely on cohesion, not
23 friction, to resist these forces.
24 So that is, I guess, my fundamental
25 problem here.

1 JUDGE LAM: Thank you.

2 BY MR. TURK:

3 Q That explains the PFS design, which is a
4 different matter than how Dr. Luk would model in order
5 to achieve a comparable analysis of the real
6 conditions?

7 A Well, I'm not sure I would agree that he
8 achieved a comparable analysis.

9 Q Okay, I understand. But what you are
10 describing is in effect the PFS design, and the
11 evolution of that design when you talk about the use
12 of this cohesion factor, you are not talking about Dr.
13 Luk's model in that regard?

14 A No, I'm just explaining how I envisioned
15 how this discussion about whether we should use
16 frictional materials, or cohesive materials, and how
17 they should work in the system.

18 Q If you would look at page 10374,
19 continuing on to page 10378 of your testimony on June
20 7th, could you confirm that up to the point where at
21 line 17, on 10378, where you talk about the one
22 foot/two foot dimension of the CTS, that what you are
23 really doing is reiterating the same concerns that you
24 expressed previously, that we have been discussing
25 until now?

1 A Pardon me, which line?

2 Q This would start at page 10374, line 19.

3 Ms. Chancellor asked you, could you recap why you

4 believe that Dr. Luk's report does not model the

5 properties at the PSF site.

6 And then you go on to answer that

7 question, and the subsequent question, which she tells

8 you go ahead, up until 10378, line 18.

9 What you are doing in that discussion is

10 really recapping what we have already been addressing

11 today.

12 A Yes. As I recall there was the issues

13 about these interface properties, then issues about

14 the Young's modulus, using the model, and then I think

15 we talked a little bit about Pecoima dam record, and

16 issues related to that.

17 Q Well, if you look at this testimony.

18 A Okay.

19 Q I don't see a mention of the Pecoima dam

20 record in this area.

21 A No, you are correct, I was just recapping

22 in my mind what I thought I discussed some two weeks

23 ago, or so.

24 Q Well, no, this was on the same date that

25 you provided that earlier testimony.

1 A Yes.

2 Q And Ms. Chancellor asked you, you'd given

3 your testimony once, she asked you to recap. And what

4 I understood you were doing, on those pages that I

5 mentioned, 10374 to 10378, was restating what you had

6 stated previously that same day, which we've already

7 addressed this morning.

8 A Yes, I just can't remember the sequence.

9 But you could ask me if they were the same issues that

10 we've already discussed, I certainly could --

11 Q Okay. Could you answer that question?

12 A And the line was, again, which line?

13 Q If you would, and maybe we can go off the

14 record to let Dr. Bartlett do this, but before we go

15 off, I would ask him to look at 10374, starting with

16 line 19, going on to 10378.

17 A So 10374, okay.

18 Q To 10378, line 18. And would you confirm

19 that there is nothing new raised there, beyond what

20 we've already been talking about this morning?

21 A Yes, I can do that.

22 MR. TURK: And we can go off the record

23 while he looks.

24 CHAIRMAN FARRAR: Well, let's take a

25 moment and do that off the record.

1 (Whereupon, the above-entitled matter
2 went off the record at 11:54 a.m. and
3 went back on the record at 11:56 a.m.)
4 BY MR. TURK:
5 Q You've had a chance to review that?
6 A Yes.
7 Q In fact those are the same issues that you
8 raised earlier in this testimony that we have been
9 discussing today, correct?
10 A Yes, I only see one minor issue, is that
11 the, and I'm on line 19, so I don't know if I've gone
12 beyond my bounds, on page 10378.
13 Q You are coming up to the next question.
14 A Okay, let's stop, then.
15 Q Up until you get to line 18 or 19 on
16 10378, there is nothing new there, that is what we've
17 already been discussing?
18 A I didn't see anything that we haven't
19 discussed this morning.
20 Q And then you raise another issue at line
21 18 of 10378, in which you indicate that Dr. Luk has
22 modeled the cement treated soil at its maximum of two
23 feet?
24 A Correct.
25 Q Whereas, in fact, PFS has indicated that

1 the design will be one to two feet?

2 A Correct.

3 Q And you are suggesting that Dr. Luk

4 inappropriately modeled, or inappropriately input this

5 value, that he should have used some other value apart

6 from two feet?

7 A My sense is it is probably not too

8 sensitive to the thickness of that model, but maybe a

9 foot and a half, or somewhere between a foot and two

10 feet, but it is not a two foot layer, it is one foot

11 minimum, two foot maximum.

12 Q If Dr. Luk utilized a two foot value,

13 would that in effect be putting in more cement treated

14 soil beneath the pad than might exist in the actual

15 design?

16 A That would be correct.

17 Q And in doing that is he, in effect,

18 creating greater stiffness of the cement treated soil

19 than would exist if he had to use one and a half feet,

20 as you suggest? Greater total stiffness as opposed to

21 the --

22 A Yes, I think when you qualified with total

23 stiffness, then I think I accept that. The system is

24 now thicker so it would behave stiffer.

25 Q In effect then if it is the same 40 PSI

1 value for the cement treated soil, by using two feet,
2 rather than one and a half feet, you've got more of
3 that 40 PSI CPS than you would have if only one and a
4 half feet, or one foot was used?
5 A Yes.
6 Q And do you know whether that might be used
7 as a modeling conservativism by Dr. Luk?
8 A That I don't know. It seems to me that it
9 affects the stiffness in the vertical direction. One
10 of the State's issues is as the -- has the system been
11 modeled too stiff.
12 But I think on the scale we are talking
13 about it is a fairly minor point, Mr. Trudeau.
14 Q If, in fact, Dr. Luk did model the cement
15 treated soil as being of two foot depth, that would,
16 in effect, result in a stiffer CTS?
17 A Correct.
18 Q And that in effect would also transfer
19 greater loads to whatever lies above the CTS, correct?
20 It would transfer more energy than if a one and a
21 half, or one foot CTS was used?
22 A Again, I guess the reason why I'm having
23 problems going into the dynamics sense is because I
24 understand it changes the stiffness of the dynamic
25 response of these non-linear systems.

1 I'm not sure at what frequencies they are
2 sensitive to. So it gets difficult for me to kind of
3 guess. I guess I understand it changes the stiffness.
4 I think it would change the high frequency response,
5 but what it does to other frequencies I'm not really
6 sure, Mr. Turk.
7 It is just hard for me to second guess
8 dynamic analysis.
9 Q In a static model, if one used more cement
10 treated soil, two feet here, rather than one foot, or
11 one and a half feet --
12 A Correct.
13 Q -- would that, in effect, transfer more
14 energy up to the casks, such that displacement, or
15 rotation of the casks would be greater than if only
16 one foot, or one and a half feet of CTS was used?
17 A I'm confused again. We went from a static
18 case to a dynamic case.
19 Q You can't answer my question?
20 A Well, I don't understand transfer of
21 energy in a static case, but tell me where the forces
22 are coming from, and I might be able to answer it.
23 Q You have an earthquake, you have a seismic
24 force?
25 A That is a dynamic case to me.

1 Q So you can't say whether or not more
2 energy would then be transferred to the casks above
3 the CTS, in the dynamic case?
4 A Well, the change in stiffness changes the
5 amplitude and frequency of the response. So I guess
6 talking about particular frequencies and the -- that,
7 I guess, we could continue the discussion.
8 But it is hard for me to continue in a
9 dynamic case.
10 Q Okay. If you would take a look at page
11 10379 of your testimony, at the top of the page. Do
12 you recount that Dr. Luk had indicated he obtained
13 soil properties from the NRC Staff.
14 Ms. Chancellor asked you: "Do you know
15 whether Dr. Luk accepted those properties he obtained
16 from the Staff on their face value?" Do you see that
17 question?
18 A Yes.
19 Q And you indicate: "That is my
20 understanding, he said he just took the parameters
21 that had been sent to him and modeled them, as he had
22 been given to them."
23 A Yes, that was my recollection from Dr.
24 Luk's deposition.
25 Q Do you recall Dr. Luk ever stating that he

1 took the properties, "at face value"?

2 A My recollection was that properties were

3 sent from him, from NRC Staff. Whether he took them

4 completely at face value, or modified his opinion of

5 them, when he received them, when he received them,

6 that I can't say, Mr. Turk.

7 Q Okay. If you would look at page 10411, at

8 line 4. You indicate you have a concern that modeling

9 done by Holtec, as well as by Dr. Luk: "Does not

10 really have the capabilities of predicting post-yield

11 behavior."

12 A Correct.

13 Q Is it your understanding that Dr. Luk was

14 attempting to model post-yield behavior?

15 A In his model using friction material I

16 don't think the concept of post-yield holds.

17 Q Well, can you answer the question I asked,

18 do you believe he was trying to model post-yield

19 behavior?

20 A I don't believe Dr. Luk's model was trying

21 to model post-yield behavior, that is correct.

22 Q Incidentally, post-yield behavior is not

23 something that occurs during the earthquake itself,

24 correct?

25 A No, the soils can yield during the

1 earthquake, they frequently do.

2 Q It also frequently happens that the yield

3 takes place several minutes after the earthquake?

4 A No, not generally.

5 Q It is your belief that the materials would

6 yield during the earthquake event itself?

7 A Generally, yes. There are a few rare

8 cases that there is failure after the earthquake, but

9 they are due to other mechanisms that we are not

10 really discussing here.

11 Q And when you talk about yield, are you

12 talking about phenomenon such as the settlement of the

13 soils as a result of seismic --

14 A Settlement can be a result of yielding,

15 yes.

16 Q Liquefaction is another typical yield

17 behavior of certain soils?

18 A It more of almost a collapse behavior.

19 But, yes, you could consider it a close failure

20 behavior.

21 Q But what you are talking about is a

22 collapse phenomenon?

23 A No, not necessarily. It is, in the case

24 of liquefaction it is the sands trying to reach a

25 denser state, and in doing so high pore pressures are

1 generated, and the soil dramatically loses strength.
2 So it is a post-failure, post-yield
3 behavior. But that is not what I'm talking about
4 here, either.
5 Q May I ask you to turn, also, to page
6 10441.
7 A Yes.
8 MS. CHANCELLOR: Your Honor, I believe
9 we're getting into testimony that was not part of the
10 rebuttal.
11 MR. TURK: Well, let me see if I can ask
12 the question, Your Honor, and see if there's an
13 objection to the question.
14 In your testimony commencing at line 13,
15 going to line 20. Do you see that discussion?
16 DR. BARTLETT: Yes.
17 MR. TURK: The question I asked you had to
18 do with displacements or rotation of the casks, vis a
19 vis the accelerations showing in, what I think Dr.
20 Ostadan referred to as the famous Figure 17 and 20.
21 DR. BARTLETT: Yes, I remember.
22 MR. TURK: In that paragraph at line 17
23 you state, "The model may tend to not properly model
24 what's happening in the foundation, and we're stuck
25 with this dilemma of why the accelerations are so

1 high, but the displacements of the casks are so low."

2 DR. BARTLETT: Uh-huh.

3 MS. CHANCELLOR: Objection, Your Honor.

4 MR. TURK: I haven't asked the question

5 yet.

6 MS. CHANCELLOR: Okay. I'll wait.

7 MR. TURK: Does this relate to the

8 concerns you expressed about the inputs used by Dr.

9 Luk of Mu 1 or Mu 2?

10 MS. CHANCELLOR: Objection, Your Honor.

11 This is part of redirect examination on Section D. It

12 does not relate, and we were very specific in the

13 transcript. The page number that Mr. Turk refers to

14 is not part of the rebuttal testimony, and if Mr. Turk

15 is going to go through various portions of the

16 transcript that are not part of the rebuttal, we'll be

17 here all day.

18 MR. TURK: Your Honor, let me cut this

19 short. If you would, please turn to the bottom of 10-

20 441 and the top of 10-442, in which I specifically

21 indicated through questioning of Dr. Bartlett, this is

22 part of his rebuttal testimony.

23 CHAIRMAN FARRAR: Ms. Chancellor, I think

24 for that reason, the transcript reference Mr. Turk

25 gives and the fact that as long ago as December 26th,

1 he pointed out how interwoven a lot of these issues
2 are. And I think that was the day Dr. Bartlett was
3 putting on and taking off hats. I don't think we want
4 to be in the position now of trying to draw too fine
5 a line, so I'll overrule the objection.
6 MR. TURK: Thank you, Your Honor.
7 Do you see that -- the testimony that I
8 referred to, and at the bottom of page 10-441 you
9 state that in making this statement, "It pertains to
10 the soil properties used in the model."
11 DR. BARTLETT: On 10-441?
12 MR. TURK: Yes.
13 DR. BARTLETT: Oh, there it is. Okay.
14 Yes, I see that.
15 MR. TURK: I only had a simple question,
16 and that is to try to understand whether it was your
17 suggestion that modeling of soil properties in Dr.
18 Luk's model was potentially responsible for high
19 accelerations in Figure 17 and 20.
20 DR. BARTLETT: I don't know if I replied
21 that, but --
22 MR. TURK: That wasn't your intent?
23 DR. BARTLETT: Could you repeat the
24 question, Mr. Turk? I'm sorry.
25 MR. TURK: Okay. I think we better create

1 a trail that we can all follow.

2 DR. BARTLETT: Okay.

3 MR. TURK: The questioning that was taking

4 place here had to do with, if you look at page 10-440,

5 for instance.

6 DR. BARTLETT: Okay.

7 MR. TURK: At line 4, there's a question

8 about Figure 20b, and I was asking you do you see

9 higher accelerations -- I was asking Dr. Ostadan,

10 apparently. "Do you see higher accelerations at the

11 center of the pad versus the free field in Figure

12 20b"?

13 DR. BARTLETT: Okay.

14 MR. TURK: And then Dr. Ostadan provided

15 an answer, and I asked, "Whether, in fact, the

16 plaintiff, Dr. Luk's including Figure 20b in the

17 report was to show soil structure interaction"?

18 DR. BARTLETT: Okay.

19 MR. TURK: You go on to say, "Yes." And

20 the questioning continues onto page 10-441.

21 DR. BARTLETT: Okay.

22 MR. TURK: At line 9, I say, "The

23 displacements or potential rotation at the top of the

24 casks are the results of whatever were the

25 accelerations experienced by the system." And you

1 answer -- and I ask you, "Correct"? And you state,
2 "Yes, it would be the results of accelerations."
3 DR. BARTLETT: Yes.
4 MR. TURK: In that same paragraph at line
5 14 you state, "I don't know which line I'm crossing
6 again, because we may be going back into issues
7 related to rebuttal."
8 DR. BARTLETT: Uh-huh.
9 MR. TURK: You state, "The model may tend
10 to not properly model what's happening in the
11 foundation, and we're stuck with this dilemma of why
12 the accelerations are so high, but the displacements
13 of the casks are so low." Do you see that statement?
14 DR. BARTLETT: Yeah.
15 MR. TURK: And then right after that I
16 asked you, "Are you making this statement based upon
17 this new look, second look you've had at Dr. Luk's
18 report"? And you state, "Yes, it pertains to the soil
19 properties used in the model."
20 And my question to you is, is it your
21 statement that the high accelerations shown in Figure
22 20b and Figure 17 are the result of soil properties
23 modeled by Dr. Luk?
24 DR. BARTLETT: I'm not sure of the cause,
25 Mr. Turk.

1 MR. TURK: It could be that, or it could
2 be some other explanation?
3 DR. BARTLETT: Yes. And my hesitancy to
4 presuppose is, again, my -- just lack of trying to
5 second-guess the nonlinear response to the dynamic
6 system.
7 MR. TURK: I'd like to ask you to turn to
8 page 10-457, and my only question is whether the
9 discussion that begins with my question at line 13,
10 and continuing onto 10-458, line 3, your answer. Is
11 that the same issue that we've been talking about
12 before, about whether or not Dr. Luk's model can -- is
13 predicting post yield behavior, and if it's simply the
14 same discussion that we've been having already, I
15 don't need to ask anything more about it.
16 DR. BARTLETT: Well, I don't know if we
17 talked much about post yield behavior. I think --
18 MR. TURK: But what I asked you -- you had
19 indicated that you didn't think that either Holtec or
20 Dr. Luk's model were predicting post yield behavior,
21 or capable of predicting post yield behavior.
22 DR. BARTLETT: Of the clays, yes.
23 MR. TURK: Of the clays. That's what we
24 talked about before.
25 DR. BARTLETT: That's my position, yes.

1 MR. TURK: And this is the same thought
2 expressed again here.
3 DR. BARTLETT: I believe so, yes.
4 MR. TURK: Okay. Incidentally, I'm going
5 to skip over Judge Lam's question about impulse
6 loading, but I would ask you, are you aware in Dr.
7 Luk's model what integrals of time were utilized in
8 the modeling?
9 DR. BARTLETT: The time steps in the time
10 history?
11 MR. TURK: The time increments.
12 DR. BARTLETT: In the time history?
13 MR. TURK: For the -- in the fine element
14 calculation, in the fine element analysis.
15 DR. BARTLETT: Uh-huh. What were the time
16 steps, increments?
17 MR. TURK: The time increments.
18 DR. BARTLETT: No, I don't recall that
19 level.
20 MR. TURK: You indicated that you've done
21 some computer runs of other finite element analyses.
22 Do you recall when we started today, you indicated
23 you'd done that?
24 DR. BARTLETT: Yes, I remember.
25 MR. TURK: Do you recall what sorts of

1 time increments were used in those FEA models?

2 DR. BARTLETT: No, it's been a few years,

3 Mr. Turk. They were not dynamic models either.

4 MR. TURK: The FEAs that you ran were not

5 dynamic models?

6 DR. BARTLETT: No, they were static.

7 Different loading conditions, but for static case, and

8 the other was for seepage.

9 MR. TURK: So Dr. Luk's report essentially

10 is the first attempt by you to evaluate a dynamic

11 analysis of finite element modeling?

12 DR. BARTLETT: I didn't look at what I was

13 doing really evaluating the numerical modeling

14 performed by Dr. Luk. I was just reviewing the

15 properties used in the model. I leave those tasks to

16 Dr. Ostadan.

17 MR. TURK: I would ask you to turn to page

18 10-530 of your testimony. Commencing with Ms.

19 Chancellor's question at line 11, the response

20 starting at line 15, that your opinion, and this has

21 to do with Dr. Luk's modeling of the PFS site. You

22 state your opinion is that, "Modeling the interface

23 nodes as a frictional material or as the sand", as Ms.

24 Chancellor referred to it, "is inappropriate." Is

25 that correct? That's the thrust of the statement?

1 DR. BARTLETT: Yes.

2 MR. TURK: And is this statement
3 continuing down to the question on 10-531, line 12.
4 The response to this question and the subsequent
5 question -- this is, again, the same issue that we
6 addressed earlier this morning, the use of Mu 1 or Mu
7 2 with these different coefficients of friction by Dr.
8 Luk in Table 8.

9 DR. BARTLETT: Yes, I think it goes back
10 to these interface properties we've been talking
11 about.

12 MR. TURK: And again, essentially, your
13 concern here is that you believe Dr. Luk was modeling
14 the underlying soils as if they were friction
15 materials. Friction materials such as sands or --

16 DR. BARTLETT: Yes, they would be common
17 materials that we would see under the foundation.

18 MR. TURK: And if Dr. Luk is able to
19 explain that that's not what he was doing, do you
20 think that might satisfy your concern?

21 DR. BARTLETT: That I can't answer.

22 MR. TURK: You'd have to wait to hear what
23 he --

24 DR. BARTLETT: I'd have to hear the
25 explanation.

1 MR. TURK: That's like asking you if I do
2 a good job, can I get an A. And you'll say you have
3 to see what kind of job I do. Right?
4 DR. BARTLETT: Yes.
5 MR. TURK: If I was one of your students.
6 I would hope for the A off the bat, but I understand.
7 Again, starting at 10-531, at line 9, and
8 again starting at line 14, it seems to me that you're
9 describing the same issue that we talked about earlier
10 today, modeling of -- using a Mu 2 of .31 or 1.0. If
11 you continue through that discussion onto page 10-533,
12 line 6. And I'd ask to go off the record to let you
13 look at those pages. My question is, is this, again,
14 the same discussion that we've had earlier today, or
15 is there something new in this discussion beyond what
16 we've addressed?
17 DR. BARTLETT: What was the ending line
18 that I was supposed to stop at?
19 MR. TURK: 10-533, line 6.
20 CHAIRMAN FARRAR: All right. We'll go off
21 the record while the witness does that.
22 (Off the record 12:22:49 - 12:23:15 p.m.)
23 CHAIRMAN FARRAR: On the record. The
24 witness has indicated he's concluded his review.
25 MR. TURK: You've looked at that testimony

1 starting at 10-531, going up to 10-533, line 6?

2 DR. BARTLETT: Yes.

3 MR. TURK: And is that essentially the

4 same discussion that we've addressed previously today?

5 DR. BARTLETT: Yes. I think we were just

6 here going through some examples of the effect of

7 different interface conditions, and at what point

8 would we start to have a force that would cause

9 sliding in the static case.

10 MR. TURK: And again, starting at page 10-

11 533, line 9. Again, this is Ms. Chancellor asking you

12 questions here. She asked you, "Did Dr. Luk observe

13 the limit of sheer strength of 2.1 CSF clays in his

14 analysis"? And you go on with your answer, beginning

15 at line 11, and continuing to page 10-534, line 24.

16 I'd ask you to look at those answers and questions off

17 the record, and to -- when we come back, tell me if

18 that, again, is the same discussion that we had

19 previously today, or the same testimony as we explored

20 earlier today. And may we go off the record while Dr.

21 Bartlett does that?

22 CHAIRMAN FARRAR: Yeah. And you meant him

23 to quit on line 23?

24 MR. TURK: Yes, line -- well, line 24 on

25 page 10-534.

1 CHAIRMAN FARRAR: Line 24 starts a new
2 question.
3 MR. TURK: Correct. Up to that point.
4 CHAIRMAN FARRAR: Up to that point. All
5 right. If the witness would do that, off the record,
6 please.
7 (Off the record 12:25:49 - 12:26:35 p.m.)
8 MR. TURK: Dr. Bartlett, have you had a
9 chance to look at that testimony?
10 DR. BARTLETT: I have.
11 MR. TURK: And again, is that essentially
12 the same concern and testimony that we've addressed
13 earlier today?
14 DR. BARTLETT: I don't think in its
15 entirety. I think we haven't talked too much about
16 the constitutive relationship for a failure of a clay,
17 describe the stress-strain behavior of a clay.
18 MR. TURK: When you indicate at line 14 on
19 10-533 that there's a cohesion strength of 2.1 KSF, is
20 that the cohesion strength within the clay materials?
21 DR. BARTLETT: That's correct.
22 MR. TURK: That's the C Value in the Mohr-
23 Coulomb failure theory?
24 DR. BARTLETT: Yes, for the clay.
25 MR. TURK: In this discussion, in essence,

1 you're explaining why you believe Dr. Luk may have
2 inappropriately modeled Mu at the interface between
3 the soil and the CTS.
4 DR. BARTLETT: Yes, that's my
5 recollection.
6 MR. TURK: And that's the same concern
7 that you raised before, perhaps expressed in a little
8 greater detail here.
9 DR. BARTLETT: Yes, but I think I'm
10 bringing in a concern about how one would begin to
11 model the potential post failure behavior of the clay.
12 MR. TURK: Which you've recognized and
13 stated before was not something that Dr. Luk attempted
14 to do with his model.
15 DR. BARTLETT: No, and that's why I may
16 have some issue with it.
17 MR. TURK: Well, you may have issue with
18 the fact that you would believe that perhaps something
19 more should be done, but that's not an issue with
20 respect to what was done.
21 DR. BARTLETT: It's an issue --
22 MR. TURK: I'm coddling it. You recognize
23 that Dr. Luk treated soil as an elastic body in his
24 analysis, or do you know?
25 DR. BARTLETT: That I'm not aware of.

1 MR. TURK: Okay.

2 DR. BARTLETT: That may be my concern, Mr.

3 Turk.

4 MR. TURK: That what?

5 DR. BARTLETT: That the soil in this case

6 may not be completely modulus in elastic material.

7 MR. TURK: But you don't know how it was

8 modeled as you sit here today.

9 DR. BARTLETT: No, I don't.

10 MR. TURK: If you look at page 10-534 --

11 oh, by the way, maybe I should correct a

12 typographical error. At 10-534, line 3, the first

13 word says "one". I inserted a C there.

14 DR. BARTLETT: Okay.

15 MR. TURK: That says, "once has reached

16 failure."

17 DR. BARTLETT: Yes, that's correct.

18 MR. TURK: Okay. Starting at 10-534, line

19 24, and going on to line 13 of the next page, 10-535,

20 Ms. Chancellor asked you, "Whether you believe Dr. Luk

21 has properly modeled the stress-strain behavior" - I'm

22 sorry - "the stress-strain behavior of the cement-

23 treated soil", as I understand the question. Is that

24 your understanding? And in fact, it continues at the

25 top of page 10-535, with that explicit statement. Do

1 you see that?

2 DR. BARTLETT: Yes, I think there's

3 discussion both of the cement-treated soil, and

4 perhaps the clay also here.

5 MR. TURK: And again going up to line 13

6 on page 10-535, that's essentially the same discussion

7 we had earlier today, except here you're addressing

8 the cement-treated soil modeling.

9 DR. BARTLETT: It's not quite the same.

10 I think most we were discussing this morning has been

11 talking about the failure envelope. Here we're

12 talking about a -- some way of modeling the stress-

13 strain behavior of the clay once it reaches failure.

14 Well, I should add maybe the pre and post failure

15 behavior of the clay.

16 MR. TURK: And what you're talking about,

17 as I understand it, for instance, lines 4 and 5 of 10-

18 535, you talk about "once the cement-treated soil goes

19 into post failure mode."

20 DR. BARTLETT: Yes, reaches its capacity.

21 MR. TURK: And you state, "Then it may be

22 appropriate to model as a frictional material, but

23 your point is not before post failure."

24 DR. BARTLETT: That's correct. Once it

25 reaches the post failure mode, then we've broken the

1 cohesion bond, and it would behave somewhat as a
2 cemented silt sliding on a cemented silt, or something
3 like that.
4 MR. TURK: So the concern that you raise
5 in this paragraph has to do with, again, the use of Mu
6 2 in modeling the behavior of the interface between
7 the pad and the CTS, and between the CTS and the soil.
8 DR. BARTLETT: Right. I don't think it
9 would capture completely the pre and post failure
10 behavior.
11 MR. TURK: At line 15, on page 10-535, Ms.
12 Chancellor is asking you about "the modeling of the
13 Pecoima Dam earthquake."
14 DR. BARTLETT: Correct.
15 MR. TURK: Her question, at least as it
16 appears in type, indicates that, "The Pecoima Dam had
17 an acceleration of 4.61G"?
18 DR. BARTLETT: That must be -- that's an
19 obvious mistake.
20 MR. TURK: And your answer starting at
21 line 18, going to line 19. You stated, "It's
22 deficient on the vertical, somewhat on the
23 horizontal."
24 DR. BARTLETT: Right.
25 MR. TURK: What's your understanding of

1 what the peak accelerations were for the Pecoima Dam
2 record of the San Fernando 1971 earthquake?
3 DR. BARTLETT: I can't remember that level
4 of detail, Mr. Turk.
5 MR. TURK: If I suggest to you that the
6 horizontal peak acceleration was .641, would that be
7 consistent with your recollection, or do you not
8 recall?
9 DR. BARTLETT: .641. No, I don't remember
10 that I -- I know it was in Dr. Luk's report.
11 MR. TURK: Do you have Dr. Luk's report
12 handy?
13 DR. BARTLETT: I do.
14 MR. TURK: Page 1, four lines from the
15 bottom. This is Staff Exhibit P.
16 DR. BARTLETT: I have found the
17 accelerations.
18 MR. TURK: And, in fact, is the peak
19 horizontal acceleration in two horizontal directions
20 .641G for Pecoima Dam?
21 DR. BARTLETT: Yes, I see a -- both of
22 those are horizontal directions. That's correct.
23 MR. TURK: And when you stated at lines 18
24 and 19 of page 10-535, that the Pecoima Dam earthquake
25 peak accelerations are "deficient in its vertical, and

1 somewhat in the horizontal."

2 DR. BARTLETT: Yes.

3 MR. TURK: Is what you're stating there,

4 that the use of the Pecoima Dam record with the .641

5 horizontal, and .433 vertical does not adequately

6 represent the earthquake that's postulated for the

7 2000 year return period PFS site?

8 DR. BARTLETT: No, the peak ground

9 accelerations for the design basis earthquake for PFS

10 are higher than these.

11 MR. TURK: But that's your point?

12 DR. BARTLETT: Yeah, I think that's the

13 point I'm trying to make.

14 MR. TURK: Was it your understanding that

15 Dr. Luk was attempting to utilize the Pecoima Dam

16 earthquake to replicate the ground motions expected

17 for the 2000 year earthquake at PFS? Is that why you

18 say that use of those numbers are somewhat deficient?

19 DR. BARTLETT: I think the intent was to

20 show that the analysis wasn't too sensitive to

21 multiple time histories, but that's not -- I can't

22 remember. It's been a while. I think there was also

23 issues about using a synthetic versus a real-time

24 history.

25 MR. TURK: And the synthetic would

1 essentially be the artificial time histories produced
2 by Geomatrix for the PFS site?
3 DR. BARTLETT: Yeah, they're truly not
4 artificial. They have in them a input record that's
5 from the real earthquake, but they've been adjusted
6 both in frequency and amplitude to match the design
7 spectrum.
8 MR. TURK: Are you aware whether in
9 selecting the Pecoima Dam record, that one factor that
10 went into the selection of that earthquake was the
11 fact that there are good data available with respect
12 to the time histories involved? Do you know whether
13 that's true or not?
14 DR. BARTLETT: I don't remember that
15 detail, Mr. Turk.
16 MR. TURK: Do you know how many
17 earthquakes have been recorded with adequate data to
18 be used in generating a time history for a finite
19 element analysis dynamic model?
20 DR. BARTLETT: I'm not sure. Adequate in
21 what sense?
22 MR. TURK: Oh, what a modeler or somebody
23 who is building a finite element analysis for the PFS
24 site, do you have an opinion as to how many
25 earthquakes have adequate data in order to be used for

1 that type of a sensitivity run, or comparison?

2 DR. BARTLETT: Adequate data in terms of

3 frequency time, step? What are we talking about?

4 MR. TURK: The records of time histories

5 and accelerations.

6 DR. BARTLETT: Well, that's many records

7 of time histories and accelerations for many

8 earthquakes.

9 MR. TURK: Well, would you agree that some

10 earthquakes have more data recorded about them than

11 other earthquakes?

12 DR. BARTLETT: Well, we capture a time

13 history with a seismogram and we measure the response.

14 There are many of those kinds of recordings.

15 MR. TURK: Did you have some other

16 earthquake in mind that might have been more

17 appropriate for Dr. Luk to use in his model, than the

18 Pecoima Dam record?

19 DR. BARTLETT: No, I was just noting that

20 his direct comparisons can be made to the PFS site,

21 that this record wasn't -- didn't have as much energy

22 as the PFS record did, if we're solely focusing on

23 PGA.

24 MR. TURK: Okay. By the way, you

25 recognize that Dr. Luk also used a 10,000 year

1 earthquake in his analyses, and reported in Table 10
2 of his report?
3 DR. BARTLETT: I remember those analyses
4 were done, yes.
5 MR. TURK: And that would have more energy
6 than the 2000 year earthquake that is proposed as the
7 design earthquake for PFS. Correct?
8 DR. BARTLETT: Certainly.
9 MR. TURK: Your Honor, I may be done. May
10 I have just a moment?
11 CHAIRMAN FARRAR: Certainly.
12 MR. TURK: I think that's it for us, Your
13 Honor.
14 CHAIRMAN FARRAR: All right.
15 MR. TURK: I would simply note that I
16 think I've kept my commitment. It's about 12:40, and
17 I'm --
18 CHAIRMAN FARRAR: All right. You didn't
19 get an A from Dr. Bartlett, but you're really
20 something. Let me ask Ms. Chancellor and Mr. Gaukler,
21 Mr. Gaukler, how long do you think you need?
22 MR. GAUKLER: I have a half hour or less.
23 CHAIRMAN FARRAR: The reason I ask is
24 everyone's getting hungry, but it would be a plus, I
25 assume, Ms. Chancellor, for you to be able to spend a

1 long lunch hour with Dr. Bartlett going over your
2 redirect. And I thinking if we had Mr. Gaukler go
3 now, then you'd have both of their cross examinations
4 to mull over, but I don't want anyone to get famished
5 here.
6 MS. CHANCELLOR: Whatever is the pleasure
7 of --
8 CHAIRMAN FARRAR: Well, I think if we take
9 lunch now, then Mr. Gaukler does his cross, then
10 you're going to need a break to get ready. Can
11 everyone stay with us another half hour or less, as
12 Mr. Gaukler suggested?
13 MS. CHANCELLOR: I'm fine.
14 CHAIRMAN FARRAR: It's basically your
15 option, Ms. Chancellor.
16 MS. CHANCELLOR: I'll choose to stay.
17 CHAIRMAN FARRAR: Okay. Then let's go.
18 All right, Mr. Gaukler.
19 MS. CHANCELLOR: Your Honor, the witness
20 is --
21 DR. BARTLETT: I have to get styrofoam
22 cups to eat while I --
23 (Laughter)
24 CHAIRMAN FARRAR: All right.
25 DR. BARTLETT: I'm fine.

1 CHAIRMAN FARRAR: Fine. Thank you, Dr.
2 Bartlett.
3 MR. GAUKLER: Good afternoon, Dr.
4 Bartlett.
5 DR. BARTLETT: Good afternoon.
6 MR. GAUKLER: I just want to clarify one
7 question, one point that you made in response to one
8 of Mr. Turk's questions. He was asking you whether
9 you had done finite element analysis of dynamic
10 loading. That was the topic, and I just want to
11 clarify. I understood you to say that you had never
12 done a finite element analysis of a dynamic loading
13 situation. Is that correct?
14 DR. BARTLETT: That's correct. The finite
15 element analyses I've done were for either static
16 cases or seepage.
17 MR. GAUKLER: You've gone over with Mr.
18 Turk this morning your concerns with respect to the
19 modeling that Dr. Luk did. Do you, yourself, know how
20 you would properly model cohesion in a finite element
21 analysis like Dr. Luk used?
22 DR. BARTLETT: No, I really don't.
23 MR. GAUKLER: Do you know whether cohesion
24 was incorporated as a practical matter in Dr. Luk's
25 model or not?

1 DR. BARTLETT: Didn't apparently have any
2 cohesion effect in it. As I understand, it was all
3 purely frictional at these interface nodes.
4 MR. GAUKLER: But you don't know for sure
5 one way or the other?
6 DR. BARTLETT: Well, if you take the
7 reported face values, obviously there was no cohesion
8 in the model.
9 MR. GAUKLER: Now going back to your basic
10 concern that you have with Dr. Luk's modeling, I
11 understand that basically your concern is that by not
12 including cohesion, Dr. Luk's model may have allowed
13 the pads to slide for the soil cement, to slide,
14 either the soil or the pads to slide, either the soil
15 cement and the soil. Is that correct?
16 DR. BARTLETT: The tendency would be to
17 slide possibly earlier if you model it purely as a
18 frictional material because of the high cohesion that
19 the design is requiring at these interfaces, so that's
20 just my instincts, without having run the model.
21 MR. GAUKLER: And I think you said that --
22 and in terms of the consequences, if the pad slides,
23 I take it -- if you look at page 10-351 of your
24 testimony at the bottom of the page. I take it your
25 concern if you allow the pads to slide is that you

1 will dampen or reduce the energy that is transferred
2 to the cask on the pads?
3 DR. BARTLETT: That could be one
4 consequence, yes.
5 MR. GAUKLER: And that that may,
6 therefore, reduce the motions or displacements of the
7 cask.
8 DR. BARTLETT: Change of the dynamics of
9 the system, yes.
10 MR. GAUKLER: And specifically you say
11 here, "It may dampen out the motion that is delivered
12 to the casks on the pads", do you see at the bottom of
13 page 10-351. Correct?
14 DR. BARTLETT: You could use it as a
15 dampening device.
16 MR. GAUKLER: And you mean there, reducing
17 the forces that would be transferred to the casks on
18 the pads. Correct?
19 DR. BARTLETT: Yes. Well, reducing --
20 changing the frequency and -- the amplitude and
21 frequency of the --
22 MR. GAUKLER: Of the force?
23 DR. BARTLETT: Of the response, yes. And
24 forces, I --
25 MR. GAUKLER: Change -- you're reducing

1 the inertial loads transferred to the cask by virtue
2 of the pad --
3 DR. BARTLETT: Generally, the high
4 frequency motion would be dampened somewhat, yes.
5 MR. GAUKLER: And you would reduce the
6 inertial loads transfer to the cask. Correct?
7 DR. BARTLETT: Yes, if we were calculating
8 those inertial loads from the high frequency, yes.
9 MR. GAUKLER: Because, as a factor now,
10 that you would now have the pad absorbing energy by
11 virtue of a sliding. Correct?
12 DR. BARTLETT: Correct.
13 MR. GAUKLER: And so, by sliding the pad,
14 you're dissipating energy. Another way to look at it
15 is you're dissipating energy that would otherwise be
16 transferred to the cask.
17 DR. BARTLETT: Dissipating energy and
18 changing the frequency content of that energy, yes.
19 MR. GAUKLER: Now I take it in the past --
20 so you're saying here that you may be reduce the
21 motions or the forces transferred to the cask by
22 virtue of the pad sliding.
23 DR. BARTLETT: That could be one
24 consequence, yes.
25 MR. GAUKLER: And isn't it true that in

1 other contexts, you have claimed that PFS' analysis of
2 the cask -- strike that. PFS' analysis of the pad
3 stability is inadequate because they may not properly
4 have calculated the potential for the pad to slide?
5 DR. BARTLETT: Really there's a potential
6 for pad sliding, yes.
7 MR. GAUKLER: And that was one of the
8 issues you raised at great length in your testimony
9 with respect to Section D. Is that not correct?
10 DR. BARTLETT: Well, in Section D we deal
11 with the dynamic loadings, and I believe that those
12 have been under-estimated. In Section C, I believe,
13 then we start talking about the resistance to those
14 loadings, and ultimately we'll talk about the clays
15 and their resistance.
16 MR. GAUKLER: But specifically in Section
17 D, you talk about the Stone and Webster stability
18 calculation, which I think is GB-04, if we've --
19 DR. BARTLETT: Right. And the concern that
20 the dynamic loads have been under-estimated.
21 MR. GAUKLER: And one of the concerns with
22 respect to -- one of the concerns you have, potential
23 concerns you have with the under-estimation of the
24 dynamic loads, as you see it, is the potential sliding
25 of the pads. Correct?

1 DR. BARTLETT: Could you repeat the
2 question? I'm sorry.
3 MR. GAUKLER: You refer to the fact that
4 the dynamic loads -- you are concerned that the
5 dynamic loads are under-estimated in the EV-4
6 calculation of past stability done by Stone and
7 Webster.
8 DR. BARTLETT: Correct.
9 MR. GAUKLER: And one of your major
10 concerns, or one of the major consequences that you
11 feel may happen as a result of under-estimating the
12 dynamic loads is sliding of the pads.
13 DR. BARTLETT: The pads could slide, yes.
14 MR. GAUKLER: And as a fact of the matter,
15 here you're criticizing Dr. Luk for allowing the pads
16 to slide because he may under-estimate the motions
17 transfer to the cask.
18 DR. BARTLETT: Right. Yes, I think, I
19 guess, the model that Dr. Luk put forth could possibly
20 show sliding even prior to that of PFS', if we, you
21 know, ran two analogous models through a computer
22 program.
23 MR. GAUKLER: And, therefore, assuming
24 that you're correct, that Dr. Luk is, in effect,
25 allowing sliding of the pads, doesn't his analysis

1 show that there's no adverse consequences from the
2 sliding of the pads?
3 DR. BARTLETT: That supposition I can't
4 make.
5 MR. GAUKLER: You can't make that
6 supposition?
7 DR. BARTLETT: No, I can't make that
8 supposition. I can't make that leap.
9 MR. GAUKLER: You can't make that leap.
10 We'll say that his modeling shows that there's no
11 adverse consequences to cask stability.
12 DR. BARTLETT: Correct. For the
13 properties he ran, yes. His model shows there's no
14 adverse consequences, but I'm not sure that we
15 necessarily agree with all the cases and everything
16 that was done.
17 MR. GAUKLER: I understood the only
18 situation -- the only point you're taking issue with
19 is the filing of the interface layers, or the
20 interface. That's what I understood your rebuttal
21 testimony to be, plus the additional point you made
22 that the Pecoima Dam peak ground accelerations are
23 less than those for the PSFS. Correct? Those are the
24 only specific deficiencies that you're raising in your
25 rebuttal testimony to Dr. Luk, is my understanding.

1 DR. BARTLETT: Plus the Young's modulus
2 and the --
3 MR. GAUKLER: Yeah, the --
4 DR. BARTLETT: -- cement-treated soil
5 depth.
6 MR. GAUKLER: I'm sorry. I didn't --
7 DR. BARTLETT: That's my recollection,
8 yes, of the --
9 MR. GAUKLER: But that's the scope of your
10 criticisms of Dr. Luk's report. Correct?
11 MS. CHANCELLOR: Objection. That doesn't
12 properly characterize all the testimony that went on
13 this morning.
14 CHAIRMAN FARRAR: Mr. Gaukler.
15 MR. GAUKLER: I will rephrase the
16 question. Why don't I do that, and I think it may be
17 simpler.
18 CHAIRMAN FARRAR: Okay.
19 MR. GAUKLER: This morning we discussed
20 the interface properties of the modeling that Dr. Luk
21 did. We also discussed the Young's modulus used for
22 the soil cement in Dr. Luk's modeling. And we also --
23 I understood those to be the two primary factors of
24 which you took issue with Dr. Luk's modeling. And
25 then I also understood you to say -- you mentioned two

1 other things. One was the depth that he used with
2 respect to the soil cement.
3 DR. BARTLETT: Uh-huh.
4 MR. GAUKLER: And the last was the using
5 Pecoima Dam as a reference point because its PGA was
6 less than that for the PFS site.
7 DR. BARTLETT: Right.
8 MR. GAUKLER: I understood those four
9 factors, or four things to be the extent of your
10 criticism of the Luk report.
11 DR. BARTLETT: Also, I think we've
12 discussed a little bit about the stress-strain and
13 constituent relationships that one would use to model
14 the pre and post failure behavior of the clays. I
15 don't think that's been done properly.
16 MR. GAUKLER: So with that addition, then
17 you would agree that that encompasses what you have
18 criticized with respect to Dr. Luk's report. Correct?
19 MS. CHANCELLOR: Your Honor, I'm going to
20 object. If Mr. Gaukler is talking in general terms,
21 that is fine, but Dr. Bartlett shouldn't be limited to
22 a four or five list of things, if that's supposed to
23 encompass his entire testimony this morning.
24 DR. BARTLETT: I think that's a good road
25 map to --

1 MR. GAUKLER: It's a good summary of what
2 you -- right?
3 DR. BARTLETT: It's a good road map, yes.
4 MR. GAUKLER: And those would be the five
5 points that you've discussed this morning. Correct?
6 I'm just asking if that's a fair characterization, if
7 those are the five points --
8 DR. BARTLETT: Those are the things that
9 I recall discussing this morning, yes.
10 MR. GAUKLER: So when you say to the
11 extent you take issue with what the Luk model, or Dr.
12 Luk's model, you're referring to those points as we've
13 discussed this morning, as you elaborated in your
14 rebuttal testimony on Friday, June 7th then. Correct?
15 DR. BARTLETT: Right.
16 CHAIRMAN FARRAR: Mr. Gaukler, let me make
17 sure in light of Ms. Chancellor's objection, the
18 witness understands what's going on here.
19 MR. GAUKLER: Okay.
20 CHAIRMAN FARRAR: Ms. Chancellor's
21 objection is a concern that Mr. Gaukler's going to get
22 you to say those are the only five things. Ms.
23 Chancellor doesn't want you to say that unless that's
24 -- well, she doesn't want you to say that, but she
25 certainly doesn't want you to say that unless it's

1 true. So, Mr. Gaukler, I don't -- I wouldn't
2 ordinarily interrupt what you're trying to accomplish
3 here, but we don't want to be faced with a record
4 later where some other points that he did cover, and
5 now he's -- so do you understand where we are? In
6 other words, are those the five main points, or are
7 those the five points?
8 DR. BARTLETT: Well, they're the five main
9 points I believe, Your Honor. There might be, as we
10 look at different examples in the Luk model, there's
11 other models that were run, Model 1, Model II, Model
12 III, different time histories, different things that
13 were done. I think some of these issues that we're
14 discussing apply to how some of those models were
15 done, so I'm not limiting, I think, my testimony to a
16 specific model on a specific page. I think I'm
17 limiting to specific issues, what's the consequences
18 of those issues in Luk's model, I would hope that I'd
19 be able to comment on. Does that help?
20 MR. TURK: May I interject something, Your
21 Honor?
22 CHAIRMAN FARRAR: Yes.
23 MR. TURK: I think the -- it's important
24 for us in structuring proposed findings that we're
25 able to say here are the main points that Dr. Bartlett

1 raised, and then we can address each of them, both we
2 and the State. I don't see anything improper in Mr.
3 Gaukler's summary. That's my understanding of the
4 issues that have been raised. There's more detail to
5 those issues than are expressed in the quick summary,
6 but those, as I understand Dr. Bartlett has stated,
7 those are the five main points. This is a good road
8 map to understanding his concerns about Dr. Luk's
9 report. I don't see a problem with trying to
10 summarize what are the issues that he raises, knowing
11 that the testimony itself is more detailed.
12 CHAIRMAN FARRAR: And I had no problem
13 with Mr. Gaukler's question. I just wanted the
14 witness to be sure he understood what's going on here,
15 so we got a full and complete answer.
16 MS. CHANCELLOR: Your Honor, I didn't --
17 MR. GAUKLER: Your Honor, just one point.
18 The reason I did, he had made a general statement at
19 some point about his criticisms of Dr. Luk's report in
20 my cross examination. I just wanted to get very clear
21 on the record exactly what those criticisms were.
22 CHAIRMAN FARRAR: And indeed, it would be
23 helpful for all of us to have that summary. But I
24 just want the witness to know that the answer could
25 prove to be an important one.

1 MS. CHANCELLOR: Your Honor, my point was,
2 Dr. Bartlett responded to Mr. Gaukler and said that
3 would be a very good road map. And then Mr. Gaukler
4 went further and said, "Well, this is the moment of
5 your rebuttal testimony. Right?" If we're saying
6 that those five points are a good road map to his
7 testimony, that's fine. I don't have a problem with
8 that, but where you try and squeeze it down even
9 narrower and say these are the -- basically the only
10 five things that you're concerned with, that's when
11 I'm starting to object.
12 CHAIRMAN FARRAR: Well, the witness, I
13 think, understands where we are, and so he'll be able
14 to either in further -- in response to further
15 questions from Mr. Gaukler or Ms. Chancellor, on your
16 redirect, to make sure we have the right picture here.
17 Go ahead, Mr. Gaukler.
18 MR. GAUKLER: We've been talking about
19 five things, so the record is very clear, can you tell
20 me what you believe the five things are that we've
21 been talking about? I believe you said it's a fair
22 summary of your criticisms of Dr. Luk's report. In
23 other words, if you just could briefly tick them off.
24 I could do it. My --
25 DR. BARTLETT: Yeah. It probably would be

1 better if you do it. My mind is a little bit in a fog
2 right now.
3 MR. GAUKLER: Okay. Just so the record is
4 very clear, since we've had this long discussion we
5 hope is a compilation of the last five minutes. And
6 my understanding of the five things we've talked
7 about, and please correct me if I'm wrong is, one, you
8 take issue with the -- Dr. Luk's modeling of the
9 interfaces between the pad and the soil cement, and
10 the soil cement in the soil.
11 DR. BARTLETT: Okay.
12 MR. GAUKLER: Second, you take issue with
13 Dr. Luk's Young's modulus used for the soil cement.
14 DR. BARTLETT: Yes.
15 MR. GAUKLER: Three, you take issue with
16 the depth of the cement-treated soil, or soil cement,
17 whatever it is, under the pads using two feet, instead
18 of something less than two feet.
19 DR. BARTLETT: Yes.
20 MR. GAUKLER: Fourth, you mentioned you
21 take issue with the -- what you claim is Dr. Luk's
22 failure to model pre and post failure of the
23 Bonneville Clays, if I understood that correctly. And
24 you may have to correct me. On that last one my
25 understanding is the least certain.

1 DR. BARTLETT: The Bonneville Clay, and I
2 might add also the cement-treated soil.
3 MR. GAUKLER: Okay. That's number four.
4 DR. BARTLETT: Okay.
5 MR. GAUKLER: And number five is the use
6 of Pecoima Dam earthquake as a reference point because
7 the PGA for Pecoima Dam is less than that for the PFS
8 site.
9 DR. BARTLETT: Yes. Those appear to be
10 the main issues, yes.
11 MR. GAUKLER: Okay.
12 MR. TURK: May I put one clarification in.
13 Mr. Gaukler asked you about soil cement in his summary
14 here, and he used the term "soil cement".
15 DR. BARTLETT: I think cement-treated
16 soils.
17 MR. TURK: It's essentially, it's under
18 the pads that you're thinking about.
19 DR. BARTLETT: Yes.
20 MR. TURK: Okay.
21 MR. GAUKLER: So those -- that's a fair
22 summary or your criticisms of Dr. Luk's report?
23 DR. BARTLETT: Those are the main items,
24 yes.
25 MR. GAUKLER: When you say "main items",

1 that kind of leaves me -- and what other items are
2 there?
3 DR. BARTLETT: Well, I think my criticisms
4 fall within those main topics, so we've agreed upon
5 the general details of the criticisms. How we
6 specifically look at these nuances and how they affect
7 the models, and his results, I don't think we've, you
8 know, explored fully.
9 MR. GAUKLER: Okay. So your criticisms
10 that you've discussed would fall under these five
11 major topics.
12 DR. BARTLETT: Yes, that's fair.
13 MR. GAUKLER: In your questioning and
14 answer with Mr. Turk this morning, you said that if
15 Dr. Luk was able to show that there was no sliding of
16 the pads in his analysis, that would alleviate your
17 concern, if I understood your testimony correctly, in
18 terms of the improper modeling that you claim existed
19 with respect to the modeling of the interfaces between
20 the pad and the soil cement, and the soil cement in
21 the soil. I believe you drew a distinction between no
22 sliding, and virtually no sliding. That's what I'm
23 getting to. Okay?
24 DR. BARTLETT: Well, there's other
25 concerns beyond that, so I guess my response would be

1 if we simply looked at no sliding versus sliding,
2 there's other issues that I had with the modeling.
3 MR. GAUKLER: I'm just talking about the
4 one issue in terms of the modeling of the interface
5 between the pad and the soil cement, and the soil
6 cement in the soil. Looking at that. I'm looking at
7 one of the five issues right now that you identified.
8 If Dr. Luk -- my understanding was, if Dr. Luk showed
9 that there was no sliding of the pads, that would take
10 care of your concern with respect to that one main
11 issue.
12 DR. BARTLETT: Yeah, but they're
13 interrelated because we're running a dynamic model.
14 And if we change other parameters, things will happen,
15 so I guess, you know, I guess I can really say no,
16 that doesn't completely alleviate all my concerns.
17 MR. GAUKLER: Well, it won't alleviate the
18 other four concerns, and to the extent the other four
19 concerns might lead to --
20 DR. BARTLETT: Well, there's interaction
21 in this model.
22 MR. GAUKLER: Right.
23 DR. BARTLETT: So if you change certain
24 parameters, you'll get certain different results. So
25 I guess, you know, just because you show me now

1 there's no sliding at any of the interfaces, without
2 resolving the other issues, I'm not sure I can answer
3 your question. Does that sound --
4 MR. GAUKLER: Well, I --
5 DR. BARTLETT: Say, the dynamics of the
6 system. Certainly the Young's modulus of the system
7 affects the dynamics of the system, and in the case of
8 maybe the Pecoima Dam, a deficiency in that record,
9 because it's not as rich in PGA as the design basis
10 earthquake here, still -- I still may have some
11 concerns about that.
12 MR. GAUKLER: Well, let's just avoid that.
13 Let's say hypothetically, assume that you're --
14 hypothetically, assume that you now have only one
15 concern, which is the proper modeling of the
16 interfaces. And just ignore for now, concerns two
17 through five. This is a hypothetical.
18 DR. BARTLETT: A hypothetical question.
19 MR. GAUKLER: Yeah.
20 DR. BARTLETT: So everything is the same
21 in the models, except the interface conditions.
22 MR. GAUKLER: Yeah. And you don't have
23 issues two to five for this purpose. Okay?
24 DR. BARTLETT: Okay.
25 MR. GAUKLER: Just assume that the only

1 issue you have is the proper modeling of the
2 interface. And hypothetically, in that situation, if
3 Dr. Luk showed that there was no sliding involved,
4 would that resolve your concern? And my understanding
5 was from the discussion you had this morning with Mr.
6 Turk, was that if there was no sliding, that would
7 resolve your concern in that respect, in that respect
8 only. But if there was virtually no sliding, you
9 couldn't go there. And I'm trying to explore the
10 difference between --
11 DR. BARTLETT: No sliding, and virtually
12 no sliding.
13 MR. GAUKLER: Right. And my -- first, if
14 I correctly understand your testimony this morning.
15 Put the other concerns aside, that with no sliding it
16 would resolve your concerns about the modeling at the
17 interface. Whereas, if the statement was virtually or
18 negligible sliding, that would not resolve your
19 concern. Am I correctly understanding your testimony?
20 DR. BARTLETT: Yeah. I guess I'm just
21 trying to understand if there is a little bit of
22 sliding, how much that dissipates energy. And that's
23 where I can't say, so I guess if there was virtually
24 -- if there was no sliding at all along an interface,
25 then the issue of the model to predict sliding early

1 would go away because there's no sliding.

2 MR. GAUKLER: Okay. And then you said you

3 could not make that same statement that virtually no

4 sliding --

5 DR. BARTLETT: No, a little bit of sliding

6 can dissipate energy, and change things fairly

7 dramatically.

8 MR. GAUKLER: That's your position that

9 you --

10 DR. BARTLETT: Well, I don't know. I'm

11 just --

12 MR. GAUKLER: Do you know how much energy

13 it would dissipate?

14 DR. BARTLETT: Again, I have a hard time

15 in the dynamic sense second-guessing these models.

16 It's just -- it's difficult for me to quantify for

17 you.

18 MR. GAUKLER: So you don't know -- your

19 concern -- the problem that you have is you don't know

20 how much energy would be dissipated by --

21 DR. BARTLETT: A little bit of sliding.

22 MR. GAUKLER: A little bit of sliding.

23 DR. BARTLETT: That's correct.

24 MR. GAUKLER: Okay. Focusing on Young's

25 modulus, the use of the 207,000 PSI for the cement-

1 treated soil, I think I've got it correct this time.
2 DR. BARTLETT: Correct.
3 MR. GAUKLER: Do you know whether that is
4 a dynamic modulus as used in Dr. Luk's model, or a
5 static modulus? Do you know?
6 DR. BARTLETT: That I don't know, no.
7 Generally, when we write a Young's modulus, it would
8 be a static Young's modulus.
9 MR. GAUKLER: But you don't know what this
10 modulus represents in Dr. Luk's model?
11 DR. BARTLETT: I would assume it means a
12 static Young's modulus.
13 MR. GAUKLER: Give me a second, Your
14 Honor. Also, with Young's modulus, you were talking
15 with Mr. Turk about the effects of Young's modulus,
16 the effect of using a higher Young's modulus in the
17 model, and what might be, in fact, the design modulus.
18 Okay? And you didn't know of the effect one way or
19 the other of using the higher or lower Young's modulus
20 in the model, Dr. Luk's model. Correct? Is that --
21 that's what I understood you to say. You didn't know
22 the effect one way or the other.
23 DR. BARTLETT: It's a little difficult for
24 me because it changes, obviously, the stiffness of the
25 system. That's a given. But then how the system

above, and how the casks and the pads respond to that, I don't know their frequencies or sensitivity. I don't know what's going on. I just know it changes the system, so I just am, you know, it's difficult for me to kind of second-guess what may happen.

MR. GAUKLER: So you don't know what effect it would have on the model, is what you're saying.

DR. BARTLETT: I know the effect is to stiffen the model. What it does to forces and displacements above me in the model, I'm not sure about. I just know that perhaps cask sliding, cask rocking, some of these other phenomenon are sensitive to certain frequencies, and we've changed the frequency of the energy, and how that effects the system above me, I just can't second-guess. It's sensitive to this.

MR. GAUKLER: I have no further questions.

CHAIRMAN FARRAR: Thank you, Mr. Gaukler. The Board has no questions, so we'll take a luncheon recess at this time. Ms. Chancellor, would more than an hour be helpful, so you'll have more time to --

MS. CHANCELLOR: No, Your Honor. An hour would be sufficient.

CHAIRMAN FARRAR: Oh, all right. It's

1 almost 1:15. Let's be back at 2:15.

2 MR. GAUKLER: Could I just ask for

3 purposes of planning how long we expect Dr. Luk's

4 rebuttal to take? We could go off the record.

5 CHAIRMAN FARRAR: Yeah, okay. Off the

6 record.

7 (Off the record 1:12 p.m. until 2:19 p.m.)

8 CHAIRMAN FARRAR: Ms. Chancellor, we will

9 begin the afternoon with your redirect of Dr.

10 Bartlett.

11 MS. CHANCELLOR: That's, Your Honor. I

12 have very little.

13 REDIRECT EXAMINATION BY MS. CHANCELLOR

14 MS. CHANCELLOR: Dr. Bartlett, you stated,

15 in response to Mr. Turk, that you have not conducted

16 a dynamic finite element model analysis, is that

17 correct?

18 DR. BARTLETT: That's correct.

19 MS. CHANCELLOR: Have you done any

20 modeling of dynamic systems before?

21 DR. BARTLETT: I have modeled dynamic soil

22 systems, yes, but not with finite element models.

23 MS. CHANCELLOR: That is, that the models

24 that you have used for soils have been dynamic models?

25 DR. BARTLETT: Yes, they are dynamic

1 models.

2 MS. CHANCELLOR: And are the results of

3 the dynamic models sensitive to changes in stiffness

4 of the soils?

5 DR. BARTLETT: Yes, they are.

6 MS. CHANCELLOR: What are those changes in

7 stiffness? What actually changes?

8 DR. BARTLETT: Well, soils are non-linear.

9 So the stiffness or the modulus that we use more

10 commonly is the shear modulus, and the shear modulus

11 is a function of strain, and the changing the

12 stiffness or the shear modulus changes the amplitude

13 and frequency of the response, depending on what the

14 changes are and where the particular soil layers in

15 the system.

16 MS. CHANCELLOR: Also in response to Mr.

17 Turk, I think this was, I believe you said something

18 about post-failure of clays and constitutive

19 relationships?

20 DR. BARTLETT: Yes.

21 MS. CHANCELLOR: Could you explain that

22 and whether it is important?

23 DR. BARTLETT: Generally, when one starts

24 modeling a dynamic system, particularly soils, there's

25 a potential, depending on the soil, to bring it into

1 a failure mode. So one has to consider not only what
2 are its properties prior to the failure, but also what
3 could be the post-failure/post-yield behavior of the
4 soil.
5 The issue for this site I think would be
6 the Bonneville clay, and there is a likelihood that it
7 could reach its failure and go into a post-failure
8 behavior, and that behavior is markedly different than
9 its pre-failure behavior.
10 MS. CHANCELLOR: Thank you. During the
11 proceedings in Salt Lake City, were you present for
12 testimony, various sets of testimony, about the non-
13 linear finite element models and the witnesses'
14 testimony that they were sensitive to input
15 parameters?
16 DR. BARTLETT: Yes, I recall the
17 discussions about how models were used for the casks
18 sliding/tipping analysis and how they're sensitive to
19 input parameters.
20 MS. CHANCELLOR: And would Dr. Kahn's
21 report, would that be an example of how input
22 parameters, to show the sensitivity of input
23 parameters?
24 MR. TURK: Objection. Beyond the scope of
25 anything that we have addressed in the rebuttal

1 previously or my cross examination of the rebuttal.

2 MS. CHANCELLOR: If I could just ask one

3 follow-up question, I think I can tie it up.

4 CHAIRMAN FARRAR: All right.

5 MR. TURK: My objection is an attempt to

6 say there's any parallel between Dr. Kahn's report and

7 Dr. Luk's report.

8 MS. CHANCELLOR: Dr. Bartlett, is your

9 reluctance in what you have been calling "second-

10 guessing" changes, the questions about what Mr. Turk

11 asked you about, well, what would Young's modulus do

12 to Dr. Luk's model -- those types of questions, was

13 your reluctance in second-guessing those based in part

14 on the sensitivity of finite element models to the

15 input parameters?

16 DR. BARTLETT: Yes, it would be based on

17 the sensitivity of the model to different input

18 parameters, different assumptions, and just it's

19 usually a very complex system and sometimes difficult

20 always to predict what will be the consequences.

21 MS. CHANCELLOR: And Mr. Gaukler asked you

22 a question about Mr. Trudeau's pad sliding analysis,

23 GB-04, and I believe was trying to -- strike that

24 question.

25 With respect to the input parameters on

1 Table 8 that Dr. Luk used in his report, what do you
2 understand those input, the soil conditions, where do
3 you understand that Dr. Luk got those soil conditions
4 or from whom?
5 DR. BARTLETT: My understanding is that
6 soil interface conditions here in Table 8 --
7 MS. CHANCELLOR: No, the Department's
8 Table 2.
9 DR. BARTLETT: Oh, excuse me, Table 2.
10 MR. TURK: Could we have the question
11 again then?
12 MS. CHANCELLOR: From whom did Dr. Luk
13 obtain the interface conditions in Table 2 of his
14 report, to the best of your knowledge?
15 DR. BARTLETT: Those really aren't
16 interface conditions, but they are best estimate in
17 lower-bound soil properties used for the dynamic
18 analysis. My understanding is that those were
19 obtained or confirmed by NRC staff and given to Dr.
20 Luk.
21 MS. CHANCELLOR: And the same for Young's
22 modulus?
23 DR. BARTLETT: Correct.
24 MS. CHANCELLOR: Just one final question,
25 Dr. Bartlett: Would you consider that the State's

1 concern about GB-04 and at what point the pad slides
2 and the State's criticism of the Luk report and the
3 use of frictional materials and the concern that the
4 pads may slide early, do you consider those to be
5 conflicting requirements or --
6 MR. TURK: Objection.
7 MS. CHANCELLOR: -- or conflicting
8 positions?
9 MR. TURK: Objection to the format of the
10 question. I don't understand what the question is.
11 I don't object to the subject matter, just to the way
12 the question was phrased.
13 MS. CHANCELLOR: Do you consider the State
14 has a conflicting position by criticizing the
15 calculation GB-04 with respect to when the pad slides
16 and the State's position with respect to the Luk
17 report and when the pad slides there?
18 DR. BARTLETT: No, I don't see really a
19 conflict. The GB-04 is not a dynamic analysis. It is
20 simply a calculation that attempts to demonstrate that
21 the foundation system has an adequate factor of safety
22 sliding above 1.1. It is really just an analysis to
23 attempt to demonstrate that Dr. Luk's model doesn't
24 really address foundation issues. It's really a
25 dynamic model trying to predict cask response.

1 MS. CHANCELLOR: And in GB-04 were the
2 site-specific soil conditions used in that analysis?
3 DR. BARTLETT: Yes.
4 MS. CHANCELLOR: And in the Luk report
5 were site-specific, PFS site-specific soil conditions
6 used in his analysis or in his --
7 DR. BARTLETT: He used site-specific soil
8 conditions for the dynamic properties where you would
9 measure -- well, maybe I should back up and just say
10 that he used site-specific soil properties regarding
11 the best estimate low-bound and upper-bound geomatrix
12 dynamic properties for the PFS site. There has not
13 been site-specific properties used at these interfaces
14 that we have been discussing this morning.
15 MS. CHANCELLOR: Or Young's modulus?
16 DR. BARTLETT: Or, yes, in the one case
17 Young's modulus. Thank you.
18 MS. CHANCELLOR: Thank you. I have no
19 further questions.
20 CHAIRMAN FARRAR: Does staff have any
21 recross?
22 RECROSS EXAMINATION BY MR. TURK
23 MR. TURK: Dr. Bartlett, have you, in the
24 course of your work in the proceeding, ever seen any
25 memos prepared by Po Lam? Do you recognize that name?

1 DR. BARTLETT: I recognize the name. I
2 know he's a part of the team that was working with Dr.
3 Luk. I can't say, Mr. Turk, whether I have reviewed
4 any of those memos in detail.
5 MR. TURK: So as you sit here today, you
6 are not familiar with the way in which soil modeling
7 was discussed by Po Lam?
8 DR. BARTLETT: I don't recall the details
9 of the discussion in a memo, no.
10 MR. TURK: I have nothing further.
11 CHAIRMAN FARRAR: Mr. Gaukler?
12 MR. GAUKLER: A few quick questions.
13 RECROSS EXAMINATION BY MR. GAUKLER
14 MR. GAUKLER: Dr. Bartlett, you said that
15 your reluctance to opine on sensitivity was due to
16 what you believe Dr. Kahn had shown on his report in
17 terms of sensitivity of dynamic analysis to modeling
18 parameters?
19 DR. BARTLETT: No, I think it's more
20 general than that, not specifically to Dr. Kahn's
21 analysis. It is just that these are non-linear systems
22 and sensitive to stiffness. As you change the system,
23 the response changes, and it is just difficult for me
24 sometimes to guess what exactly is going to happen.
25 MR. GAUKLER: So you're not relying on Dr.

1 Kahn's --

2 DR. BARTLETT: No, no, not solely. I'm

3 just making a general comment that non-linear systems

4 are sensitive to some of these parameters.

5 MR. GAUKLER: You said you didn't see a

6 conflict between your position on GB-04 and the Luk

7 report? That's what you basically said here a few

8 minutes ago here?

9 DR. BARTLETT: I have a conflict?

10 MR. GAUKLER: Do not see a conflict?

11 DR. BARTLETT: Well, the purposes of the

12 two calculations are entirely different, and what they

13 are doing as far as analysis are entirely different.

14 MR. GAUKLER: But you criticized GB-04

15 because it may no adequately protect when the cask

16 slides, the pads slide, and the potential consequences

17 that would arise from pads sliding, correct?

18 DR. BARTLETT: I don't believe GB-04 Rev.

19 9 shows that there is adequate factors of safety

20 against sliding.

21 MR. GAUKLER: And your concern, therefore,

22 is that the pad may slide?

23 DR. BARTLETT: Yes.

24 MR. GAUKLER: Now in your criticism of Dr.

25 Luk's report you're criticizing him because he does

1 allow the pad to slide, correct?

2 DR. BARTLETT: No, I'm just saying that

3 the properties that Dr. Luk has used in his model

4 don't adequately represent the PFS site.

5 MR. GAUKLER: You say one reason they

6 don't represent the PFS site is because they

7 overemphasis sliding of the pads, correct?

8 DR. BARTLETT: That may be a consequence.

9 I'm not sure.

10 MR. GAUKLER: I thought that is what you

11 clearly stated in your testimony, rebuttal testimony.

12 DR. BARTLETT: Well, I think I was just --

13 we were going through some static cases where we were

14 looking at what horizontal force may induce sliding

15 versus what may not. There might be somewhat of a

16 tendency to overemphasize sliding in the model. I am

17 not sure I can say that I can demonstrate that. As we

18 discussed, I haven't looked at the runs in that

19 detail.

20 MR. GAUKLER: I have no further questions.

21 CHAIRMAN FARRAR: Ms. Chancellor?

22 MS. CHANCELLOR: Yes, nothing further,

23 Your Honor.

24 CHAIRMAN FARRAR: All right. Dr.

25 Bartlett, you are excused with our thanks yet again.

1 DR. BARTLETT: Thank you.

2 (Witness excused.)

3 CHAIRMAN FARRAR: Ms. Chancellor, you had

4 no other rebuttal witnesses on this issue, correct?

5 MS. CHANCELLOR: I believe everything that

6 we had to do was done in Salt Lake City, Your Honor.

7 CHAIRMAN FARRAR: Right.

8 MS. CHANCELLOR: There could be rebuttal

9 after --

10 CHAIRMAN FARRAR: Right, but at this

11 point.

12 Mr. Turk, you were going to present Dr.

13 Luk on surrebuttal?

14 MR. TURK: Yes, Your Honor. If we are

15 ready for that, I will ask Dr. Luk to take the witness

16 stand, and if you would allow us a few minutes to

17 organize papers while he goes up there?

18 CHAIRMAN FARRAR: Okay.

19 (Pause.)

20 CHAIRMAN FARRAR: All right, Mr. Turk, if

21 you're ready?

22 MR. TURK: Thank you, Your Honor.

23 CHAIRMAN FARRAR: Oh, Dr. Luk, you

24 previously have been sworn, so you'll consider

25 yourself still under oath.

1 DR. LUK: Yes, sir.

2 CHAIRMAN FARRAR: And don't try any early

3 escapes this time.

4 (Laughter.) .

5 DR. LUK: I have some other obligations.

6 (Laughter.)

7 WHEREUPON,

8 VINCENT LUK

9 having been previously duly sworn, resumed the witness

10 stand, was examined and testified as follows:

11 SURREBUTTAL EXAMINATION BY MR. TURK

12 MR. TURK: Dr. Luk, you flew in yesterday

13 for the purpose of attending this hearing?

14 DR. LUK: Yes, sir.

15 MR. TURK: And you will be leaving

16 tomorrow?

17 DR. LUK: Tomorrow afternoon.

18 MR. TURK: Okay. Let me, first of all, on

19 the record say thank you very much for coming and for

20 joining us, and for your assistance in this matter.

21 Let me start with a fairly basic question.

22 Do you believe it is necessary for someone who

23 evaluates your report to be familiar with finite

24 element analysis methodology and dynamic modeling in

25 order to understand what you have done?