

1 JUDGE FARRAR: No. We appreciate your
2 willingness to add some more, but let me indicate
3 what's on the Board's mind.

4 First, Ms. Nakahara, you mention the
5 notion of, you know, nullifying the State's work.
6 And this is an issue that goes way, way back with
7 intervenors. In my previous lifetime here, I saw
8 many instances where intervenors came in, raised a
9 valid contention, the Applicant and the Staff did
10 something about it, and in my mind, the intervenor
11 won, but the intervenors didn't think they won
12 because they didn't want the reactor in their
13 neighborhood.

14 So this has been a continuing problem --
15 not a problem, a continuing feature of Commission
16 activity that people win and intervenors contribute
17 to the public health and safety, but they don't get
18 what they set out for, which is running the
19 Applicant out of town, as it were. And so the fact
20 that work you did led to further -- leads to
21 further analysis, should not be taken as a negative
22 in terms of contributing to the overall public
23 health and safety.

24 The second thing would be this is an
25 unusual case in that our ruling was in December and

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1 it wasn't just on summary disposition of an old
2 contention, it was on admitting a late filed
3 contention, and that did change the picture. And
4 the Board's impression is given the relative amount
5 of resources available, the State has made heroic
6 efforts to get ready for this hearing, compressing
7 that discovery, particularly in a period where
8 everyone else had access to their offices, and the
9 State had four weeks of -- three weeks or four
10 weeks of Olympics here.

11 Finally, given all the circumstances to
12 conduct the deposition of Dr. Luk this past weekend
13 in the midst of all this is just more of the same,
14 in terms of heroic activity to get ready for the
15 case and not to ask for extension.

16 It seems to us, given the nature of this
17 report, we would be remiss in not including it in
18 the record. If anyone wants to know ultimately if
19 this facility would be safe from a seismic point of
20 view, they would want to have this report. But
21 you're correct that it is very late -- now, if this
22 was late through something that was trial tactics
23 or to use a stronger word, chicanery or something
24 like that, then we'd have a basis to exclude it. I
25 think the other side has made a decent case of how

1 this naturally evolved, and so there's no reason,
2 because of their tactics or strategy, to exclude
3 this.

4 So our notion is we would deny your
5 motion to strike it or to exclude it, but since we
6 all will be gathered in D.C. over a month from now,
7 we think it would be fair -- to wrap up the seismic
8 issue, we think it would be fair if at that time,
9 you want to call Dr. Luk back for further
10 cross-examination, we would permit you to do that,
11 thereby giving your experts a good deal of
12 additional time to look this over.

13 So unless there's somebody who needs to
14 be heard, that will be our ruling.

15 MS. NAKAHARA: No, thank you, Your
16 Honor. We appreciate the opportunity to
17 cross-examine Dr. Luk again, if necessary.

18 MR. TURK: Your Honor, may I have a
19 moment to ask Dr. Luk a question off the record?

20 JUDGE FARRAR: Yes.

21 (A discussion was held off the record.)

22 MR. GAUKLER: One point, Your Honor.
23 You mentioned resuming this in D.C. sometime in
24 June. From my understanding, we are going to try
25 to resume at least this portion of seismic

1 contention back here in Utah on June 3rd?

2 JUDGE FARRAR: Right. We'll be back
3 here June 3rd to 7th, but I want to give them the
4 maximum -- if they're ready, if they want to do it
5 then, we could do it then. But I wanted to give
6 the State the maximum possible time on the
7 assumption we are not going to finish by June 7th,
8 that we'd be back in D.C. for some period of
9 probably less than a week, if we continue on our
10 one panel a day approach.

11 MR. GAUKLER: The only thing I would say
12 on that is that I think we plan to have all the
13 witnesses that would be relevant to this subject
14 matter, trying to get them here the week of June
15 3rd in Salt Lake. That may not be the intent in
16 terms of getting those same witnesses back in D.C.
17 the week of June 10th.

18 JUDGE FARRAR: Well, given the
19 significance of Dr. Luk's report, I would think
20 people would be willing to make the effort to make
21 him available one way or another. One way or
22 another, meaning if he's physically not somewhere,
23 there's always phone and video, which is not your
24 best setup, but my view is once you've seen a
25 witness on the stand, people may be comfortable

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1 with doing things long distance.

2 Mr. Turk, you wanted to go off the
3 record before.

4 MR. TURK: I was checking my witness's
5 ability to join us again for another week.

6 I'd like to note an objection, Your
7 Honor. I think your ruling will stand, but I have
8 to note that in our view, we did give the State
9 advance notice and we had talked about making him
10 available for deposition the last 10 days of March.
11 We had not at that time indicated that his report
12 would be in any way vitiated by the changes that we
13 would make. In fact, I had a letter to
14 Ms. Chancellor which specifically indicated the
15 types of changes that we saw making. On March 20th
16 I had a telephone conversation with Ms. Chancellor,
17 and on March 22nd, I sent her a letter which
18 informed her that the captions in certain
19 appendices had to be changed to show a correct
20 factor of coefficient of .2 rather than .8, and I
21 informed her there that we would doing the two
22 additional runs of the .8 case for Pacoima Dam and
23 the 10,000-year earthquake.

24 There was no indication that anything in
25 the March 8th report would be changed except for

1 what I stated in my letter. And, in fact, those
2 are the changes that were made in the March 31st
3 report. So there was no reason for them to delay
4 deposing Dr. Luk at that time. I have to
5 recognize, however, we've been extremely busy, all
6 parties have been. Those final 10 days before
7 filing testimony on seismic issues was a
8 tremendously busy period for all parties, and I
9 don't blame the State if they found they had too
10 many other things to do in that period to conduct a
11 deposition. But I think in terms of fairness, we
12 disclosed to them what the changes would be and
13 they could have taken the deposition at that time,
14 if they had the resources and time available.

15 JUDGE FARRAR: Mr. Turk, there was
16 nothing in our ruling -- in fact, exactly the
17 opposite -- to indicate that we thought the Staff
18 had not been as forthcoming and honorable as they
19 should have been. And, in fact, if we had thought
20 the opposite, we would have reached a different
21 underlying ruling. It's clear, I think from the
22 report and the testimony, that this is a key piece
23 of work, and for that reason, it seems to us we
24 have to make absolutely sure that those who may
25 disagree with it have had full and fair opportunity

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1 to come to grips with it.

2 So we appreciate the additional
3 information in support of the legitimacy of the
4 approach the Staff has taken, but that wouldn't
5 cause us to change our mind.

6 Well, with board questions earlier today
7 and with this -- let me again compliment all
8 counsel for a very well-presented argument on a
9 concern in a key piece of evidence. Given the
10 Board's questions earlier and the time consumed in
11 argument, let's all take a look at our watches and
12 try to keep to our one panel a day rule.

13 Ms. Nakahara, several hours ago, you said you had
14 two hours of cross-examination, very little of
15 which has actually been conducted with the other
16 business we've been doing, so if you're ready to
17 move ahead, let's go.

18 MS. NAKAHARA: Thank you, Your Honor.
19 Actually, none of it has been conducted thus far.

20 Q. (By Ms. Nakahara) Dr. Luk, if you'll
21 look at your prefile testimony in response to
22 Answer 3. Towards the bottom of the paragraph, you
23 state that, "I am the principal author of several
24 documents describing this confirmatory analysis",
25 and then you cite the titles of these documents.

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1 Just to clarify, the summary report on seismic
2 analysis of HI-STORM 100 casks of Private Fuel
3 Storage (PFS) facility dated February 22, 2002, is
4 it correct that that summary report summarizes your
5 results in the preceding reports that you described
6 in this paragraph?

7 MR. TURK: I would object to that. The
8 report that counsel is referring to is the February
9 report. It was superseded or at least followed by
10 the March 8th and March 31st report.

11 MS. NAKAHARA: And if Dr. Luk can
12 testify to what it was, I'd appreciate it.

13 JUDGE FARRAR: We had said during the
14 motion -- the argument on the motions in limine a
15 couple of weeks ago, that it was fair to
16 cross-examine someone on previous reports.

17 MR. TURK: Well, my objection is not
18 that it's unfair to examine them on it. But the
19 characterization was that that February report
20 summarizes what's in the March 31 report, and we've
21 already indicated that it includes two additional
22 runs with respect to the Pacoima Dam and the
23 10,000-year earthquake. So I think the question
24 was an unfair formalization of the inquiry.

25 MS. NAKAHARA: I'm really confused, Your

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1 Honor.

2 JUDGE FARRAR: Let's --

3 MS. NAKAHARA: How about if I take
4 another stab at it Judge Lam -- I'm sorry, Judge
5 Farrar.

6 JUDGE FARRAR: Okay.

7 Q. (By Ms. Nakahara) Dr. Luk, will you
8 generally describe the summary report on seismic
9 analysis of HI-STORM 100 casks at the Private Fuel
10 Storage facility dated February 22, 2002?

11 DR. LUK: To the best of my knowledge, I
12 was instructed to put a few pages of summary
13 together for all the analysis that we conduct for
14 the Private Fuel Storage that includes all three
15 seismic loadings. But this is nothing more than a
16 summary of the results. We did not go into the
17 details of the explanations of analysis
18 methodology.

19 JUDGE FARRAR: Is that an exhibit in
20 front of us?

21 MS. NAKAHARA: No.

22 JUDGE FARRAR: No.

23 Q. (By Ms. Nakahara) So this summary
24 report summarizes NRC's Exhibit P; is that correct?

25 MR. TURK: I object, Your Honor.

1 Exhibit P is dated March 31st. It contains its own
2 summary. The report that Ms. Nakahara is referring
3 to is the early providing of summary results that
4 the State in fact --

5 MS. NAKAHARA: I'll withdraw the
6 question.

7 JUDGE FARRAR: Tell me --

8 MS. NAKAHARA: I'll reask it a different
9 way.

10 JUDGE FARRAR: Where am I going to find
11 this February report you're talking about?

12 MR. TURK: Your Honor, I served a copy
13 of it upon the State by letter dated February 25th.

14 JUDGE FARRAR: But this is not an
15 exhibit and it's not referred to in his testimony?

16 MR. TURK: No.

17 MS. NAKAHARA: No. All I'm trying to
18 establish is they're not independent.

19 JUDGE FARRAR: But you try -- in other
20 words, I'm just trying to make sure we know what it
21 is we're talking about here. So this is a February
22 report that Dr. Luk did? It's a February report
23 that Dr. Luk did?

24 MS. NAKAHARA: Yes.

25 JUDGE FARRAR: Okay. And what

1 specifically do you want to ask him about?

2 Q. (By Ms. Nakahara) Dr. Luk, the February
3 22nd, 2002 summary report, is it correct that it
4 summarizes the analyses that are included in detail
5 in the March 31st, 2002 report that's included as
6 NRC Exhibit P?

7 MR. TURK: Your Honor, again I object.
8 We've indicated the March 31 document includes more
9 than existed at the time of the February summary
10 report.

11 MS. NAKAHARA: It's a summary.

12 JUDGE FARRAR: But I'm sorry, I had
13 overlooked that there was a reference to this
14 report in his testimony. That's what I was getting
15 at.

16 MR. TURK: May I make my objection a
17 little more understandable.

18 JUDGE FARRAR: Yeah, I need some help
19 here on where you're trying to go and what the
20 objection is. I mean it is in his testimony, go
21 ahead.

22 MR. TURK: The February report, Your
23 Honor, was an early attempt to try to get
24 information to the State. However, the March 31st
25 report contains several summary sections of its

1 own, which summarized what's in the March 31
2 report, and it's a more complete summary. I would
3 object to a characterization of the February
4 document as being a summary of the later document.

5 JUDGE FARRAR: Let's not characterize
6 it. Just ask him questions about it. You don't
7 have to characterize it. You can just ask him.
8 Isn't it true you said such-and-such in your
9 February report and ask him what he meant by it,
10 but you don't have to characterize what it is.

11 Q. (By Ms. Nakahara) Dr. Luk, in the
12 summary report dated February 22nd, 2002, if the
13 analysis that you describe in this summary report
14 -- are the analysis different from those
15 described -- strike that.

16 Are the cases in which you analyzed, are
17 those different from the February 22nd, 2002
18 summary report than those described in the March
19 31st, 2002 report?

20 DR. LUK: My answer to your question is
21 that the summary report dated on February 22nd,
22 2002 is a few pages summary. The information of
23 that is actually contained in the March 31 report.
24 The only reason why the summary report was
25 submitted earlier is because like Mr. Turk just

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1 mentioned, is trying to provide as fast as I can
2 some of the information to the Staff.

3 Q. Is it correct you said the March 31st
4 report?

5 DR. LUK: No. March 8 report. Because
6 at that time, I did not actually -- I did not even
7 know that I have to conduct two more analysis on
8 February 22nd, 2002?

9 Q. And are the results of the March 8th,
10 2002 report, are they included in the March 31st
11 2002 report?

12 DR. LUK: Can you repeat the question.

13 Q. Are the results in the March 8, 2002
14 report, are they included in the March 31st, 2002
15 report?

16 DR. LUK: Yes.

17 Q. Thank you.

18 Dr. Luk, this morning Mr. Gaukler was
19 asking you questions --

20 JUDGE FARRAR: New subject?

21 MS. NAKAHARA: Yes.

22 JUDGE FARRAR: Let me make sure I
23 understand on these last two. Is there anything in
24 the February 22nd report that's not in the March
25 31st report? I don't mean a word here and there, I

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1 mean, is there any analysis that appeared in the
2 February 22nd that got excluded from the final
3 report?

4 DR. LUK: Everything in the summary
5 report dated March 2nd --

6 JUDGE FARRAR: February 22nd.

7 DR. LUK: Was included on the March 31st
8 report.

9 JUDGE FARRAR: You just said March 2nd,
10 which doesn't exist. February 22nd and March 8th.

11 DR. LUK: Yes.

12 JUDGE FARRAR: I'm asking about February
13 22nd. Is everything that was in the February --
14 let me ask it negatively. Is there anything that
15 was in the February 22nd report that was excluded
16 from the March 31st report?

17 DR. LUK: No.

18 JUDGE FARRAR: And I think you've
19 already answered this this morning, but let's be
20 sure. Was there anything in the March 8th report
21 that was excluded from the March 31st report?

22 DR. LUK: No.

23 Q. (By Ms. Nakahara) Dr. Luk, this morning
24 Mr. Gaukler asked you questions about other site
25 specific analyses you've conducted. You indicated

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1 that you conducted an analyses of freestanding
2 casks at the Hatch plant; correct?

3 DR. LUK: Yes.

4 Q. Isn't it true the free field ground
5 motions at Hatch are approximately .15 g horizontal
6 and .1 g vertical?

7 DR. LUK: Yes.

8 Q. You've also conducted a seismic analysis
9 of dry casks at San Onofre; correct?

10 DR. LUK: Yes.

11 Q. The casks at San Onofre are horizontal
12 casks; correct?

13 DR. LUK: Yes.

14 Q. And the horizontal casks are combined in
15 a set of three casks together; is that correct?

16 DR. LUK: They tie three modules
17 together in one unit.

18 Q. Thank you.

19 Other than in the PFS and the San Onofre
20 case, you have not conducted a seismic analysis of
21 casks where the ground motion equals or exceeds
22 0. -- approximately 0.7 gs, have you?

23 MR. TURK: I'm sorry, other than the San
24 Onofre?

25 MS. NAKAHARA: And the PFS case.

1 DR. LUK: In the process of evaluating
2 the Hatch analysis, we were asked by the Staff to
3 look at the cask response when a g value was
4 artificially increased to a much higher value. We
5 were tasked to go through the barometric analysis
6 on the Hatch cask. So in that sense, we did
7 perform seismic analysis of Hatch casks at various
8 levels of g loading.

9 JUDGE FARRAR: Is that why -- maybe I
10 misheard the numbers. Is that why -- isn't Hatch
11 in Georgia?

12 MS. NAKAHARA: Yes.

13 JUDGE FARRAR: Is that why those numbers
14 sounded high to me for a Georgia facility?

15 DR. LUK: The task we did on the design
16 base is .15 g.

17 JUDGE FARRAR: .15.

18 DR. LUK: Yes.

19 JUDGE FARRAR: I'm sorry, I thought you
20 said 1.5.

21 DR. LUK: No, sorry. No, 1.5 is for San
22 Onofre.

23 JUDGE FARRAR: I thought she said for
24 Hatch, something that sounded very large to me.
25 But I must have misplaced a decimal point.

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1 Q. (By Ms. Nakahara) Dr. Luk, is it
2 correct your analysis for the PFS site incorporated
3 soil-structure interaction?

4 DR. LUK: Yes.

5 Q. You, yourself, do not claim to have any
6 expertise in soil-structure interaction; isn't that
7 true?

8 DR. LUK: Yes.

9 Q. And you relied on other coauthors to
10 your report to provide soil-structure interaction
11 expertise; correct?

12 DR. LUK: Yes.

13 Q. Mr. Guttman, isn't it true you have
14 never performed a seismic analysis of freestanding
15 casks?

16 MR. Guttman: That's correct.

17 Q. Are either of you aware of any facility
18 in the United States that has a similar design as
19 the PFS facility where spent nuclear fuel will be
20 stored in individual freestanding casks supported
21 by cement-treated soil at a site where peak ground
22 acceleration equals or exceeds .0711 g in the
23 horizontal direction and 0.695 g in the vertical
24 direction?

25 MR. Guttman: I'm not aware of it, but

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1 I'm not sure exactly what the San Onofre ground
2 motions are, and they have freestanding casks.

3 Q. But they're not individual freestanding
4 casks?

5 MR. Guttman: Yes, they are. I'm sorry,
6 not San Onofre. Is it Rashashiko.

7 Q. Dr. Luk?

8 DR. LUK: Yes. In our evaluation of the
9 seismic performance of the horizontal cask at San
10 Onofre, we were not limited to only to investigate
11 these structural response of the single -- of the
12 unit that tie together three modules. We did go
13 through the systematic evaluation of a single
14 module. So in that sense, yes, we look at the cask
15 performance at a much higher g level than the g
16 level for the 2,000-year return record.

17 Q. So if I understand your response, you're
18 saying at San Onofre, you looked at that; is that
19 correct?

20 DR. LUK: Yes, the answer is we did have
21 analysis experience of the structural points of a
22 cask at a much higher g level than .7 for the
23 horizontal component and seismic input.

24 Q. Are either of you aware of any structure
25 at a nuclear power plant with a shallow embedded

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1 foundation supported by cement-treated soil?

2 MR. Guttman: I'm not aware of any.

3 DR. LUK: No.

4 Q. Are either of you aware of any nuclear
5 structure where soil cement has been used to resist
6 seismic loading on that structure?

7 MR. Guttman: No.

8 DR. LUK: No.

9 Q. For your PFS analysis, Dr. Luk, you were
10 provided the input parameters from Dr. Mihandra
11 Shah with NRC; correct?

12 DR. LUK: Yes.

13 Q. Dr. Shah provided you with the
14 dimensions of the cask and the pad; correct?

15 DR. LUK: Yes.

16 Q. Dr. Shah provided you with the material
17 properties of the cask and the pad such as the
18 concrete being 3,000 psi; correct?

19 DR. LUK: Dr. Shah provided me with the
20 information, but I don't think the strength of the
21 concrete is 3,000 psi. I would like to call your
22 attention to Page 8 on the analysis report dated
23 March 31st, 2002. It's within the Section 3.3.

24 Q. Okay. And is it correct, Page 8 states
25 the cask and pad moduli are based on assumed

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1 concrete strength of 5,000 psi and 4,000 psi
2 respectively?

3 DR. LUK: Yes.

4 Q. And those concrete strengths were
5 provided by Dr. Shah; is that correct?

6 DR. LUK: Yes.

7 Q. Dr. Shah provided you the soil
8 properties categorized as the upper bound, lower
9 bound and best estimate; correct?

10 DR. LUK: Yes.

11 Q. Dr. Shah provided you with the
12 dimensions of aggregate soil cement layer; correct?
13 Strike that. I didn't read the comma.

14 Dr. Shah provided you with the
15 dimensions of the aggregate layer and the soil
16 cement layer; correct?

17 DR. LUK: I got those dimensions
18 directly from some other staff at NRC but it was
19 later confirmed by Dr. Shah.

20 Q. Oh, thank you.

21 And Dr. Shah provided you with the
22 material properties of the soil cement layer; is
23 that correct?

24 DR. LUK: Yes.

25 Q. And perhaps just to clarify, in your

1 report, Dr. Luk, you modeled soil cement around the
2 concrete pad; is that correct?

3 DR. LUK: Yes.

4 Q. And you also modeled what you label as
5 soil cement beneath the concrete pad; is that
6 correct?

7 DR. LUK: Yes.

8 MS. NAKAHARA: And for the benefit of
9 the Board, the various parties and expert witnesses
10 in the past -- during last week have referred to
11 the soil cement layer beneath the concrete pad as
12 the cement-treated soil.

13 JUDGE FARRAR: Right.

14 MS. NAKAHARA: There may be a little bit
15 of confusion in this. I'll try to point that out
16 as we go through.

17 MR. TURK: I would simply note, Your
18 Honor, that the testimony does not make the
19 distinction. The prefile testimony only uses the
20 phrase soil cement, regardless of whether it's the
21 material next to or underneath the pads.

22 DR. LUK: Can I offer a little bit of
23 substantiation to --

24 JUDGE FARRAR: Wait, wait. Mr. Turk, is
25 that something we need to go through and correct in

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1 the testimony, or is it apparent from the prefile
2 testimony when -- you know, which is meant by a
3 particular reference?

4 MR. TURK: Your Honor, I would point you
5 to Page 10 as an example. Tables 2 and 3 appear in
6 the report. I don't believe you need to correct
7 the testimony because the testimony reflects in the
8 report. If you'll notice for layer No. 1 --

9 JUDGE FARRAR: Wait, wait, I'm sorry.
10 You're referring just now to the report after the
11 testimony?

12 MR. TURK: Correct, I'm sorry.

13 JUDGE FARRAR: Page which?

14 MR. TURK: Page 10.

15 JUDGE FARRAR: Oh, okay.

16 MR. TURK: For Layer No. 1, you'll see
17 the use of the term soil cement both for the soil
18 cement adjacent to the pad and that underneath the
19 pad. And you'll notice also that they have very
20 different Youngs modulus stated in terms of psi.

21 JUDGE FARRAR: Okay.

22 MR. TURK: So I think if the questioner
23 would like to focus on a term soil cement, she
24 should make it clear to the witness.

25 JUDGE FARRAR: Yeah. Ms. Nakahara given

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1 your suggestion and Mr. Turk's, that would be a
2 sufficient way to handle it.

3 Q. (By Ms. Nakahara) Dr. Luk, Dr. Shah
4 provided you with one set of free field time
5 history ground motions for 2,000-year return
6 interval earthquake at the PFS site; correct?

7 DR. LUK: Yes.

8 Q. Dr. Shah also provided you with one set
9 of free field ground motions for a 10,000-year
10 return interval earthquake, correct?

11 DR. LUK: Yes.

12 Q. Dr. Shah also identified the 1971
13 Pacoima Dam earthquake as the -- as a ground motion
14 analysis to conduct; is that correct?

15 DR. LUK: Yes.

16 Q. You did not independently verify whether
17 the input parameters provided to you by Dr. Shah or
18 another NRC Staff member, in fact, adequately
19 characterized the PFS site; isn't that true?

20 DR. LUK: Would you mind repeating the
21 question.

22 Q. You did not independently verify whether
23 the input parameters provided to you by Dr. Shah or
24 another NRC Staff member, in fact, adequately
25 characterized the PFS site; isn't that true?

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1 DR. LUK: Correct.

2 Q. Isn't it also true you did not have
3 input into the number of time history sets provided
4 by NRC?

5 DR. LUK: Would you mind repeating the
6 question.

7 Q. Isn't it also true you did not have
8 input into the number of time history sets provided
9 by NRC? For example, you did not have input into
10 whether you received one set of free field time
11 history ground motions for 2,000-year return period
12 or whether you received multiple sets?

13 DR. LUK: That is correct, I did not
14 have any input.

15 Q. Your model accounted for frictional
16 effects at the interface between the cask and the
17 pad; correct?

18 DR. LUK: Yes.

19 Q. Your model also accounted for frictional
20 effects at the interface between the pad and the
21 soil cement beneath the pad or what has been
22 referred to as the cement-treated soil layer
23 beneath the pad, in this hearing; correct?

24 DR. LUK: Yes.

25 Q. Your model accounted for frictional

1 effects at the interface between the soil cement
2 layer beneath the pad or the cement-treated soil
3 layer beneath the pad and the soil foundation;
4 correct?

5 DR. LUK: Yes.

6 Q. Dr. Shah directed you to use the
7 coefficient of friction value of 0.31 used at the
8 interfaces between the pad and the soil cement
9 layer beneath the pad; isn't that correct?

10 DR. LUK: Yes.

11 Q. Dr. Shah directed you to use the
12 coefficient of friction value of 1.0 used at the
13 interface between the soil cement layer or the
14 cement-treated soil layer beneath the pad and the
15 foundation layer; correct?

16 DR. LUK: We started to use the
17 coefficient of friction .1 and this application was
18 later confirmed by Dr. Shah.

19 MR. TURK: .1 or 1.0?

20 DR. LUK: 1.0.

21 Q. (By Ms. Nakahara) So you selected the
22 1.0 coefficient of friction yourself; is that
23 correct?

24 DR. LUK: That selection was by the
25 research team that worked together.

1 Q. Dr. Luk, do you agree that the shear
2 force has both a frictional and cohesive component?

3 DR. LUK: Would you mind to substantiate
4 the question.

5 Q. Dr. Luk, do you agree that shear force
6 has both a frictional and cohesive component?

7 MR. TURK: I have to ask for a
8 clarification. The question shear force or shear
9 resistance?

10 MS. NAKAHARA: Shear resistance. Thank
11 you, Mr. Turk.

12 DR. LUK: Can you repeat the question.

13 Q. (By Ms. Nakahara) Yes, I'll try it
14 again.

15 Dr. Luk, do you agree that the shear
16 resistance has both a frictional and cohesive
17 component?

18 DR. LUK: I need your help to repeat the
19 question, because technically, there's some
20 problems with the question.

21 Q. It wouldn't surprise me.

22 Dr. Luk, do you agree that shear
23 resistance has both a frictional and cohesive
24 component?

25 JUDGE FARRAR: If you don't understand

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1 the question -- if you don't understand it at all,
2 say so, but if you have a general understanding and
3 you want to modify the question to answer it,
4 you're free to do that.

5 DR. LUK: I will try the second
6 approach. Friction does play a significant role in
7 shear resistance, but as to the degree or the
8 effect of cohesiveness at the interface, it's
9 probably secondary in order and if you -- if anyone
10 would like to go back to the consultive relations
11 of material, we actually have well established our
12 theories to discuss the cohesiveness of materials
13 or of dissimilar materials at the interface.
14 Unless as drastically was some advanced material
15 for the geological material that goes -- the effect
16 due to the cohesive content, is probably secondary
17 as compared to the resistive force by friction.

18 Q. Your model accounted only for the
19 frictional component of shear resistance; correct?

20 DR. LUK: Yes.

21 Q. In fact, you were directed by NRC to
22 only consider the frictional component of shear
23 force or resistance; isn't that correct?

24 DR. LUK: That is not correct. We were
25 tasked to develop the analysis models. It is our

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1 job to develop the model and submit it to the Staff
2 in NRC for review and comment.

3 Q. By using a 1.0 coefficient of friction
4 at the interface between the soil cement layer
5 beneath the concrete pad, or as we've been
6 referring to it as the cement-treated soil layer
7 and the soil foundation, you believe there will be
8 no relative displacement between the layers;
9 correct?

10 MR. TURK: I have to object. I don't
11 understand the question.

12 MS. NAKAHARA: Can you read the question
13 back.

14 (The record was read as follows:

15 "Q. By using a 1.0 coefficient of
16 friction at the interface between the soil
17 cement layer beneath the concrete pad, or as
18 we've been referring to it as the
19 cement-treated soil layer and the soil
20 foundation, you believe there will be no
21 relative displacement between the layers;
22 correct?")

23 MR. TURK: And my objection, Your Honor,
24 is to the use of the term layers, especially
25 between those bodies or layers --

1 JUDGE FARRAR: You mean the two layers
2 for which the 1.0 coefficient of friction was used?

3 DR. LUK: Well, the answer can actually
4 be in two parts. In any physical phenomena, if
5 there's no physical constraints for motions or
6 something in this case in the horizontal
7 directions, there will always be relative movements
8 at the interface. But the question in mind for
9 engineers is that are those measurable? Are those
10 significant? So when people use a coefficient of
11 friction at the interface of 1.0, it's strongly
12 indicated that the amount of relative movement
13 between two different layers at the interface are
14 very small. Now, that there, there's no relative
15 movement. But from the eyes of the engineers, it
16 is very, very small that we usually take that as
17 zero displacement.

18 Q. (By Ms. Nakahara) Dr. Luk, if you'll
19 turn to Figure 17. We've had a lot of discussion
20 this morning on what Figure 17 means, and I would
21 just like to clarify a few things. Figure 17
22 represents the acceleration at single nodes D Prime
23 and A Prime; correct?

24 DR. LUK: Yes.

25 Q. And the purpose of including Figure 17

1 into your report is to show the importance of
2 soil-structure interaction effects; correct?

3 DR. LUK: Yes.

4 Q. Is it fair to say that Figure 17
5 demonstrates the importance of accurately accessing
6 the effects of soil structure analysis?

7 DR. LUK: And if you don't mind, I want
8 to inject a little bit different words. Instead of
9 demonstrating the importance of the soil-structure
10 interaction effect, we try to demonstrate the
11 significance and the presence of the soil-structure
12 interaction effects.

13 Q. In this report, do you show the
14 accelerations at the pad due to soil-structure
15 interaction other than in Figure 17?

16 DR. LUK: Would you mind to qualify the
17 accelerations in what directions or where?

18 Q. In the horizontal direction at the
19 bottom of the pad?

20 DR. LUK: No.

21 MR. TURK: I'm sorry, I don't understand
22 what the question and answer were.

23 JUDGE FARRAR: Could you read it,
24 please.

25 (The record was read as follows:

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1 "Q. In the horizontal direction at the
2 bottom of the pad?

3 DR. LUK: No.")

4 Q. (By Ms. Nakahara) You also --

5 JUDGE FARRAR: Wait a minute. No,
6 meaning it's not anywhere else in the report?

7 DR. LUK: Yes, sir.

8 MR. TURK: And we're talking about the
9 2,000-year case, correct?

10 MS. NAKAHARA: Yes.

11 Q. (By Ms. Nakahara) You also do not show
12 the accelerations in the horizontal direction on
13 the cask -- on the bottom of the cask from a
14 2,000-year return period due to soil-structure
15 interaction; correct?

16 DR. LUK: Would you mind to read the
17 question.

18 (The record was read as follows:

19 "Q. You also do not show the
20 accelerations in the horizontal direction on
21 the cask -- on the bottom of the cask from a
22 2,000-year return period due to soil-structure
23 interaction; correct?")

24 DR. LUK: Your Honor, I need a minute.

25 JUDGE FARRAR: Okay.

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1 DR. LUK: The answer is no.

2 Q. (By Ms. Nakahara) You cannot
3 quantitatively state the maximum horizontal
4 acceleration experience at the bottom of the cask
5 or the bottom of the pad; correct?

6 MR. TURK: I would have to object, Your
7 Honor. It's a compound question.

8 Q. (By Ms. Nakahara) All right, I'll take
9 it one piece at a time.

10 You cannot quantitatively state the
11 maximum acceleration in a horizontal direction for
12 a 2,000-year return period at the bottom of the
13 cask; correct, due to soil-structure interaction
14 effects?

15 DR. LUK: From the engineer or the
16 analyst's perspective, there is various methods
17 that people can use to quantitatively describe the
18 structural behavior of a structure, and in this
19 case, the cask. And we choose to use horizontal
20 displacement, vertical displacement, angular
21 rotation of the cask with respect to the vertical
22 access in the two horizontal directions. And we
23 feel if you put the things in its total entirety,
24 we can adequately describe the structural behavior
25 of the cask. So we cannot use acceleration

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1 components.

2 Q. But based on the data employed in your
3 report, you cannot quantitatively define what the
4 maximum accelerations in the horizontal direction
5 for a 2,000-year report at the bottom of the cask
6 are; correct?

7 DR. LUK: If you don't mind, I would
8 like to correct the word. It's not we cannot, we
9 choose not to use acceleration components to
10 quantitatively characterize the structural response
11 of the cask.

12 Q. Yes, Dr. Luk, I understand that. But
13 based on the information in your report, you cannot
14 identify that, as you sit here today, with the
15 maximum accelerations in the horizontal direction
16 for a 2,000-year report at the base of the cask;
17 correct?

18 DR. LUK: Correct.

19 Q. Thank you. However, based on Figure 17,
20 isn't it true Figure 17 does show that
21 soil-structure interaction effects in the
22 horizontal -- strike that.

23 Based on Figure 17, isn't it true that
24 Figure 17 shows that soil-structure interaction
25 effects will enhance the accelerations in the

1 horizontal direction for a 2,000-year return period
2 earthquake at the PFS site on the cask?

3 MR. TURK: Enhance or effect?

4 MS. NAKAHARA: Enhance.

5 MR. TURK: Do you understand that
6 question?

7 DR. LUK: Yes, I need a qualifier for
8 the question.

9 Q. A qualifier?

10 DR. LUK: Can you substantiate your
11 question?

12 Q. Isn't it true that Figure 17 --

13 JUDGE FARRAR: Wait, wait. Why don't
14 you add the qualifier in the answer. In other
15 words, if you have to give a qualified answer, you
16 can do that.

17 DR. LUK: Okay. My answer is as
18 follows: We were tasked to develop the
19 state-of-the-art analysis methodology, and we chose
20 to used a highly coupled front end model. So
21 there's a question that we need to address
22 quantitatively. Why do we have to go through all
23 the sophistications to conduct coupled analysis.
24 Is there any easier, simpler method? Our answer to
25 the question is that we need to demonstrate yes,

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1 there's significant, dynamic coupling occurred
2 which routinely people identified as the
3 soil-structure interactions. So what we simply
4 said, is the ground motion significantly modified
5 or changed by the presence of a structure. That is
6 the very definition of a soil structure
7 interaction. By picking two points in Figure 17, A
8 Prime, which is at a free field location on the
9 free surface, and also a point directly underneath
10 the pad. We actually demonstrate yes, there is
11 presence of the SSI effect as well as they are very
12 important. And we use accelerations in different
13 directions to demonstrate that. But it's not
14 limited to this case only. For example, people can
15 use velocity, people can use displacements. But
16 the reason why we use that acceleration is because
17 that is the direct output from the analysis model.
18 And we want to use the raw analysis results so that
19 we will not contaminate the integrity of the
20 analysis results. And that is the only intent.

21 Q. But in characterizing that the SSI or
22 the soil-structure interaction effects are
23 important, in this case in Figure 17, does it not
24 show that the accelerations in the horizontal
25 direction are enhanced or increased?

1 DR. LUK: Yes, by the presence of the
2 cask and the pad.

3 Q. Thank you. Earlier --

4 MR. TURK: Could I hear that question
5 and answer again, Your Honor.

6 JUDGE FARRAR: You want the question and
7 answer reread?

8 MR. TURK: Yes.

9 (The record was read as follows:

10 "Q. But in characterizing that the SSI
11 or the soil-structure interaction effects are
12 important, in this case in Figure 17, does it
13 not show that the accelerations in the
14 horizontal direction are enhanced or increased?

15 DR. LUK: Yes, by the presence of the
16 cask and the pad.")

17 MR. TURK: Well, I'm not sure I
18 understand it, but I'll let the questions proceed.

19 JUDGE FARRAR: Yeah. If this is a new
20 subject, we've been at it almost two hours this
21 afternoon, and it would be a good time to take our
22 break and change reporters. It's 3:20. We'll come
23 back at 3:35.

24 (A recess was taken.)

25 JUDGE FARRAR: Let's continue the

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1 State's cross, again with the goal of finishing
2 with this panel today.

3 Q. (By Ms. Nakahara) Dr. Luk, I'd like to
4 go over a number of documents that PFS has
5 submitted in this licensing procedure to understand
6 whether you have reviewed these documents or you
7 are aware of these documents. The first, and with
8 the consent of the Board, Ms. Chancellor will take
9 the document over to allow Dr. Luk to look at it.

10 JUDGE FARRAR: Okay.

11 MR. TURK: For clarity, are these
12 exhibits in the proceeding? Maybe you could refer
13 to them by their name as well as exhibit numbers so
14 the record is clear.

15 Q. Okay. The first one is PFS Exhibit UU.
16 It's entitled Stability Analysis of Cask Storage
17 Pads, G(B) 04 is the document number, prepared by
18 Stone & Webster.

19 DR. LUK: Thank you. The answer is no.

20 Q. The next document is Stability Analysis
21 of Canister Transfer Building, G(B) 13, also
22 prepared by Stone & Webster. PFS Exhibit VV as in
23 Victor.

24 DR. LUK: Thank you. No.

25 Q. The next document is entitled Soil and

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1 Foundation Parameters for Dynamic Soil Structure
2 and Interaction Analysis, 2000 Year Return Period,
3 Design Ground Motions, prepared by Geomatrix.
4 Calculation number G(PO18)-2.

5 DR. LUK: Thank you. The answer is no.

6 Q. The next document is entitled Dynamic
7 Response of Free-Standing HI-STORM 100 Excited by
8 2000 Year Return Earthquake at PFS, HI 2012780,
9 prepared by Holtec International.

10 DR. LUK: The answer is no.

11 Q. And the next document is Multi-Cask
12 Response at PFS ISFSI from 2000 Year Seismic Event,
13 Revision 2, HI 2012640, which is State's Exhibit
14 173, I believe. Yes, it is State's Exhibit 173.

15 DR. LUK: The answer is no.

16 Q. The next document is PFSF Beyond-Design
17 Basis Scoping Analysis, Holtec Number HI 2022854,
18 which is PFS Exhibit --

19 DR. LUK: The answer is no.

20 Q. -- which is PFS Exhibit 86.

21 The next document is Multi-Cask Seismic
22 Response at the PFS ISFSI, Report Number HI 971631
23 prepared by Holtec International.

24 DR. LUK: The answer is no.

25 Q. The next document is Storage Pad

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1 Analysis and Design Calculation Number G(PO17)-2,
2 prepared by International Civil Engineering
3 Consultants, Incorporated.

4 DR. LUK: The answer is no.

5 Q. The next document is Development of Time
6 Histories for 2000 Year Return Period Design
7 Spectra, document number G(PO18)-3 prepared by
8 Geomatrix.

9 DR. LUK: The answer is no.

10 Q. And the last document is Soil and
11 Foundation Parameters for Dynamic Soil Structure
12 Interaction Analysis, 2000 Year Return Period
13 Design Ground Motions, prepared by Geomatrix,
14 calculation number G(PO18)-2.

15 DR. LUK: The answer is no.

16 JUDGE FARRAR: Were the last few
17 exhibits?

18 MS. NAKAHARA: No.

19 JUDGE FARRAR: They were not exhibits in
20 the case?

21 MS. NAKAHARA: No.

22 Q. (By Ms. Nakahara) Given that you have
23 not reviewed or seen any of those documents that I
24 have just described that were submitted by PFS in
25 this licensing proceeding, is it fair to

1 characterize that you have not compared your
2 results with any of the results that PFS obtained
3 for soil structure interaction?

4 DR. LUK: May I add a qualifier? I did
5 not review any of the reports that you went
6 through. But I was offered the same opportunity to
7 touch those reports last Saturday. So I did see
8 them once, but only for a few seconds. So that's
9 on the record.

10 MS. NAKAHARA: Just so the Board
11 understands, during the deposition.

12 JUDGE FARRAR: Right. With that
13 qualifier, though, can you answer the latest
14 question, if you remember it?

15 DR. LUK: Can you repeat the second part
16 of the question?

17 Q. (By Ms. Nakahara) You have not compared
18 your soil structure interaction effects for 2000
19 year return interval with those obtained by PFS; is
20 that correct?

21 DR. LUK: Correct.

22 Q. Is it also true you have not compared
23 your cask displacement results with those obtained
24 by PFS for 2000 year return interval?

25 DR. LUK: Correct.

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1 Q. Is it also true that you have not
2 compared your displacement results for a 10,000
3 year return interval at PFS with those obtained by
4 PFS?

5 DR. LUK: Correct.

6 Q. Is it also true that you have not
7 compared your deconvoluted time histories for a
8 2000 year return period with those obtained by PFS
9 at a similar depth level?

10 DR. LUK: We do our own deconvolution
11 process, so the answer is "correct".

12 Q. And is it also true that you have not
13 compared your deconvoluted time histories for a
14 10,000 year return interval at the PFS facility
15 with those obtained by PFS at a similar depth
16 level?

17 DR. LUK: Correct.

18 Q. This is the supporting information for
19 simulations listed in Answer 118 of Dr. Krishna
20 Singh and Dr. Alan Soler's testimony that was
21 provided by PFS. And I guess if I could ask a
22 question of PFS's counsel, are you planning to make
23 this an exhibit?

24 MR. GAUKLER: I have no objection to
25 making it an exhibit.

1 MS. NAKAHARA: Then I'd like to mark it
2 as an exhibit, as State's Exhibit 179.

3 JUDGE FARRAR: We will have the reporter
4 mark that for identification.

5 (EXHIBIT-179 WAS MARKED.)

6 JUDGE FARRAR: Ms. Nakahara, we have
7 marked as State's 179 for identification a document
8 entitled Supporting Information for Simulations
9 Listed in Answer 118 of certain of the Applicant's
10 testimony. This, however, is a document you all
11 prepared?

12 MS. NAKAHARA: This is a document --
13 I'll allow Mr. Gaukler to characterize.

14 MR. GAUKLER: We had Mr. Soler prepare
15 this to answer questions raised by the State with
16 respect to the simulation that we show in this part
17 of the testimony. And this lists the inputs for
18 the eleven simulations as well as the displacements
19 for Cask 1 which we agreed to provide the State.

20 JUDGE FARRAR: So this is his work, not
21 tables they prepared based on his work?

22 MR. GAUKLER: This is Dr. Soler's work
23 and he will be ready, if you have additional
24 questions on that, he will be available at a
25 convenient point in time.

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1 JUDGE FARRAR: All right. Go ahead, Ms.
2 Nakahara.

3 MS. NAKAHARA: In fairness to Dr. Luk, I
4 don't know if he has seen this document before.

5 DR. LUK: No, I have not.

6 Q. (By Ms. Nakahara) The bulk of my
7 questions are going to be on Page 13, which are the
8 Displacement Response for Simulations, which
9 identify the maximum excursion of the top of the
10 cask from the location at the start of the run. If
11 you want to take a moment to look at those.

12 JUDGE FARRAR: Dr. Luk, were you here
13 when Dr. Soler testified?

14 DR. LUK: Yes, I was here.

15 JUDGE FARRAR: So does this exhibit make
16 sense? I mean, you can follow what it is.

17 DR. LUK: Yes, sir.

18 JUDGE FARRAR: Okay. Then go ahead and
19 take a look at it and tell us when you are ready.

20 MR. TURK: I would note that the witness
21 stated he hasn't seen this document before. I
22 probably would object to questions - I will wait to
23 hear them - based on lack of knowledge and
24 familiarity.

25 MS. NAKAHARA: If it would help to allow

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1 him time to look at the document --

2 JUDGE FARRAR: Right. That's what he is
3 doing. And we can either, Mr. Turk, have you
4 object or we can instruct the witness that if his
5 lack of familiarity would hinder him, that he
6 should say so rather than answer. Would that be a
7 better way to have a kind of a standing, not
8 objection on your part; but would that be a better
9 way to handle it?

10 MR. TURK: Well, I really should wait to
11 hear the question. But the document on this page
12 indicates that these are displacement responses for
13 different simulations, and it lists eleven
14 different simulations. Unless the witness is
15 familiar with what those simulations were and what
16 was included in them, I don't know whether his
17 testimony with respect to this document would have
18 much weight.

19 JUDGE FARRAR: Well, let's -- when he is
20 ready we will ask the question and you can state
21 the objection and we will ask in his opinion, and
22 then we will rule.

23 Q. (By Ms. Nakahara) And if I may assist
24 Dr. Luk, if you will look on the first page it
25 describes what each case simulation is.

1 DR. LUK: If you'll allow me to ask a
2 question, then I think we can go forward. Can
3 there be a better explanation for, "Max. Excursions
4 of Top of Cask from Location at Start of Run"? The
5 start of the run, is that basically assumed there
6 is zero displacement as the initial condition?

7 Q. That's my I understanding, yes.

8 JUDGE FARRAR: Let's do something
9 irregular. Dr. Soler, you are here. Consider
10 yourself still under oath. Can you answer that
11 question for the witness?

12 DR. SOLER: At time zero after the
13 static position was established, that is the start
14 of the run. And I am simply calculating the
15 difference between the starting position of the
16 particular point at the top of the casks and its
17 maximum excursion from that point. I think if you
18 look at the figure that I think you've got there,
19 it describes the curves. It's the difference
20 between Point B minus Point A, I believe.

21 DR. LUK: Okay. If you don't mind, can
22 I interact with Dr. Soler in this?

23 JUDGE FARRAR: As long as we have been
24 this irregular, we might as well go on, since it
25 will help us formulate a better record.

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1 DR. SOLER: What was the question?

2 JUDGE FARRAR: He wants to know if he
3 can talk to you. We will eliminate the middle man.
4 You two just have a conversation that the court
5 reporter can hear.

6 DR. SOLER: Be my guest.

7 DR. LUK: My question is you did not
8 actually reset, as initial condition, zero for the
9 starting point of your execution of the computer
10 run?

11 DR. SOLER: Are you talking about time
12 or position in that resetting? The position --

13 DR. LUK: At start of run.

14 DR. SOLER: At the start of the run, the
15 first thing that happens is the inertia forces are
16 turned off. The casks are located in a certain
17 position. The only force acting is gravity. And I
18 let the system settle down so that you ensure that
19 the casks are in contact with the pad and the pad
20 is in contact with the soil. At that point in
21 time, time is re-zeroed but position is not.
22 Velocity horizontal, is. And the inertia forces
23 are turned on. And then the execution progresses.

24 DR. LUK: Thank you. Because it is
25 usually analyst's something's choice. He can

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1 zero out the displacement at the time zero.

2 DR. SOLER: That is correct. But I did
3 not do that.

4 DR. LUK: That was the reason for the
5 question.

6 JUDGE FARRAR: And Dr. Soler's
7 explanation allows you to work with this table,
8 then?

9 DR. LUK: Except I think for every run
10 the starting point, which you identified as A, is
11 not specified.

12 DR. SOLER: It is the beginning of the
13 plot. And for each run that change spring
14 constants, because say the earthquake changed, the
15 initial location of the casks may be slightly
16 different because in getting to their static
17 position they jiggle a little bit. But then once I
18 start, the curve, the data, the numerical results,
19 the initial point of Cask 1 net location is the
20 square root of the sum of the squares of wherever
21 it is.

22 DR. LUK: So in other words, the results
23 that you provide in the table, even though it
24 includes the initial displacement, but since it is
25 so small it is negligible as compared to the final

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1 location which you identified as the excursion.

2 DR. SOLER: Yeah. I think what you
3 want to do is not call that "initial displacement"
4 but "initial position".

5 DR. LUK: Okay.

6 JUDGE FARRAR: Thank you, Dr. Soler.

7 DR. LUK: Can I also ask a second
8 question?

9 JUDGE FARRAR: Wait a minute. You are
10 getting to be like the lawyers here. They have one
11 question and then they have five. You're learning
12 fast. Go ahead.

13 DR. LUK: It's actually related to the
14 next column in a single run. I mean, in a single
15 cycle.

16 DR. SOLER: Yes. I think if you refer
17 to the figure, that column, if you apply it to this
18 figure, is really the value of Point B minus the
19 value at Point C.

20 DR. LUK: Okay. Sorry, your Honor. I'm
21 ready.

22 JUDGE FARRAR: Seriously, we would
23 rather you ask more questions and be sure of where
24 you stand than to be at all confused about it.

25 Then with that or those explanations

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1 from Dr. Soler, go ahead, Ms. Nakahara.

2 MS. NAKAHARA: Thank you, your Honor.

3 Q. (By Ms. Nakahara) Dr. Luk, if you will
4 look on Page 1 of State's Exhibit 179. Isn't it
5 correct that Case 3 is one cask on a pad for a
6 10,000 year return period event and a coefficient
7 of friction of .8?

8 DR. LUK: Yes.

9 Q. And if you will look --

10 MR. TURK: Your Honor, I would just say
11 yes, that's what the document shows. I don't think
12 the witness has any independent knowledge of
13 whether the table is correctly prepared or not.

14 JUDGE FARRAR: Right.

15 Q. And if you will look on Page 13 under
16 Case 3, isn't it correct that the document shows a
17 maximum displacement of 60 inches?

18 MR. TURK: Displacement at the top of
19 the cask.

20 MS. NAKAHARA: Thank you.

21 DR. LUK: Yes. This was indicated in
22 this table.

23 Q. (By Ms. Nakahara) Now, if you compare
24 that to your results on Table 10 for a 10,000 year
25 return period, isn't it true for the maximum

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1 displacement what you obtained in the lower-bound
2 case, which is the highest relative displacement,
3 is 15.94 inches which is just under four times less
4 than what Dr. Soler obtained in his Case 3 and up
5 to nine times less for the lower-bound case with a
6 coefficient of .8 than what Dr. Soler obtained?
7 Isn't that true?

8 MR. TURK: Your Honor, I would object.
9 It is apples and oranges.

10 JUDGE FARRAR: If it is, the witness can
11 tell us.

12 MR. TURK: If the witness is aware, your
13 Honor. He is being shown this document for the
14 first time.

15 JUDGE FARRAR: He knows enough about it
16 to respond either that he can answer or that he
17 can't.

18 DR. LUK: By having in front of me these
19 two sets of results, my position is that nobody
20 should do a direct comparison between the two sets
21 of results because the methodology involved in the
22 analyses are entirely different, not to mention
23 some of the other important input parameters are
24 critically different. In particular, for example,
25 for Case 3 on Page 1, it was identified that one

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1 percent of damping was used and not even mentioned
2 where the damping was applied. In our coupled
3 analysis model, we have to specify the damping
4 ratio at every horizontal layer in our soil
5 foundations. So in that regard, we are entirely
6 dealing with two different analysis models.

7 Q. Then I will just ask you one more
8 question. If you will look at Case Number 7 that
9 Dr. Soler ran, which is four casks on a pad for a
10 10,000 year return event with a coefficient of
11 friction of .8, he obtained a rotational angle from
12 vertical of 10.13 degrees, if you look back on Page
13 13. Is that correct?

14 DR. LUK: Yes.

15 Q. And based on your explanation you gave
16 to my last question, is that how you explain the
17 difference in rotational angles between what
18 Dr. Soler obtained for a maximum of 10.13 degrees
19 and what you obtained for a coefficient of friction
20 of .8 of 0.65 or 1.163?

21 DR. LUK: Yes. I would apply the same
22 reasoning; that we should not use any direct
23 comparison method to look at these two sets of
24 analyses results.

25 Q. Do I understand your testimony correctly

1 that you cannot compare these two reports?

2 DR. LUK: It's not --

3 MR. TURK: Objection. The witness said
4 you should not make a direct comparison.

5 MS. NAKAHARA: I'm asking him if I
6 understood him correctly. He can speak for
7 himself, thank you.

8 JUDGE FARRAR: Wait. Wait. That was a
9 good ruling, Ms. Nakahara. But I should have made
10 it instead of you.

11 MS. NAKAHARA: I apologize.

12 JUDGE FARRAR: That's fine.

13 Mr. Turk, this is a fully legitimate
14 cross-examination and the witness has proved
15 himself capable of answering with understanding and
16 not being trapped into saying something he doesn't
17 want to say. So Ms. Nakahara, you can keep going.

18 DR. LUK: The answer to your question is
19 not whether I can or cannot, but whether I should
20 or should not. I should not use any direct
21 comparison method to evaluate the integrity of
22 these two sets of analysis results.

23 MS. NAKAHARA: Before I move on to
24 another related area, I'd like to move for the
25 admission of State's Exhibit 179.

1 JUDGE FARRAR: Any objection?

2 MR. GAUKLER: No objection, your Honor.

3 MR. TURK: I'm not sure what the
4 document is. I think we should have a proper
5 sponsoring witness.

6 JUDGE FARRAR: I thought we had said it
7 was material Dr. Soler turned over to the State in
8 response to the requests they had made some time
9 ago. Again, departing from the norm, Dr. Soler,
10 this is your work?

11 DR. SOLER: Yes, it is.

12 JUDGE FARRAR: Does that take care of
13 your objection, Mr. Turk?

14 MR. TURK: Is Dr. Soler going to be
15 brought back as a witness, your Honor?

16 JUDGE FARRAR: If somebody wants him.

17 MR. GAUKLER: I was going to make him
18 available to answer questions on this table at the
19 Board's convenience and party's convenience. I was
20 thinking of doing that Thursday, would be a good
21 time.

22 MR. TURK: My problem with this, your
23 Honor, is it's a lot of data. Each page consists
24 of a long table with maybe 15 or 20 different data
25 points. I don't know what they represent and I'd

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1 like to get an explanation from the person who
2 prepared it to make sure we understand it. The
3 doctor has identified it for the record, and if he
4 is going to be a witness I think we should defer
5 its admission until questions can be asked about
6 what the document actually is. Otherwise it is
7 just a piece of paper on the record with a lot of
8 numbers that may not mean anything at all.

9 MR. GAUKLER: I have no problem with
10 that, your Honor.

11 MS. NAKAHARA: And I have no objection
12 to Mr. Turk's objection.

13 JUDGE FARRAR: Let's refer -- we are
14 inclined to allow the admission of the exhibit but
15 we will withhold that ruling pending developments
16 with the Staff perhaps wanting to question
17 Dr. Soler before it is formally admitted.

18 MR. TURK: Thank you, your Honor.

19 JUDGE FARRAR: Okay.

20 Q. (By Ms. Nakahara) Dr. Luk, if you will
21 turn to Table 8 of your report, your March 31, 2002
22 report. Page 30. This morning in response to some
23 questions by Mr. Gaukler, I'd like to clarify some
24 issues. Is it true that you believe that your
25 Model Type 3, which is the coupled model which

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1 includes the dead loads to seven adjacent casks and
2 neighboring concrete pads, confirm that your Model
3 Type 1 would encompass the modeling of eight casks?

4 DR. LUK: Yes. It confirms that using a
5 single cask on a single pad actually quantitatively
6 characterized the structural behavior of the cask
7 on the pad.

8 Q. And I believe you indicated to Judge
9 Farrar that you were present during Dr. Soler's
10 presentation showing the animated movements of the
11 casks?

12 DR. LUK: Yes.

13 Q. Is that correct?

14 DR. LUK: Yes.

15 Q. Do you recall a discussion between
16 counsel for the State and Dr. Soler in which
17 Dr. Soler appeared to have acknowledged that in one
18 particular case Cask Number 4 did appear to be
19 moving with greater deformation than Cask 1?

20 DR. LUK: I do not recall the details of
21 that specific case.

22 Q. For the purposes of my question, if you
23 assume that my representation is correct, that Cask
24 4 did, for this particular run, have greater
25 displacement than Cask 1, how would your Model Type

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1 1 encompass the movement of the eight different
2 casks?

3 DR. LUK: I can only testify to what we
4 have done. What we have done is that we have
5 looked at quite specific -- if you go by the
6 numbering systems that I witnessed last week,
7 there's only two locations of cask locations that
8 are different. So it is either 1 and 3, or 2 and 4
9 for that matter. And in our sensitivity study, we
10 did put casks at either 1 or 3 locations. And the
11 analysis results did not indicate any difference.

12 Q. And in your sensitivity study, did you
13 run that for a 2000 year return earthquake?

14 DR. LUK: Yes. A significant portion of
15 the sensitivity study was based on 2000 year return
16 seismic event.

17 Q. Did you also do a sensitivity study for
18 the 10,000 year return earthquake?

19 DR. LUK: No, we did not.

20 MR. TURK: With respect to this issue?

21 MS. NAKAHARA: Yes.

22 MR. TURK: That's how the witness meant
23 it?

24 DR. LUK: Yes.

25 Q. (By Ms. Nakahara) In conducting your

1 sensitivity studies, did you, in fact, run a model
2 where all eight casks were moving?

3 DR. LUK: No. That's probably not
4 because we don't want to, but because, first, we
5 don't think it is technically necessary. Second,
6 the model would be so huge it would probably lock
7 up the computer for a long time.

8 Q. With ABAQUS, is it possible to run all
9 eight casks?

10 DR. LUK: Oh, yes. I think we run much,
11 much more complicated, much, much more
12 sophisticated models. But I probably have to turn
13 to much bigger computers. The simple answer is
14 yes, definitely. We can model materials down to
15 the molecular level.

16 Q. You've referenced several times today,
17 and at least once in your report, you have referred
18 to computational penalty. Is that with respect to
19 computer time?

20 DR. LUK: Yes.

21 Q. Did you feel there were any restrictions
22 placed upon you by NRC to limit your computational
23 time due to costs?

24 DR. LUK: The issue I state is not how
25 much time, how much resources is needed to execute

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1 the analysis. Since we are engineers, we were
2 tasked to come up with engineering solutions. And
3 in that context, we have to come up with a
4 practical analysis methodology so we hoped
5 eventually it will become available to the public
6 and the public can use it.

7 Q. So did you feel there were any
8 restrictions placed upon you by the NRC staff in
9 computational time, that would limit computational
10 time in your analysis?

11 DR. LUK: No. We were not given any
12 restrictions by the Staff at NRC.

13 Q. Dr. Luk, isn't it true that you have not
14 compared the results from ABAQUS with any actual
15 physical data such as shake table test data?

16 DR. LUK: Correct.

17 Q. And in response to a question by Judge
18 Farrar earlier, you gave a very detailed
19 explanation that ABAQUS accounts for nonvertically
20 propagating waves. Is that correct?

21 DR. LUK: Yes.

22 Q. And in my lay understanding, you didn't
23 mean to say that ABAQUS, in fact, redistributed
24 vertically propagated waves to an angle up to 10
25 degrees as it strikes the storage pads or the

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1 casks, did you?

2 DR. LUK: Can you repeat the question?

3 MS. NAKAHARA: Can you read that back?

4 (The record was read as follows:

5 "Q. And in my lay understanding, you
6 didn't mean to say that ABAQUS, in fact,
7 redistributed vertically propagated waves to an
8 angle up to 10 degrees as it strikes the
9 storage pads or the casks, did you?")

10 MR. TURK: I would object. I don't
11 understand the question. If the witness does, he
12 can answer.

13 JUDGE FARRAR: Do you understand it?

14 DR. LUK: Yes. I did not explicitly
15 describe my answer in the manner that is included
16 in the question. But what I did say is that in the
17 formulation, based on existing theory that has been
18 incorporated in the ABAQUS code, they include the
19 equation of state and also included constitutive
20 relations for various material. And in that
21 regard, the theory of wave propagation has been
22 incorporated. That, to address your question in
23 particular, the nonpropagating waves, it's part of
24 the phenomenon.

25 Q. Did your model of PFS include inclined

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1 waves?

2 DR. LUK: My answer again is that since
3 all the theories related to wave propagations of
4 various kinds are already incorporated in the
5 theory, which were actually used as the base to
6 develop the numerical scheme for the ABAQUS code,
7 the simplistic answer to your question is yes.

8 Q. Are you aware that the time histories
9 that were provided to you included only vertically
10 propagating waves?

11 DR. LUK: We were given the time history
12 by Dr. Shah. He's the staff at NRC.

13 Q. Okay. Thank you. I have no further
14 questions, your Honor.

15 JUDGE FARRAR: All right. The Board has
16 a few questions. Mr. Guttman, this will be you,
17 although it is based on something in Dr. Luk's
18 executive summary.

19 Page 1, where it says, "A typical
20 Independent Spent Fuel Storage Installation
21 licensed under 10 CFR Part 72 consists of arrays of
22 free-standing storage casks resting on a concrete
23 pad." Questions that I will have deal with the
24 spent fuel storage system nationally, and some of
25 the questions may seem to you very elemental and

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1 you are free to take them that way.

2 Going way back to the beginning, the
3 late '60s or early '70s, when reactors were
4 licensed, and if you can speak generally, how big
5 were the spent fuel pools in terms of their ability
6 to handle how many years worth of off-loading of
7 fuel?

8 MR. GUTTMAN: I don't know the answer to
9 that. But my understanding is it was big enough
10 for continued operation until at that time the
11 licensees believed DOE would take possession of
12 those fuels.

13 JUDGE FARRAR: Right. But then it would
14 not have held the entire 40 year off-loading.

15 MR. GUTTMAN: That's correct.

16 JUDGE FARRAR: Then, as I understand it,
17 spent fuel pools were reconfigured so that now they
18 hold more, but still not the whole 40 years.

19 MR. GUTTMAN: That is correct.

20 JUDGE FARRAR: Okay. Did some reactors
21 add additional spent fuel pools?

22 MR. GUTTMAN: I'm not aware of any.

23 JUDGE FARRAR: Okay. So then once they
24 started to get filled up and recognized that they
25 have to have capacity to off-load the entire or

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1 have to have free capacity to off-load the entire
2 fuel -- well, there were 103 or 104 operating
3 reactors, and a number shut down. Is that around
4 70 sites?

5 MR. GUTTMAN: In the seventies.

6 JUDGE FARRAR: Counting two, three, four
7 reactors in a place?

8 MR. GUTTMAN: Around 70 in a ballpark.

9 JUDGE FARRAR: Let's use 70 for purposes
10 of the discussion. How many of those are now
11 storing their own fuel in dry casks on site?

12 MR. GUTTMAN: I don't know that number.

13 JUDGE FARRAR: I mean is it one, is it
14 ten?

15 MR. GUTTMAN: I would guess in the
16 teens.

17 JUDGE FARRAR: And am I correct that
18 most of those didn't need a license amendment
19 because they get a certificate of compliance for
20 whomever casks they were using, and then they
21 notify the Staff that they wanted to go ahead and
22 store fuel under their general or under their
23 reactor license to possess fuel, and just send you
24 a letter that says, for example on seismic, "The
25 seismic design criteria we told you about when we

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1 built the reactor are within the certificate of
2 compliance." Is that how the system works?

3 MR. GUTTMAN: For most cases, that's
4 correct. The reason I said the "most cases" is
5 because some utilities have requested for
6 site-specific license.

7 JUDGE FARRAR: Okay. Is that -- how
8 many reactor sites are taking fuel - this will be a
9 two-part question - are taking fuel from other
10 sites owned by the same reactor owner? And I'll go
11 back to the old days when Duke Power owned McGuire
12 and Catawba and Oconee and some others. How many
13 are taking fuel from their own other sites?

14 MR. GUTTMAN: I don't know the number.
15 I believe that Virginia Power might be shipping
16 from one reactor to another. But I think -- I'm
17 not sure if they are putting it into another pool
18 or dry storage. I don't know the answer.

19 JUDGE FARRAR: Do they need a special
20 license to do that?

21 MR. GUTTMAN: No.

22 JUDGE FARRAR: So if it's their own fuel
23 they can move it to another of their own sites?

24 MR. GUTTMAN: That is correct.

25 JUDGE FARRAR: Okay. So when Dr. Luk

1 says a typical ISFSI consists of these arrays, that
2 would be a reference to these in the teens where
3 people are doing it at their own sites?

4 MR. GUTTMAN: It's at their own sites;
5 correct.

6 JUDGE FARRAR: Are there any reactor
7 sites thus far that are taking fuel from other
8 sites not owned by the same utility company?

9 MR. GUTTMAN: I don't know the answer to
10 that.

11 JUDGE FARRAR: Okay. When we hear that
12 there have been no shipping accidents, what's the
13 database for that? Is that this movement of fuel
14 from reactor to reactor?

15 MR. GUTTMAN: As well as Department of
16 Energy.

17 JUDGE FARRAR: And this PFS proposal is
18 the only one thus far which would be at a
19 nonreactor site?

20 MR. GUTTMAN: That's my understanding.

21 JUDGE FARRAR: If you want to elaborate
22 on any of the answers, if you want to correct at a
23 future time -- I know you didn't expect this line
24 of questioning. But you are the only person, the
25 closest thing I thought we were going to have to

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1 someone who might be knowledgeable on this. And
2 the questions are purely factual. So if you want
3 to supplement your testimony or correct it at a
4 later time --

5 MR. TURK: May I make a suggestion,
6 also?

7 JUDGE FARRAR: Yes.

8 MR. TURK: The Environmental Impact
9 Statement, the FEIS, contains a discussion of dry
10 cask storage facilities presently existing in the
11 United States. And I think it is under the
12 discussion of the need for the facility.

13 JUDGE FARRAR: And I had seen that but I
14 didn't know if it had all the details.

15 MR. TURK: It might be more inclusive in
16 the testimony and perhaps a little more correct.

17 JUDGE FARRAR: I'll look at that. I
18 didn't have it here with me and I didn't want this
19 opportunity to escape without making sure we --

20 MR. TURK: We would rely on that, your
21 Honor, because I think that document was an attempt
22 to do a deliberate discussion of the spent fuel
23 storage situation in the United States.

24 JUDGE FARRAR: Okay. I will take
25 another look at that.

1 Dr. Luk, on the question about the
2 shaking table, I take it that's -- is that a real
3 table, not a model table?

4 DR. LUK: The -- at the very start of
5 this project, I visited U. C. Berkley as well as
6 U. C. San Diego. Both of those have sizable shake
7 tables. But the one I use at Berkeley, if you
8 don't mind me saying, is a little old. So we are
9 trying to focus on the one at U. C. San Diego. But
10 they need some upgrade before they can conduct any
11 tests for the cask. And I think the latest
12 information I got is that U. C. San Diego actually
13 filed a proposal to the National Science Foundation
14 to do the upgrades and they did ask me for a letter
15 of recommendation. So I included that. So
16 hopefully that facility will be enhanced so that,
17 you know, when the appropriate time comes, we can
18 conduct this kind of shake table test on the cask.

19 JUDGE FARRAR: The reason I ask is
20 Dr. Hardland's and Dr. Ostadan's testimony,
21 Dr. Ostadan says in question and answer 19, that a
22 model of the system can be built on a shaking
23 table. Is what you are saying, there's no facility
24 now existent that you think is up to par on doing
25 that kind of work?

1 DR. LUK: Can I give you a little bit of
2 a qualifier, some background? You can always do a
3 sub- scale of the cask. For example, if you reduce
4 the full-size scale cask by a factor of 10, for
5 example, you tremendously reduced its geometry as
6 well as mass. And I think there are facilities in
7 this country, as well as in some other countries,
8 available to do that. As a matter of fact, more
9 than ten years ago there was a shake table test on
10 a subscale of dry cask at CRIEPE of Japan. Those
11 are the shorthand --

12 JUDGE FARRAR: It's an acronym.

13 DR. LUK: Yes. For task facilities in
14 Japan.

15 JUDGE FARRAR: That's fine.

16 DR. LUK: But what they did is they did
17 the shake table test on a one-fifth and a one-third
18 scale.

19 But it's also very limiting. They only
20 applied the horizontal motion in one direction
21 only. They did not have the orthogonal horizontal
22 excitation and likewise did not have the vertical
23 excitations. But more important, as background
24 information, it's very difficult to conduct soil
25 structure interaction on top of a shake table

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1 because not only you have to put the cask, the pad,
2 and some sizable mass for soil, but everybody who
3 is engaged in soil mechanics will know if you move
4 soil, you change its in situ, if you change the in
5 situ soil properties you basically changed soil.
6 So it's very difficult to systematically conduct a
7 shake table test of cask to also, at the same time,
8 incorporate the soil structure interaction. So the
9 best we can do is to put a cask on the concrete pad
10 and then put both of those two structures on top of
11 the shake table.

12 JUDGE FARRAR: And how time-consuming,
13 or recognizing the limitations, how time consuming
14 and costly would that be?

15 DR. LUK: We did have an estimate,
16 because like I say at the start of this project, we
17 did investigate or try to find any other
18 possibility of conducting a dry cask on a concrete
19 pad and put on a shake table. I think for a series
20 of six tests, for example, the range of the budget
21 required is between \$500,000 to \$600,000, depending
22 on whether we will be able to get a donated free
23 cask.

24 JUDGE FARRAR: To get what?

25 DR. LUK: You know, if --

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1 JUDGE FARRAR: Just say the words again.

2 A what?

3 DR. LUK: Donated, free cask.

4 JUDGE FARRAR: Okay.

5 DR. LUK: Because I think to fabricate
6 something which I think will closely resemble a dry
7 cask would probably take \$100,000.

8 JUDGE FARRAR: Mr. Guttman, hold that
9 answer in mind and I will come back to you in a
10 second.

11 On the question of sequencing when I
12 asked you this morning with the eight positions on
13 the pad, and you pointed out where you -- there
14 were only two different locations you can put; in
15 effect only two different locations you can put the
16 first one, but then once you have picked one of
17 those two, for each of those cases there are seven
18 different locations where you can put the second
19 one. And none of them seemed to be the same.

20 DR. LUK: Yes.

21 JUDGE FARRAR: Geometrically.

22 DR. LUK: Yes.

23 JUDGE FARRAR: And then it got too
24 complicated for me to scratch it out here and do
25 the next one. But assuming then, even though there

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1 will be some duplicates, that there's six places
2 you can put the third one, I get 10,080 possible
3 combinations but it may be less because some of
4 them may be duplicates. Tell me why, with all
5 those possibilities, why what you did can assure us
6 that you have taken into account any abnormalities
7 or unusual features that might creep in from any of
8 those 10,000 different possible asymmetric, most of
9 them, arrangements.

10 DR. LUK: Yes. If you don't mind, can I
11 answer your question in parts? The first one is
12 probably the most relevant one. There is published
13 the report by the staff at Hatch. They did go
14 through a systematic study to identify the proper
15 sequencing for installing different pads.
16 Different casks on the pad. But that -- the base
17 of that investigation is purely from the
18 perspective trying to maintain the integrity of the
19 pad. It has nothing to do with the seismic
20 response of the cask.

21 And the second part is that we are
22 trying to address the issues if we decided to use a
23 single cask on the pad, where is the appropriate
24 locations. We did go through this selection by our
25 review panel. We have, in our project, a review

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1 panel which actually consists of members of staff
2 at NRC as far as experts in the industry. And they
3 agree with our selection of the location for the
4 single cask on a pad.

5 JUDGE FARRAR: But did they assure you
6 that modeling that, that there were sufficient
7 reasons to model only that and not any of the
8 10,000 other different ways you could array from
9 one to eight casks on a pad?

10 DR. LUK: What we did is that
11 periodically we submit status reports which include
12 a detailed explanation of the methodology and the
13 analysis results for them to review. So they have
14 been very much familiar with our analysis
15 methodology as well as our results. So in essence,
16 they agreed with our approach.

17 JUDGE FARRAR: Okay. Mr. Guttman then,
18 I guess as a management issue or policy issue you
19 would have wrestled with, we talked about the
20 shaking table and talked about the 10,000 different
21 arrays. And Dr. Luk this morning said there was a
22 big penalty in terms of time and money in terms of
23 modeling all eight so they ran one. He said they
24 didn't have a super computer available. He said he
25 recognized it's a very important task, they needed

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1 to come up with a practical model. Given all that,
2 tell us about your thought processes and where is
3 the assurance for us that -- you can't do
4 everything, but this is a controversial project,
5 it's a first-of-its-kind project, it's a lot of
6 tasks, there's a lot of public interest. Where is
7 the assurance to us that you have done everything
8 that it was reasonable to do and, in fact, have an
9 answer that -- since you couldn't do everything,
10 your first answer would be, "Good. Let's model all
11 this and get the super computer. Let's do
12 everything possible so that there can't possibly be
13 any question ever raised about the legitimacies of
14 the work." That would be one approach a manager
15 could say. That's the first thing you say. And
16 then you say, "Well, wait a minute, I can't do
17 that. What am I going to do and how will I prove
18 to people that what I did was enough?" That's a
19 very long and involved and probably an
20 ungrammatical question. But I think you get the
21 idea.

22 MR. GUTTMAN: When we make a regulatory
23 decision, we base it on public health and safety.
24 At this point it is true that the magnitude of
25 storage casks is large, nonprecedented in our

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1 history. But it's not true that it is unique in
2 that plants are already storing dry casks at their
3 sites. When we look or consider public health and
4 safety, let's take a look at the worst possible
5 scenario. The worst possible scenario, which is
6 not a probable scenario, is that the casks tip
7 over. What would happen if the casks tipped over?
8 Nothing. Other than the cask is going to be laying
9 on its side. The canister is going to remain
10 intact. The temperatures within the fuel pins will
11 increase. But they will increase within the
12 maximum allowable short-term temperature limits.
13 Basically that temperature limit stays there. We
14 did a calculation where we tipped over a cask and
15 let it go to steady state conditions and the
16 temperature stayed low.

17 Now, what would happen if the
18 temperature increases beyond that limit? What
19 would happen is the reason we at first established
20 that temperature limit is to -- it's a convenient
21 means of insuring that the cladding will not burst.
22 That's what convenient calculation means. If, for
23 example, let's say that the cladding due to creep,
24 the underlying criteria analysis that we are
25 discussing, creep, that is the mechanism by which

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1 the cladding could fail.

2 And so if the temperature for even the
3 worst event exceeds that, what would the
4 consequences be? The consequences would be that
5 you will have a small pinhole leak or crack
6 occurring at the cladding. Okay. What does that
7 do? That basically stops the progression of clad
8 degradation because inside the clad are gasses that
9 pressurizes the fuel pin. As soon as you punch a
10 hole in it, it relieves that pressure. Therefore,
11 there is no more driving force to create further
12 degradation or creep.

13 You don't have to worry about
14 metal/water reaction; the cask is inert. And in
15 the analyses, when we assume an accident, our
16 accident analysis assumes that all the fuel is
17 basically failed for accident evaluations. So in
18 terms of any type of credible accident that could
19 jeopardize public health and safety, we couldn't
20 find one.

21 So now the question is we have analysis
22 methodologies that are conservative if you follow
23 the Standard Review Plan and apply the appropriate
24 regulatory input. If you don't apply the
25 appropriate regulatory input, then we are going to

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1 reject that application.

2 We have a relatively conservative
3 calculation and we have a more realistic
4 calculation that Dr. Luk performed. All
5 indications, if you use the conservative
6 calculations, nothing happens. The cask is not
7 going to tip over. For the cask to tip over you
8 are going to have to tilt the cask 29 degrees. The
9 conservative calculations showed something on the
10 order of -- I can't recall. Something like nine or
11 ten degrees. Dr. Luk's calculations showed a
12 fraction of a degree. So a more realistic
13 calculation indicates that the cask is not going to
14 tip over. So in terms of licensing basis, in terms
15 of public health and safety, we have reasonable
16 assurance that the public health and safety will be
17 assured by the system.

18 JUDGE FARRAR: So that allows you to be
19 comfortable with your decision not to go model a
20 whole lot of other scenarios of number of casks on
21 a pad. Because you think, if I can paraphrase what
22 you just said, you think you have done well enough
23 and even if you were wrong, there's no long-term or
24 there's no health and safety consequences to it

25 MR. GUTTMAN: There's no health and

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1 safety consequences. Plus we are way beyond or way
2 before -- the limits are way beyond what we are
3 calculating. We are not even getting anywhere, no
4 one is getting anywhere near the 29 degrees tilt.

5 JUDGE FARRAR: So if you have run this
6 one model and gotten near 29, you might have said,
7 "Let's do some more. Let's model some other
8 things." Is that right?

9 MR. GUTTMAN: If we came close to the
10 limits, we would probably reassess everything and
11 may require them to anchor it. I don't know.
12 That's all hypothetical.

13 JUDGE FARRAR: And I'll have one
14 question at the end. I'll ask Judge Kline and
15 Judge Lam if they have any.

16 JUDGE KLINE: I'll just follow up with
17 one. It has to do with your regulatory process.
18 You indicated a sequence of events that act in a
19 sort of, would you call that in casks a
20 defense-in-depth type scenario where, in the first
21 place, you don't think the casks are going to tip;
22 but if they did, the canister wouldn't rupture; and
23 if it did, the fuel wouldn't fail? Some sequence
24 like that.

25 MR. GUTTMAN: That is going beyond the

1 design basis.

2 MR. KLINE: Okay

3 MR. GUTTMAN: But if we would -- within
4 the design basis we feel there are ample margins
5 and have a reasonable assurance that the cask, it
6 is improbable, unlikely that the cask would even
7 tip.

8 MR. KLINE: My question, then, is if you
9 were close to the margins on cask tipping, but all
10 the rest of the analysis continued to show that
11 there was no public health and safety consequences,
12 can you, in a sense, sort of trade off the factors
13 in your licensing decision? Or do you have to hold
14 the cask tip to an absolute standard?

15 MR. GUTTMAN: At this point we have a
16 regulatory posture. It shouldn't tip. Now, if an
17 applicant would like to test our endurance and test
18 the financial resources to go beyond that, we will
19 look at their analyses.

20 MR. KLINE: Okay. So you don't have a
21 position on it until you are faced with a case. Is
22 that right?

23 MR. GUTTMAN: At this point we haven't
24 been tasked to face that by the industry.

25 MR. KLINE: Okay. Thank you. That's

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1 all.

2 JUDGE LAM: Mr. Guttman, if indeed there
3 exists so much safety margin, do you recall then
4 what was the reason for the applicant to ask for an
5 exemption?

6 MR. GUTTMAN: If you are going to
7 request something that has not been performed
8 before, then you would have to ask for an
9 exemption.

10 JUDGE LAM: So the exemptions request
11 was not based on lack of safety margin? Is that
12 your understanding?

13 MR. GUTTMAN: I really don't know the
14 basis, I did not review the basis for the
15 exemptions.

16 MR. TURK: Just for background, the
17 regulations require following 10 CFR Part 100
18 appendix (a) and the Applicant asked for an
19 exemption from that. That would have required a
20 deterministic analysis and they asked for
21 permission to go with a probabilistic seismic
22 hazard analysis using a particular return period.
23 I think the original application was 1000 years.
24 They ratcheted it up to 2000 years. And that's
25 where they are now.

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1 JUDGE LAM: Okay. I have some questions
2 I'd like Dr. Luk to answer. Dr. Luk, I had heard
3 in these proceedings that your study and your model
4 represent the state-of-the-art analysis in
5 modeling. May I ask you to describe what are the
6 most important features that you consider
7 state-of-the-art?

8 DR. LUK: Two aspects. One is the
9 inclusion in our model, the interface between
10 different substructures, in particular used in
11 contact elements, to allow freedom of the
12 substructure to slide one on top of the other. And
13 second, to actually have an explicit simulation of
14 the soil foundations and include that in our model
15 to give us the proper treatment of dynamic
16 coupling.

17 JUDGE LAM: Now, I know you hesitated to
18 critique Dr. Soler's work. What is the advantage
19 or disadvantage of using soil spring?

20 DR. LUK: Maybe I'll try to answer your
21 questions in the foreign perspective. We were
22 tasked to use the state-of-the-art to come up with
23 the analysis methodology. We don't have any
24 constraints. That means we don't have any
25 guidelines. We basically try to develop the best

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1 methodology we know how. Has no co-constraints or
2 whatever guidelines set forward by the NRC. And in
3 that perspective when engineers and analysts try to
4 select a model, they probably should have an
5 objective in mind, what other things they try to
6 get from the model. So I think in that regard, we
7 probably have a different objective related to
8 what's our desire to get from the analysis model.

9 JUDGE LAM: Perhaps I can be more blunt.
10 What is wrong with using soil spring in modeling?

11 DR. LUK: I don't think there's anything
12 wrong, but I don't know how the springs in one
13 series can represent the dynamic characteristics of
14 site-specific soil profile data that is tabulated
15 in many different horizontal layers. And what we
16 tried to do in our modeling is mainly trying to
17 duplicate that with an organized discretization
18 scheme. So in that manner, just use springs, I
19 will say it again, is not good or bad. It may
20 not -- it may not or it might not be adequate in
21 that sense.

22 JUDGE LAM: So what you are saying is in
23 your model, you model soil property down to a level
24 of 140 feet and divide them into six different
25 layers. Are you saying that would be a difficult

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1 model to construct using soil springs?

2 DR. LUK: I think you can -- this is
3 purely speculative. You can, for example, for each
4 horizontal layer, you can come up with a series of
5 springs and lay another springs on top of that. So
6 one series would represent one horizontal layer,
7 for example. What we do is, in essence, in
8 engineering terms, to use springs for each
9 horizontal layer. So there's nothing wrong to use
10 springs to represent soil foundations. But the
11 question is how much detail there should be
12 included.

13 JUDGE LAM: I see. But the way you
14 modelled your soil foundation, it's a lot more
15 complicated than using soil springs. Is that
16 correct?

17 DR. LUK: Yes, sir.

18 JUDGE LAM: Dr. Luk, my understanding of
19 your model is basically you are, with all the
20 space- dependent soil properties and structural
21 properties, you are attempting, in your model, to
22 solve a set of second order differential equations
23 with a forcing function of space time dependent,
24 and where the material property are depending on
25 space. Is that a correct understanding of what you

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1 are trying to do mathematically?

2 DR. LUK: Yes.

3 JUDGE LAM: Then tell me how many PCs
4 that you strung together to do a 48-hour run for
5 one set of computations?

6 DR. LUK: It is actually one.

7 JUDGE LAM: Just one?

8 DR. LUK: Yes. I think that was -- we
9 have in our perspective, eventually we have to
10 develop a model that is called practical. So we
11 are trying to stay with one and we do not try to
12 put any specific requirements on the public, if
13 this model would become available in the public
14 domain.

15 JUDGE LAM: So there's no parallel
16 computation, no interfacing issue here.

17 DR. LUK: No, sir.

18 JUDGE LAM: You are just using one
19 computer?

20 DR. LUK: Correct.

21 JUDGE LAM: Then may I ask, how do you
22 track the original computation? Do you indeed
23 track them within the 48 hours?

24 DR. LUK: Yes. Yes, I think it is
25 actually a painstaking process when we first

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1 started this effort. So that was the reason why we
2 have a student/contractor; because I asked him to
3 show up to work every two hours.

4 JUDGE LAM: So it is not that you turn
5 on the computer and go home and come back?

6 DR. LUK: No. We cannot. Right. But
7 we did go through that tedious process for a few
8 initial runs. And after that, our level of
9 confidence increases and we stopped that practice.

10 JUDGE LAM: Now, Dr. Luk, you also
11 testified that you use, in 1971, San Fernando
12 earthquake data for input?

13 DR. LUK: Yes, sir.

14 JUDGE LAM: Now, the use of that data,
15 do you have data of the actual ground motion as
16 well as any structural damages that you can
17 validate? I mean, to me -- let me be more
18 specific. To me I envision you used earthquake
19 data to do some validation. There is earthquake
20 data in 1971 for San Fernando for ground motions
21 and perhaps there is also some data related to some
22 structural damages for known structures with
23 well-defined characteristics. Then perhaps you can
24 model, using the computer that you have run, to see
25 if, indeed, using the ground motion data you can

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1 correctly predict structural damages. Now, I don't
2 have that impression here that's what you had done.

3 DR. LUK: When we receive the actual
4 earthquake record, I had a lengthy discussion with
5 one of our contractors, Mr. Lange. He was actually
6 at Cal Tech at that time. And what he told me, he
7 had extensive knowledge based on the earthquake
8 simply because he was actually nearby. And it was
9 actually at that time that Cal Tech was charged or
10 was tasked to go through an extensive evaluation of
11 the damage as well as the source term for the
12 earthquake. So I think what he said, I quote,
13 "That is a good choice."

14 JUDGE LAM: But the question was, what
15 did you use the earthquake data for? Just another
16 set of time history input?

17 JUDGE FARRAR: Yes.

18 JUDGE LAM: I see. I thought you may
19 have used that to validate some structural damages
20 that you put in. I mean, not specifically related
21 to a cask. Perhaps in your model you can put in a
22 garage, a house that has collapsed as a result of
23 an earthquake, and use that history or ground
24 motion and history of structural damage to run the
25 computer program to validate that. So that has not

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1 been done?

2 DR. LUK: No. We did not use the
3 specific actual earthquake records to do anything
4 but use it as an input seismic to execute our
5 coupled model.

6 JUDGE LAM: Okay. Dr. Luk, in the
7 report that you submitted on March 31, on Page 8
8 you make references to the U.S. Corps of Engineers
9 guidelines and ASCE standard on soil foundation
10 modeling. Can you quickly describe what these
11 standards are?

12 DR. LUK: Yes. This is an engineering
13 letter. I actually want to call your attention to
14 the reference.

15 MR. TURK: Page 41, Dr. Shah tells me.

16 DR. LUK: Yes. It is on Page 41 of the
17 same analysis report, reference number 11. That is
18 identified as U.S. Army Corps of Engineers.
19 Engineer Technical Letter Number 1110-2-339, March,
20 1993. In this technical letter it described if the
21 analyst or if the engineer tried to model the soil
22 foundations, the minimum outside boundary should be
23 seven times that of the structure under
24 consideration or investigation.

25 JUDGE LAM: I see. Well, Dr. Luk, let

1 me ask you a final question. We are dealing with a
2 very complicated model. We are dealing with very
3 large structures like the pad around the cask, and
4 we are dealing with a huge amount of data that you
5 had modelled. For example, your soil foundation
6 model I see 700 feet, 300 feet, and then 140 feet
7 depth, six different layers, different engineering
8 material, and then different material
9 characteristics, and then the excruciating detail
10 time history inputs, and then you ran the computer
11 for two days to come up with a displacement
12 measuring inches and a rotational angle measuring a
13 degree or less.

14 Tell me, Dr. Luk, what confidence do you
15 have that, indeed, these are the right results from
16 the modeling? Would you be surprised if within a
17 week or two weeks later somebody else ran the same
18 model and came up with a very different answer? I
19 mean, basically the result tells me nothing
20 happened, when I'm looking at a 60-foot long pad.
21 We are talking about displacement of inches.
22 Looking at this cask with eleven feet of diameter,
23 20 feet of height, you tell me rotational angle is
24 half a degree. Nothing happened. What confidence
25 do you have after all this work that indeed these

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1 are the right results? Could you be wrong by a
2 factor of ten? Could you be wrong by a factor of
3 100?

4 DR. LUK: The answer is that this has
5 been the first year of our project. The seismic
6 analysis of the Private Fuel Storage cask is not
7 the first one that we studied. Actually, there has
8 been a huge accumulation of experience that we
9 developed in the past three years. Take, for
10 example, the San Onofre horizontal cask. When one
11 module of that unit was put on a shake table,
12 subject to two horizontal components of 1.5g and
13 1.0g in the vertical directions, the single module
14 would slide off the pad. It is gone.

15 So what I'm simply saying is this: They
16 are all dependent on the input parameters. There's
17 cases that we have actually come up with analysis
18 results indicating that the cask is not stable at
19 all. Okay? So our experience base actually helps
20 us to identify on a reasonable base how good or to
21 what level is the range of our analysis results we
22 indicate.

23 And we also performed extensive
24 sensitivity analysis simply to address your
25 concerns because we have had that concern in mind

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1 for a long time; how good, how valid is our
2 solution, without the chance to actually validate
3 our analysis results with available test data.
4 That's why we try to do our best to go for a
5 systematic, sensitivity evaluation. But the very
6 point is that in some casks, they are very
7 unstable.

8 Take the second example for Hatch. We
9 were tasked to go through parametric analysis to
10 increase the load, basically trying to find out
11 what is the threshold value of the input seismic
12 loading which would cause the incipient tipping of
13 the cask. And we identified the limit. That means
14 we identified the threshold of the higher g value,
15 which would cause the incipient tipping. What that
16 simply means is that our model is sensitive enough
17 that for some given input of the seismic input
18 loading, we will be able to see a cask that becomes
19 unstable.

20 JUDGE LAM: Thank you, Dr. Luk and Mr.
21 Guttman. Appreciate your answers.

22 JUDGE FARRAR: Speaking of being off by
23 a factor of a hundred, that 10,080 has been
24 troubling me, the number of different sequences.
25 And as I picture it out, just like there are only

1 two cases for the first one, I think a lot of the
2 cases would be the same and be reduced by factors.
3 But even if it was only a hundred different
4 loadings, the question is the same: Why don't you
5 have to look at a hundred models rather than one?
6 And I think you have answered that. So if somebody
7 later does the math and we are off by a factor of a
8 hundred, I think we were able to ask the question.

9 Mr. Guttman, were you here when the
10 State cross-examined Dr. Singh and Dr. Soler about
11 their financial interests?

12 MR. GUTTMAN: No.

13 JUDGE FARRAR: Okay. The point of the
14 cross-examination was that these gentlemen, as
15 entrepreneurs and inventors, had a huge financial
16 stake in the success of their casks. When their
17 proposal came to you, does that fact lead you to
18 ask more questions than you would ask if somebody
19 without a financial stake presented calculations to
20 you?

21 MR. GUTTMAN: No, sir. I'm in the
22 technical area. I don't consider or no one under
23 me or near me considers financial interests. We
24 totally review the analysis and base our decision
25 on the technical merits of the analysis.

1 JUDGE FARRAR: So even if a charitable
2 organization came in with a technical analysis, not
3 that that could ever happen, but you would give it
4 the same or you are saying you would give it the
5 same scrutiny as you give it coming in from someone
6 with a financial stake in the outcome?

7 MR. GUTTMAN: That's correct.

8 JUDGE FARRAR: Okay. One of you or an
9 earlier witness mentioned that you had taken
10 certain steps in response to a contention that the
11 State had filed or material that the State had
12 submitted to you. Maybe it was not you. I was
13 just wondering in terms of any awareness you had of
14 the contributions the State has made to this being
15 a more deeply analyzed facility or a safer facility
16 because of submissions they have made to you.

17 MR. GUTTMAN: I'm not aware of anything
18 that the State did to make the analyses or the
19 review process any better. But they have raised
20 some questions that are analytically answerable,
21 and we try to the best of our abilities to answer
22 those questions.

23 JUDGE FARRAR: Ms. Nakahara, as is our
24 custom, if the Board's questions have led you to
25 want to do any additional cross, we will do that

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1 before we go back to the other parties.

2 MS. NAKAHARA: Thank you, your Honor. I
3 just have a few follow-up questions.

4

5 CONTINUED CROSS-EXAMINATION

6 BY MS. NAKAHARA:

7 Q. Dr. Luk, in response to a question from
8 Judge Farrar concerning the placement of particular
9 casks that you selected, you selected to run a
10 model with one cask on a pad. Correct?

11 DR. LUK: Yes.

12 Q. Is it correct that you reference an
13 analysis at the Hatch plant in which you varied the
14 position of the casks?

15 DR. LUK: Yes.

16 Q. Isn't it true at Hatch, Hatch proposes
17 to store six casks on a pad in a 2 x 3 array?

18 DR. LUK: I have to refer to my report.

19 Q. That's fine.

20 DR. LUK: Because my recollection, on
21 Page 7 of the report, has the title Final Report of
22 Seismic Analysis of HI-STORM 100 Cask at Hatch
23 Nuclear Power Plant, on Page 7. At 3.2.2 it
24 actually indicates that we were given the
25 information the concrete pad only holds four casks

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1 on it per pad, which is half of the configurations
2 of 2 x 2.

3 I'm sorry. We use half of it. It is
4 actually 2 x 4. The same design. Okay? And then
5 we go through the configurations as it turned out
6 at either one of three locations. And then we went
7 to the experts who have actually associated with
8 the owner of the Hatch site, and he more or less
9 agreed with us.

10 Q. Actually, just to confuse the record
11 even more, if you will look on Page 5, I actually
12 cited the wrong cite. I said 2 x 3. And if you
13 look under 3.2.2 on Page 5 of the Hatch report, the
14 first sentence says, "A continuous concrete pad
15 holding 2 x 6 HI-STORM 100 casks.

16 MR. TURK: Could the witness have a
17 moment to look at his report?

18 MS. NAKAHARA: Yes.

19 MR. TURK: This was issued in May of
20 last year. A year ago. June, I'm sorry.

21 DR. LUK: Can you tell me again what
22 page is that?

23 Q. (By Ms. Nakahara) It is from the Hatch
24 report on Page 5, under Section 3.2.2, entitled
25 Concrete Pad Sub Model, which is not a document

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1 that the Board has, that we distributed to the
2 Board.

3 MR. TURK: You are asking about the
4 model or what would exist at the facility?

5 MS. NAKAHARA: First I'm asking what
6 existed at the facility.

7 MR. GAUKLER: Mr. Turk, the page number
8 may be different because she has an electronic
9 printout. I found that section on Page 7 on my
10 draft copy.

11 DR. LUK: Yes. To make the record
12 correct, it is my best recollection at the Hatch
13 site, on each concrete pad they have 2 x 6 casks.
14 That means 12 casks per pad. And in that analysis,
15 we actually were concerned whether we should
16 simulate the full-size pad. So instead I --
17 instead of using a full-size pad, we basically
18 truncated and used only 2 x 2, that means one-third
19 of the full-size pad in our model. And this
20 approach has been subjected to review and has
21 actually been approved by our review panel.

22 Q. And the 2 x 2 array that you, in fact,
23 modelled on a square pad is different than what is
24 proposed at PFS; correct?

25 DR. LUK: Yes. For the Private Fuel

1 Storage site, we actually used a full-size pad.

2 Q. And just to clarify, the seismic ground
3 motions at the Hatch facility are approximately
4 0.15g. Is that correct?

5 MR. TURK: Horizontal.

6 DR. LUK: 0.15g in the horizontal
7 direction and 0.1g in the vertical direction.

8 Q. Thank you. You just mentioned a model
9 that you did at Hatch and I believe you also
10 mentioned, with respect to the PFS analysis, a
11 review panel. You indicated that there were
12 members of NRC on this review panel. Correct?

13 MR. TURK: It was a review panel with
14 regard to the project.

15 DR. LUK: Yes. This is a review panel
16 for the project, not just for the Private Fuel
17 Storage site.

18 Q. Okay. The review panel for the project,
19 which would include the analysis for the Private
20 Fuel Storage site; correct?

21 DR. LUK: Yes.

22 Q. Consists of members of NRC staff. Is
23 that correct?

24 DR. LUK: Yes.

25 Q. You also indicated there were members of

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1 industry on this panel? Is that correct?

2 DR. LUK: Yes.

3 Q. Who were the members of industry on this
4 panel?

5 DR. LUK: Can you just give me a minute?
6 I want to talk with my sponsor.

7 (Discussion off the record.)

8 DR. LUK: We have two portions of
9 membership on the review panel; on the industrial
10 side is headed by Dr. Bob Kassawara of EPRI. His
11 spelling is K-A-S-S-A-W-A-R-A.

12 Q. Could you repeat his company again?

13 DR. LUK: E-P-R-I. EPRI. Sorry. And
14 the three other members are Robert Kennedy. He is
15 a private consultant. But he is a very established
16 consultant. Don Moore, and he represents the
17 Southam Company and he is a very well-established
18 analyst. And Mr. Torrey Yee. T-O-R-R-E-Y, last
19 name is Y-E-E. He represents the San Onofre
20 Nuclear Power Generation Stations.

21 JUDGE FARRAR: And so the record will be
22 clear, EPRI is the Electric Power Research
23 Institute?

24 DR. LUK: Yes, sir.

25 Q. Is it correct San Onofre is owned by

1 Southern California Edison?

2 DR. LUK: I don't have any idea. I just
3 know that their shorthand is SONGS, SONGS.

4 Q. Do you know if Southern California
5 Edison is a member of Private Fuel Storage?

6 DR. LUK: I have no knowledge of this.

7 Q. I have no further questions at this
8 time. Thank you.

9 JUDGE FARRAR: It's 5:15. Two
10 questions: Which of you wishes to go first? And
11 how long will it take?

12 MR. TURK: Your Honor, just to simplify,
13 I have only one redirect. I would say if the
14 Applicant is ready, let them go and I will follow.
15 As far as redirect, I would have twenty minutes to
16 half an hour.

17 MR. GAUKLER: I would guess I would have
18 half that amount, ten or fifteen minutes.

19 MS. CHANCELLOR: The good news is we
20 have reached a stipulation with Mr. Soloman, I have
21 with PFS, and I need to double check with the
22 Staff. So he probably won't need to testify.

23 (Board confers off the record.)

24 JUDGE FARRAR: Let's do this: We don't
25 want to encourage the practice of thinking that

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1 6:00 is our quitting time instead of 5:00. Parties
2 did move quickly today. We did have a lot of Board
3 questions and that extensive argument. So if the
4 parties are willing, let's wrap these witnesses up
5 by 6:00 but let's take a seven-minute break.
6 Everyone be back here promptly at 5:25 and we will
7 push on and finish with these witnesses.

8 (A break was taken.)

9 MR. TURK: Your Honor, it may be 30 to
10 45 minutes for me.

11 JUDGE FARRAR: I thought by you having
12 the extra conference, you were going to come back
13 and say it would only be five minutes.

14 MR. TURK: But I have managed to
15 eliminate others, and I realize I still have more.

16 JUDGE FARRAR: Then, Mr. Gaukler, you
17 said you had --

18 MR. GAUKLER: I think I have fifteen,
19 twenty minutes.

20 JUDGE FARRAR: Why don't we do yours and
21 see how everybody feels about continuing.

22 MR. TURK: Okay.

23 JUDGE FARRAR: Mr. Guttman, are you
24 staying with us or are you anxious to get back,
25 given your other responsibilities?

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1 MR. GUTTMAN: For how long?

2 JUDGE FARRAR: I didn't know if you were
3 trying to get out of town tonight.

4 MR. GUTTMAN: Not tonight. Either
5 Tuesday or Wednesday.

6 JUDGE FARRAR: Go ahead, Mr. Gaukler.

7

8 RECROSS-EXAMINATION

9 BY MR. GAUKLER:

10 Q. Dr. Luk, you refer to, at one point in
11 your response to a question from Judge Farrar, the
12 sequencing of the cask or loading the casks at the
13 Hatch plant.

14 DR. LUK: Yes, sir.

15 Q. Did I understand that right?

16 DR. LUK: Yes, sir.

17 Q. And I take it the point of that was the
18 cask was essentially the same regardless of what
19 the loading sequence is?

20 DR. LUK: I think in that particular
21 report, produced by the staff at the Hatch site,
22 they try to make sure, during the installation of
23 different casks on the pads, it would not cause any
24 problem on the integrity of the pad. That's why
25 they come out with a well-thought sequencing order

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1 for the placement of the individual casks on the
2 pad.

3 Q. And have you had an opportunity to
4 review the sequencing of the order for placement of
5 casks on the PFS pad?

6 DR. LUK: I was not aware of that and I
7 was not given the assignment to evaluate that.

8 Q. Would you expect that the result would
9 be the same for the PFSF?

10 DR. LUK: Well, I think for one thing,
11 the number of casks on a single pad is different
12 for Hatch and Private Fuel Storage site. So the
13 answer is no.

14 Q. Okay. In terms of cask response, do you
15 think it makes any difference in terms of
16 sequencing of loading for the PFSF site in terms of
17 cask response to a seismic event, wholly apart from
18 Hatch?

19 DR. LUK: In that regard, I asked Hatch
20 people is there any long duration during which a
21 pad is only partially loaded? And the answer is
22 no. So when they started to install casks on pads,
23 it's their plan now to install all casks and finish
24 one pad at a time. So maybe, you know, you can
25 arrange within a week or two week time frame,

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1 there's time durations the pad is partially loaded.
2 But it's their plan to try to put all the casks on
3 the pad in a continuous fashion. So for any longer
4 durations, at no time there will be partially
5 loaded pad.

6 Q. With respect to the Hatch plant, you
7 mentioned that I believe the horizontal/vertical
8 earthquake was 0.15 g in both directions?

9 DR. LUK: Yes.

10 Q. And the vertical was 0.10g?

11 DR. LUK: Yes.

12 Q. And then you ran parametric studies at
13 earthquake levels higher than that; right?

14 DR. LUK: Yes. We systematically
15 increased the g-load.

16 Q. And how high did you increase the g-load
17 to?

18 DR. LUK: If you don't mind, I will have
19 to make reference to the Hatch analysis report
20 dated June 28.

21 Q. Would you do that, please?

22 DR. LUK: 2001. Yes.

23 MR. TURK: Would you like to give him a
24 page reference?

25 Q. I think it's on Table 3 on Page 19, if I

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1 have identified it correctly.

2 DR. LUK: Actually, also available on
3 the executive summary.

4 Q. And so how high did you run the
5 parametric studies to in terms of the g-loads?

6 DR. LUK: When we increased the g-load
7 to eleven times what I was given as the g-load,
8 that simply means the two horizontal components at
9 0.15g and the vertical component at 0.10g, if we do
10 eleven times of that, that the cask will slide 36.6
11 inches when subjected to this kind of high level
12 seismic excitations.

13 Q. And what is the level of seismic
14 excitation when you are doing it eleven times the
15 design basis earthquake at Hatch?

16 DR. LUK: So it is eleven times --

17 Q. 0.15?

18 DR. LUK: Yes. Eleven times 0.15. It
19 is 1.65g in the horizontal direction, and 1.1g in
20 the vertical direction.

21 Q. Okay. Thank you. Now, is that higher
22 than the 2000 year earthquake accelerations
23 evaluated at the PFSF?

24 DR. LUK: Yes.

25 Q. And what type of storage cask system

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1 were you evaluating with respect to the Hatch
2 plant?

3 DR. LUK: I was given the information as
4 HI-STORM 100 cask.

5 Q. And you understand that to be the same
6 cask system that's to be used at the PFSF?

7 DR. LUK: Yes. This was the information
8 that was given to me.

9 Q. I think this may have been stated in the
10 record, but I want to make sure that it is. What
11 were the g-loads, both horizontal and vertical, for
12 which you did your evaluation of the casks at the
13 San Onofre plant?

14 DR. LUK: The g-load that I was given is
15 1.5g in the two horizontal directions and 1.0g in
16 the vertical direction.

17 Q. And that's again higher than the PFSF
18 2000 year design-basis earthquake?

19 DR. LUK: Yes, sir.

20 Q. Did you do any sensitivity test to
21 determine whether a pad below the surface of the
22 soil due to settlement would make any difference in
23 the results of the seismic analysis?

24 DR. LUK: We did not do systematic
25 investigation in that area.

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1 Q. Do you run your Model 2 for several
2 situations? I think Model 2 is where you assumed
3 no soil cement or cement-treated soil.

4 DR. LUK: Yes, we did conduct a
5 sensitivity study for two cases when we removed
6 compact aggregates as well as the soil cement layer
7 adjacent to the pad as well as underneath the pad.
8 In that case, we used two different locationings
9 for the pad. One is that the bottom of the cask is
10 in line with the free surface of the soil
11 foundation. The second, the top of the pad is in
12 line with the soil foundations. And with those two
13 cases, there's virtually no difference in the
14 analysis results.

15 Q. So one case the pad rests on top of the
16 soil; is that correct?

17 DR. LUK: Yes. When the bottom of the
18 cask is in line with the free surface, it simply
19 means the pad is actually sitting on top of the
20 soil foundations. And for the second case, then
21 the top of the pad is in line with the free surface
22 of the soil foundation, it means we can actually
23 see the lateral side of the pad.

24 Q. So the lateral side is covered up by the
25 soil adjacent to it?

1 DR. LUK: Yes.

2 Q. There were also some questions in terms
3 of whether your Model 1 that you ran for the PFSF
4 site encompassed more than one cask on the pad.
5 And I take it that was one reason why you ran Model
6 3 for the PFSF site?

7 DR. LUK: I was instructed by Dr. Shah
8 to get into Model Type 3 mainly trying to see is
9 there any relative inference by the presence of the
10 other seven casks that we did not include in our
11 model as well as the neighboring fully-loaded pad
12 that was also not included in our standard Model
13 Type 1.

14 Q. And you found in that, that -- so the
15 Model 3 you had in the pad in which you were
16 analyzing the load of all eight casks; correct?

17 DR. LUK: Yes.

18 Q. And seven of them were just dead loads?

19 DR. LUK: Yes.

20 Q. And one was active, able to move?

21 DR. LUK: Yes.

22 Q. And from your analysis, you found that
23 the results from your Model 1 where you just had
24 one cask on the pad bounded to your results from
25 Model 3?

1 DR. LUK: Yes. The Model Type 1
2 actually gave us a higher maximum horizontal
3 displacement of cask with respect to the pad.

4 Q. For the Pacoima Dam earthquake for which
5 you used the time history in running the PFSF site
6 analysis, do you know what the location of the
7 earthquake epicenter was compared to the
8 observation point or measurement point at which the
9 time histories were taken?

10 DR. LUK: Yes. I don't know the details
11 of -- I cannot answer your question in technical
12 details but I did go through fairly extensive
13 discussions with Mr. Lam simply because he was
14 there, he was at the center which was tasked to
15 study this seismic event, yes.

16 Q. And do you know how the location of the
17 epicenter of the Pacoima Dam earthquake compared to
18 its observation point compared to the location of
19 the quake to the PFSF site? In other words, used
20 in the time history.

21 DR. LUK: Would you mind to repeat the
22 question?

23 Q. Do you know how close to the location of
24 the PFSF site is the source of the earthquake, or
25 would the source of the earthquake waves be?

1 DR. LUK: I don't know the exact
2 locations but I did try to look at the map. And by
3 not going through all the size characterizations, I
4 have to resort to my contract with Mr. Lam. And he
5 did indicate that if someone had to pick a site,
6 that is probably a good choice.

7 Q. So in other words, the distance from the
8 epicenter to the observation point for the Pacoima
9 Dam earthquake would be a good choice if you wanted
10 to compare that to the PFSF site?

11 DR. LUK: Yes. In that regard, unless
12 there's actually something happening near Salt Lake
13 City, you would not have the actual test record. I
14 mean the actual earthquake record.

15 JUDGE FARRAR: Mr. Gaukler, let me ask a
16 clarification. When we did -- were you here last
17 week when we did the tutorial on Tuesday noon
18 explaining how the earthquake time histories,
19 hypothetical ones, are generated?

20 DR. LUK: Yes.

21 JUDGE FARRAR: I don't remember anyone
22 telling us at that time that the hypothetical
23 curves have an epicenter associated with them. So
24 when Mr. Gaukler asked you about the epicenter for
25 the possible PFS earthquake, I couldn't follow

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1 that.

2 MR. TURK: May I explain, your Honor, if
3 I may? We are talking about the testimony by
4 Dr. McCann and Stamatakos? They were speaking
5 about the problemistic seismic hazard analysis
6 which includes many different earthquakes. It
7 doesn't have a single epicenter.

8 JUDGE FARRAR: Right. And that's why my
9 question. Mr. Gaukler, I thought you were saying
10 there was an epicenter associated with the
11 hypothetical PFS earthquake and I didn't think
12 there was one.

13 DR. LUK: Thank you for bringing up the
14 issues. I was thinking that the question is
15 related to the 1971 actual earthquake record.

16 JUDGE FARRAR: At the dam?

17 DR. LUK: Yes.

18 JUDGE FARRAR: But I thought he said to
19 make a comparison between the epicenter of that
20 earthquake and the observation point with the
21 hypothetical epicenter of the PFS earthquake --

22 MR. GAUKLER: Let me rephrase the
23 question. I think it may have been unclear. Let
24 me try it again, your Honor.

25 JUDGE FARRAR: Yes.

1 Q. (By Mr. Gaukler) Are you aware of the
2 main faults that would give rise to earthquake
3 motions at the PFSF site where they are located?

4 DR. LUK: Yes. But only briefly.

5 Q. And those are the Stansbury Fault, which
6 is about six, seven kilometers from the site;
7 correct?

8 DR. LUK: Yes.

9 Q. And then there's an east and west fault
10 somewhat closer to the site?

11 DR. LUK: Yes.

12 Q. And how does the -- I guess my question
13 is how does the location of the observation point
14 at which the earthquake was observed at Pacoima Dam
15 to its epicenter compare to a likely epicenter that
16 might have a similar earthquake impact on the PFSF
17 site? And is it possible to make a comparison
18 between those or is it not?

19 DR. LUK: Given all the choices, I was
20 informed, after detailed discussions with Mr. Lam,
21 he did mention that is a good choice. But I think
22 when you talk with seismologists related to
23 earthquake events, you can actually sit down for
24 hours.

25 Q. Okay.

1 JUDGE FARRAR: Let me ask a question.
2 In view of the parties' stipulation on A and B, did
3 you all agree that there are or that the
4 Applicant's geologic investigations were sufficient
5 to identify all the faults in the area; the
6 Stansbury, and those are the only possible faults?

7 MR. GAUKLER: I think what we have
8 agreed to is that the parties have stipulated and
9 agreed that the PSHA done by PFS, done by
10 Geomatrix, adequately identifies, for purposes of
11 this proceeding, the relevant earthquake locations
12 or strikes that the relevant faults and earthquake
13 hazards are encompassed in the Geomatrix
14 evaluation, PSHA evaluation.

15 MS. CHANCELLOR: I'd characterize it
16 differently. We decided not to go forward with
17 litigating Part A and Part B. This is a huge
18 issue. We decided which issues were important to
19 us. We stipulated that we would not litigate Part
20 A or Part B of the contention. And I wouldn't
21 characterize it further.

22 JUDGE FARRAR: Okay. Given that, I
23 think we -- I understand where we are.

24 MR. TURK: Your Honor, I think there's a
25 little more we can add. Dr. Arabasz will be

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1 appearing for the State for Part E of the
2 contention. I was present at a deposition of his
3 in which my recollection is, and forgive me if I'm
4 paraphrasing and correct give me if I'm wrong, but
5 his belief was the applicant of PHSA was adequate.
6 And in terms of the faults, there are a number of
7 other faults. The Staff's SER, which is Exhibit C,
8 does contain a depiction of the faults in the area.
9 And this would be in Section 2.1.6.

10 JUDGE FARRAR: The faults that are
11 known?

12 MR. TURK: The known faults, yes.

13 JUDGE FARRAR: And then the question
14 that I had was how much has been done so that when
15 we say those are the known faults we are pretty
16 sure there are no unknown ones?

17 MR. TURK: And the PSHA work includes
18 uncertainties with respect to faults that have not
19 yet been identified, if there are some.

20 JUDGE FARRAR: We don't have to
21 characterize anything else at any greater length on
22 that. Go ahead, Mr. Gaukler.

23 MR. GAUKLER: The parties have
24 stipulated that is not an issue here.

25 Q. (By Mr. Gaukler) If you recall, Ms.

1 Nakahara was asking you some questions in terms of
2 whether you could calculate or could identify in
3 your report the accelerations due to soil structure
4 interaction, I believe it was at the bottom of the
5 cask or the bottom of the pads. Now, if I
6 understand correctly, your program would evaluate
7 the accelerations at any point in terms of the cask
8 or the pads or the free field ground motion;
9 correct?

10 DR. LUK: Yes, sir. As part of the
11 finite elements model you can prescribe any
12 locations with whatever physical quantities that
13 you would like to get as part of the output.

14 Q. And for the physical quantities here,
15 you prescribed instead of accelerations at the base
16 of the cask you prescribed displacements and angles
17 of rotations. Correct?

18 DR. LUK: Yes. Because our main focus
19 of the investigation is to evaluate or examine the
20 structural response of the cask with respect to
21 pad. That's why we choose to use horizontal
22 displacements in the two horizontal directions as
23 well as the vertical displacements plus the angular
24 rotations with respect to the vertical axis in two
25 horizontal directions.

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1 Q. So you gathered or reported that
2 information because you believe that's the
3 information that was important; correct?

4 DR. LUK: To us, this set will uniquely
5 characterize the structural behavior of the cask.

6 Q. So you also had some questions with
7 respect to Figure 17 in the report on Page 34. And
8 I believe that you said in response to one of her
9 questions that the accelerations were enhanced due
10 to soil structure interaction effect. Did you mean
11 to say enhanced when compared to the free field
12 accelerations?

13 DR. LUK: Maybe a better word is
14 increased by the presence of the structure.

15 Q. Compared to the acceleration in the free
16 field?

17 DR. LUK: Yes, sir.

18 Q. And just to clarify, the free field is
19 without any buildings or structures, free field
20 acceleration would be?

21 DR. LUK: Free field in our model is
22 somewhere which is not influenced by the presence
23 of the concrete pad and also not influenced by the
24 presence of the edge of our soil foundation model.

25 Q. Dr. Luk, you were shown a number of

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1 documents prepared by PFS or by other parties on
2 behalf of PFS with respect to the Private Fuel
3 Storage Facility. And you had answered that you
4 had seen none of those documents. Do you recall
5 that?

6 DR. LUK: Yes. I have not reviewed any
7 one of those documents.

8 Q. Did you feel that you had sufficient
9 technical information to conduct an independent
10 review without needing those documents?

11 DR. LUK: I think you mean independent
12 analysis, instead of independent review.

13 Q. Right. Did you have enough information
14 to do the independent analysis of the potential
15 effect of earthquakes on cask stability at the PFSF
16 without having reviewed those documents?

17 DR. LUK: Yes. The process we follow is
18 that we come up with a list of information that is
19 requested to the Staff at NRC. And in return, they
20 give me the informations which will provide us the
21 base for input to our model.

22 Q. And it would also be fair to say, since
23 you hadn't seen any of those documents, that the
24 results that were reported by PFS in no way
25 influenced your analysis?

1 DR. LUK: Correct.

2 Q. You also had a question from Ms.
3 Nakahara concerning the fact that the sheer
4 resistance would include, in addition to friction,
5 would include cohesion? Let me rephrase that
6 question.

7 You also had a question from Ms.
8 Nakahara that the sheer resistance of the soil that
9 you used was just a friction resistance in your
10 analysis; but that in addition to that, there would
11 also be some sheer resistance due to cohesion. Do
12 you remember that question and answer?

13 DR. LUK: Yes.

14 Q. And if you had included cohesion, the
15 sheer resistance due to cohesion in your analysis,
16 would that have had the effect of reducing the
17 sliding or potential sliding of the pad?

18 DR. LUK: In my answer I said we simply
19 just use the frictional resistance. We did not
20 include the effect of adhesion. In the theory, the
21 people used to develop ABAQUS code, you would know
22 that if ever there is cohesion effect, in
23 constitutive relations for the material, it will be
24 there. But it is also my understanding from the
25 mechanics of the behavior of geological material

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1 for the type that we consider at the site for
2 Private Fuel Storage, the effect due to adhesion is
3 secondary effect at best.

4 Q. You ran three models with respect to the
5 PFS site and my understanding is that you used the
6 same basic methodology on all three models, except
7 for the differences we have discussed.

8 DR. LUK: With the exceptions of the
9 differences we identified for the three different
10 types of models, the basic analysis methodology is
11 identical.

12 Q. And you made no changes to your
13 methodology based on the size of the earthquake?

14 DR. LUK: No, sir.

15 MS. NAKAHARA: Can I ask a clarifying
16 question? This is with respect to the PFS
17 analysis; correct? The three models?

18 MR. GAUKLER: Yes, it is.

19 MS. NAKAHARA: Okay.

20 MR. GAUKLER: Give me one second.

21 No further questions, your Honor.

22 (Discussion off the record.)

23 JUDGE FARRAR: Mr. Turk, I hope this
24 won't disappoint you but I think we will quit for
25 the evening in light of our previous directions.

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1 While it would be nice to spend some time and
2 finish these people, you all usually have a lot of
3 homework to do.

4 MR. TURK: I think we will be better
5 served to relax and get some dinner.

6 JUDGE FARRAR: Then we will start up
7 first thing tomorrow at 9:00 and finish these
8 witnesses.

9 What we are ready to say about Mr.
10 Soloman?

11 MR. GAUKLER: I think that essentially
12 we have reached an agreement in terms of
13 stipulating his testimony into the record.

14 MS. CHANCELLOR: I need to double check
15 with the Staff, your Honor. I gave it to Mr.
16 O'Neill and I don't know if Mr. Turk has had a
17 chance to look at it.

18 MR. TURK: We haven't. But I will look
19 it over tonight.

20 JUDGE FARRAR: And then our plan would
21 be how long with these witnesses; 45 minutes?

22 MR. TURK: That should do it.

23 JUDGE FARRAR: Then we are going to try
24 to finish the two State panels even though we will
25 get a late start on them tomorrow. Take three days

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1 to finish the two State panels. Is that a plan?

2 MS. NAKAHARA: And this will fit in
3 with Dr. Kahn's availability. He won't be here
4 until approximately ten o'clock tomorrow morning.

5 JUDGE FARRAR: Okay. Good. Do we know
6 what we are doing on Friday?

7 MR. GAUKLER: We are going to do Mr.
8 Lewis, I understand.

9 MS. CHANCELLOR: The day of?

10 MR. GAUKLER: Probably do him Thursday.

11 JUDGE FARRAR: No. Assume you don't get
12 to him. Assume we do the two staff panels on
13 Tuesday through Thursday. What do we do Friday?

14 MR. GAUKLER: Mr. Lewis on Friday.

15 MS. NAKAHARA: You mean the State
16 panels; correct?

17 JUDGE FARRAR: What did I say?

18 MS. NAKAHARA: Staff.

19 JUDGE FARRAR: I could understand how
20 you would not like that.

21 MS. CHANCELLOR: I thought we were going
22 to have Friday off and on Saturday we were going to
23 do Dr. Cornell and try and get through as much of
24 the Staff panel as we could, and maybe having to
25 kick that over until Monday morning.

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1 JUDGE FARRAR: As much of the who panel?

2 MS. CHANCELLOR: Staff. Stamatakos,
3 Stewart, and Chen.

4 JUDGE FARRAR: Do that on Saturday?

5 MR. GAUKLER: As much as possible.

6 JUDGE FARRAR: You're kidding?

7 MR. TURK: Your Honor, one of our
8 witnesses, Dr. Chen, has a small child and she is
9 falling out on Friday. And if we can get her on
10 Saturday, we will put her on Saturday.

11 JUDGE FARRAR: Do those two on Saturday?
12 You would have Friday off but you say that would be
13 a good time for the Board to do Utah SS with other
14 lawyers?

15 MS. CHANCELLOR: With other lawyers,
16 that's fine, your Honor.

17 JUDGE FARRAR: Who is doing it? Mr.
18 Stewart?

19 MS. CHANCELLOR: Mr. Stewart.

20 MR. GAUKLER: Mr. Silberg would have to
21 be tied in by phone, but that would be fine.

22 MR. TURK: Which Friday?

23 JUDGE FARRAR: This-coming Friday, May
24 10. We would do oral argument on Utah SS.

25 MR. TURK: I will check overnight, your

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1 Honor.

2 MS. CHANCELLOR: I need to check.

3 JUDGE FARRAR: Off the record.

4 (Discussion off the record.)

5 JUDGE FARRAR: These witnesses are
6 excused for the evening. We will see you back at
7 nine o'clock tomorrow morning. Thank you.

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9 (The proceeding was concluded

10 for the day at 6:05 p.m.)

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CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of:

Name of Proceeding: Private Fuel Storage, LLC

Docket Number: Docket No. 72-22-ISFSI

ASLBP No. 97-732-02-ISFSI

Location: Salt Lake City, Utah

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission taken by me and, thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings.

15/ 
Diana Kent
Official Reporter
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