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Official Transcript of Proceedings

NUCLEAR REGULATORY COMMISSION

Title: Private Fuel Storage, LLC

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

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UNITED STATES OF AMERICA
 NUCLEAR REGULATORY COMMISSION

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

U. S. Nuclear Regulatory Commission
 Utah State Capitol
 Salt Lake City, Utah

On June 8, 2002 the above-entitled matter came on for hearing, pursuant to notice, before: .

MICHAEL C. FARRAR, CHAIRMAN
 Administrative Judge
 Atomic Safety & Licensing Board Panel

DR. JERRY R. KLINE
 Administrative Judge
 Atomic Safety & Licensing Board Panel

DR. PETER S. LAM
 Administrative Judge
 Atomic Safety & Licensing Board Panel

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E X H I B I T S

No.	MRKD/ADMTD
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APPLICANT EXHIBITS

86B	Ex. 86, minus additional run	10543/
86C	Ex. 86, with changes by Singh and Soler	10543/10549
86D	Ex. 179, with corrections by Singh and Soler	10543/10550
225	Previously Marked	/10585
225A	Disk of Simulations	10543/10587
225B	Results and input parameters for a run from 225	10543/10597
225C	1 page - slide with graphs	10590/
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227	e-mail message from Paul Gaukler with attachments	10728/10729
00	Previously Marked	/10554

STATE EXHIBITS

168	Previously Marked	/10751
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1 June 8, 2002

9:08 a.m.

2
3 P R O C E E D I N G S

4
5 (APPLICANT'S EXHIBITS-86C, 86D, 225A
6 AND 225B WERE MARKED.)

7
8 JUDGE FARRAR: Good morning, everyone.
9 We're here at the state capitol. We stopped in the
10 Wasatch Room this morning at the Sheraton, and it
11 was like we were never there. What we did there
12 will live longer than the arrangements did.

13 We thank the State again for their good
14 offices in making this legislative hearing room
15 available for us.

16 In terms of the microphones, those of
17 you who were here before, the controls are at the
18 chairman's desk, so if you need to talk privately,
19 you can't turn your microphone off. Push it away
20 from you.

21 We're here to do the Applicant's
22 rebuttal witnesses.

23 Any preliminary matters?

24 MR. GAUKLER: Yes, Your Honor. I've
25 handed out some exhibits. I want to talk briefly

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1 about two, which these are 225 and 226. 225 is the
2 additional cask analyses for the PFSF, and this is
3 identical to the 225 that was discussed earlier
4 this week, the only difference being that the
5 proprietary and confidential has been signed off.
6 So this is a public document, and it should replace
7 in its entirety what was previously marked as 225.

8 JUDGE FARRAR: All right. What we will
9 do is instruct the court reporter to take this new
10 version of 225 back to their files, discard and, in
11 fact, if -- yes, discard the original of this that
12 was filed and substitute this for it.

13 MR. GAUKLER: The second document that
14 is in the same category as that one is PFS 226.
15 That was an excerpt from a Holtec calculation. The
16 two-page -- that excerpt has no confidential
17 material, and, therefore, we have just recopied and
18 resubmitted identical to what was 226 before. It's
19 labeled Multi-Cask Seismic Response at the PFS
20 ISFSI, and it's the one that has the calculation
21 for the stiffness springs. And, again, it is
22 identical except the proprietary has been crossed
23 off, and this should replace what is 226.

24 JUDGE FARRAR: All right. We will have
25 the court reporter do the same with this as with

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1 225, that is, substitute this for those previously
2 filed.

3 MR. GAUKLER: I would also, then, like
4 to talk about PFS 86C which is the beyond design
5 basis.

6 JUDGE FARRAR: Now, the problem with
7 that is the copy we have says "Proprietary" on it.

8 MR. GAUKLER: Yes. That one is
9 proprietary, and this is -- well, this is a
10 document that we had requested be admitted on
11 Tuesday. It will show corrections similar to the
12 corrections that were made to Dr. Singh's and
13 Dr. Soler's testimony in terms of the input data
14 for the simulations that have been seen earlier.
15 We had a lengthy discussion on it. Your Honors
16 denied admission of the revised document at that
17 time because it contained an additional run,
18 without prejudice to our resubmitting a new
19 document with just the changes or corrections, and
20 so this is that new document. It's the same as
21 86 -- PFS Exhibit 86 except for the changes and --
22 except for the corrections to correlate with the
23 corrections that Dr. Singh and Dr. Soler made to
24 their testimony on Tuesday.

25 JUDGE FARRAR: And this is -- has the

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1 vertical lines in the margin indicating what the
2 corrections are?

3 MR. GAUKLER: Yes, that's correct,
4 Your Honor.

5 JUDGE FARRAR: And has -- as you
6 indicated, has the extra run eliminated?

7 MR. GAUKLER: Extra run has been
8 eliminated.

9 JUDGE FARRAR: But you do want this
10 considered proprietary?

11 MR. GAUKLER: Yes, because the original
12 86 was proprietary.

13 JUDGE FARRAR: And you're moving
14 admission of this at this time?

15 MR. GAUKLER: Yes, I am. Yeah, and this
16 will be 86C.

17 JUDGE FARRAR: Right.

18 Any objection, State?

19 MS. NAKAHARA: We would renew our
20 objection, if you recall a long discussion --

21 JUDGE FARRAR: You say you renew your
22 objection?

23 MS. NAKAHARA: On this document not to
24 give the Applicant --

25 MR. GAUKLER: This is different.

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1 MS. NAKAHARA: Oh, this is a different
2 document?

3 MR. GAUKLER: This is a different
4 document, Connie.

5 MS. NAKAHARA: Thank you.

6 MR. GAUKLER: This is the one that we
7 had the additional run in initially, and the Board
8 denied it because of the additional run. And we've
9 taken the additional run out of it, and all we've
10 done is identify the corrections analogous to the
11 corrections that were made to Dr. Singh's and
12 Dr. Soler's testimony on Tuesday in what is
13 Exhibit 86B.

14 JUDGE FARRAR: Mr. Gaukler, 86 will
15 remain in the record?

16 MR. GAUKLER: Yes.

17 JUDGE FARRAR: Because I think the State
18 was concerned that they wanted to have in the
19 record the historical record. That one came in --

20 MR. GAUKLER: Right.

21 JUDGE FARRAR: -- and needed to be
22 corrected, so we will have both the original and
23 the corrected version in the record?

24 MR. GAUKLER: Just like the testimony,
25 the original testimony's in the order, and the

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1 corrected testimony was introduced as Exhibit 86B.

2 JUDGE FARRAR: If I recall, that was the
3 only -- that and the extra run were the only basis
4 for the State's objection at that time.

5 MS. NAKAHARA: Initially we had an
6 additional objection which we would -- I shouldn't
7 say probably, which we would retain, which is the
8 data only shows displacement for Cask No. 1, and as
9 we observed on the record, some of the casks in
10 various runs appear to move more than Cask No. 1.
11 And so to the extent that this is being proffered
12 for only showing the displacement of Cask No. 1 in
13 each case and not to show the maximum displacement
14 in the -- for the 8 casks in which -- the cases
15 that have 8 casks, we would have no objection, if
16 you could understand that.

17 JUDGE FARRAR: If I can paraphrase that,
18 you think this document has a shortcoming, but to
19 me that would not be a reason not to admit it. If
20 it, in fact, has the shortcoming that you just
21 urged, that's something that you all can argue goes
22 to its weight and impact in the case.

23 Does the Staff have any objection?

24 MR. O'NEILL: No objection, Your Honor.

25 JUDGE FARRAR: Then we'll admit the

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1 document subject to arguments later about what
2 weight to give it or what deficiencies it may or
3 may not contain.

4 (APPLICANT'S EXHIBIT-86B WAS ADMITTED.)

5 MR. GAUKLER: Then one last document I'm
6 going to discuss now, and I'll leave the rest until
7 after Dr. Soler testifies. That is what we have
8 identified as Exhibit 86D.

9 JUDGE FARRAR: D?

10 MR. GAUKLER: Yes. And this is
11 identical to State Exhibit 179 which has the
12 results of the VisualNastran runs that are
13 discussed in 86C but, again, making the corrections
14 corresponding to the corrections that were made in
15 Dr. Singh's and Dr. Soler's testimony.

16 JUDGE FARRAR: And that, again, has a
17 vertical line in the margin?

18 MR. GAUKLER: What it has -- what it has
19 here, you'll see a vertical line at the bottom of
20 the first page which tells you what's been changed.

21 JUDGE FARRAR: All right.

22 MR. GAUKLER: The value 16 has been
23 replaced by the value 34. And the only other
24 changes in the document are we added a title that
25 does correlate it directly to the report to which

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1 these results go, and we made one site
2 clarification in a title for one of the tables at
3 the end.

4 JUDGE FARRAR: Any objection?

5 MS. NAKAHARA: No objection.

6 JUDGE FARRAR: Staff?

7 MR. O'NEILL: No objection.

8 JUDGE FARRAR: Then 86D will be
9 admitted.

10 (APPLICANT'S EXHIBIT-86D WAS ADMITTED.)

11 MS. NAKAHARA: May I ask a clarifying
12 question?

13 JUDGE FARRAR: Certainly.

14 MS. NAKAHARA: The admittance of PFS
15 86C, that only includes the hard copy, is that
16 correct, and not the animations?

17 MR. GAUKLER: She points out a good
18 point. At this point I would also move for
19 admission of PFS Exhibit 00 which are the
20 simulations that go with the report, and they also
21 go with the results that are in 86D. These are
22 simulations that Dr. Soler showed --

23 JUDGE FARRAR: Was 00 a disk?

24 MR. GAUKLER: 00 was a disk and are the
25 simulations that Dr. Soler showed on the first day

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1 of his testimony back on April -- April 29 or April
2 30. I forget which day it was.

3 THE WITNESS: That's the first CD they
4 already have.

5 MR. GAUKLER: No, that's what we're
6 talking about.

7 THE WITNESS: Oh, okay.

8 MR. TURK: And that goes with 86D?

9 MR. GAUKLER: That goes with 86D and
10 86C. So Exhibit OO are the simulations of the
11 cases that are discussed in 86C and to which the
12 input data and data are shown in 86D.

13 JUDGE FARRAR: And that's the disk we
14 got a copy of before we ever came out here back in
15 March or April?

16 MR. GAUKLER: That's correct,
17 Your Honor.

18 JUDGE FARRAR: All right.

19 MR. GAUKLER: It was served a day or two
20 after the testimony was served. And I would move
21 for the admission of Exhibit OO.

22 JUDGE FARRAR: For the benefit of anyone
23 later reviewing this record, there may be some
24 confusion during the course of the day, since
25 everybody had to box up a lot of materials last

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1 night when we left the Sheraton courtroom. So
2 there may be some confusion today about names of
3 different documents which are now in boxes
4 somewhere.

5 Any objection to OO?

6 MS. NAKAHARA: The State objects on the
7 same grounds we raised earlier and even more so now
8 that PFS 86D has been admitted. 86D provides all
9 the input parameters, the results, and it
10 appears -- the State would proffer that 86D
11 provides the best evidence, and there's a potential
12 for the animations to be taken out of context at a
13 subsequent reviewing level in a subsequent
14 jurisdiction.

15 JUDGE FARRAR: Staff?

16 MR. TURK: We have no objection,
17 Your Honor. The CD provides a dramatization of
18 what appears on paper. I think it's a useful
19 exhibit. We don't object.

20 MR. GAUKLER: Also, I would note that it
21 actually clarifies one of the State's objections to
22 86C, which was that some of the -- some of the
23 casks may have greater movement than that reported
24 in the data, and you can see that by looking at the
25 CD, the simulation.

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1 MS. NAKAHARA: Your Honor, if I might
2 add one small point.

3 JUDGE FARRAR: Hold on a second.

4 (A discussion was held off the record.)

5 JUDGE FARRAR: Go ahead.

6 MS. NAKAHARA: Mr. Gaukler's point
7 emphasizes the State's point that you cannot
8 quantify the animations, and, thus, they could
9 mislead a tribunal in the future.

10 JUDGE FARRAR: Before we rule, what's
11 225A, which looks like another disk?

12 MR. GAUKLER: 225A is a disk of what we
13 just saw this week earlier, and we'll be seeing
14 some more today and after the completion of
15 Dr. Soler's testimony. I would move for the
16 admission of that as well.

17 MR. TURK: I'm sorry. I didn't hear the
18 explanation of 225A, or maybe I didn't understand
19 it. Could you say that again or --

20 MR. GAUKLER: 225A is the disk that goes
21 with the simulations that we saw earlier this week,
22 and we'll see three more today, I believe, which
23 are on there which relate to the report, PFS 225.

24 (The Board confers off the record.)

25 JUDGE FARRAR: We understand the State's

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1 objection but think that the danger of anyone being
2 misled by this -- by this simulation is slim
3 because without -- we haven't, of course, started
4 writing our opinion, but I assume there will be a
5 significant section on this animation and on all of
6 Dr. Soler's, and Dr. Singh's calculations, and we
7 will say in that opinion whether that work and the
8 attendant simulation is good, bad or indifferent,
9 so I don't think there's any real danger that
10 anyone would later pick up the simulation and say,
11 oh, there's the answer, if we, in fact, have put in
12 our opinion that it's not the answer. So I don't
13 think there's any danger there.

14 So we will admit PFS OO.

15 (APPLICANT'S EXHIBIT-OO WAS ADMITTED.)

16 MR. GAUKLER: Thank you, Your Honor.

17 With those preliminaries, I think we're ready to
18 begin with the rebuttal testimony of --

19 MS. CHANCELLOR: I have one more matter.

20 MR. GAUKLER: Okay.

21 MS. CHANCELLOR: Your Honor, we
22 requested that PFS put on Dr. Soler first, and they
23 have kindly acceded to that. And the reason for
24 that request is that, if you recall, on May 1 and
25 May 3 we received some additional data from Holtec

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1 with respect to the force histories, and as part of
2 the examination on rebuttal, we would request
3 permission to ask questions of Dr. Soler with
4 respect to the data that we received on May 1 and
5 May 3. And we did reserve those -- that objection
6 to receiving the late information on -- we reserved
7 those objections in early May with the right to
8 recall Dr. Soler or Mr. Trudeau.

9 JUDGE FARRAR: So, if I understand that,
10 Dr. Soler now would be here for purposes of
11 presenting PFS rebuttal testimony and also -- which
12 you will get to cross-examine, but also you will
13 cross-examine on a matter left over from before?

14 MS. CHANCELLOR: That's correct,
15 Your Honor.

16 JUDGE FARRAR: I take it there's no
17 objection to that?

18 MR. GAUKLER: I recall that being left
19 open, yes. No objection.

20 JUDGE FARRAR: All right. Staff?

21 MR. O'NEILL: No objection here.

22 JUDGE FARRAR: All right. Then we will
23 do that.

24 MR. GAUKLER: Just a point of
25 clarification. Do you want to do it now or after

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1 cross on the rebuttal?

2 MS. CHANCELLOR: Ms. Nakahara is going
3 to do it, but I think we'd segregate what was
4 questions on rebuttal and what were questions on
5 the forces but do it all together.

6 MR. GAUKLER: Okay. So we're going to
7 do rebuttal on it, in other words?

8 JUDGE FARRAR: Right.

9 MS. CHANCELLOR: Correct.

10

11 ALAN I. SOLER,

12 called as a rebuttal witness having been
13 previously duly sworn to tell the truth, was
14 examined and testified as follows:

15

16

17

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DIRECT EXAMINATION

19 BY MR. GAUKLER:

20 Q. Dr. Soler, do you have before you a copy
21 of Rebuttal Testimony of Alan I. Soler on Section D
22 of Unified Contention Utah L/QQ dated June 7, 2002?

23 A. Yes, I do.

24 Q. Was that testimony prepared by you or
25 prepared under your supervision?

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1 A. Yes.

2 Q. Do you adopt that testimony as being
3 true and correct for your rebuttal testimony in
4 this proceeding?

5 A. Yes, I do.

6 MR. GAUKLER: Your Honor, I would
7 request that the rebuttal testimony of Alan I.
8 Soler be bound into the record as if read.

9 JUDGE FARRAR: Any objection?

10 MS. NAKAHARA: No objection, Your Honor.

11 JUDGE FARRAR: Staff?

12 MR. TURK: No objection, Your Honor.

13 JUDGE FARRAR: All right. Then the
14 reporter will bind the rebuttal testimony into the
15 record at this point as if read.

16 (Prefiled Rebuttal testimony of
17 Alan Soler follows:)

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June 7, 2002

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of)	
)	
PRIVATE FUEL STORAGE L.L.C.)	Docket No. 72-22
)	
(Private Fuel Storage Facility))	ASLBP No. 97-732-02-ISFSI

**REBUTTAL TESTIMONY OF ALAN I. SOLER
ON SECTION D OF UNIFIED CONTENTION UTAH L/QQ**

**I. REBUTTAL TO TESTIMONY OF STATE OF UTAH WITNESSES DR.
FARHANG OSTADAN AND DR. STEVEN E. BARTLETT**

A. Pad-to-Pad Interaction

Q1. In their answer to question 31 in the “State of Utah Testimony of Dr. Steven F. Bartlett and Dr. Farhang Ostadan on Unified Contention Utah L/QQ (Dynamic Analyses)” (“Bartlett/Ostadan Direct Testimony”), and in oral testimony at the May 8, 2002 hearing (Tr. 7517-29) Dr. Ostadan and Dr. Bartlett raise the concern that the effect of pad-to-pad interaction may be important, particularly with respect to the sliding motion of the unanchored cask on the pads and the pad-to-pad interaction for pads spaced only 5 feet apart in the horizontal direction. Have you evaluated this concern?

A1. Yes. Holtec Report No. HI-2022878, “Additional Cask Analyses for the PFSF,” identified in this proceeding as PFS Exhibit 225 (“PFS Exh. 225”) summarizes the results of analyses I conducted using the Visual Nastran (“VN”) computer code of the potential effects of pad-to-pad interaction on the stability of HI-STORM 100 storage casks at the PFSF facility. The input data for these computerized analyses are described in Sections 4.1 and 4.3 of PFS Exh. 225; the analyses themselves are described in Section 6.2, and the results are summarized in Section 8.2. Our conclusions with respect to this concern are presented in Section 9.0 of PFS Exh. 225.

Q2. Please describe the analyses you conducted on the pad-to-pad interaction issue.

A2. To evaluate the potential effects of pad-to-pad interaction, we conducted a simplified analytical solution and two sets of computer-generated numerical analyses. The simplified analytical solution and the first set of numerical analyses respond to the claims by Drs. Bartlett and Ostadan at above cited hearings on May 8, 2002 that if two pads are loaded with a different number of casks, the different total masses associated with adjacent pads could cause out-of-phase motion and a transmittal of additional forces between pads. To assess this concern, a VN dynamic model was developed that included two adjacent pads, five feet apart, one pad fully loaded with eight casks, the other having only a single cask. The model included a representation of the soil cement between the pads. We performed two simulations for this model: one in which the soil cement between the pads is assumed to retain its integrity and therefore be able to transmit both tension and compression forces; and another simulation in which the soil cement is assumed to be cracked and thus able to transmit only compression forces.

The second analysis examined the potential effect of having a gap between a pad and the adjacent soil cement layer. The analysis evaluated the impact forces that would be imparted on the pad as a result of its collision with the soil cement across the gap and the effect of those forces on the stability of the casks on the pad. For this analysis, a single pad fully loaded with eight casks was modeled. The pad was allowed to slide on the underlying soil and lift off. A fixed, rigid frame was modeled surrounding the entire pad with a clearance gap of approximately 0.6" to all edges of the moving pad.

Q3. Where do you present the input data and the calculation details for these two sets of simulations?

A3. The input data for these simulations are listed in Table 2 on page 13 of PFS Exh. 225. Additional details on the simulations are provided in Section 6.2 on pages 16 through 18. Appendix A of PFS Exh. 225 contains the calculation details for these simulations.

Q4. Based on purely physical considerations, would you expect that pad-to-pad interactions would only result in small loadings on the pads and casks?

A4. Yes. As described in Section 8.2.1. on pages 26 and 27 of PFS Exh. 225, a coupled two-degree of freedom mass spring system with masses equivalent to those of two fully loaded pads (8 casks each) will vibrate with a first natural

frequency of approximately 4.939 Hz and a second natural frequency of 29.765 Hz. The first natural frequency of approximately 5 Hz is within the range of frequencies for which 2000-year return period design basis earthquake for the PFSF has the largest energy content. This first natural frequency corresponds essentially to in-phase motion of the two pads, in which the pad-to-pad interaction effects are minimal.

The second natural frequency of approximately 30 Hz corresponds essentially to out-of-phase motion of the two pads, in which pad-to-pad interaction effects should be the most severe. However, that frequency is above those for which the 2000-year return period design basis earthquake for the PFSF has significant energy content, meaning that little energy from the earthquake ground motion is available to be transmitted from one pad to the other. Therefore, the effect of pad-to-pad interaction should be negligible.

Q5. Is that conclusion verified by the results of your VN simulations?

A5. Yes.

Q6. Would you please summarize the results of your computer simulations?

A6. The results of the simulations are reported in Section 8.2.2 on pages 27 through 29 of PFS Exh. 225. As more fully discussed there, all three cases predict some interactions between pads or between the pads and the surrounding soil cement, resulting in some loadings being applied to the pads. However, the forces imparted as a result of the interactions do not result in significant motions of the casks on the pads. The maximum peak-to-peak cask displacement observed in any of these cases is six inches, and the maximum cask excursion from its starting location is 3.8 inches.

The insignificant effect of pad-to-pad interactions on the motion of the casks is understandable because of the large area that is available on each pad to absorb any loads produced by the interaction. For example, the simulation of the impact between a pad and the surrounding soil cement across a 0.6" gap predicts a maximum 2,000,000 lb. compression impact force transmitted to the end of the pad, having an area of 90 square feet (30' by 3') which in turn results in only a pressure of 154.3 psi on the pad. Since the allowable stress in compression of reinforced concrete, conservatively ignoring the strength of the reinforcement, is

on the order of 3600 psi, it is evident that the pad pressure produced by the impact between the pad and the soil cement is insignificant.

Q7. In light of the analytical considerations you just described and the results of your N simulations, what are your conclusions regarding the effect of pad-to-pad interaction on the stability of the casks and pads at the PFSF?

A7. The analytical considerations and VN runs confirm that pad-to-pad interaction effects and the potential collision of a pad with the surrounding soil cement across a postulated gap between them do not impart forces of sufficient magnitude on the pads to affect the stability of the casks on the pads. This is true regardless of pad loading and whether a gap is assumed to be present between a pad and the soil cement adjacent to it. Therefore, the concerns expressed about these phenomena in the testimony of Drs. Bartlett and Ostadan are inconsequential.

B. Long Term Pad Settlement

Q8. At the hearing, Dr. Ostadan and Dr. Bartlett expressed concern that long term settlement of the pad, in particular potential “dishing” in the middle of the pad (Tr. 7509-7512), might affect the dynamic response of the casks under earthquake conditions. How do you respond to this claim?

A8. Based on the testimony of Paul Trudeau, a reasonable estimate of long term settlement of the pad is in the range of 0.50 inches. Even if it is presumed that this long term settlement occurred at the pad’s center, with no settlement at the edge, resulting in “dishing” of the pad at its center, the average slope measured along the short side of the pad is only 0.159 degrees. Based on my experience with cask stability analyses, this slight angle would have an insignificant effect on the analyses results and would certainly not alter the conclusions.

Q9. Does this conclude your testimony?

A9. Yes.

1 MR. GAUKLER: As part of the rebuttal
2 testimony, the rebuttal testimony describes three
3 runs that are in PFS Exhibit 225, and I would
4 suggest that Dr. Soler now show the simulations
5 related to those three runs which are discussed in
6 both PFS 225 and his rebuttal testimony with a
7 brief description, telling you what he's showing
8 you just as he has done in the past.

9 JUDGE FARRAR: Any objection to that?

10 MS. NAKAHARA: No objection. I just
11 moved so everybody could see.

12 THE WITNESS: We have to wait till the
13 light warms up here.

14 If I may add a little clarification to
15 the CD that was just presented, that contains
16 everything that I showed this week, including the
17 three spheres that drop. There are 10 simulations
18 on the disk -- on the CD.

19 MR. TURK: Can we lower the lights? Is
20 there a switch?

21 MS. CHANCELLOR: Which CD are you
22 talking about, Dr. Soler, the one that goes with
23 this rebuttal?

24 THE WITNESS: The one that's just been
25 submitted.

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1 MS. CHANCELLOR: It hasn't been
2 submitted.

3 MR. GAUKLER: Your Honor, the one that
4 was submitted is a different CD than this.

5 We'll talk about this CD later,
6 Dr. Soler.

7 THE WITNESS: Oh, okay. You've got me
8 confused now.

9 MR. GAUKLER: He's talking about the CD
10 that goes with 225.

11 THE WITNESS: I performed three
12 simulations, both -- or all three of them -- well,
13 two of the three involving two pads. And this was
14 an attempt to address, I believe, Dr. Bartlett's
15 question concerning pads moving out of phase with
16 the soil underneath the pads remaining elastic but
17 the soil cement between the two pads possibly
18 either being elastic or possibly, during the course
19 of an earthquake, cracking to the extent that the
20 soil cement could only resist compression and not
21 tension.

22 The first one that I will show -- I'll
23 just check to see if this is in focus here.

24 MR. TURK: May we go off the record for
25 a moment?

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1 JUDGE FARRAR: Yes.

2 (A discussion was held off the record.)

3 JUDGE FARRAR: Back on the record.

4 THE WITNESS: The first simulation, it
5 is assumed that the soil cement between the two
6 pads, the 5-foot span between two adjacent pads, is
7 able to take both tension and compression. One of
8 the pads will be completely full with 8 casks. The
9 other pad will be -- only have 1 cask on it, and
10 that cask will be in a location which I have been
11 told is the most likely location to install the
12 first cask on an empty pad.

13 Q. (By Mr. Gaukler) Now, this is real
14 time?

15 A. This is real time. This will take 30
16 seconds.

17 MS. NAKAHARA: And this is at the
18 2,000-year --

19 THE WITNESS: This is with the
20 2,000-year earthquake.

21 Now, before I shut this down, what you
22 do not see in this picture are the springs that
23 represent the soil cement. In the report I believe
24 they show in the -- in the pictures that are
25 appropriate to this run. But I put two linear

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1 springs at each corner -- I'll use my mouse.
2 There's a linear spring that was attached to two
3 pads along that edge and back along that edge --
4 and I believe -- well, that's not necessary -- so
5 that I could simulate not only direct compression
6 and tension but also, if the two pads tended to
7 twist relative to each other, the fact that I
8 modeled it with two springs would -- would
9 incorporate that to some extent.

10 JUDGE FARRAR: And so the record would
11 be clear, you're pointing with the arrow there to
12 the long dimension --

13 THE WITNESS: The long dimension --

14 JUDGE FARRAR: -- the area along the
15 long dimension?

16 THE WITNESS: Yes, with reference --

17 JUDGE FARRAR: At the --

18 THE WITNESS: -- to the report, Figure 6
19 on page 38 actually shows this figure but with the
20 springs denoted in the way VisualNastran would
21 denote a spring, so it locates the springs in
22 Figure 6.

23 JUDGE FARRAR: This is page 38 of --

24 THE WITNESS: Page 38 of report 2022878
25 which I guess is 225?

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1 MR. GAUKLER: Yes.

2 MR. TURK: May I ask if this is also
3 Figure 2 in PFS Exhibit 225?

4 THE WITNESS: Yes. Figure 2 is a larger
5 representation, and that shows the spring as sort
6 of a series of coils.

7 JUDGE LAM: So, Dr. Soler, what does
8 this run intend to demonstrate?

9 THE WITNESS: This run intends to
10 demonstrate that if you had two pads which had the
11 most, I guess, diverse total dead weight, one of
12 them, the one that's fully loaded, if you count the
13 weight of the 8 casks, you have roughly a 3.8
14 million total dead weight, whereas the other one
15 you have about a little over 1 million dead weight.
16 So according to Dr. Bartlett's hypothesis, it would
17 be quite possible for these two pads to move out of
18 phase and that -- therefore, generate forces in the
19 soil cement between the two pads and, therefore,
20 affect the motion of either pad modeled.

21 So this was -- this was an attempt to
22 simulate the hypothesis that the soil cement
23 between the two pads did not fail in any manner
24 and, therefore, could take tension as well as
25 compression.

1 JUDGE LAM: Dr. Soler, how would you
2 detect any failure in the soil cement in your model
3 even if that were to occur?

4 THE WITNESS: Well, this model would not
5 detect failure. It would simply report the force
6 in the soil cement, whatever it was. If it went to
7 a high enough tension so that the total force in
8 tension was more than the soil cement could take in
9 tension, it would not care. It would just keep
10 going.

11 The next run is the other extreme where
12 you assume that the soil cement can't take any
13 tension no matter what -- no matter how small the
14 load is, and the only time it can take load is when
15 the two pads move toward one another so they
16 compress those springs.

17 MR. TURK: I'm sorry. May I ask one
18 more question about the figure in 225?

19 THE WITNESS: Which one, Figure 2?

20 MR. TURK: Figure 6.

21 THE WITNESS: Hold on a second. Okay.

22 MR. TURK: To me it looks -- the left
23 hand -- upper left-hand picture of the cask sitting
24 on the pad, to me that looks identical to Figure 2.

25 THE WITNESS: Well, it is. It's just

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1 smaller.

2 MR. TURK: Okay.

3 THE WITNESS: Okay. The next simulation
4 is the same case, but by virtue of programming
5 with -- within VisualNastran, I was able to
6 basically zero out any capability for those two
7 springs to take any tensile load. So while the
8 springs are still there, they now behave as -- I
9 guess I'll call them piece-wise linear springs.
10 And the results of that simulation are a, let me
11 say, picture of the results at the instant in time,
12 and graphs for the entire time span are shown in
13 Figure 7 of the report.

14 MR. GAUKLER: And I would add that the
15 numerical results are shown on page 28 of 43 for
16 the three runs that Dr. Soler will be showing here.

17 THE WITNESS: And this is the
18 compression-only soil cement, and it is, again,
19 going to be in real time.

20 There are some differences in details if
21 you read the report, but from looking at the two
22 movies, you would be hard pressed to see any
23 significant difference between the two runs.

24 Now, the third simulation is an attempt,
25 I believe, to address the question of asymmetrical

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1 loading. In this case the soil cement completely
2 around one of the pads that's fully loaded is
3 assumed to at time zero have a 6/10-of-an-inch gap
4 between the edge of the pad and the beginning of
5 the soil cement, so it's as if we dropped a
6 rectangle, being the pad, into a picture frame
7 which was slightly larger around the periphery than
8 the pad itself.

9 In this case, since we knew that, in
10 general, elastic movement of the pad was not going
11 to close that gap, we allowed in this case the pad
12 to slide under the action of the forces, and we
13 assume the coefficient of friction between the base
14 of the pad and the underlying substrate was .31 in
15 order to ensure that the pad would slide and
16 presumably close the gap and impact with the
17 adjacent soil cement.

18 The difference, to the extent that the
19 model allows it, is the fact that here we will
20 truly get some impactive forces between the soil
21 cement and the moving pad, whereas in the previous
22 case of a compression-only spring between the soil
23 cement, all we are saying is that whenever the soil
24 tries to take tension, it's zeroed out so that it
25 can't take tension and doesn't act during the

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1 period when the solution would indicate that it
2 would take tension. There are no what I'll call
3 impactive forces between the soil cement and the
4 pad in the first two simulations, but there are in
5 this one.

6 Now, of course, we're only modeling one
7 fully loaded pad here. This, again, will be in
8 real time.

9 Now, the results from this simulation
10 gave cask displacement where it gave results for at
11 least the cask that we tracked that were much less
12 than the other two runs. And if you look at this
13 before you start the simulation, you have two
14 competing effects. You have -- first of all, you
15 will get impacts between the pad and the
16 surrounding soil cement which would tend to
17 dissipate energy, but, on the other hand, you are
18 getting impact forces which presumably would be
19 larger than the forces you would get from just a
20 spring effect where you would have a gradual
21 application of compression and possibly tension.

22 So you have two competing effects, so
23 it's not clear which one will dominate, the
24 dissipation of energy, or the higher level of
25 impactive force. But I think from looking at the

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1 simulations and, of course, looking at the data,
2 you find that the greater increase impactive force
3 does not really cause a problem, but the fact that
4 impacts occur, you dissipate energy in another
5 mechanism rather than sending it to the casks to be
6 dissipated.

7 Now, that completes the simulations that
8 are discussed in the report.

9 Q. (By Mr. Gaukler) Thank you, Dr. --

10 A. I believe I can turn this off now and
11 we'll...

12 MR. GAUKLER: I have a couple more
13 questions, Your Honor, just in terms of additional
14 rebuttal and explanation.

15 MR. TURK: At some point I'd like to ask
16 a question about that last simulation.

17 JUDGE FARRAR: Why don't you ask it now
18 while it's fresh in our mind.

19 MR. TURK: Okay. Dr. Soler, in the last
20 simulation you showed us, Simulation No. 3, we saw
21 a pad with 8 casks sitting on it. We saw no other
22 pads in the area around it.

23 THE WITNESS: That's correct.

24 MR. TURK: What does that simulation
25 show us? If there are no other -- if there are no

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1 other pads around it, then does that show anything
2 about the potential action of a surrounding pad
3 upon this pad?

4 THE WITNESS: Well, in this case the
5 simulation and -- let me -- let me state that this
6 simulation was generated and done prior to the
7 simulations -- the first two simulations with two
8 casks. And this simulation was generated --

9 MR. TURK: With two pads.

10 THE WITNESS: Two pads. Pardon me.
11 This simulation was generated to respond or attempt
12 to respond in our own minds to the question of
13 asymmetric loading that was raised at the last
14 series of hearings. So it was the first of the
15 three simulations done before we had considered
16 Dr. Bartlett's questions concerning pads moving out
17 of phase. So our thinking there was to say let us
18 assume that, for whatever reason, the soil cement
19 surrounding one pad is essentially moving with the
20 rest of the ground, and the only thing moving
21 relative to the ground is this one pad that is
22 surrounded by the soil cement. And we have this
23 gap of approximately 6/10 of an inch on all four
24 sides.

25 MR. TURK: So, in fact, then, if there

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1 was an impact force of the pad against the
2 surrounding soil cement separated by a gap from the
3 pad, then we would see how that affects the
4 movement of the casks above the pad?

5 THE WITNESS: That's correct. The
6 question was could that impactive force, which was
7 presumably going to be of a larger magnitude than,
8 of course, no force at all, which is what some of
9 our isolated pads have dealt with, whether that
10 impactive force could suddenly -- I'll use the term
11 jerk the casks and increase the deformation. But
12 what is shown here is that, in fact, the energy
13 dissipation into the adjacent soil cement
14 outweighed the increased magnitude of the impactive
15 force, and the casks actually did not see as much
16 energy, so they ended up with less movement
17 relative to the pads.

18 MR. TURK: And, I'm sorry. Is that
19 because the pads -- some of that energy dissipated
20 with the movement of the pads so it wasn't
21 translated into the casks?

22 THE WITNESS: Well, some of the energy
23 dissipation is due to the sliding of the pad. The
24 rest of the energy dissipating is due to the
25 impacting of the sliding pad on the adjacent soil

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1 cement which isn't moving. And the net of those
2 two extra mechanisms, if you will, reduced the
3 effect on the casks themselves on the pad.

4 MR. TURK: Thank you.

5 JUDGE LAM: Dr. Soler, if there were no
6 soil cement underneath the pad, how do the casks
7 behave?

8 THE WITNESS: If there were no soil
9 cement underneath the pads. I can only answer that
10 by referring to some of our earlier work. And by
11 earlier work, I mean 1,000-year return earthquake
12 and the initial runs in which we were given moduli
13 that presumably did not include the effect of soil
14 cement, and, therefore, the springs, the soil
15 springs that were generated, presumably did not
16 include any effect of soil cement.

17 My recollection of these very early
18 submittals is that, of course, the numbers changed
19 slightly, but the conclusions didn't change because
20 the soil cement which is represented by 6 springs,
21 while the numbers changed, they didn't change to
22 the extent that they completely negated our results
23 that basically say the casks won't move more than 3
24 to 5 inches and they remain stable and they don't
25 impact one another. That has remained constant for

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1 all of the runs. So the presence of the soil
2 cement in the view of Holtec's, was simply well, we
3 reran -- we reran the simulations for different
4 sets of parameters for the soil springs, but the
5 conclusions were always the same.

6 JUDGE LAM: The reason I ask that
7 question was for two reasons. One, I want to have
8 a clarification as to what is the need for soil
9 cement; two, assuming there may be construction
10 errors in constructing the soil cement and the pad,
11 what would be the consequences of that hypothetical
12 error. So is it true that your answer is -- is
13 telling us with or without soil cement the casks
14 would basically behave the same during the
15 2,000-year design earthquake?

16 THE WITNESS: Well, let me say that
17 within the scope of looking at this strictly from
18 the point of view of dynamic analysis of the pad
19 and with the -- I guess the assumption that pad
20 sliding does not occur so that the soil springs
21 remain elastic, then as far as Holtec's simulation
22 is concerned, soil cement is not needed under the
23 pads for dynamic stability of the casks.

24 Now, I can't speak for the canister
25 transfer building or I can't speak for the

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1 necessity of satisfying a technical regulation of a
2 1.1 safety factor. But as far as the question of
3 stability of the casks and their response under an
4 earthquake, soil cement is not critical or the
5 presence of soil cement under the pad is not
6 critical.

7 JUDGE LAM: Are we talking about
8 2,000-year return earthquake?

9 THE WITNESS: 2,000-year, 1,000-year,
10 whatever earthquakes were involved in the whole
11 series of simulations from I guess 1997 through the
12 final 2,000-year earthquake, the presence or
13 absence of soil cement would not affect the final
14 conclusions.

15 MR. TURK: May I inquire, Dr. Lam?

16 JUDGE LAM: Please.

17 MR. TURK: When I first heard your
18 question, I thought you were asking about soil
19 cement between the pads, and you --

20 JUDGE LAM: No. I meant --

21 MR. TURK: -- meant the cement-treated
22 soil --

23 (A discussion was held off the record.)

24 MR. TURK: I apparently had
25 misunderstood. I thought you were talking about

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1 the soil cement between the pads. Now I understand
2 you were talking about the cement-treated
3 underneath the pads.

4 JUDGE LAM: Right. I meant the soil
5 cement underneath the pad.

6 JUDGE FARRAR: Is that --

7 THE WITNESS: That's the way I
8 understood the question.

9 JUDGE FARRAR: You understood it as the
10 material under the pads?

11 THE WITNESS: Yes, that's how I
12 understood the question.

13 MR. TURK: I apologize.

14 JUDGE FARRAR: Mr. Gaukler you were
15 attempting to ask a few additional questions.

16 MR. GAUKLER: I just have a few
17 questions.

18 Q. Dr. Soler, would you please turn to page
19 28 of PFS Exhibit 225?

20 A. Yes, I have it.

21 Q. There was testimony yesterday by
22 Dr. Ostadan and Bartlett on the value of maximum
23 compression load in the soil cement between the
24 pads. Do you remember that?

25 A. Yes.

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1 Q. Now, the value -- will you please
2 describe what the values listed in this table are
3 in terms of the maximum compression movement of the
4 soil cement under the pads?

5 A. Okay. If you'll recall my explanation
6 during the presentation of the movies, I noted that
7 the effect of the soil cement in the first two
8 simulations was done by incorporating two springs
9 into the model. With respect to the first two
10 simulations, the third column in this table on page
11 28 simply lists the maximum value of the force in
12 the sum of the two springs, in other words, the
13 total either compressive or tensile force, as at
14 least in Case 1 would represent, the maximum
15 magnitude from the sum of the values in the two
16 springs.

17 And that represents -- certainly in the
18 second case, of 1.9 million pounds, it represents a
19 total compressive force. In the first case, I
20 honestly without -- well, I can look at the figure,
21 but I'm not sure whether it was a tensile force or
22 a compressive force that leads to that -- that
23 value. You can see -- well, I can see myself that
24 I reported the tensile load of 1.2 million and a
25 compressive load of 800,000.

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1 Now, the third row or the fourth row in
2 that table which lists the results for the effects
3 of adjacent soil cement around the pads and the
4 value of 2 million simply represents the total of
5 the impact force that you get when -- when you hit
6 in any direction. And I did not go into detail in
7 this table about which direction you got the 2
8 million because I was only interested in reporting
9 the number.

10 Q. And on the bottom of that page you show
11 what the effect is in terms of psi of that impact
12 force on the side of the -- or the edge of the pad?

13 A. Yes. This -- this is a question to
14 address. 2 million or 1.9 million represents a
15 large number to the man on the street, say, but in
16 terms of stress in the concrete, it's a very small
17 number of about 154 psi. And I believe in my
18 direct testimony that I have compared that with the
19 allowable compressive load in the concrete under
20 this condition which would be about 3500 psi, if my
21 memory serves me correctly.

22 Q. Is that in your rebuttal testimony?

23 A. Yeah, there it is in my rebuttal, page 4
24 of the prefiled testimony. 3600 psi would be the
25 limit that the ACI, American Concrete Institute,

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1 code, would say that you could develop in direct
2 compression.

3 Q. Now, Dr. Soler, in this table on page 28
4 is there listed anywhere there the forces on the
5 soil underneath the soil cement?

6 A. No.

7 Q. Does your program actually calculate
8 those forces and were you able to identify what
9 those forces are?

10 A. I was able to identify those forces, but
11 the original simulation that led to these tables --
12 let me explain a little more. The program will
13 calculate anything you tell it to calculate and
14 archive. By any meter that I create -- and by
15 meter I mean any of the pictures on any of the
16 reports that show curves. They're called meters in
17 VisualNastran. If you want to measure something,
18 you define a meter to measure it, and then it
19 records the data in both graphical form and -- if
20 you so desire, you can create an Excel spreadsheet
21 which has the numbers.

22 Now, in the original simulations that
23 led to the graph on page -- the table on page 28 --
24 they were done roughly, I guess, about a week and a
25 half ago -- I did not create meters for the forces

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1 in the soil cement springs.

2 In view of the testimony yesterday
3 concerning the fact that 1.9 million pounds might
4 be additive to the previously estimated soil spring
5 forces by Mr. Trudeau, last night I took the
6 simulation model corresponding to compression-only
7 soil cement, added a meter -- or added two meters
8 to it to generate the forces in the soil cement to
9 determine whether or not this 1.9 million pounds
10 directly adds or potentially subtractions somewhat
11 from the soil cement springs. So while it is a run
12 that was created last night and, in fact, did not
13 go to 30 seconds for lack of time -- it stops at
14 about -- I stopped it at about 22 seconds -- it
15 directly gives the magnitudes of the forces in the
16 soil cement under each of the two pads in that
17 simulation.

18 Q. And what were those forces?

19 A. I can put up a slide, if you will, but
20 my recollection is that the maximum force under any
21 of the two pads that would tend to increase or
22 decrease the -- that would tend to predict whether
23 or not a pad would slide, actually decreases
24 somewhat from the value predicted by Mr. Trudeau.
25 I believe that the peak force in -- under any of

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1 the slabs that you would use in a comparison to
2 determine whether or not the pads slide is about
3 2.3 million pounds, and for the case considered --
4 and these cases were all done with lower bound, is
5 my recollection of conversations with Mr. Trudeau,
6 that for that case he had predicted about 27
7 million or 29 million pounds in the soil cement
8 under the pads and from that would lead to his
9 conclusion that he didn't get sliding.

10 So it appears from the results from this
11 simulation or the rerunning of the same simulation
12 with some extra force meters so I could get the
13 data directly, that over time the forces in the
14 soil cement between the two pads tends to reduce
15 somewhat the force in the soil springs underneath
16 the pad.

17 MS. NAKAHARA: May I ask a clarifying
18 question?

19 MR. GAUKLER: That's all I have so --

20 MS. NAKAHARA: When you say the forces
21 were forces under the soil, do you mean --

22 THE WITNESS: Under the pad.

23 MS. NAKAHARA: I'm sorry. The point
24 under the pad on top of the spring? Is that the
25 point of application?

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1 THE WITNESS: No. The way the soil was
2 modeled in these runs was to, in effect, create a
3 series of 6 springs right under the center of the
4 pad at its bottom surface, I guess is the best way
5 to say it, and, therefore, I directly calculated
6 the force in the horizontal direction.

7 MS. NAKAHARA: At the top or the bottom?

8 THE WITNESS: At the base of the pad
9 where it contacts whatever I considered was
10 underneath the pad.

11 MS. NAKAHARA: Okay. Thank you.

12 Do you have the data for this run?

13 THE WITNESS: I have a slide, and I also
14 have a hard copy of that slide which could be
15 submitted. The data, the input data does not
16 change from what is in the report. I simply reran
17 the case and added meters to directly track that
18 force. At the time I originally ran the
19 simulation, the only thing I was really interested
20 in was in the response to the cask, so I didn't
21 really track that. Last night I simply opened up
22 the run, added two meters to track the forces under
23 each of the two pads and reran the simulation.

24 Now, I can show the slide or we can put
25 the piece of paper that -- the picture that I took

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1 of the slide which has the results on it. Your --
2 your preference is my command.

3 MR. TURK: Could I ask that we see the
4 slide?

5 MR. GAUKLER: Certainly.

6 THE WITNESS: Okay. Let's --

7 MS. NAKAHARA: I'd do the opposite. I'd
8 ask for the paper --

9 MR. TURK: I don't omit that either.
10 I'd like to see the slide while we're talking about
11 it.

12 THE WITNESS: Okay. And this is just a
13 snapshot. I didn't see any need for a movie since
14 it was -- well, since time didn't permit it and,
15 also, the meter is not going to come up with
16 anything. Let me -- let me go get this slide.

17 MS. NAKAHARA: Your Honor, this doesn't
18 give us an opportunity to rebut anything that
19 Dr. Soler's presenting because we can't analyze an
20 animation without --

21 THE WITNESS: Well, this will not be an
22 animation.

23 MS. NAKAHARA: Which case does this
24 correspond to that you added the two additional
25 meters?

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1 THE WITNESS: This would correspond to
2 Figure 7 in the report.

3 Now -- now, just so that you can track
4 and correspond the results of this slide with the
5 previous run in the report, I have included in the
6 lower left-hand corner the compressive forces in
7 the soil cement that were presented in Figure 7.
8 The two larger graphs on the right represent the
9 soil springs. The top one is called adjacent pad
10 force, meaning the one with -- the pad with only
11 one cask on it, and the lower one is for the full
12 pad.

13 And it's hard for you to see, but there
14 are forces superposed (sic) on each other. In
15 other words, if you look at the title, you see FX
16 and FY forces given. But as far as we're concerned
17 here, I would direct your attention to the lower
18 right-hand meter in which at roughly, I guess,
19 about 4 and 3/4 seconds, you're somewhere just in
20 excess of 2.3 million pounds, it turns out, in
21 compression in the springs.

22 Q. (By Mr. Gaukler) Can you use the arrow
23 to point to that?

24 A. Yeah. There you go, right there.

25 So I -- I mean this slide provides a

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1 direct correlation between the paper because these
2 two -- in the report because these two are already
3 in the report, and, of course, the picture while --
4 at least tells you the case that's running, and you
5 will see the fact that the -- when this was run, it
6 was last night. That's how I titled the model.

7 I have a hard copy. It's in my bag. If
8 you'll excuse me for a minute, I'll get it.

9 MR. GAUKLER: Ms. Nakahara, does our
10 paralegal know how to get copies of that made?

11 MS. NAKAHARA: No. We're having
12 problems getting in the office ourselves this
13 morning.

14 (A discussion was held off the record.)

15 THE WITNESS: Let me add one thing,
16 that, of course, the input data for this run is in
17 the report. There was no change in input data.
18 It's simply defining the meter.

19 Q. (By Mr. Gaukler) So the purpose --

20 A. In this case, two meters.

21 Q. So the purpose of this run was to
22 respond or address issues that were raised
23 yesterday by Dr. Ostadan and Dr. Bartlett?

24 A. That's correct. The sole purpose of
25 this run was to directly calculate the soil

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1 springs -- the forces in the soil spring direct
2 from the simulation rather than taking data and
3 using some approximating formula to estimate what
4 they were doing.

5 And as I believe Dr. Ostadan pointed out
6 a number of times -- he asked the question why was
7 not the data directly transmitted by Holtec to
8 Mr. Trudeau, and the direct answer to that question
9 was nobody asked for it. And having now seen the
10 need for it, we generated it. Our initial data
11 transmission during the course of this project was
12 directly to ICEC who asked us for the forces from
13 the casks on the pad.

14 MR. GAUKLER: I have no further
15 questions, and I -- I'm going to get the slides
16 marked and ask they be introduced once we get
17 copies back for it.

18 JUDGE FARRAR: All right.

19 MR. GAUKLER: I would like at this time
20 to move to introduce PFS Exhibit 225 which is the
21 report -- additional cask analyses for the PFS.
22 That includes the simulations that we saw today as
23 well as the simulations that we saw Tuesday.

24 JUDGE FARRAR: Had you previously moved
25 admission of that and we deferred action?

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1 MR. GAUKLER: We had previously moved
2 it. That led to the issue with the State objecting
3 that it was really rebuttal testimony, that it was
4 really -- we were going to have Mr. Diaz go through
5 with Dr. Soler and Dr. Singh and have them give the
6 testimony that was put in the report, and then the
7 State withdrew that objection. And we moved it --
8 moved to admit it at that time, and then the State
9 correctly pointed out we still had additional
10 evidence to present with respect to it, so we held
11 off the admission until today. And now having had
12 Dr. Soler give additional testimony and evidence, I
13 would move for the admission of 225.

14 JUDGE FARRAR: Any objection?

15 MS. NAKAHARA: No objection, Your Honor.

16 JUDGE FARRAR: Staff?

17 MR. TURK: No objection.

18 May I ask for a clarification? Does
19 this include 225A?

20 MR. GAUKLER: I'm coming to that next.

21 I would actually move for the admission
22 of -- oh, excuse me.

23 MR. TURK: So I have no objection to
24 225.

25 JUDGE FARRAR: Okay. Then 225 will be

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1 admitted.

2 (APPLICANT'S EXHIBIT-225 WAS ADMITTED.)

3 MR. GAUKLER: Next we'd move for the
4 admission of PFS 225A. This is the disk, compact
5 disk showing the simulations that were shown on
6 Tuesday and today and which correspond to the runs
7 that were set forth in PFS Exhibit 225.

8 JUDGE FARRAR: Any objection?

9 MS. NAKAHARA: For the record, the State
10 would pose the same objections we had to PFS
11 Exhibit 00 and even more so with respect to the
12 falling casks and falling balls simulation which
13 our experts pose is not realistic and even more
14 subject to misunderstanding at a subsequent
15 tribunal.

16 JUDGE FARRAR: And are the --

17 MR. GAUKLER: Yes. I --

18 JUDGE FARRAR: -- the casks and the
19 balls on 225?

20 MR. GAUKLER: Yes, they're on there as
21 well.

22 JUDGE FARRAR: As well as --

23 THE WITNESS: The fallen casks.

24 MR. GAUKLER: Yeah. We have the -- I
25 forget to mention we have the 11 simulations or the

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1 simulations from the report itself plus the
2 simulation of the falling balls which is discussed
3 in the report, but -- I don't know if we've
4 mentioned the fact there was a simulation in the
5 report -- and the three casks corresponding to the
6 balls.

7 JUDGE FARRAR: And does this also have
8 some material from OO, or this is all different?

9 MR. GAUKLER: All different from OO.

10 JUDGE FARRAR: Okay. Didn't we deal
11 with the falling casks and balls before, or was
12 that in terms of their testimony? Did we --

13 MS. NAKAHARA: Yes. It's in PFS
14 Exhibit 225.

15 JUDGE FARRAR: No, but it seems to me
16 there was an objection raised about either that
17 testimony or something related to it a few days
18 ago.

19 THE WITNESS: I don't -- I don't recall
20 but that doesn't mean anything.

21 MR. GAUKLER: I remember the issue
22 coming up. I forget if there was an objection or
23 not. But it certainly was discussed in
24 cross-examination.

25 JUDGE FARRAR: Was there a motion to

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1 strike or --

2 MS. NAKAHARA: I don't believe that
3 we -- the State posed a motion to strike. We have
4 grave concerns with -- that this is not a realistic
5 situation and, in particular, the falling casks are
6 unrealistic. You may be recalling
7 cross-examination --

8 JUDGE FARRAR: Okay.

9 MS. NAKAHARA: -- of Dr. Soler to that
10 effect.

11 JUDGE FARRAR: Okay. And, again, with
12 everything packed up, we don't have the previous
13 transcripts here with us, so we're operating at a
14 little bit of a disadvantage.

15 (The Board confers off the record.)

16 JUDGE FARRAR: I think we would add here
17 to the same ruling we made earlier today, that
18 we're expecting our opinion will deal with all
19 these matters, so there's no real chance of
20 confusion by some higher tribunal. And you will be
21 free to argue at the appropriate time that this
22 material should be given little or no weight, and
23 the other side will argue the opposite. So we will
24 admit 225A.

25 (APPLICANT'S EXHIBIT-225A WAS ADMITTED.)

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1 JUDGE FARRAR: I'm sorry. I didn't ask
2 the Staff what their opinion was.

3 MR. TURK: We have no objection.

4 MR. GAUKLER: I now have had distributed
5 and marked -- have you had time to mark it? Would
6 you please mark the one page we just distributed as
7 225B? That was the last slide shown by Dr. Soler.

8 JUDGE FARRAR: We'll take a moment and
9 have the reporter mark that.

10 (APPLICANT'S EXHIBIT-225B WAS MARKED.)

11 JUDGE FARRAR: Mr. Turk, does the Staff
12 have any cross they'd like to do?

13 MR. TURK: Yes.

14 JUDGE FARRAR: Go ahead.

15 JUDGE LAM: May I interrupt you --

16 MR. TURK: Yes.

17 JUDGE LAM: -- for a quick question,
18 Mr. Turk?

19 Dr. Soler, I'm puzzled with some of the
20 figures in Exhibit 225. May I ask you to go look
21 at Figure 6?

22 THE WITNESS: Okay.

23 JUDGE LAM: May I ask you to see the
24 position at the top of HI-STORM net displacement in
25 inches?

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1 THE WITNESS: Yes.

2 JUDGE LAM: I see 280 inches, 289?

3 THE WITNESS: The starting point -- the
4 starting point, because of where the cask was and
5 where the origin of coordinates is, is roughly
6 284 -- at location 284.7, which is the X coordinate
7 squared plus the Y coordinate squared, square root
8 of the sub.

9 JUDGE LAM: Oh, I see. This is a
10 location marking --

11 THE WITNESS: This is a location, and
12 then you're tracking the changing location.

13 JUDGE LAM: Okay. I see. So I should
14 interpret all the results from Figure 5, Figure 6,
15 Figure 7, Figure 8 in that light?

16 THE WITNESS: Right.

17 JUDGE LAM: Okay. Thank you.

18 THE WITNESS: That is why I think the
19 data in at least one of the submittals shows a --
20 sort of picture of how you interpret displacement
21 results in terms of either excursion from the
22 origin or peak-to-peak excursion.

23 JUDGE LAM: Right. I thought you may be
24 proposing testimony on the flying casks again.

25 THE WITNESS: No.

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1 JUDGE LAM: Okay. Thank you.

2 MS. NAKAHARA: Your Honor, may I ask a
3 procedural question, which I think Mr. Gaukler's
4 getting to? Did you admit Exhibit 226?

5 MR. GAUKLER: 225. I think I may have
6 made a mistake in labeling, so let me go back and
7 correct my mistake, first of all. The one page
8 that we just handed out I would like to have marked
9 as 226C, please.

10 MR. TURK: That's what we referred --

11 MR. GAUKLER: 225C. Excuse me.

12 MR. TURK: That's what you had
13 previously identified as 225B?

14 MR. GAUKLER: Right. Because I have
15 another document that I've handed out that is
16 identified as 225B already.

17 JUDGE FARRAR: Wait. So the one page
18 slide and graphs will be -- you want marked as
19 225C?

20 MR. GAUKLER: Okay.

21 JUDGE FARRAR: Okay. If the reporter
22 would change that marking.

23 (APPLICANT'S EXHIBIT-225C WAS MARKED.)

24 THE WITNESS: Your Honor, if I may, may
25 I make a little addition to my testimony in

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1 response to the question by Dr. Lam? And that is
2 the -- the graph and all of the figures that was
3 originally questioned starts at a -- at time zero
4 at 284.7 inches. That has been a meter that has
5 been around in all of my simulations, going back to
6 late April. However, in -- when I generated the
7 second pad with the 1 cask on it and created a
8 meter to track its displacement, I was cognizant of
9 the fact that I would be starting at a non-zero
10 location, and I zeroed the meter prior to start to
11 be approximately at zero. So you will notice that
12 the execution of the lone cask on the second pad,
13 those graphs are -- roughly start at zero.

14 JUDGE LAM: That's clear enough. You
15 know, I think I may want to suggest to you,
16 Dr. Soler, you know, these figures, the labeling of
17 the vertical axis misled me. Of course, you know,
18 on top of it you did the label of that chart, which
19 is a position on top of HI-STORM. But then I see a
20 label, and that is placement in inches versus time
21 in seconds, and I see -- on your vertical axis I
22 see 289 --

23 THE WITNESS: Uh-huh.

24 JUDGE LAM: -- an exponent of 2. That's
25 where the confusion was to me. I'm glad you

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1 clarified.

2 THE WITNESS: Okay. Thank you.

3 Q. (By Mr. Gaukler) I had handed out
4 earlier and the court reporter has marked a
5 three-page document identified as PFS Exhibit 225B,
6 and, Dr. Soler, do you have that in front of you?

7 A. Yes, I do.

8 Q. And could you just briefly tell me what
9 225B is in relationship to PFS Exhibit 225? And
10 you may want to refer directly to page 29 of PFS
11 225.

12 A. On page 29 of 225 we are doing various
13 what I'll call sensitivity studies to look at the
14 effect of the -- changing certain parameters,
15 namely, the contact stiffness and contact damping
16 on the response of the casks.

17 Q. And then what does 225B represent?

18 A. 225B represents what I'll call -- and
19 I'll say what Holtec thought was its base case in
20 the beyond design basis report which has been
21 corrected and resubmitted in that we -- subsequent
22 to submittal of that report, we found that we were
23 not really doing 40 million stiffness and 40
24 percent of critical damping, but we were doing
25 roughly 19 million stiffness and 27 1/2 percent of

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1 vertical damping.

2 Q. Now, in terms of what's in 225B, are
3 those the results and input parameters for one of
4 the runs that are shown in 225?

5 A. Yes.

6 Q. And which one is that?

7 A. The first run in 225 is simply the 2K
8 earthquake with 40 million as the contact
9 stiffness, total stiffness for each cask on the
10 pad, and 40 percent of critical damping that goes
11 along with that 40 million.

12 Q. And this -- and the graphs that are
13 attached and the table correspond to the
14 outputs/inputs?

15 A. That's right. The input table, this is
16 called Case 12, gives you the input, and the graph
17 summarizes the result for Cask No. 1. Since the
18 movie definitely -- well, for this case, there was
19 no significant difference between the displacement
20 of Cask No. 1 and any of the other casks on the
21 pad, so only Cask No. 1 is reported because that
22 was the one that was tracked.

23 MR. GAUKLER: Your Honor, I move for the
24 admission of 225B.

25 JUDGE FARRAR: Any objection?

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1 MS. NAKAHARA: May I ask one question?

2 JUDGE FARRAR: Yes.

3 MS. NAKAHARA: You just testified that
4 Cask No. 1 -- there was no other cask that had more
5 displacement than Cask No. 1.

6 THE WITNESS: In that simulation -- no,
7 actually, I did not actually create a simulation
8 for that, but from visually observing it while the
9 movie -- while the program was running, I observed
10 that the displacements of all other casks, at least
11 from my visual observation, were not significantly
12 different than the one that's reported.

13 MS. NAKAHARA: And that's based on your
14 visual observation of the movement of the casks?

15 THE WITNESS: That is correct. In other
16 words, I can -- I can play the movie, if you will,
17 from within the program by just moving the cursor
18 on the -- on the time slider. To create a rendered
19 movie as I've done here requires another three or
20 four hours of work, so I saw no need to do it for
21 this particular case.

22 MS. NAKAHARA: With that clarification
23 and appreciation by the State that Dr. Soler
24 corrected his mistake, we have no objection.

25 JUDGE FARRAR: Staff?

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1 MR. TURK: I need to ask a
2 clarification.

3 It's not clear to me how this impacts
4 PFS Exhibit No. 225. Does the information
5 presented here replace information that's in 225?

6 THE WITNESS: The results of this run in
7 225B are reported on page 29 in Exhibit 225.

8 MR. TURK: And that would be the table
9 that appears on the bottom --

10 THE WITNESS: The table, yes.

11 MR. TURK: -- on the bottom of page 29.

12 THE WITNESS: Yes.

13 MR. GAUKLER: And if I just may clarify
14 for the record.

15 MR. TURK: Well, may I -- okay.

16 MR. GAUKLER: We're putting this in just
17 so we have the analogous input and output in this
18 case that we did for all the other cases in the
19 record. So this input and output is not shown in
20 225, so we just created a separate document with
21 that so we would have the same input and output
22 shown for this as we do for the other cases.

23 MR. TURK: If I wanted to understand
24 where to place 225B as I'm reading 225, should it
25 essentially be an insertion at the end of the

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1 discussion on page 30?

2 THE WITNESS: May I answer that?

3 MR. GAUKLER: Yes.

4 THE WITNESS: If you will recall, the
5 results in Exhibit 225B, the proper place for them
6 would have been in the report 86 -- which one is
7 it? 86. And that was the objection raised by the
8 State that we were doing a new run.

9 If this was a technical report to a
10 client, the proper place for this information would
11 have been in that report. Since we had made a
12 change and then we were trying to show that the
13 effect of that change in text didn't really have an
14 effect on the results that we were giving, the
15 proper place to put it was in that original report.
16 And we did, but it was objected to, so we removed
17 it from that report, made it a separate exhibit.
18 But it is referred to in 225.

19 I'm not sure whether that clarifies or
20 confuses the issue.

21 MR. TURK: And just so I'm a little more
22 clear -- and I hope you forgive me if I'm the only
23 one having a problem with this -- can you point to
24 a sentence that addresses this in Exhibit 225?

25 THE WITNESS: Yes. If you'll go to page

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1 29, above the table it says the first of these
2 analyses varied the damping -- wait a minute --
3 yes, varied -- varied the damping value used in
4 Case 12 of 3 from 40 percent to just below 5
5 percent, and the second analysis varied the total
6 contact stiffness using Case 12 of 3 from
7 approximately 40,000 kips per inch to 4,760 kips
8 per inch. Case 12 of 3 is PFS Exhibit 225B.

9 MR. TURK: With that explanation,
10 Your Honor, I have no objection to the admission of
11 this exhibit.

12 JUDGE FARRAR: Then 225B will be
13 admitted.

14 (APPLICANT'S EXHIBIT-225B WAS ADMITTED.)

15 MR. GAUKLER: And I would move for the
16 admission of 225C.

17 JUDGE FARRAR: Any objection?

18 MS. NAKAHARA: Your Honor, the State
19 objects that this would not represent the best
20 evidence. As Dr. Soler himself testified --
21 Dr. Soler testified that it's difficult, I would
22 pose that it's impossible, to distinguish between
23 the X and Y representation on the time -- on the
24 force time histories in which they're overlaying on
25 top of each other. And we would not have an

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1 objection if -- and we recognize -- the State
2 recognizes that the copies were made off of our
3 copy machine, and we would not have an objection to
4 PFS substituting this exhibit --

5 JUDGE FARRAR: So your objection is not
6 to the substance but to the fact that this document
7 is a bad depiction?

8 MS. NAKAHARA: Yes.

9 JUDGE FARRAR: Then why don't we not
10 admit it at this time, and you can bring in a --
11 subject to PFS's right to bring in a better or
12 cleaner version at some future time.

13 MR. GAUKLER: We'll certainly try to
14 work with the State to resolve its concern. I'm
15 not quite clear exactly what that is, but we'll do
16 that.

17 MR. TURK: May I ask, is there a color
18 version of this page?

19 THE WITNESS: Well, if you look at the
20 PBF file, yes, but I can, assuming that there might
21 be a printer that I can connect to --

22 JUDGE FARRAR: We don't need to do it
23 today.

24 THE WITNESS: Okay.

25 JUDGE FARRAR: You can do it given some

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1 time?

2 THE WITNESS: Oh, yes, I mean I can do
3 it with a color printer or I could simply redo the
4 plot with just the one component on it.

5 JUDGE FARRAR: All right. Let's move
6 on, then.

7 MS. NAKAHARA: And, Your Honor, one more
8 request.

9 JUDGE FARRAR: Okay.

10 MS. NAKAHARA: And I hate to ask this,
11 but subject to the State having additional
12 cross-examination questions based on being able to
13 distinguish the time histories for the different
14 forces that were overlain, we'd like to reserve our
15 right to ask Dr. Soler any follow-up questions.

16 JUDGE FARRAR: At some future date, you
17 mean?

18 MS. NAKAHARA: Yes.

19 MR. GAUKLER: I would suggest that they
20 can look at this on Dr. Soler's screen, and they'd
21 be able to distinguish what they need to find out.
22 I'm sure that we can make that available to them
23 during the break.

24 MS. NAKAHARA: That sounds reasonable.

25 JUDGE FARRAR: Yeah. I hate to leave

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1 too many things dangling for later, so if we can do
2 that one that way, let's do it, Mr. Turk.

3 MR. TURK: I would also suggest if a
4 color depiction is available to Dr. Soler, that
5 somebody be instructed to run to Kinko's, make a
6 copy. Let's finish this today rather than come
7 back with one more open item in the future.

8 JUDGE FARRAR: We can try to do that and
9 see what happens.

10 MR. TURK: There's a danger in
11 prolonging too many things for future questioning.

12 JUDGE FARRAR: All right. Let's -- how
13 much --

14 THE WITNESS: Well, I --

15 JUDGE FARRAR: No, no, no. It's over.

16 MR. TURK: Limited cross-examination?

17 JUDGE FARRAR: Why don't we see if we
18 can -- how long?

19 MR. TURK: Probably 10 to 12 minutes, if
20 that much, but I need to consult. I do have some
21 questions about the presentation of soil springs,
22 which I can do now, and I would need to consult to
23 make sure I don't have anything further.

24 JUDGE FARRAR: Why don't we take a break
25 now. We'll need a little more time, given the

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1 facilities here, so let's take a 15-minute break
2 and be back at 10 of.

3 (A recess was taken.)

4 JUDGE FARRAR: While we were off the
5 record, we talked about taking definite time for
6 lunch for the reporters' benefit so they'll know
7 what to do on this Saturday session, so we'll break
8 for lunch at 12:30. It's now 5 of 11:00, and I
9 think we've reached the point for the Staff's
10 cross-examination.

11 MR. TURK: Yes, sir.

12

13 CROSS-EXAMINATION

14 BY MR. TURK:

15 Q. Dr. Soler, I want to come back to
16 something that you mentioned orally during
17 examination this morning. You were discussing a
18 statement that 2.3 million pounds of force were
19 needed in order to cause pad sliding and that
20 Dr. Trudeau had predicted 27 or 29 million pounds.
21 And your conclusion was, therefore, there will be
22 no sliding. There's some kind of a disconnect or
23 something missing in that statement.

24 A. I think the -- and I don't -- you'll
25 have to ask Mr. Trudeau, but the point I was making

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1 is that my prediction of 23 million and his
2 prediction of 27 million, I believe, for the case
3 were the actual forces computed. The force to
4 cause sliding at that location I believe is on the
5 order of 4 -- 4 million.

6 MR. GAUKLER: Dr. Soler, I think you
7 said 23 million and 27 million. Did you mean to
8 say 2.3 million and --

9 THE WITNESS: 2.3 million and 2.7
10 million, respectively, for myself and Mr. Trudeau.
11 But I believe in his calculation as to whether or
12 not that causes sliding under the pad, the -- his
13 calculation for the force necessary to cause
14 sliding is about 4 million, therefore, he concludes
15 that it will not slide, the pad will not slide on
16 the underlying substrate. And the solution that
17 I've presented today is simply to demonstrate that
18 the peak magnitude of the force comes down.

19 Q. (By Mr. Turk) Just to be clear, your
20 number is 2.3 million?

21 A. Yes, the worst magnitude.

22 Q. And the number predicted by Mr. Trudeau
23 was 2.7 or 2.9 million?

24 A. Something like that, yes. So 2.9 --
25 2.9 million -- I'm not sure of the exact number,

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1 but it was higher than 2.3 million.

2 Q. Okay. So if there's a mention before of
3 a 27 or a 29 million, that's an incorrect
4 statement?

5 A. That was a -- yes, that was incorrect,
6 but the order of magnitude is reasonably correct, I
7 guess.

8 Q. As corrected, I believe I understand
9 what -- your statement.

10 You used the word that you added meters,
11 certain meters?

12 A. Yes.

13 Q. As you use the term "meters," are you
14 stating that you added an output data point? What
15 do you mean by the word "meter"?

16 A. VisualNastran uses the term "meter" for
17 a measuring device. And for instance, if I wanted
18 to measure the time history of displacement at the
19 top of Cask No. 3, for instance, I would have first
20 defined a coordinate at the appropriate location at
21 the top of Cask 3. I would have then embedded that
22 coordinate so it became part of Cask 3, and then I
23 would define a meter for that coordinate which
24 would take -- calculate and put on a graph the
25 three components of displacement of that point.

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1 And then I could put in any programming that I
2 wanted to to compute the net displacement of that
3 point.

4 So you could read meter in terms of the
5 common -- a graph, if you will.

6 Q. Could you turn to PFS Exhibit 225C?
7 This is that one page which has not yet been
8 admitted, I understand.

9 A. Oh. B? Oh, C, okay.
10 I have it.

11 Q. Could you explain how this correlates
12 with Figure 7 in PFS Exhibit 225? Is it, in
13 fact -- I believe in your testimony you indicated
14 there was some correlation between the two.

15 A. Yes. Let me -- the tension of
16 Constraint 88 is VisualNastran's description of one
17 of the springs.

18 Q. That's the first graph that appears
19 below the picture of the casks?

20 A. Yes, that is correct.

21 MS. NAKAHARA: Of both exhibits?

22 THE WITNESS: I'm looking at both
23 exhibits, and I'm looking now. And they do not
24 appear to be identical. Those two curves -- those
25 four curves, although the -- well, wait. I have to

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1 watch myself because the scales are different.

2 Q. (By Mr. Turk) Right, but that's
3 something that had appeared to me, and I was
4 wondering if the difference in scales is the only
5 reason for a difference of what appears there.

6 A. Let me -- certainly I'm looking at the
7 peak that's somewhat less than 5 seconds on 88,
8 Constraint 88, and it's about 1.1 million. And I
9 have to look -- 4, 6 -- if you look at the bottom
10 at Constraint 91, the -- just below 5 -- or just
11 above 4 seconds, which is hard to see on the other
12 one, there's an 800,000. The -- however, at 12
13 seconds -- let's make sure. 12 seconds and 12 --
14 there's 800,000 on this one, and there's 800,000 on
15 the other one. And at 12 seconds here on the 91,
16 the curve on the new figure seems to have missed
17 the -- the curve on the old figure which seems to
18 have a 1. -- hard to tell, maybe 1.1 million. I
19 cannot explain that. But it appears to be, as far
20 as I can see, near the only difference, and it may
21 simply be on the point that it saved. But I can't
22 address that issue with the data here as to why the
23 curve today did not pick up the 1.1 million pounds
24 from Figure 7.

25 And I ought to clarify something else.

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1 The titles of the curves are sometimes not left to
2 my discretion. And since this is a spring, it
3 reports tension or compression, but all of the data
4 goes from zero down to something. The minus sign
5 is not appearing on the curves on Figure 7 simply
6 because of lack of space.

7 I would say the curves are identical
8 except for that one point, as near as I can see by
9 just looking at it, and I cannot explain why I
10 missed that one point.

11 Q. And just now you were comparing the --
12 the graphic demonstrations at the bottom left-hand
13 corner of those two pages?

14 A. Yes.

15 MR. TURK: I have no further questions,
16 Your Honor.

17 May we go off the record for a moment?

18 JUDGE FARRAR: Yes.

19 (A discussion was held off the record.)

20 JUDGE FARRAR: Back on the record.

21 Then we're ready for the State's
22 cross-examination.

23 MS. NAKAHARA: Your Honor, in accordance
24 with --

25 JUDGE FARRAR: 2.733.

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1 MS. NAKAHARA: Yes, thank you. I would
2 request that you permit Dr. Ostadan to pose the
3 questions, the cross-examination to Dr. Soler on
4 the basis that you've already set the precedent
5 with Dr. Stamatakos, you've already acknowledged
6 the earlier exchange between Dr. Ostadan and
7 Dr. Soler on the record and it is extremely more
8 expeditious than if I conducted it and that
9 Dr. Ostadan would meet the criteria of 2.733. He's
10 qualified by scientific or technical training --

11 JUDGE FARRAR: Right.

12 MS. NAKAHARA: -- by the testimony --

13 JUDGE FARRAR: Right.

14 MS. NAKAHARA: -- and he has prepared
15 himself to conduct a meaningful and expeditious
16 examination.

17 JUDGE FARRAR: All right.

18 Mr. Gaukler, any objection?

19 MR. GAUKLER: No.

20 JUDGE FARRAR: Staff?

21 MR. TURK: No, Your Honor.

22 JUDGE FARRAR: Okay. Do you want to
23 start yourself, Ms. Nakahara, or just Dr. Ostadan
24 right from the beginning?

25 MS. NAKAHARA: Dr. Ostadan would start

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1 from the beginning, but I would just like to remind
2 the parties that he will ask questions concerning
3 the force time histories that you afforded us an
4 opportunity to question.

5 JUDGE FARRAR: Okay. So we will start
6 with the --

7 MS. NAKAHARA: Not necessarily. He's
8 going to proceed in the manner that makes most
9 sense but --

10 JUDGE FARRAR: Okay. So we will have a
11 mixture of the deferred cross from before and the
12 cross dealing with today's rebuttal?

13 MS. NAKAHARA: Yes, Your Honor.

14 JUDGE FARRAR: And trust that everyone
15 in the room will sort it out for themselves if that
16 need be done.

17 All right. Go ahead, Dr. Ostadan.

18 DR. OSTADAN: Thank you, Your Honor

19

20 CROSS-EXAMINATION

21 BY DR. OSTADAN:

22 Q. Thank you, Dr. Soler for the description
23 and additional information.

24 I'm going to ask you a few questions
25 related to the movies and then some other few

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1 questions as it relates to these forces. But let
2 me just point out that you indicated towards the
3 ends of the presentation about the comment I raised
4 yesterday that no other party has asked for the
5 information, and, therefore, you did not feel
6 obliged to provide it. For what I expressed a
7 concern was acceleration of the pad and not the
8 forces, and I was surprised nobody has asked for
9 it. But I am still wondering if in the course of
10 these new analyses or any one of your previous
11 analyses that you have saved your meters to see
12 what is the acceleration of the pad?

13 A. Well, as far as the first question is,
14 that, quote, nobody asked, unquote, we were tasked
15 with the -- to get the forces from the casks on the
16 pad and transmit them to ICEC. We were not party
17 to the calculations being done by ICEC, nor were we
18 party to the calculations being done by Stone &
19 Webster in Boston. We wrote the reports. We had
20 conversations with Wen Tseng as to how we should
21 transmit the forces to him, but we were not party
22 to what use he was going to make of those forces.
23 When we were asked for information, we provided
24 information.

25 Of course, DYNAMO, we had the ability to

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1 calculate the accelerations on the pad without
2 rerunning the information because it was stored.
3 With the VisualNastran runs, in everything we've
4 done with VisualNastran, we have been focusing on
5 what the casks do.

6 Now, as far as your question on can we
7 plot accelerations of the pad or can we set up a
8 meter to get accelerations of the pad? We can, and
9 the raw data is available to do that. But we have
10 not offered that because I would not offer in the
11 same manner that Dr. Luk said that he was
12 presenting raw data and it should be filtered. I
13 make the same claim with respect to my analyses
14 here because the soil spring between -- the soil
15 cement spring between the two pads is a very stiff
16 spring by the nature of the 5-foot span and the
17 large area and the estimates on the modulus, and,
18 therefore, the direct calculation of acceleration
19 shows these high frequency effects. So since I did
20 not have the ability to filter that data, I did not
21 offer it in this exhibit.

22 Q. Do you have a feel for what that number
23 would be unfiltered?

24 A. Unfiltered, I suspect it's the same
25 order as Dr. Luk has presented.

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1 Q. Thank you, Dr. Soler.

2 May I ask you, do you have that slide
3 still on the one you showed? It might help the
4 discussion --

5 A. This is -- this is the summary of the
6 one page?

7 Q. That one page, yes.

8 A. Let me go get it here.

9 I guess I could turn this off.

10 MS. NAKAHARA: That's been marked as PFS
11 Exhibit 225C.

12 THE WITNESS: I think it will shortly
13 appear behind -- behind you as soon as the light
14 comes on.

15 Q. (By Mr. Ostadan) Okay. Thank you.

16 This is the case that you modeled the
17 soil cement between two pads as compression only?

18 A. Compression only.

19 Q. Is it fair to say this for tension --

20 A. Yes. I -- the tension is -- the program
21 considers it a spring, and, therefore, tension and
22 spring, so negative numbers mean compression. And
23 I believe I just -- well, they show on this slide
24 as negative numbers. Figure 7 doesn't show as
25 negative.

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1 Q. Let me see if I understand the physics
2 of this. You have two pads, and these pads are
3 supported by springs. And you have two lateral
4 springs, if you will, or horizontal springs that
5 can act only in compression. And based on that
6 analysis, you are saying the forces in the soil
7 cement are in these two figures on the left?

8 A. Correct.

9 Q. Now, if these two pads were to move
10 together in phase --

11 A. Yes.

12 Q. -- if you can imagine that, there would
13 not be any force on the soil spring in between the
14 two pads?

15 A. If it was a pure in-phase motion, I
16 agree.

17 Q. Okay. Now, the reason that you getting
18 forces in these two springs are here primarily
19 because the mass of the estimate on one pad is
20 quite different from the other.

21 A. Well, the reason I'm -- the reason I'm
22 predicting forces is because the spring constant is
23 very high and the relative deflections between the
24 two pads is very small, and the product of the two
25 is giving me the force. But the -- if you -- here

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1 you have to go to the movie which, of course, I
2 didn't create. But the pads are generally moving
3 in phase.

4 If you'll let me digress, I would like
5 to discuss a little bit of my written prefiled
6 testimony along these lines.

7 Q. Please do.

8 A. Prior to running the first two of the
9 three visualizations that were presented this
10 morning in movie form, I ran a very simple
11 analytical calculation of two masses, one mass
12 being the total of 8 casks plus a pad, which is
13 about 4 -- I think about 3.8 million pounds total,
14 and the other mass being equivalent to 1 mass plus
15 the pad -- 1 pad -- 1 cask plus the pad, and that
16 is roughly a little bit over 1 million. So it is
17 the case I've run in here, but I simplified it to a
18 2-degree of freedom linear system in which the two
19 masses are connected to the ground by identical
20 soil springs, but the two masses are connected to
21 each other by the soil cement spring.

22 Now, if you assume that that simplified
23 problem is completely linear, you can calculate the
24 eigenvalues -- e-i-g-e-n-v-a-l-u-e-s, all one
25 word -- and you find that the natural frequencies

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1 of oscillation for that system, depending upon how
2 many -- I did it for the case of no casks on the
3 second pad, 1 cask on the second pad, and 8 casks
4 on the second pad. And this is reported as part of
5 the PFS Exhibit 225.

6 And you find that the first natural
7 frequency is about 5 to 6 hertz, and the second
8 natural frequency of this 2-degree of freedom
9 system is on the order of anywhere from 29 to 47
10 hertz, depending on how you populate the empty,
11 quote, unquote, pad, my conclusion being there that
12 in this case since the earthquake provides its --
13 the majority of its power in say the low frequency
14 range of 0 to 10 hertz, that this earthquake would
15 primarily excite the in-phase motion. But, of
16 course, in a 2-degree of freedom linear system, you
17 never get exactly the pure in-phase and the pure
18 out-of-phase motion. You get a combination of the
19 two. And the relative importance of those two pure
20 modes to the combined solution depends on the
21 nearness of the natural frequencies to the input
22 power.

23 So having done that solution, I was
24 confident at the outset that my VisualNastran
25 solutions, the two involving the two pads would

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1 simply serve as confirmation. The fact that I've
2 generated forces in the soil springs simply
3 reflects that nothing is exactly purely in phase
4 and purely out of phase, and the particular choice
5 of 8 casks versus 1 cask was a reasonable attempt
6 to model what would likely be present over a long
7 period of time.

8 Q. Thank you.

9 But nevertheless, then, because of the
10 slight differences in the motion, as you said, from
11 one pad to the other and the high stiffness of the
12 soil cement you get the forces that you get there?

13 A. That is correct.

14 Q. And do you feel that you used reasonable
15 properties for the soil cement based on the
16 compressive strength of the design?

17 A. Well, certainly the area is fixed, the
18 distance between the pads is fixed, and I requested
19 and received from Stone & Webster an estimate of
20 the Young's modulus that should be appropriate.
21 The number I received was 350,000 to a million, and
22 since my initial thinking was to emphasize the soil
23 cement, I picked the larger of the numbers to run
24 here rather than the smaller.

25 Q. Well, we are certainly glad you obtained

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1 this additional information. It's been always the
2 State's position that pad-to-pad interaction is
3 important. And this 900 kips or so, if you look at
4 the total load for stability in the pad in order of
5 3,000 or so, is a significant number. It's about
6 one-third or so.

7 And so, now, the next question is for --
8 please recognize that Dr. Bartlett and I come from
9 the foundation side of the issues -- is that for
10 stability analysis now, we have some forces that
11 are going from the pad to the soil under the pad
12 represented by these two figures on the right, and
13 then we have some additional forces that for one
14 reason or the other, one pad is pushing the other
15 pad. Should we, in your opinion, then add up these
16 forces for stability analysis? How -- what do you
17 recommend --

18 A. Well --

19 Q. -- to be used for a stability analysis?

20 A. Well, I believe the question to be
21 addressed is the stability of the pads -- of the
22 pad with respect to meeting the regulatory
23 requirement of 1.1, so in that respect, what would
24 be most important, in my opinion, would be to know
25 the force in the substrate underneath the pad so

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1 you could compare that force as predicted by
2 whatever analysis program you're using against what
3 is purported to be the limit that you could take
4 before the pad would slide. So in that respect, I
5 would not be doing any addition if I could do it
6 any other way.

7 And here I attempted last night to do it
8 directly, to simply say, I'm not going to take
9 results from ICEC, which came from inputs that we
10 provided early in the analysis, and I'm not going
11 to, then, try to estimate what the forces from the
12 pad are because I, unfortunately, don't have a pad
13 acceleration, so I have to use my best guess that
14 it's going to be the PGAs, but, instead, simply
15 directly try to measure the time history of those
16 forces underneath the pad. And within the
17 constraints of how the soil is modeled, namely, the
18 6 springs, you can get, then, the time history of
19 those forces directly.

20 If you wanted to know whether a
21 particular force added or subtracted at any given
22 time, you, then, probably have to process the data
23 in a more elaborate way outside very this program,
24 although I suspect with a little ingenuity one
25 could create a meter that actually looked at the

1 difference between the total force and the force in
2 the other meter. But this seemed to be the most
3 direct way to do something in an 8- or 9-hour span.

4 Q. And let me see if I can ask the question
5 again. The results showed that one pad is pushing
6 the other pad.

7 A. That is correct, in some instances.

8 Q. In some instances. This is an
9 additional active force, if you will, that a
10 neighboring pad is exerting on the pad we are
11 looking at.

12 A. That is correct.

13 Q. This force needs to be considered in the
14 sliding analysis of the pad, the interaction
15 between the two pads.

16 A. That is correct.

17 Q. So would you agree that, therefore, this
18 additional interaction force between the two pads
19 should be added to the force below the pad for
20 stability analysis?

21 A. No, because the -- if you recall
22 Mr. Trudeau's testimony, the number that he was
23 working with or has been working with is the
24 maximum value of a force underneath the pad that he
25 has estimated by taking some results from ICEC and

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1 then adding some results of his own having to do
2 with the force exerted by the pad.

3 Now, he has one number which is a
4 maximum value at, presumably, some instant of time,
5 which I do not believe he uses in his analysis, and
6 it was suggested that having this other number of
7 1.9 million, you should directly add that force to
8 his force. That was precisely the reason for which
9 I did this reanalysis, to determine that while it
10 is true that you may have to add the two forces,
11 you can't be adding forces that may occur at
12 different times and simply add them up.

13 So, if you will, I submit that the
14 numbers shown in the two right-hand graphs, one
15 above another, include the additive or subtractive
16 effects of those forces because it depends, when I
17 have a compressive force between the two pads, as I
18 obviously do at some instance in time, it is not
19 clear, unless you have this analysis, to determine
20 whether what -- the force in the soil spring is at
21 that instant and whether it is, in fact, tension or
22 compression to decide whether you have to add it or
23 to subtract it. I submit that this analysis
24 bypasses that and simply says this is the total
25 force that you measure in this spring to put the

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1 particular pad in equilibrium with all of the other
2 forces, including the pad-to-pad force and the
3 inertia forces of the pad itself and the casks
4 themselves and anything acting at the contact
5 surface.

6 So in the simplest case, if one could
7 determine that Mr. Trudeau's force was at 5
8 seconds, say, for argument's sake, and that you
9 could also determine that a particular pad-to-pad
10 interaction force was at 5 seconds, then it would
11 be correct to either add it or subtract it if you
12 knew the sine at that time because it is clear that
13 Mr. Trudeau's calculation did not include the
14 effect of this pad-to-pad force, but I submit it is
15 too simplistic to simply take its magnitude and add
16 it to his number.

17 Q. I agree with that, Dr. Soler, but let me
18 understand this. PFS's position has been that
19 pad-to-pad interaction is not important, and I'll
20 let the record speak for itself that one of the
21 inferences on PFS side is that it's a secondary
22 effect and it would not impact the loads.

23 Now, we have 900 kips here that you have
24 calculated, and apart from what Mr. Trudeau has
25 done, if we have to do a stability analysis from

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1 scratch today, is it your recommendation that we
2 should add the loads on the graph on the left with
3 the one on the right and use that for a stability
4 analysis or just use the ones at the right?

5 A. Just use the ones on the right.

6 Q. Okay. Let me move on, then. I think
7 all of us yesterday had the opportunity to look at
8 the figure where it shows the layout of the pads.

9 A. I'm not sure that I may have been
10 present at that time so --

11 Q. It's one of the exhibits, I believe,
12 from yesterday.

13 MR. GAUKLER: Dr. Soler, do you want to
14 turn off the slide now?

15 MR. TURK: Can I ask for a
16 clarification?

17 JUDGE FARRAR: Yes.

18 MR. TURK: At different times there's
19 mention of the graphs on the left and graphs on the
20 right. Just for the clarity of the record, I
21 assume we're talking about 225C?

22 THE WITNESS: Yes.

23 JUDGE FARRAR: Thank you.

24 MS. NAKAHARA: Dr. Soler is looking at
25 PFS Exhibit 84.

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1 Q. (By Dr. Ostadan) Again, let me remind
2 you that Dr. Bartlett and I are primarily dealing
3 with the foundation and the stability of the
4 foundation.

5 The logic that has been set forth so far
6 has been that the loads from casks would be
7 transmitted to the pad and then from the pad to the
8 soil treated with cement underneath and then to the
9 Bonneville clay underneath and so on. That has
10 been the primary focus of the way the load gets
11 down to the foundation into the soil medium when we
12 are obviously looking at whether the soil has the
13 capacity to carry such loads or not.

14 And what your new results show, that a
15 significant part of the load is taken out by this
16 ladder of the spring, the soil struts or soil
17 cement struts, so, therefore, looking at the figure
18 that you have in your hand and recognizing that in
19 each column we have 10 pads separated each by 5
20 feet, if you carry on your analysis, the one you
21 did last night, now, with 10 pads and you ask
22 yourself -- and there are now zillions of
23 combinations on how many casks on each pad -- where
24 do we end up on these loads between the pads? This
25 1900, would it increase? Significantly decrease?

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1 If you look at these, are they all pushing each
2 other? How could we carry this logic to our
3 foundation design?

4 A. Well, this is an extrapolation of the
5 largest magnitude. If I had modeled, assuming that
6 I could within the capacity of the program in a
7 computer, 10 pads in a row with any number of casks
8 on each pad but the same soil springs underneath
9 each pad and the same soil cement spring between
10 each pad, I -- obviously the same total load exists
11 and will get back to the soil. It's just which pad
12 will -- let me back off a little bit.

13 If I had examined each pad separately, I
14 would predict, of course, that all the load goes
15 directly into the soil directly below that pad
16 because I've assumed that nothing surrounds it. As
17 I add pads and if I extrapolate my results here
18 that would say that cask-to-cask interaction
19 because of slight movements of each pad relative to
20 one another, are going to generate a load in each
21 soil cement spring and therefore transfer some of
22 the load that would go into the soil directly
23 possibly over one pad, if that were the case, on
24 the basis of the result that I have and on the
25 basis of all of the other results that I've done

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1 for whichever model you care to pick, I would be
2 willing to hazard a guess, based on engineering
3 judgment, that while the individual results would
4 change from -- from what I've gotten, I do not
5 believe that certainly I would start predicting
6 that a cask would overturn on any one of the pads.

7 As far as the total load in the soil
8 underneath a respective pad, all I can do is go
9 back to these results and say, of the two pads,
10 certainly while there is a load transfer between
11 pad to pad, and certainly the results of what load
12 goes into the soil directly under a given pad would
13 change somewhat, I do not believe that you would
14 ever come up with a case where they would directly
15 add to the point mathematically where you would
16 exceed the limit for sliding.

17 Now, that's just an opinion, and it
18 is -- requires a great extrapolation. I would
19 obviously feel more comfortable and more emphatic
20 in my statement if one could model 6 pads. My
21 modeling of only 2 was directed primarily, I think,
22 by Dr. Bartlett's testimony that he thought that 2
23 pads would be enough to see whether there was some
24 kind of an effect. So that's what I concentrated
25 on.

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1 Q. I appreciate that. I think that was
2 very useful. It just turned out that what you did
3 showed a significant change, at least in my
4 thinking, as how the load goes down to the soil.
5 And I really think that the total load is what the
6 total load is, but let me submit to you that how it
7 goes to the soil is very important from our end of
8 issues. And whether it all goes down right under
9 the pad or part of it is maybe, I guess,
10 transmitted laterally, whether or not you have this
11 progressive compounding compressive effect from one
12 pad to the other, depending how they are loaded, I
13 guess it's fair to say is not known at this time?

14 MR. TURK: Your Honor, may I interject?
15 Dr. Ostadan is serving as counsel today, not as a
16 witness, so we will not cross-examine him on any of
17 the statements he's making. By the same token, we
18 submit that Dr. Ostadan's statements are not going
19 to be offered as evidence by the State unless he's
20 sitting in the witness chair and is able to be
21 cross-examined.

22 MS. NAKAHARA: Your Honor, Mr. Turk
23 himself has testified multiple times in this
24 proceeding and has gotten statements on the record
25 about the position of the Staff and has not used

1 Staff experts to enter the information on the
2 record.

3 JUDGE FARRAR: Well, let me -- it's one
4 thing -- it's one thing when counsel makes a
5 statement of what he or she thinks is correct
6 because that we know to disregard, in a manner of
7 speaking. I was hoping that Dr. Ostadan's last
8 statement was going to end with isn't that correct,
9 Dr. Soler, but it didn't end with that, so what I
10 heard was more a statement in the nature of
11 testimony. So what I would -

12 MS. NAKAHARA: Your Honor, if I may make
13 a suggestion that you use Dr. Ostadan's statements
14 in his cross-examination as background to setting
15 up the next question --

16 JUDGE FARRAR: In other words,
17 Dr. Ostadan --

18 MS. NAKAHARA: -- not as testimony that
19 will --

20 JUDGE FARRAR: What he just said we will
21 take as a statement of the State's -- not as
22 testimony but as a statement of the State's
23 position. And now if you'd like to follow up and
24 ask Dr. Soler whether he agrees with that position,
25 we may extricate ourselves from this.

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1 Mr. Gaukler, would that satisfy you?

2 MR. GAUKLER: Yes, it would, with
3 Dr. Ostadan saying now it's not testimony based on
4 the State's position.

5 JUDGE FARRAR: Mr. Turk would that
6 satisfy you?

7 MR. TURK: Yes, Your Honor.

8 DR. OSTADAN: Your Honor, that is what I
9 said corrected.

10 JUDGE FARRAR: At the risk of confusing
11 the issue, could you repeat what you said?

12 MR. GAUKLER: Could we read back --

13 JUDGE FARRAR: Well, do we need -- do
14 you remember the gist of it?

15 THE WITNESS: I'm not sure I remember
16 the conclusion which was inferred from the gist of
17 it.

18 JUDGE FARRAR: All right. Then let's
19 read it back.

20 MR. TURK: Or ask Dr. Ostadan to ask the
21 question.

22 JUDGE FARRAR: Yeah. It -- the reason
23 I'm hesitant to read it back is it was a very long
24 statement.

25 Dr. Ostadan, is there a way you could

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1 ask a -- based on that statement, ask not a very
2 simple question, do you agree, but a slightly more
3 complex question that could be based on that
4 statement?

5 DR. OSTADAN: Yes, Your Honor, I'll try.

6 Q. Your result of casks indicated a load
7 transfer from one pad to the other. In this case
8 it turned out to be in the order of 900 kips. The
9 question is if we look at 10 pads and considering
10 various loading combination on these pads from 1 to
11 a few, would there be compounding of these
12 compressive forces from one pad to the other,
13 looking at, let's say, a row of 10 pads?

14 A. First let me clarify your question. You
15 said 900. Didn't you mean 1900?

16 Q. I'm sorry. 1900.

17 A. And you also said in looking at the case
18 of two casks. I assume you meant two pads.

19 Q. Thank you very much. That's what I
20 meant.

21 A. Okay. Having clarified that, you could
22 certainly infer that because, from the solution
23 here that presumably predicts when compared to
24 Mr. Trudeau's solution that there is a decrease in
25 force to the pads -- to the soil underneath one

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1 pad, that if you model 10 casks, somewhere along
2 the line there presumably might be an increase in
3 force under one of the pads. Otherwise, at some
4 instant of time, you wouldn't be in equilibrium.

5 Assuming that's a reasonable assertion,
6 on the bases of what's done, I would proffer the
7 fact that the decrease that I predicted would most
8 likely be on the same order of magnitude as the
9 increase that you might see somewhere else, so I
10 would certainly not rule out the possibility that
11 Mr. Trudeau's number of 2 million 900 kips, as a
12 total soil load, could go down to 2 million 300 and
13 could possibly go up to 3 million 500, that order.
14 However, I don't believe -- and, again, this is
15 just engineering judgment -- that it would exceed
16 the technical requirement of the load needed to
17 give you a 1.1 safety factor, but I can't prove it.

18 Q. You haven't quantified that?

19 A. I haven't quantified it. The only
20 numbers I have are two pads.

21 Q. I don't mean to be impolite, but does
22 this means as we put more inertia on more pads,
23 it's getting better and better?

24 A. I'm not sure I understand your question.

25 Q. You're saying the loads are --

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1 transported under the pads are reducing. I'm
2 saying as we increase the pads and add the casks to
3 them, looking at the big project as a whole, does
4 it really basically mean that it's going to improve
5 in terms of reducing seismic loads?

6 A. No. I think things will just be
7 shifting around. You have to -- you have to draw a
8 boundary around your problem somewhere. I've drawn
9 it as two pads. If you drew it at 10 pads and were
10 able to fit that into the model in the detail that
11 I've done here, then Mr. Trudeau would say, on the
12 basis of the results that he's able to calculate,
13 that his total load into the soil would be 10 times
14 2 million 900 kips, assuming that everything was
15 lockstep in phase. I have shown here that, in
16 fact, the peak load in this case goes down to 2.3
17 million. That is not to infer that if I put 10
18 casks -- 10 pads in a line that I would be reducing
19 the total load in the soil. The total load in the
20 soil remains -- and I -- I'd be comfortable using
21 his as an average -- remains 10 times his number,
22 but it's highly likely that it will -- any
23 individual pad will oscillate one way or another
24 about the number 1/10 of the total. That's the
25 best I can say.

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1 MS. NAKAHARA: Just to clarify for the
2 record, I think Dr. Ostadan and Dr. Soler
3 understood each other. I'm not sure everybody else
4 did.

5 The question implied that as each cask
6 is subsequently loaded and -- you have more casks
7 loaded, it's more pads loaded. Is that how you
8 understood the question?

9 THE WITNESS: Well, I think I understood
10 the question as whether you model 2 pads or 10
11 pads, so maybe I didn't understand the question if
12 that was the real intent.

13 Q. (By Mr. Ostadan) I am satisfied with
14 your response.

15 A. Okay.

16 Q. Let me move on --

17 MR. GAUKLER: Well, I'd like to have the
18 record clear, and I think that what Dr. Soler just
19 said was he assumed that the question was the
20 modeling of 2 pads versus 10 pads.

21 Is that how you assumed the question --

22 THE WITNESS: That was what I assumed
23 the question, that if I had modeled 10 pads, would
24 I not -- and here's my words, not Dr. Ostadan's --
25 would I not expect some soil loads to go up rather

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1 than down? And I think my answer simply was yes.

2 MS. NAKAHARA: That question is fine.
3 It answers his question.

4 Q. (By Dr. Ostadan) Thank you. Do you
5 recall yesterday we were talking about the angle of
6 incidence in Dr. Young's testimony?

7 A. I don't believe I was present at that
8 time.

9 Q. Part of that testimony, the discussion
10 went on that if you consider two or three groups of
11 pads with larger plan dimensions, then as small as
12 these angles are, they would translate to a bigger
13 time shift, if you will, in arrival time and phase
14 delay in response. Now, in looking at your results
15 today and the mechanism that you have observed that
16 there will be certainly a load transfer taking
17 place, a significant load transfer, would you now
18 render an opinion as to if one group of these pads
19 and the other group tend to move out of phase on
20 the account of incoming waves which you have not
21 included in your calculation last night, it would
22 aggravate the transfer of loads, then?

23 MR. GAUKLER: Objection. It's going
24 beyond the scope of his rebuttal, going into the
25 nonvertically propagating waves which was

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1 Dr. Youngs' testimony that we discussed yesterday.

2 MS. NAKAHARA: It relates to Dr. Soler's
3 calculations of soil cement and how this all ties
4 together, which has been the State's premise from
5 the beginning, that we cannot bifurcate these
6 issues, that the analysis has to be conducted
7 comprehensively.

8 JUDGE FARRAR: Does the Staff have any
9 thoughts?

10 MR. TURK: I would reiterate what my
11 position was yesterday with respect to the scope of
12 cross. It's limited by the testimony offered.

13 JUDGE FARRAR: We have the complicating
14 situation here that we're not only crossing on the
15 rebuttal but crossing the previously reserved
16 opportunity. Which does this tie in to? Or --

17 MS. NAKAHARA: I submit it ties in to
18 both.

19 MR. TRAVIESO-DIAZ: If I may say
20 something --

21 JUDGE FARRAR: Yes.

22 MR. TRAVIESO-DIAZ: -- since I was here
23 yesterday during the discussion, they attempted for
24 a number of times to get Dr. Youngs to testify to
25 the effect of changes of the angle of arrival of

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1 the nonvertical waves into movements of rows of
2 pads. Now they're trying to do the opposite,
3 trying to take testimony that was given in
4 Dr. Youngs' and was Dr. Youngs' views, the areas to
5 which Dr. Youngs had knowledge and apply to this
6 witness who has not testified on that theory. The
7 State may want to tie all these thoughts together,
8 but that is either for testimonial witnesses or,
9 better yet, for finders of fact. He's now trying
10 to get to that through witnesses, each of which has
11 a different area of expertise. And to ask Dr.
12 Soler who has not testified as to nonvertical
13 propagating waves as to testimony which is in the
14 scope of Dr. Youngs I think is both ineffective and
15 not really fair, in addition to which it's way
16 beyond the scope of the testimony that he has
17 proffered here.

18 (The Board confers off the panel.)

19 JUDGE FARRAR: Having consulted with my
20 colleagues, we're all of the view that in
21 situations like this it would be better that,
22 rather than us acting on the lawyers' objections,
23 we ask Dr. Soler if this is something that he's
24 familiar -- familiar with in the context in this
25 case and its proceeding, I don't mean generally

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1 familiar with in your education and background
2 somewhere, but is this question fairly -- in your
3 judgment, Dr. Soler, fairly a part of your
4 testimony and your presentation?

5 THE WITNESS: I believe I could address
6 what I believe the final sentence of his question
7 is heading toward, and that is isn't it possible
8 that one pad could be moving much more out of phase
9 than another pad at the other end of the row. Is
10 that -- no?

11 JUDGE FARRAR: But whether or not you
12 can answer that, is that something that you feel
13 deals with the presentation you've made here?

14 THE WITNESS: Well, certainly I have
15 addressed the issue of in and out-of-phase motion,
16 so I would feel comfortable in fielding a question
17 to the extent that I could dealing with anything
18 that could possibly lead to such out-of-phase
19 motion, although I wouldn't feel comfortable
20 addressing, I guess, the causes of what leads to
21 the waves coming up at different times.

22 (The Board confers off the record.)

23 JUDGE FARRAR: All right. Then go ahead
24 and answer it as you understand it.

25 THE WITNESS: Now, apparently I didn't

1 anticipate correctly what you're driving at, so --

2 Q. (By Dr. Ostadan) Let me ask -- maybe
3 that would help, if I ask a simpler question. Did
4 you analyze two groups of pads next to each other,
5 say a group of 10 each with soil cement in between,
6 considering incoming waves?

7 A. No.

8 Q. Thank you.

9 With respect to pad-to-pad interaction
10 again --

11 JUDGE FARRAR: And, again, Dr. Ostadan,
12 in order to make this go efficiently, let me ask
13 you to try to ask more questions in the nature of
14 that one that you just asked rather than the ones
15 that have a very long preface.

16 DR. OSTADAN: Yes, Your Honor. I'll
17 try.

18 JUDGE FARRAR: And then if the witness
19 doesn't understand the question, then we can give
20 more background. I think the way to solve the
21 problem we just had is to ask more of the
22 straightforward questions.

23 DR. OSTADAN: Yes, Your Honor. I'll
24 observe.

25 Q. The forces that you got between the two

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1 pads indicates significant load transfer from one
2 pad to the other pad. Dr. Tseng in the past has
3 testified that pad-to-pad interaction is a
4 secondary effect. Have you discussed his result
5 with him and seen his opinion?

6 A. No, I have not.

7 (A discussion was held off the record.

8 MR. TURK: Your Honor, may I request in
9 line with your suggestion a moment ago, there seems
10 to be a characterization before the question, if we
11 could avoid that and just ask the question rather
12 than load it with a conclusion first?

13 DR. OSTADAN: Very well. I'll do that.

14 Q. And I have very few more very basic
15 questions. This will hopefully help the testimony
16 coming up. It has to do with forces again.

17 Going back to your original model that
18 you analyzed the cask and pad for 2,000-year
19 motion, let's concentrate for a moment on the
20 interface between the cask and the pad. And I
21 realize you did various scenarios of 8 casks, 4
22 casks, 2 casks. Let's just think of 1 cask for a
23 moment. And could you explain what is the boundary
24 conditions between the bottom of the cask and the
25 pad, specifically how many springs, how many dash

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1 pots and in which directions you put those in?

2 A. Okay.

3 MR. GAUKLER: That's beyond the scope of
4 the rebuttal.

5 MS. NAKAHARA: This relates to
6 understanding the force time histories.

7 MR. GAUKLER: Okay.

8 THE WITNESS: Just a question to you in
9 clarification. Are you interested in the results
10 from DYNAMO or the VisualNastran?

11 Q. (By Dr. Ostadan) The analysis that you
12 provided of the forces to ICEC.

13 A. Okay. That --

14 MR. GAUKLER: Okay. Just, I guess, for
15 clarification, now we're going into
16 cross-examination of the time histories, correct?

17 MS. NAKAHARA: Yes.

18 THE WITNESS: In the DYNAMO solutions or
19 model, the interface between the casks and the pads
20 are represented by 36 contact points around the
21 periphery. I would not classify those locations as
22 boundary conditions. Rather, they are simply
23 relationships between a point on a cask and a point
24 on the pad at a particular location around the
25 periphery consistent with the assumptions of small

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1 motions. At each one of those 36 points there is a
2 normal spring, normal being vertically oriented,
3 and two horizontal springs in the X and Y
4 direction, those being the two horizontal
5 directions. The value of the normal spring is 1/36
6 of the 454 million pounds per inch.

7 Q. (By Dr. Oshadan) If I may save some
8 time, you do not need to give estimate --

9 A. Okay.

10 Q. -- just the nature --

11 A. The algorithm in the computer program
12 says that at every instant in time determine the --
13 whether or not the normal spring compresses. If it
14 compresses, then calculate the forces in the
15 horizontal springs from mu times that instantaneous
16 normal force and determine whether those forces are
17 greater than or less than the force necessary to
18 slide. If, of course, there is liftoff at that
19 location, the normal force has no force in it, the
20 force is zero of that spring, and, therefore, there
21 is no ability to resist horizontal loads, and,
22 therefore, sliding is indicated at that location.

23 There is no other assumption except what
24 is built into the coding to check whether or not,
25 first, the two points that you're tracking are, in

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1 fact, in contact, and, if they are in contact, then
2 comparing the allowable horizontal force based on
3 the coefficient of friction with the calculated
4 horizontal force directly in the two springs. And
5 then you get an either-or condition, either the
6 horizontal springs act elastically in accordance
7 with the very stiff value we put in or we get
8 sliding.

9 Q. Is there a dash pot at this contact
10 point also for damping or just --

11 A. Only in the normal spring to represent
12 impact damping.

13 Q. So there is a dash pot only in vertical
14 direction?

15 A. Only in the vertical direction.

16 Q. In other words, only in the compression
17 of it?

18 A. Only invoked when you have compression.

19 Q. So the forces that you provided ICEC, I
20 assume, re the time history of the forces in these
21 springs, vertical and horizontal, as you
22 calculated --

23 A. I believe after -- and this is strictly
24 by memory, but I believe after some discussion back
25 and forth between the two companies we provided

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1 them with the net force per quadrant, 4 quadrants.
2 Rather than giving them 36 individual time
3 histories for each direction, we agreed -- or they
4 requested that based on what they planned to do, it
5 would be simpler to just provide them with the sum
6 of 9 sets for each quadrant.

7 MR. GAUKLER: Now, quadrant here, you're
8 talking about one -- you're talking about one cask,
9 just to clarify the record?

10 THE WITNESS: Actually, we provided
11 those results --

12 MR. GAUKLER: I'm just talking when
13 you're talking about quadrant here, you're talking
14 about --

15 THE WITNESS: A quadrant for each cask.

16 MR. GAUKLER: Okay.

17 Q. (By Dr. Ostadan) And how did you
18 calculate the forces that you gave to ICEC for each
19 quadrant, briefly? Did you add up the forces in
20 the spring in each quadrant time --

21 A. Time-wise, yes.

22 Q. So, for example --

23 A. We have -- DYNAMO saves the complete
24 time history of every spring force that we model,
25 and, therefore, we simply extracted the vertical,

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1 say, in groups of 9 and then, I believe, used a
2 separate program to simply add them up at each
3 interval.

4 Q. So, for example, for quadrant 1, for the
5 sake of discussion, you have 9 vertical springs,
6 your program has given 9 time histories of vertical
7 forces. You simply went there and added them up --

8 A. Time-wise, correct.

9 Q. -- as a function of that?

10 A. Correct.

11 Q. What did you do with the force in the
12 vertical dash pot?

13 A. Well, the force in the vertical dash pot
14 and the force in the vertical spring are reported
15 as a sum, so the forces we provided to them, I
16 guess you could say, were the sum of the components
17 that go through the spring and the components that
18 go through the dash pot.

19 Q. So you also included the force in the
20 dash pot?

21 A. Yes. It was the total vertical force
22 between the cask and the ground.

23 Q. Cask and the pad, you mean?

24 A. Cask and the pad.

25 Q. Do you recall how much is it due to dash

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1 pot, how much is it due to spring --

2 A. I have no capability to separate the
3 two.

4 Q. Okay. Let me move on on the same --
5 same -- similar topic for in the pad now and the
6 soil under. You have a set of conditional springs
7 that you use in your model?

8 A. Correct.

9 Q. Okay. And I suppose there are three
10 translation and three rocking and torsional
11 springs. Is that fair to say?

12 A. Here I would have to refresh my memory,
13 but I believe, although I may be confusing
14 projects, since -- since the pad was -- I guess, to
15 be honest, I'd have to look at the appendix to that
16 report to really be sure of my answer.

17 MR. GAUKLER: What report are you
18 referring to?

19 THE WITNESS: This would be the one that
20 has the infamous Rev. 2 in its title.

21 MR. GAUKLER: That's State Exhibit 173,
22 I believe.

23 JUDGE FARRAR: Does anyone have that?

24 MR. TURK: We should.

25 MR. GAUKLER: We have it right here.

1 THE WITNESS: I think I know the answer
2 to the question.

3 MS. NAKAHARA: We have it.

4 THE WITNESS: Yes, the -- the
5 description of the soil was with 6 soil springs, 3
6 forces and 3 moments, under the pad at its center.

7 Q. (By Dr. Ostadan) And six dash pots
8 also?

9 A. And six dash pots, correct.

10 Q. So the forces that you calculated, the
11 foundation forces, for example, the forces you
12 showed earlier in exhibit to be admitted 225C, are
13 these the forces in the springs or the dash pots or
14 both?

15 A. Both. They -- the notation "soil
16 springs" is -- since its considered as a spring, it
17 has -- a general spring, it has both spring and
18 damper capabilities. Of course, one can turn off
19 one or the other by simply zeroing either the
20 spring constant or the damping coefficient and make
21 it either a pure damper or a pure spring. But what
22 it reports, it being the meter, is -- is the total
23 of whatever you have defined. If you've defined a
24 non-zero spring constant and a non-zero dash pot,
25 the result you'll report is the total force, and I

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1 believe in the theoretical section of 255 on
2 page --

3 MR. GAUKLER: You mean 225.

4 THE WITNESS: 225. In particular, on
5 page 11 of that report, there was a formula which
6 relates force to deformation and velocity. F is
7 what is reported, both in what we sent to ICEC
8 using DYNAMO and what we've reported when we
9 reported it in all of the simulations using
10 VisualNastran.

11 Q. (By Mr. Ostadan) Do you have a feel how
12 much of this force is due to spring and how much of
13 it is due to dash pot?

14 A. I have no feel at all, and without
15 manually creating another meter which simply, say,
16 tracks C delta dot or KX -- KX just together -- I
17 could not begin to offer an opinion.

18 Q. I assume in the set of results you have
19 provided it would not be possible to get that
20 information either?

21 A. Not -- not -- not without setting up
22 meters and redoing the runs.

23 DR. OSTADAN: Thank you, Dr. Soler.

24 MS. NAKAHARA: Your Honor, that
25 concludes our cross-examination.

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1 Thank you. Dr. Soler.

2 JUDGE KLINE: I would like -- give me
3 some sound here.

4 I have to ask the boss for sound.

5 I've been sitting here wondering how
6 your 2-pad interactive analysis applies to the full
7 array of pads also. And my understanding from your
8 Question and Answer 4 is that when we have in-phase
9 forces that we really don't have much to worry
10 about, that is to say, that the pads move in phase
11 and then interact to a very small degree. Is
12 that -- that's -- that's my understanding of your
13 testimony. Is that correct?

14 THE WITNESS: Well, yes. If I had a
15 pure -- think of it this way: If you assume that
16 my simple model exactly represented 2 pads, which
17 it doesn't, and I solved that problem exactly and
18 then I imposed a sinusoidal input to represent the
19 earthquake, now if I adjusted that earthquake so it
20 exactly had a frequency of 5 hertz or whatever the
21 appropriate number was, then I would purely excite
22 the pure in-phase motion of those 2 masses. On the
23 other hand, if I said that the earthquake really
24 had -- was equivalent to a sine wave with -- let's
25 take one of the cases -- 29 hertz as the peak power

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1 point of the earthquake, then in this simple model
2 I would excite the purely out-of-phase motion.

3 Now, the fact that the real earthquake
4 has distributed frequencies from -- important ones
5 from, say, half a hertz on up to 33 hertz and
6 perhaps beyond, you will obviously in the real
7 problem -- and if you'll forgive my modesty, the
8 real problem being the VisualNastran solution, you
9 will excite both, and it's only the degree of
10 excitation of each case.

11 Now, the compounding problem here is
12 that you have a very stiff spring between the 2
13 pads, and therefore the slightest bit of relative
14 motion between the 2 can excite a large force. But
15 the important thing is whether -- whether -- at
16 least from our point of view, is whether or not
17 this large force could do any damage to the casks
18 in terms of increasing the displacements,
19 increasing the propensity of them to move. This
20 last solution, of course, is attempting to aid in
21 the understanding of what happens in the -- in the
22 soil.

23 Now, have I answered your question or
24 not?

25 JUDGE KLINE: Well, we're going to go on

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1 from there.

2 THE WITNESS: Okay. Then let me stop
3 there and see what you've got.

4 JUDGE KLINE: So let's stop there. And,
5 now, do consider the out-of-phase portion of your
6 answer and back away now and take an artist's view
7 of the whole array of casks. Would it be fair to
8 say that for the out-of-phase motions that the
9 summation of forces across the full array would sum
10 to zero, well, for the pad-to-pad interactions?
11 That is, even though this is -- for individual pads
12 there may be forces on one to the other, across the
13 full array of pads, they would sum to zero, would
14 they not --

15 THE WITNESS: Let me think about that.

16 JUDGE KLINE: -- for the out-of-phase --
17 for the out-of-phase motions?

18 (A discussion was held off the record.)

19 THE WITNESS: Ready?

20 JUDGE KLINE: Yeah, I'm ready. I've
21 been ready.

22 THE WITNESS: I'm not sure I would
23 necessarily agree or disagree. It's impossible to
24 construct a simple free body --

25 JUDGE KLINE: Yeah.

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1 THE WITNESS: -- which would enable you
2 to get to that conclusion.

3 JUDGE KLINE: Well, let me put it this
4 way: Look at your Figure 225C, and let us add a
5 third -- a third pad down to the lower left of the
6 pad that has a single cask on it.

7 THE WITNESS: Okay.

8 JUDGE KLINE: And ask, now, for the two
9 pads that you show a compressive force acting
10 between the two pads, is it fair to say that the
11 forces between our imaginary third pad and the
12 second one would be tension, would be in tension?

13 THE WITNESS: Well, except for the fact
14 that in this case I have precluded any tension.

15 JUDGE KLINE: Well, I understand your
16 model. What I'm asking is the physics of it.

17 THE WITNESS: Well, I think the
18 physics says, I've been led to believe, that it's
19 highly likely that may get some cracking if you
20 develop tensile forces, and without me addressing
21 yes or no, I simply did the two cases.

22 JUDGE KLINE: Okay.

23 THE WITNESS: Now, I could certainly in
24 my mind imagine a situation with 3 casks -- 3 pads
25 and some motion which at some instant in time the 2

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1 outer pads were moving toward one another --

2 JUDGE KLINE: Ah, that -- okay.

3 THE WITNESS: -- and the pad in the
4 middle wasn't moving at all. And in that case you
5 would have compressive loads in both cases, and I
6 believe in that case you'd probably find they add
7 up to zero.

8 JUDGE KLINE: Yeah, that was my next
9 question. Really it has to do with whether --
10 assuming that there's an array of some kind of
11 tensile forces and compressional forces across the
12 full array of pads, setting aside for a moment
13 whether they sum exactly to zero -- I don't know if
14 they do either, but is there any physical means by
15 which these forces might in some sense focus such
16 that several pads acting together just
17 coincidentally focus their energy on one pad in
18 such a way that is non -- that's noncancelling, in
19 other words, in such a way that it's additive?

20 THE WITNESS: I don't believe -- and
21 this is a real leap --

22 JUDGE KLINE: Yeah.

23 THE WITNESS: -- that I could conceive
24 of some pad in the middle or whatever it is --

25 JUDGE KLINE: Yeah.

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1 THE WITNESS: -- having things line up
2 to the extent where at a particular instant in time
3 the forces from each adjacent cask --

4 MR. GAUKLER: Each adjacent pad.

5 THE WITNESS: You can see where my mind
6 is after such a long period.

7 -- each adjacent -- you're lucky I'm not
8 talking about racks in the pool -- in each adjacent
9 pad could add up so as to drastically affect the
10 force in the soil underneath the pad.

11 Now, at the risk of saying too much, I
12 will say I have certainly had experience with racks
13 in spent fuel pools. Now, granted there's water
14 that's kind of distributing everything amongst
15 everything else, but in that case, you do -- if you
16 step back far enough, you generally see everything
17 going back and forth and you do not see any anomaly
18 where one particular rack suddenly seems to get
19 much, much larger forces than all the rest as far
20 as the reactions on the floor.

21 JUDGE KLINE: All right. Now, just one
22 more -- one more brief series, then, and that is
23 there are some -- in the full array of pads, there
24 are some -- what you might call asymmetries, or
25 what you've called half-space in other contexts,

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1 which occur at the outside border of the array of
2 casks. That is to say, at the outside border,
3 there are pad-to-pad interactions arising from the
4 interior of the array, but none arising from the
5 exterior.

6 THE WITNESS: That's correct.

7 JUDGE KLINE: Is there any kind of
8 focusing of forces that might occur by virtue of
9 the pads being on the outside border of the array?

10 THE WITNESS: Well, I mean for the
11 particular analyses I've done, both casks are on
12 the outside border --

13 JUDGE KLINE: Well, I --

14 THE WITNESS: -- but that's just --

15 JUDGE KLINE: No. I'm thinking of the
16 full array where there could be some coincidental
17 convergence of forces that might momentarily focus
18 on one or especially situated cask that's, for
19 example, in the outer boundary.

20 THE WITNESS: I can't answer that
21 truthfully yes or no, but if you'll permit me, I
22 would like to extend my remarks as far as they
23 refer to cask stability and sliding of pads.

24 I know that the -- the whole thrust of
25 the State's questions to me today are directed

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1 toward admitting, if I could or would, the
2 possibility of the forces under a particular pad
3 getting so large as to cause the technical
4 requirement of the 1.1 safety factor of sliding to
5 be exceeded momentarily. I would like to go on
6 record as saying, as far as the casks are
7 concerned, I really couldn't care because the casks
8 will only see less energy if they're momentarily
9 sliding, and in real life, real life meaning
10 outside of the technical regulations, I, again, do
11 not have a problem with -- with casks sliding --
12 pads sliding as long as we're talking small
13 numbers. I obviously wouldn't want to have a pad
14 sliding a large distance, but minute amounts of
15 sliding to me are just bound up in this technical
16 regulation which really was not written with this
17 particular problem in mind. We just have to live
18 with it.

19 JUDGE KLINE: Okay. Thank you. That's
20 as far as I'll pursue it, and I'll leave it to the
21 State if they want to take it any further.

22 JUDGE FARRAR: Let me just ask a
23 clarification. When you just used the terms
24 "large" versus "minute," give us some idea what you
25 mean by that.

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1 THE WITNESS: Well, I guess if I were
2 standing somewhere in the vicinity of a 30-foot be
3 67-foot pad with 8 casks that were roughly 20 feet
4 high on them, I would get somewhat perturbed if I
5 saw it coming toward me a foot, foot and a half,
6 but an eighth of an inch, I wouldn't even see it.

7 JUDGE LAM: Now, Dr. Soler, a pad, an
8 empty pad without any casks sitting on it weighs
9 slightly less than a million pounds.

10 THE WITNESS: Correct.

11 JUDGE LAM: Now, when I'm seeing forces
12 between pads approaching 2 million pounds, are we
13 seeing any pad -- pads sliding here?

14 THE WITNESS: No. This -- this
15 particular analysis that we're talking about did
16 not -- the soil springs were elastic, and they
17 could take tension as well as compression. Only
18 the soil cement between the pad was restricted to
19 be a compression-only pad. The one case that I
20 did, which was the -- what I'll call the case where
21 one pad was surrounded by a picture frame, that was
22 the only case in which I allowed the pad to slide.
23 Otherwise, I could never close the 6/10-of-an-inch
24 gap. And sliding did occur in that calculation
25 because I allowed it to occur if it wanted to.

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1 JUDGE LAM: Oh, I see. I see. So you
2 are not testifying that these forces --

3 THE WITNESS: Right. I -- I have to --
4 I can either model the soil with sliding -- I can
5 either model the pad/soil relationship as one of
6 simply the -- a set of 6 linear springs, or I can
7 model it as I did for that one simulation in a
8 manner which would allow the pad to lift off from
9 the soil if it tended to rock and also slide
10 relative to the soil if the dynamic forces got
11 large enough.

12 JUDGE LAM: Now, in Dr. Ostadan's
13 question to you, Dr. Soler, I remember hearing him
14 repeatedly saying these are significant pad-to-pad
15 loading. I don't recall hearing your response to
16 that statement.

17 THE WITNESS: Would you repeat the
18 statement, and I'll see if I responded to it.

19 JUDGE LAM: I remember Dr. Ostadan
20 saying, well, these are significant pad-to-pad
21 loading, and I don't recall you had any response to
22 that.

23 THE WITNESS: Well, I believe in
24 response to that question that I said certainly, to
25 the layman, 2 million pounds force or 1.9 million

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1 pounds force could be viewed as a significant
2 number. The results of my analysis showed that,
3 for this particular case, it certainly didn't
4 adversely affect the force in the soil springs, and
5 it did not change significantly the conclusions
6 about pad motions -- cask motions.

7 JUDGE LAM: Thank you.

8 JUDGE FARRAR: Do we have any redirect
9 by the Applicant?

10 MR. GAUKLER: Let me just take a couple
11 minutes.

12 JUDGE FARRAR: Certainly.

13 MR. TURK: May we go off the record?

14 JUDGE FARRAR: Yes.

15 (A discussion was held off the record.)

16 JUDGE FARRAR: Mr. Gaukler?

17 MR. GAUKLER: Yes. I have several brief
18 questions.

19

20 REDIRECT EXAMINATION

21 BY MR. GAUKLER:

22 Q. First of all, we've been talking with
23 respect to the forces from the soil cement between
24 the pads. Now, in your modeling of the soil cement
25 between the pads, did your model take into effect

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1 any transfer of force from that segment of soil
2 cement between the pads downward into the soil
3 below the soil cement?

4 A. No.

5 Q. And so is it fair to say, therefore,
6 there would be some transfer of force from the soil
7 cement down --

8 A. Presumably the soil cement at the -- at
9 its lower interface would have a certain shear
10 capacity and that could transfer any force
11 developed in that soil cement directly to the soil.
12 My solution here did not attempt to model that and
13 have to deal with some other assumed capability. I
14 assumed in this model that any force generated in
15 that soil cement could only go to either one pad or
16 the other adjacent to it.

17 Q. So your solution would maximize --

18 A. It should -- it should, then, give a
19 maximum result because if any force went directly
20 down into the soil below the soil cement later that
21 I was modeling by springs, that would reduce the
22 peak force that I predict here, but I could not
23 tell you how much.

24 Q. Also, you were talking with Judge Lam in
25 respect to sliding of the pads. Assume that the

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1 pads did slide a foot or more. What effect would
2 that have on the casks?

3 A. Well, the more sliding of the pads you
4 have, as far as the casks are concerned, the less
5 energy the casks have to deal with. So the -- from
6 the selfish point of cask stability to the pads, I
7 would love to have a completely isolated foundation
8 with a coefficient of friction of zero because then
9 I wouldn't have to do any analysis of the pad
10 overturning. So in that respect a pad sliding
11 helps the casks, but it runs afoul of a regulation.

12 Q. And you're not taking credit for this in
13 your calculation, correct, any sliding of the
14 casks?

15 A. No. The only calculation which I did
16 which allowed sliding of the pad in these recent VN
17 simulations has simply been to assure that I could
18 get the pad to move at least 6/10 of an inch so it
19 would close the gap in one or more directions to
20 this hypothetical fixed soil cement surrounding the
21 pad so it could study the effect of impacts.

22 Q. And with respect to sliding of the casks
23 or sliding of the pads, whatever the case may be,
24 in your analysis you're not taking credit for that,
25 you're just allowing what happens happens?

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1 A. Well, the -- except for that one
2 simulation, the model assumes that the effect of
3 the substrate on the pads is elastic and that there
4 is no sliding. Whether or not the total load is
5 consistent with sliding or not, I don't know. But
6 the pads are not allowed to slide in any of the
7 simulations that I've done, save the one with the
8 6/10-of-an-inch gap and the earlier runs with
9 DYNAMO submitted in a report before the hearing.

10 Q. You were also asked a question by
11 Dr. Ostadan about accelerations on the pad, and you
12 mentioned that you had -- could see or might see
13 some raw accelerations on the same order that
14 Dr. Luk saw and reported in his report?

15 A. Yes.

16 Q. Would they be meaningful?

17 A. To me, not without filtering.

18 Q. Please explain.

19 A. The acceleration results would be, and
20 I'll use the word "corrupted" without necessarily
21 meaning that in a bad sense, by the fact that I
22 have very stiff springs and there's going to be
23 some high frequency effect introduced into this raw
24 acceleration data and that before I would present
25 it as physical accelerations of the pad, I feel it

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1 would have to be filtered in order to remove the
2 effect of -- the high frequency effect.

3 The forces that I've presented do not
4 show that effect simply because those forces are
5 calculated from displacements which are integrated
6 from the accelerations, and the integration process
7 effectively serves as a filter to get rid of these
8 high frequency, raw peaks.

9 I can give you an analogy where this is
10 actually used in the licensing of transport casks
11 where we were required to, first of all, develop a
12 hopefully simple model to predict the peak
13 accelerations of the cask when it's dropped from 30
14 feet with impact limiters on it and then show that
15 the model has some meaning by conducting quarter
16 scale drop tests with a system that is accurately
17 instrumented with accelerometers.

18 We did, as part of our transport
19 submittal, this drop test, and, of course, when you
20 read the raw accelerometer data, you find peak
21 accelerations all over the place. I mean we're
22 purporting to show that we are limiting the real
23 accelerations to, say, 60 g's in the case of the
24 transport cask, and the recall accelerometer data
25 would show maybe 150 g's.

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1 But this is all wave propagation effect,
2 and when you filtered this data at about 350 hertz
3 for that particular problem, you got -- as did
4 Lawrence Livermore Labs with their test data, you
5 got what we named the rigid body accelerations of
6 the cask subject to this condition, and those were
7 the numbers that we compared with the 60-g limit
8 which had to do with the capacity of the fuel.

9 So there is precedence for filtering
10 acceleration data in the licensing arena, and
11 before I would look at pad accelerations here, I
12 would make sure that I filtered the data
13 appropriately. But, in my mind, to directly
14 address the question of does the pad slide, the
15 VisualNastran solution gives it to you directly
16 because it gives you the force in the soil spring
17 and you can compare that force with whatever the
18 limit is that is presumed to initiate sliding. And
19 if you exceed that limit, then presumably the cask
20 slides and your solution isn't really --

21 Q. You mean the pad slides?

22 A. I mean the pad slides, and your solution
23 isn't really correct. But if it's below that
24 limit, then you're okay.

25 MR. GAUKLER: No further questions,

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1 Your Honor.

2 JUDGE FARRAR: Does the Staff have any?

3 MR. TURK: Yes, very limited,

4 Your Honor.

5 JUDGE FARRAR: Okay.

6

7

RECROSS-EXAMINATION

8

BY MR. TURK:

9

Q. In redirect just now, Dr. Soler, you
10 indicated that you wouldn't be concerned about pads
11 sliding because that reduces forces that the casks
12 would have to face.

13 A. Correct.

14 Q. Correct?

15 And you indicated that you thought that
16 ran afoul of a regulation. When you stated that,
17 were you, in fact, referring to regulatory
18 guidance?

19 A. I guess to be correct I was referring to
20 regulatory guidance.

21 Q. The regulation itself would be 10 CFR
22 72.122, is that correct, which addresses
23 structures, safeties and components important to
24 safety and their ability to withstand natural
25 phenomena?

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1 A. I believe so, yes.

2 Q. Are you familiar with the Staff's SER --
3 consolidated SER which is Staff Exhibit C?

4 A. On this project? I have not read it.

5 MR. TURK: I would ask if the parties
6 have a copy, to turn to it. I'll read it into the
7 record.

8 Q. I'd like to read from page 2-60 of the
9 SER and ask you if this statement is consistent
10 with your view. Quote -- incidentally this is the
11 statement that appears in Section 2.1.6.4 entitled
12 Stability of Subsurface Materials which commences
13 at page 2-55 of the SER.

14 At page 2-60 the following statement
15 appears: Quote, the Staff agrees with the
16 Applicant's conclusion that sliding of the pads
17 would not constitute a safety hazard because pad
18 sliding tends to increase the stability of the
19 casks against sliding or tip-over and there are no
20 safety-related external connections to the pads or
21 casks that may rupture or be misaligned as a result
22 of pad sliding. Therefore, the Staff concludes
23 that the proposed cask/pad design is acceptable,
24 considering the potential for instability resulting
25 from sliding of the pads under dynamic loading,

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1 close quote.

2 Is that statement consistent with your
3 views?

4 A. Yes.

5 MR. TURK: That's all we have at this
6 time, Your Honor.

7 JUDGE FARRAR: All right. Any recross
8 by the State?

9 MS. NAKAHARA: Just a little bit,
10 Your Honor.

11 JUDGE FARRAR: All right.

12

13 RECCROSS-EXAMINATION

14 BY MS. NAKAHARA:

15 Q. In response so Judge Kline and Judge
16 Lam's question, you attempted to quantify the
17 amount of sliding that you would not be concerned
18 with as an eighth of an inch.

19 A. Well, on strictly layman's physical
20 terms, I wouldn't -- because -- putting myself next
21 to a pad during an earthquake -- and I have gone
22 through an earthquake so I know what's going on, I
23 guess -- I probably wouldn't have time to be
24 concerned in reality before the event was over or
25 it had reversed. But I would surmise that if I saw

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1 the pad plus 8 casks moving toward me, if I had
2 time to react, I wouldn't stand there. But I
3 suspect I would not see -- with this earthquake see
4 that much of a movement where I have the time to
5 gather my facilities and -- and move away.
6 That's -- that's about the best I can give you as
7 an answer.

8 Q. Dr. Soler, you would still move away
9 when you were absolutely certain the casks would
10 not tip over?

11 A. I can only -- I can only give you an
12 example of a case where a 20,000-pound spent fuel
13 rack began to move. It was on a truck, and it was
14 not near me. And it wasn't an earthquake. It was
15 just an instability at what's called center of
16 gravity over corner. And it jerked from one
17 position to another, and the reaction of everybody
18 in the truck bay was, well -- half of the people,
19 their immediate reaction was to put their hands out
20 as if they were going to stop the rack. The
21 remaining people simply stood in place. And by the
22 time anybody would have been able to do anything,
23 it was over, and it was in a new position.

24 Now, I recognize in -- an earthquake
25 takes place 30, 40 seconds, whatever's really going

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1 to happen, I don't believe that I would physically
2 react. I think I'd be more concerned with just
3 standing there, wondering what was going on and
4 whether I should be laying down or covering my head
5 or running which way and the other. But from my
6 own personal experience, you generally just stay
7 where you are, and that's probably what would
8 happen regardless of how these pads tend to move
9 toward me or away from me.

10 My physical feeling based on --

11 JUDGE FARRAR: Well, I think we've --
12 you've had rebuttal.

13 THE WITNESS: Okay. I'll quit while I'm
14 ahead.

15 Q. (By Ms. Nakahara) Would you be
16 concerned about a 0.6-inch sliding as you modeled
17 in your assumption of a clearance gap of 0.6
18 inches?

19 A. I don't believe with the scale of the
20 cask, that unless I was standing right next to an
21 edge of the pad -- pardon me, with the scale of the
22 pad, unless I was standing right adjacent to the
23 edge of the pad, I don't think I'd be able to
24 notice a half an inch of movement during an
25 earthquake.

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1 Q. And the case that you modeled, the
2 second case, if -- if the pad with a single cask
3 saw the forces of 1900 kips applied on it, how much
4 would you expect it to slide?

5 A. Well, I think -- I think my analysis, if
6 you accept those results, shows that it doesn't
7 slide. It's held -- it's held by the soil springs.

8 Q. So are you saying that a pad at the end
9 of the row -- a row of 10 pads with one single cask
10 on it, weighing approximately 1300 kips, seeing a
11 force of 1900 kips would not slide?

12 A. Well, remember, you have to balance the
13 force coming -- sticking strictly with my model,
14 you have -- the pad is being acted upon by inertia
15 forces from the casks, by the force transmitted
16 from the soil cement adjacent to that pad in one
17 direction and the soil springs, and the sum of
18 those three forces, if you will, tells you -- it
19 should be, of course, in equilibrium and add up to
20 zero at any given instant in time. The only thing
21 that determines whether the pad slides, in reality,
22 would be if the force in the soil spring exceeds
23 its capacity. Then my solution would not be
24 correct subsequent to that, but it would certainly
25 answer, at least for that instant of time, a yes or

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1 no whether the pad slid. And in this solution that
2 force in the soil spring never exceeded the limit.

3 Q. Mr. Gaukler asked you a question whether
4 the accelerations on the pad that your model
5 generated was meaningful if it wasn't filtered, or
6 something to that effect. What would -- in your
7 opinion, what would meaningful -- strike that.

8 In your opinion what would be the value
9 of meaningful accelerations you would expect out of
10 your 2000-year model on the pad?

11 A. I would hesitate to give an answer to
12 that. The only thing I would say is that I would
13 probably filter it at about 20 hertz to make sure
14 that I included the major power from the earthquake
15 and then see what the filtered data gave me. I --
16 I cannot give you a definite answer to the question
17 you've asked.

18 Q. Could you estimate -- do you have an
19 opinion whether they would be greater than
20 freefield accelerations?

21 A. They could be somewhat greater, but I
22 couldn't give you a number. Certainly -- certainly
23 they wouldn't be 6 g's, as the raw data might
24 indicate.

25 Q. What is your basis for filtering at 20

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1 hertz?

2 A. Well, the major -- the major power from
3 this earthquake is at roughly 5 hertz, and I would
4 filter at some frequency above that to make sure I
5 wasn't deliberately excluding some effect that --
6 that really is there. But it would be -- it would
7 be a matter of engineering judgment as what to
8 filter at.

9 MS. NAKAHARA: That's all I have. Thank
10 you.

11 MR. GAUKLER: Two very quick questions
12 that I think can be answered yes and no.

13 JUDGE FARRAR: Excellent.

14 THE WITNESS: I hope so.

15

16 FURTHER REDIRECT EXAMINATION

17 BY MR. GAUKLER:

18 Q. Dr. Soler, in terms of all the
19 discussion we had about concern -- your potential
20 personal concern about sliding, you were speaking
21 in terms of a person, specifically yourself, being
22 in the vicinity of the cask and the pad; is that
23 correct?

24 A. Yes.

25 Q. And do you have any concern from a

1 design viewpoint?

2 A. No.

3 MR. GAUKLER: Thank you.

4 JUDGE FARRAR: All right.

5 MS. NAKAHARA: And I can't resist. I
6 apologize. One question.

7 JUDGE FARRAR: All right.

8

9 FURTHER RECROSS-EXAMINATION

10 BY MS. NAKAHARA:

11 Q. Dr. Soler, in response to Mr. Gaukler's
12 question that -- you were reacting as a person --
13 you were reacting as a person who's knowledgeable
14 about the modeling that he's conducted on the
15 HI-STORM 100 cask and is assured that these casks
16 would not tip over, correct?

17 THE WITNESS: Yes.

18 MS. NAKAHARA: Thank you.

19 JUDGE FARRAR: All right. Then with
20 that, it's almost 12:50, so let's come back at
21 1:50, and we will have at that point Dr. Win Tseng?

22 MS. NAKAHARA: We have very short
23 rebuttal on Dr. Soler with -- to Dr. Soler's
24 testimony, to Dr. Soler's testimony, with
25 Dr. Ostadan.

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1 JUDGE FARRAR: Right, that was our plan
2 to do it that way.

3 MR. GAUKLER: I missed the time you
4 said, Your Honor, when you said we'd be --

5 JUDGE FARRAR: 10 of.

6 (Lunch recess was taken.)

7 JUDGE FARRAR: We're back for the
8 afternoon session, and the State was going to do
9 its rebuttal of Dr. Soler's rebuttal.

10 MS. NAKAHARA: Your Honor, to probably
11 make things more confusing but hopefully expedite
12 things, would you permit the State to put on
13 Dr. Ostadan like you did yesterday with Dr. Ostadan
14 with surrebuttal to Dr. Soler's rebuttal testimony
15 in addition to any rebuttal testimony that
16 Dr. Ostadan has with respect to Dr. Soler's
17 prefiled and oral direct testimony?

18 JUDGE FARRAR: Yes. We found that to be
19 efficient yesterday, so we'll do it again today.

20

21

DR. FARHANG OSTADAN,

22

called as a rebuttal witness, having previously

23

been sworn, was examined and testified as follows:

24

25

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DIRECT EXAMINATION

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BY MS. NAKAHARA:

Q. Good afternoon, Dr. Ostadan. Is it important to distinguish the amount of force in the dash pots and soil springs?

A. Yes, in my view it is. As I indicated before, unfortunately the Holtec report, which is the basis of the entire CSA design for this facility, is extremely brief. It doesn't provide enough information for a reviewer like me to make a complete assessment of the results. We have discussed this a number of times in the past, and PFS experts also express opinion specifically with respect to damping, that the damping could be very large and damping associated with the SSI effects of pads. And I think it would be important to be able to separate these forces in the springs and dash pots as well as indicated by Dr. Soler that can be done. So that will give us a better opportunity to better understand the results.

Q. I'm asking a foundational question after a question, but it's your understanding that Dr. Soler did not distinguish between the dash pot forces and the soil spring?

A. That's correct. He indicated that these

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1 forces are the total effects, and he did not know
2 the breakdown in the forces for spring and dash
3 pots.

4 Q. Dr. Ostadan, based on Dr. Soler's
5 rebuttal, written rebuttal testimony and oral
6 testimony this morning, given the transfer of loads
7 that Dr. Soler observed from pad-to-pad
8 interaction, does the design of the soil cement now
9 play an increased role and important?

10 A. Yes, in my view it has now become much
11 more important. We have, all in all the State has
12 been concerned about pad-to-pad interaction and
13 that's the position we have been taking. PFS
14 position has been, my understanding, that it is a
15 secondary effect that is not important, and
16 Dr. Soler results indicated that it indeed is
17 important. And therefore the role of the soil
18 cement in the pads becomes much more important in
19 their ability to transfer the loads.

20 And further down the road it also
21 changes the entire design concept, at least in my
22 mind, as to what is the load path now, how the
23 loads from the casks coming to the pad are really
24 transmitted to the clay layer under the pads. It
25 seems to me that significant amount of force is

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1 being transmitted on the side through the soil
2 cement. And now when you think about this whole
3 array of the pads and various combinations that may
4 take place in real life when these pads are loaded,
5 I have not seen any really systematic assessment of
6 complication of foundation loads to be sure that
7 the most critical facility loads now have been
8 calculated and used.

9 Q. Dr. Ostadan, in PFS Exhibit 225 C, if
10 you assume the schematic of the two pads, one pad
11 with a single cask on it and the other pad with the
12 eight casks, and you assume that that pad and cask
13 configuration occurs at the end of a row of ten
14 pads, in your opinion, what would the sliding
15 effects be?

16 A. I think it's important just to work with
17 some basic numbers here rather than bogging down to
18 this, really the numerical analysis. If I think of
19 one pad, one cask as was mentioned earlier this
20 morning, the pad being 900 odd kips and one cask
21 being 360, it's about 13, 1,400 kips total weight
22 of this one cask and the pad, this is located on
23 the surface of a weakly treated soil cement, and
24 this 13, 400 kips of weight is now receiving about
25 1,900 kips of lighter load. I can't see how this

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1 can stay in place. Without doing any really
2 calculations, it is very easy for me to see this is
3 a serious situation. ,

4 Q. In your experience in the design of
5 nuclear facilities, have you ever observed a case
6 where the foundation is allowed to slide as a
7 design philosophy under the design-basis
8 earthquake?

9 A. No, never, never, no. Foundations
10 always been a very important component of any
11 building, specifically when it comes to nuclear
12 structures. We have always, in my experience, made
13 sure we have enough margin to design foundations.

14 Q. Dr. Soler appeared to be indifferent
15 about the 1.1 factor of safety for the pads. As an
16 engineering design expert, will you explain the
17 purpose of the factor of safety and give your
18 opinion on the importance of meeting factors of
19 safety?

20 A. As a foundation engineer, I certainly do
21 not appreciate ignorance of how good or bad the
22 foundation could be. I think foundation is always
23 an important component of any building design, and
24 like any other engineering design, it needs to be
25 treated properly, designed adequately to make sure

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1 it performs to its function.

2 With respect to the factor of safety,
3 this is very common in our engineering design and
4 analysis. We realize we don't know enough about
5 the parameters that we adopt to use, both on the
6 capacity side, both on the demand side. Factor of
7 safety is a measure for us to make sure we have the
8 margin for these uncertainties and unknowns so that
9 the building at the end would perform to its
10 function.

11 Q. And finally, after reviewing Holtec's
12 many analyses that they've submitted for the
13 licensing proceedings and through the -- through
14 this hearing, are you satisfied that the cask
15 stability has been adequately analyzed?

16 A. Are you referring to the cask or the
17 pad?

18 Q. Cask stability.

19 A. No, I remain very concerned with respect
20 to the stability of the foundations for this
21 facility, and particularly the pads. I think there
22 are enough unknowns and parameters, assumptions
23 being discussed and disputed by both sides that
24 easily could change the balance here for a factor
25 of safety. And that probably makes a very

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1 difficult situation for the Board, I believe, on
2 one hand recognizing the foundations and the margin
3 allowed or lack of it, and on the other hand,
4 trying to see what will be the ultimate failure and
5 performance of the cask, which goes beyond my
6 expertise. But in my opinion the foundation and
7 design at this time is not adequate, and it would
8 not have enough margin to perform as we typically
9 design it.

10 MS. NAKAHARA: Thank you, Dr. Ostadan.

11 We have no further questions.

12 JUDGE FARRAR: Mr. Gaukler?

13 MR. TRAVIESO-DIAZ: Mr. Chairman, not to
14 break with tradition, I think I'm going to take
15 this one myself.

16 JUDGE FARRAR: All right.

17

18 CROSS-EXAMINATION

19 BY MR. TRAVIESO-DIAZ:

20 Q. Dr. Ostadan, I'm mystified or at least
21 somewhat unclear as to your first, the answer to
22 your first question, which was why is it
23 distinguished and differentiate between the forces
24 on the dash pots and the forces on the springs.
25 Aren't you more interested in the resultant force

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1 in any case?

2 A. No, I think if I look at it from the
3 foundation design perspective, as you know, a
4 number of issues has come up as to why Stone &
5 Webster, for example, has used acceleration of .71
6 g to estimate the inertia of the pad. I think the
7 designer himself, I believe he will testify later
8 how he believes damping could be as high as 48, 50
9 percent. He said it when he typed up his opinion.

10 I found it very difficult to believe
11 that we could have such a high amount of damping,
12 and I think one way to get there is have Holtec
13 separate the forces in the spring and dash pots so
14 you have another angle to look at this damping.

15 Q. Oh. So what you're saying is not that
16 it makes a difference as far as, if you will,
17 loadings or whatever, which component of the model
18 you will compute as one thing or the other, but
19 rather you are saying that in order to better
20 understand how certain parameters behave, such as
21 the remediation damping, it will be helpful to be
22 able to say what force goes one way, one force goes
23 the other. Is that what you're saying?

24 A. I think I remain concerned about these
25 forces not to be adequate. And to help out the

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1 matter, I think one way to get there is to try to
2 provide additional information which is not
3 presented in this brief report to start with. And
4 separating these forces will be a good thing to do.

5 Q. Just so that the record is clear: your
6 interest in seeing this separation is so that you
7 can better understand, if you will, the physics of
8 the problem and trying to Figure out whether the
9 assumptions that the Applicant is making as to
10 remediation damping are correct or not. Is that
11 right?

12 A. It goes back to the foundation forces.
13 As I indicated, I remain concerned, as was -- I was
14 concerned until yesterday about pad-to-pad
15 interaction, and we saw today that was a valid
16 concern. I remain concerned about adequacy of
17 foundation forces. And therefore how significant
18 it is, I can't express an opinion. I have not
19 calculated it myself.

20 Q. I'm sorry. I can see that I'm not
21 making my question clear. Are you saying that the
22 only way that you can tell whether the predicted
23 forces as made by Holtec are correct is by knowing
24 which component of each of the forces given by the
25 force attributable to dash pot and the force

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1 attributable to the soil spring? Is that what
2 you're saying?

3 A. I would change the word "correct" to
4 "adequate," and then my answer is yes.

5 Q. I'm sorry?

6 A. If you ask the question if the forces
7 are adequate, if you separate the forces, my answer
8 is yes.

9 Q. So you need to see them separated into
10 components just to form a judgement as to whether a
11 certain force has been adequately computed?

12 A. Correct.

13 Q. Now, you said a moment ago that the fact
14 that Exhibit 225 C documents a number or Figure for
15 pad-to-pad interaction forces changes the load
16 path. Can you explain to me a little more what you
17 mean by that?

18 A. Yes, sure. The design philosophy so far
19 has been primarily having the loads from the casks
20 going to the pad and then going to the treated soil
21 under the pad and then going to the clay and so on.
22 It has been viewed on the part of Applicant that
23 pad-to-pad interaction is secondary effect. Now,
24 this limited study done shows that about 30 percent
25 of these horizontal loads is being transmitted

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1 laterally from one pad to the other, so that
2 changes the picture as far as the foundation and
3 soil is concerned quite a bit.

4 Q. Did I hear you say horizontal?

5 A. I think we discussed the horizontal
6 forces.

7 Q. What I'm trying to understand is how
8 that affects the load path, given that if you're
9 talking forces transmitted to the soil, that will
10 be vertical loadings, won't it?

11 A. No, no. I think the key here, although
12 vertical is important, the key is horizontal
13 forces, and the shear stresses in the clay and
14 ability of clay there to take the force.

15 Q. I thought the pad-to-pad interaction
16 analysis was intended to determine how the forces
17 seen by one pad from the seismic loads get
18 transmitted to the other pad. What does that have
19 to do with the shear strength of the soils
20 underneath either?

21 A. Oh, a lot. You know, when you -- the
22 total load from pad and eight casks is a number.
23 Now, where is it going? Until yesterday they were
24 all believed to be going to the soil cement and
25 clay underneath. Now, while 30 percent of it is

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1 now being transmitted laterally, so let's say 70
2 percent of it. In this case the studies goes on,
3 it's less.

4 If you think of the whole area of pads
5 in these various scenarios, now, would you have a
6 scenario where you have all these added up at
7 certain locations and you have concentration of the
8 loads, and you're going to have much loads to deal
9 with and carry through the foundations. How many
10 scenarios we need to look at, I don't think it has
11 been sorted out on the part of the Applicant. I
12 think this was done on the part of Dr. Soler, in my
13 view, to indicate that if pad and pad interact
14 stresses on the concrete pad is small, and he has
15 made that point, and I don't think we have to worry
16 about structural design of the pad, for that
17 matter. At the same time it changed the picture as
18 to how these loads are now being transmitted.

19 Q. Well, here is my concern. I thought
20 that all along in this proceeding our concern has
21 been with the stability of the casks, which are the
22 material that contains the radioactive matter. And
23 I thought that when pad-to-pad interaction was
24 traced by you some time ago, always the concern was
25 pad A is going to produce a force on pad B and that

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1 could change the loading that the casks could see,
2 could make them less stable. Why do I care how
3 much force goes down to the soil? My interest will
4 be how much force goes up onto the cask. Can you
5 illuminate that?

6 A. Yes. I think the record will speak for
7 itself. One of the concerns has always been the
8 effect of pad-to-pad interaction on the sliding
9 analysis, and basically that means how much one pad
10 is pushing the other. And this has not been picked
11 up or analyzed, and now we are seeing an evidence
12 of it.

13 To answer the second part of your
14 comment as to what is the impact on the stability
15 of the cask, I have always stayed away from that
16 subject as not my area of expertise. I believe I
17 have expressed a concern that if the impact or the
18 gapping due to movement may create additional
19 source of energy on the pad, that could also
20 increase the motion of the cask. I think perhaps
21 that concern has been expressed. The main concern,
22 again, being an expert on the foundation here, has
23 been really on the stability of the foundation.

24 Q. On the stability of the foundation, you
25 mean the stability of the soil underneath the pad?

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1 A. Yes, the pad and the soil.

2 Q. So your concerns are really having to do
3 as to the extent to which the soil underneath the
4 pad is going to remain stable; but this doesn't
5 address directly the loads on the casks, does it?

6 A. Very much so. I think we've got to look
7 at the load pad and how it comes down to the soil.
8 Are they going to accumulate and then go down --
9 you see, the fact that you transfer a load from one
10 pad to the other doesn't mean that this load
11 disappears forever, because it goes down somewhere.
12 Because it keeps the constant regime. The load
13 just doesn't go away because you have a neighbor.
14 This load has to get down to the clay a certain
15 stage.

16 So I think that hasn't been carefully
17 studied on the part of PFS. It has now only shown
18 that there is this interaction. I think there's
19 some careful thinking needs done and a study to see
20 what is the critical thesis and critical condition.

21 Q. One more time. You just said it I think
22 very well. The concern here is that this load is
23 not going to disappear, it may go from pad A to pad
24 B, but ultimately it's going to go down to the
25 soil, isn't it?

1 A. Right.

2 Q. So why do we care with respect to the
3 casks above which way the loading goes?

4 A. Well, if you create a condition that you
5 may have a concentration of this load for various
6 reasons on a specific pad, you're going to also
7 impact the motion of the pad.

8 Q. Oh. Then what you're saying is that the
9 effect, the potential effect that you are positing
10 will be one in which there could be some
11 circumstance in which a pad for some reason could
12 accumulate these loadings from various directions.
13 Is that what you're saying?

14 A. Various directions and various
15 neighboring pads, yes.

16 Q. I take it you don't agree with what
17 Dr. Soler said a moment ago that he couldn't
18 envision how that would happen?

19 A. Given his assessment that he hasn't
20 quantified it, he said he can't see, or something
21 to that effect. But he has certainly not analyzed
22 this. Nobody I think has really thought through
23 this.

24 Q. I thought he said he couldn't even
25 conceive how you could have such a preferential

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1 loading on a single pad as opposed to --

2 A. Oh, no. He just went through one
3 example in response to State's counsel. He assumed
4 just one pad with one cask at the end of the row of
5 ten pads as receiving certainly 1,900 kips kick.
6 Can you tell me the motion of this pad is same as
7 before or not?

8 Q. Before we go on to that, which we will,
9 let me ask you a question of your understanding of
10 what Dr. Soler was doing in this analysis that is
11 presented on 225 C. Is it your understanding he
12 was trying to create a case that was intended to
13 maximize in all possible ways the possibility of
14 the loadings from one pad to another due to
15 pad-to-pad interaction, decided to put a boundary
16 to assess what a maximum value will be?

17 A. In all honesty, I think Mr. Soler, and
18 he can correct me, probably did not understand our
19 concern accurately. He tried to calculate the
20 stresses in the concrete pad due to this pad-to-pad
21 interaction, which he did, and he showed these are
22 smaller. This was never our concern or statement.

23 Q. Excuse me for a second. To go over to
24 my last question, is it also your understanding
25 that Dr. Soler was doing a run that was intended to

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1 maximize the potential loadings, forces that would
2 result in this effect?

3 A. It might be his opinion. I don't
4 remember that. But I don't agree -- if that was
5 his opinion and his intent, I don't agree that this
6 limited study shows that this is the worst case.

7 Q. The reason why I'm asking you all this
8 is, I remember very clearly, I think I have the
9 transcript here to show it, that when I asked you
10 way back in May what your concern here was, you
11 continued to express the view that the concern with
12 pad-to-pad interaction is that you will increase
13 the loading from one pad to the other through
14 potential transmission to the soil cement,
15 ultimately resulting in greater loadings on the
16 casks. And now you're telling me all this story
17 about potential loadings going down to the soil,
18 making this potentially through forces to the clay,
19 and I have to say that in fairness to Dr. Soler,
20 what he was doing in his analysis was answering the
21 concern you raised. And my question to you was
22 whether you understood that that's exactly what he
23 was trying to do in the analysis he presented
24 today.

25 A. Well, I think answer is given what

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1 Dr. Soler concluded out of his two cask analysis.
2 In my view, he did not understand the concern. As
3 I said, he ran and attempted to calculate the
4 stresses in the concrete pad and show these 150 PSI
5 or so. That was never my concern anywhere. Many
6 you can explain to me, if you understand, where do
7 we express the concern about the structural design
8 of the pad with respect to pad-to-pad interaction?

9 Q. Let me ask you another thing. I'm not
10 sure I got -- at least I understood you are
11 particularly focusing on an assumption of the
12 situation which you had an eight-cask array --
13 eight-cask array, one pad, and a single cask
14 configuration on the other; and these two pads
15 being at the end of the row, can you tell me what
16 that particular instant will prove?

17 A. Like I said, this hasn't been really
18 studied thoroughly through various scenarios. We
19 just take the case that has been studied. For the
20 moment let's assume it's at the end of a row of ten
21 pads. So at the very end you have one pad and one
22 cask. And this body weighs around 1,300 kips. And
23 then you have next to it a pad with eight casks,
24 and this analysis shows now that a fully loaded pad
25 is going to put a 1,900 kips lateral load on this

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1 lightly loaded pad. It's a pretty serious
2 situation right there.

3 Q. Well, but will that serious situation
4 depend to some degree on whether the combined
5 forces that are applied to that cask exceed the
6 resistance capability of the soil underneath the
7 pad to sliding?

8 A. Yes, you could say that.

9 Q. All right. And in your positing that
10 hypothetical, do you consider or are you suggesting
11 that in fact the number which Dr. Soler testified
12 is never approached was exceeded in that case? If
13 I remember, Dr. Soler said that it was 2,300 kips
14 under the pads.

15 A. Now, keep in mind I'm only looking at
16 the 1,900 kips additional loads coming from the
17 neighboring pad. You still have the load of its
18 pad and the single cask that needs to be taken into
19 account.

20 Q. I want you to explain to me how you
21 manage to add the 2,300 which Dr. Soler said was
22 the maximum and you put 1,900 on top of it.

23 A. As I said, I haven't done any
24 calculation. All I realize is, the picture here
25 is, you have a body of something, the pad and one

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1 cask which weighs about 1,300 kips. That's all.
2 And you place it virtually on the surface of the
3 soil here, and now you're kicking it with 1,900
4 kips. It just doesn't make sense to me to
5 automatically assume this is going to stay stable.

6 Q. I apologize, I don't understand the
7 point you're trying to make, and it's just that I
8 need a second to think about it. I thought what
9 Dr. Soler testified to was that if maximum force
10 that he computed, which is already taken into
11 account in Mr. Trudeau's calculation, is less than
12 what Mr. Trudeau's had in the first place, I don't
13 see how, if that conclusion is right but you may
14 not agree with, you have a situation very worse, no
15 matter what the location of the pad is. That's
16 what I'm trying to understand from you.

17 A. I beg your pardon. Could you be more
18 specific in your question? I'm also lost.

19 Q. I guess it shows I am lost myself. I
20 thought that the analysis that Dr. Soler produced
21 was trying to determine -- maybe we can look at
22 it together -- what the maximum force on the pad
23 would be in a situation in which -- in addition to
24 whatever other forces you have on the pad, you have
25 a configuration in which you have two adjacent pads

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1 in which one exerts a force on the other. And I
2 understood the 2,300 that Dr. Soler testified to
3 being in total, not being the contribution of
4 soil-structure interaction alone, being the total
5 forces with soil-structure interaction and
6 pad-to-pad interaction added to it. So I don't
7 understand your mathematics what you're adding to
8 what when 2,300 is said to be the total.

9 A. If you want my opinion, I will reserve
10 my opinion until I receive the breakdown of soil
11 spring and damping acceleration of the pads.

12 Q. And maybe Dr. Soler can add some more.
13 I apologize if I sounded combative or
14 argumentative. I just don't understand your
15 argument.

16 One moment, please.

17 Okay. Just one brief reference again
18 to, and I think this has been touched upon by
19 various witnesses before, but since you brought it
20 up I think it may be well to try to define what we
21 mean here. Is it your understanding that a factor
22 of safety of 1.1 that you referred to a moment ago
23 was the relevant guidance applicable to nuclear
24 power plants?

25 A. I think it's in one of the guidance,

1 yes.

2 Q. Would that be perhaps because in nuclear
3 power plants when you have buildings that are
4 connected through piping and other lines, the
5 possibility of sliding could have safety
6 consequences?

7 A. I will say no, because for any other
8 building that do not have pipelines or anything
9 connected, we make sure we have enough margin
10 against sliding.

11 Q. Well, let me ask the question a
12 different way. Is it your understanding that the
13 guidance that was developed by the NRC with respect
14 to nuclear power plants that resulted in a 1.1
15 factor of safety against sliding, was that intended
16 to preclude having adverse safety consequences in
17 the event that sliding takes place?

18 A. I do not know the basis and what was the
19 thinking of the authors of the regulations. I can
20 only tell you that my view of it is probably should
21 not have been, because as I said, any other
22 buildings, interconnected or not, would not allow
23 sliding to take place.

24 Q. But in order to determine whether breach
25 of the 1.1 factor of safety against sliding

1 constitutes a safety concern, will you need to know
2 in fact what the safety consequences would be in
3 not meeting that 1.1 factor of safety against
4 sliding?

5 A. I don't know what would be the
6 consequence of nonperformance of the foundation on
7 the cask and radiation release. All I know, it's a
8 requirement to have this factor to be met.

9 Q. Could you perhaps be willing to modify
10 your answer by saying not requirement but a
11 guidance Figure that is offered in documents that
12 are not regulations?

13 A. I can only say that for every project I
14 have worked on nuclear, we made sure we exceed
15 that.

16 MS. NAKAHARA: Dr. Ostadan, could you
17 clarify what you mean by that, factor of safety?

18 THE WITNESS: The factor of safety, in
19 all different foundation design we have done for
20 nuclear structures we've made sure a factor of
21 safety exceeds 1.1 for sliding.

22 Q. (By Mr. Travieso-Diaz) By the way,
23 Dr. Ostadan, going back for a moment to -- I'm
24 still trying to understand the implications of this
25 end of the row scenario you posited. Isn't it true

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1 that the potential applicability, if you will,
2 assuming that the forces that you say are additive
3 on having that 1.9, 1.9 million pounds applied on
4 one pad to the other would depend, first of all,
5 where the pad -- what directions the pads were
6 moving? Because there will be situations in which,
7 I think we discussed this before, there will be
8 some questions in which in fact there will be zero
9 effect because the pads were in fact not impacting
10 each other?

11 A. If they move in phase there will not be
12 any force.

13 Q. All right. And also this -- well, I'll
14 let it stay at that for a second.

15 Dr. Ostadan, I'm going to read you from
16 the transcript of May 8th, pages 1759 -- I'm
17 sorry -- 7519 to 7521. The reason I'm going to go
18 through the time of taking this is, I understood,
19 Dr. Soler understood and perhaps the Board
20 understood that if the position of pad-to-pad
21 interaction that you gave us --

22 (Off the record briefly.)

23 Q. Strike that question and I'll ask it
24 again, and I'm going to ask it a much more simple
25 way. The transcript of the May 8th, 2002

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1 testimony, starting on page 7519, at the bottom of
2 the page, Question, "By influencing each other, you
3 mean potentially impacts with the pad? That's what
4 I'm trying to --" Answer, "Okay. Basically what
5 would happen here, the concern is that, remember
6 there is the soil cement in between the pads on the
7 sides of the pad. And the soil cement are very
8 poor in tension, but they are pretty good in
9 compression. So once one pad is trying to move in
10 one direction, and if the motion of the other pad
11 is out of phase, each pad is going to be pushing
12 the other pad. There will be extra force coming to
13 the pad because of the interaction of these pads."

14 I'll go down through some intervening
15 questions, and I ask again, question, "I
16 understand. But again, I'm not asking you to
17 accept the results, but if you accepted the results
18 that the element of this concern we're talking
19 about, which will be potential impacts of effects
20 from the sliding would not be present. Is that
21 correct?"

22 And your answer was, "No, no, I would
23 disagree with that. Whether they slide or not,
24 even if they do not slide, by the mere fact that
25 this one pad is moving to the left, neighboring pad

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1 is moving to the right -- due to shaking; there is
2 no sliding here -- there will be extra force above
3 and beyond what is considered now will be exerted
4 on the pad."

5 If I understood that testimony I just
6 read you, you were expressing a concern about what
7 forces are going to be in the pad on the pad given
8 the potential transmission of forces from one pad
9 to the other. Is that correct?

10 A. That's correct, yes.

11 Q. Okay. Did you -- I don't recall at the
12 time that you gave that testimony that you said
13 that a concern was not the forces on the pad but
14 the load path going to the soil and so on. I'm
15 just trying to understand what you're telling us
16 today that you didn't tell us on May 8th.

17 A. Nothing, really. I think the load pad
18 is a consequence of load going to the pad, and
19 maybe this is new to you, but basically the issue
20 is when the load is extra load you're talking about
21 here goes to the pad, how is it really transferred
22 to the soil. Do we have really a foundation
23 stability above and beyond what's been considered?
24 That's what it boils down to.

25 Q. I'm sorry. Could you tell us now what

1 this boils down to?

2 A. In my viewpoint, this is primarily
3 foundation stability.

4 Q. So it's not transmitted?

5 A. The concern has been expressed, and some
6 of it is here and there may be other places, I
7 don't remember, that the impact may cause
8 additional vibration on the pad that could have
9 some effect on the cask.

10 Q. And your understanding of what Dr. Soler
11 was attempting to do with this exhibit is what?

12 A. My understanding of Dr. Soler's exhibit
13 are two. First, he tried to show that the
14 structure design of the pad is okay, additional
15 stresses is not going to impact the structural
16 design. And the second was the movement of the
17 cask on the pad are still within a few inches.

18 Q. And do you have a dispute with either
19 portion of Dr. Soler's conclusions based on this
20 exhibit?

21 A. I never have the concern with the
22 structural design of pad with respect to pad-to-pad
23 interaction, so it's good information to have. As
24 to the additional vibration cause, the case that
25 has been studied shows that displacement are still

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1 small. Whether this is the worst case, now
2 recognizing there's interaction, a chain action
3 going on, is it the worst case or not remains to be
4 seen.

5 MR. TRAVIESO-DIAZ: Thank you very much.
6 That's all I have right now.

7 JUDGE FARRAR: Staff have any?

8 MR. TURK: Yes, I do, your Honor.

9

10 CROSS-EXAMINATION

11 BY MR. TURK:

12 Q. Dr. Ostadan, you've just stated that
13 you've never had a concern about the structural
14 impact upon the pad, correct?

15 A. As far as the pad-to-pad interaction is
16 concerned.

17 Q. And is that correct for the State in
18 this proceeding?

19 A. To the extent I can testify is that --

20 MS. NAKAHARA: Objection. Dr. Ostadan
21 can't speak for the State.

22 JUDGE FARRAR: Mr. Turk, that seems --
23 he can speak for his portion of the State's
24 position, but it did strike me that that's a broad
25 question, but I'll hear you on it.

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1 MR. TURK: If my understanding of the
2 State's concerns is correct, I thought that the
3 State was raising that concern, perhaps not through
4 Dr. Ostadan but through Dr. Bartlett. If the State
5 shows me that that's not the issue, I'll drop it.

6 JUDGE FARRAR: I think that's not how I
7 heard the question. Let us hear it back.

8 (The record was read as follows:
9 "And is that correct for the State in
10 this proceeding?")

11 JUDGE FARRAR: Why don't you re-ask that
12 and make it a little more specific what you're
13 getting at.

14 Q. (By Mr. Turk) In your testimony which
15 you presented jointly with Dr. Bartlett concerning
16 Part D of this contention, I recall that -- excuse
17 me so I can get the testimony out.

18 At page 2 of your combined testimony, in
19 answer 4 you stated that Dr. Bartlett and yourself
20 have worked closely together in your analyses and
21 your review of the PFS design concept, dynamic
22 loading and the effects of loading, effects that
23 loading will have on the casks, pad, and building
24 foundations and soils. And you did present joint
25 testimony with Dr. Bartlett, and I just want to see

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1 if I understand. The State is not raising a
2 concern as presented through your joint testimony
3 about pad-to-pad interaction as that may affect the
4 structural capacity or structural design of the
5 pads?

6 A. I already expressed my view and opinion.
7 Whether or not I represent the State, that is up to
8 counsel.

9 Q. Let me -- so to the extent that if the
10 State has raised any concern about pad-to-pad
11 interaction as it affects the pad itself, that's
12 not the concern you're presenting, that would be
13 presented by somebody else?

14 A. I never expressed a concern about the
15 structural design of the pad relating to additional
16 forces caused by pad-to-pad interaction.

17 Q. At several points during your rebuttal
18 testimony you indicated that without doing any
19 calculations you nonetheless had certain concerns.
20 Have you done any calculations with respect to the
21 issues you've raised in this proceeding?

22 A. I have not done any calculations.

23 Q. With respect to the factor of safety of
24 1.1 against sliding, where does that appear? Do
25 you know which document, regulatory document that

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1 appears in?

2 A. I don't remember the number right now.

3 Q. I would ask you to turn to Staff Exhibit
4 EE, which is Section 3.8.5, foundations of NUREG
5 0800.

6 MS. NAKAHARA: Can you provide him a
7 copy?

8 MR. TURK: I have only my own copy.

9 MS. NAKAHARA: Well, we need a copy
10 also.

11 MS. CHANCELLOR: Maybe you could stand
12 over there.

13 MR. TURK: If I may approach DR. SOLER?

14 JUDGE FARRAR: Certainly.

15 MR. TURK: May we go off the record?

16 JUDGE FARRAR: Yes.

17 (Discussion off the record.)

18 Q. (By Mr. Turk) Have you seen this
19 document before?

20 A. Yes.

21 Q. Is this the regulatory document which
22 forms the basis for your belief that there's a
23 factor of safety of 1.1 specified for an ISFSI
24 storage pad?

25 A. Yes.

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1 Q. And do you understand that NUREG 0800 in
2 which this section appears is regulatory guidance
3 specifically applicable to nuclear power plants?

4 A. Yes.

5 Q. There's no discussion in this document
6 of independent spent fuel storage installations, is
7 there?

8 A. I can't be 100 percent sure, but I
9 suspect not.

10 Q. And you recognize this is regulatory
11 guidance?

12 A. I recognize that, yes.

13 Q. You mentioned that in all nuclear
14 projects in which you've been involved, determining
15 that there was a sufficient factor of safety of 1.1
16 was always an issue and that you always looked to
17 meet that, correct?

18 A. I did not say it was an issue. I said
19 we always made sure we meet that.

20 Q. And you also mentioned that in that work
21 you were dealing with buildings, correct?

22 A. That's correct.

23 Q. In any of your work did you deal with
24 storage pads that did not constitute buildings?

25 A. Can you repeat the question? I'm sorry.

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1 MR. TURK: Could you read it back,
2 please?

3 (The record was read as follows:

4 "In any of your work did you deal with
5 storage pads that did not constitute
6 buildings?")

7 THE WITNESS: I have not dealt with the
8 storage pads.

9 Q. (By Mr. Turk) So all of your work was
10 with respect to buildings?

11 A. Buildings and other types of structures.

12 Q. But not storage pads?

13 A. I'm thinking back in order to give you
14 an accurate response. I certainly have dealt with
15 pads that support heavy machineries, but pads that
16 stored nuclear fuel on top, no, I haven't.

17 Q. And the pads that you mentioned that
18 support heavy machinery, those pads also support
19 structures, correct?

20 A. No, just the machine. Maybe a turbine
21 or a diesel generator or various pieces of
22 equipment.

23 Q. Were they freestanding pieces of
24 equipment?

25 A. No, they were always anchored.

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1 Q. So is it fair to say, then, that all of
2 the structures that you examined with respect to
3 the factor of safety against sliding of 1.1 had
4 something anchored to them, either a building or
5 heavy machinery or something of that nature?

6 A. I think it's fair to say that, yes.

7 Q. And you recognize that the storage pads
8 for the PFS ISFSI will not have something anchored
9 in them or attached to them, correct?

10 A. Unfortunately, yes.

11 Q. During your testimony I often saw the
12 word "unprecedented" used in connection with the
13 PFS ISFSI design. And that's one of the things
14 that's unprecedented in your review, isn't it?

15 A. Yes.

16 Q. In Dr. Soler's analysis that was
17 described today in PFS Exhibit 225 C, how did he
18 deal with forces imparted to the soil cement
19 between storage pads?

20 A. I think Dr. Soler explains that he
21 analyzed two scenarios. In one he modeled the soil
22 cement within the pads, the capacity to take both
23 tension and compression as one scenario, and the
24 other scenario was soil cement to take compression
25 only.

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1 Q. Did he assume that the force that would
2 be imparted from one pad into the soil cement would
3 be transferred to the pad next to it?

4 A. That model, yes, would be able to
5 calculate the transfer of load from one pad to the
6 other.

7 Q. Did he diminish that load at all as the
8 load traveled from one pad to the next, or did he
9 just take that load and say, I'm going to apply it
10 to the next pad through the soil cement?

11 A. No. The model was a combined model of
12 two pads, two pads and the soil spring in them. So
13 for this case, whatever load gets transferred is
14 what he showed.

15 Q. And my question is, the load that
16 originated at one storage pad before it moved into
17 the soil cement, was that same load at its origin
18 point then transferred directly to the next storage
19 pad? Do you know?

20 A. I'm not sure I understand your question.
21 It's a complicated interaction going on here. I'm
22 sorry, I don't understand.

23 Q. There was an assumption that there's a
24 certain load that would be transferred from one pad
25 to the next pad, correct?

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1 A. (No audible response.)

2 Q. What load -- I'm sorry; that was yes?

3 A. I'm listening to you. Please go ahead.

4 Q. No, could you answer that question? Do
5 you need it read back?

6 A. Yes.

7 (The record was read as follows:

8 "There was an assumption that there's a
9 certain load that would be transferred
10 from one pad to the next pad, correct?")

11 THE WITNESS: There was a concern that a
12 certain amount of load could be transferred from
13 one pad to the other. How much of it was unknown.

14 Q. (By Mr. Turk) When you say how much was
15 not known, in other words, you don't know how much?

16 A. I didn't know until Dr. Soler's
17 evaluation.

18 Q. Is there a document you can point us to
19 where we can find the answer?

20 MS. NAKAHARA: Answer to what?

21 MR. TURK: To the question of how much
22 load was assumed to transfer from one pad to the
23 next.

24 A. It was not assumed. It came out of the
25 analysis results and is shown in Dr. Soler's

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1 results. I forgot the exhibit number. It shows
2 the load and the springs.

3 MS. NAKAHARA: PFS Exhibit 225 C.

4 MR. GAUKLER: PFS Exhibit 225 is where
5 the table appears, I believe.

6 Q. (By Mr. Turk) Are you familiar with
7 that document enough to point me to the load that
8 was calculated to be transferred from one pad to
9 the next?

10 A. Okay, I'm looking at Exhibit 225, page
11 28. There's a table there, and under the maximum
12 compression loads in soil cement within the pads,
13 under that column you can see the load for various
14 scenarios.

15 Q. And the soil cement between the pads, is
16 that essentially, you mentioned it was modeled as a
17 spring?

18 A. Yes, that's what's indicated.

19 Q. Did Dr. Soler take into account any
20 potential for absorption of energy within that
21 spring?

22 A. I did not hear him talking about that.
23 I don't know his model in detail to give you my
24 opinion.

25 JUDGE FARRAR: Let's go off the record

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1 for a second.

2 (Discussion off the record.)

3 Q. (By Mr. Turk) Would you agree that the
4 soil cement between the pads is compressible as
5 compared to the pads?

6 A. It's more compressible as compared to
7 the pads.

8 Q. So that if one pad does start to move in
9 the direction of another pad, there would be some
10 compression of the soil cement, in effect some
11 crushing of the soil cement?

12 A. There will be compression of soil
13 cement, and if the compression is excessive, there
14 will be crushing.

15 Q. And that compression or, as you say, if
16 you get enough compression crushing, that would
17 tend to reduce the amount of load that is
18 transferred to the pad next door, correct?

19 A. After the crushing takes place the load
20 transfer will be less.

21 Q. And if the soil cement does crush, that
22 would take place over a certain period of time;
23 it's not an instantaneous thing, correct? If you
24 would picture a pillow, you place your hand on the
25 pillow and it compresses, it doesn't happen all at

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1 once, there's some amount of time required for the
2 load to be absorbed?

3 A. Now, here we are getting to engineering
4 behavior of materials. It depends whether it's
5 brittle or ductile material. If it acts in a
6 brittle manner it will crush very quickly.

7 Q. And whether it's brittle or not would
8 depend upon the stiffness of the material?

9 A. In part.

10 Q. And the soil cement is designed to have
11 a stiffness of how much? Do you recall?

12 A. I think -- I'm not sure of the numbers,
13 but it's the brittle mix on the side of the pads, I
14 believe it's like two or three hundred PSI.

15 Q. Approximately 250 PSI, would that
16 refresh your recollection? Yes?

17 A. Yes.

18 Q. And for material that has a 250 PSI,
19 when it's placed in between the storage pads which
20 have a PSI, comparative PSI of approximately how
21 much?

22 A. I would say three to four thousand, I
23 would guess.

24 Q. Would you expect that the soil cement
25 would crush if there was to be enough pad-to-pad

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1 interaction such that a load from one pad would
2 attempt to be transferred into the pad next door?

3 A. It depends. Now, we need to look at the
4 physics of the problem. .In the worst case a
5 neighboring pad let's say does not move, and one
6 pad is pushing towards that and the force becomes
7 excessive, then yes, you have the crushing of the
8 soil cement. But the real scenario here, you have
9 all these pads laid out, and as the force builds up
10 within the pads, the neighboring pads tends to move
11 away so you don't necessarily end up crushing the
12 soil cement if the neighboring pad slides and
13 moves.

14 Q. Well, you wouldn't crush that soil
15 cement, necessarily. In other words, if pad A is
16 moving in the direction of pad B and pad B moves
17 away, you wouldn't get a crushing. But accepting
18 that scenario, you might get that crushing if the
19 force was strong enough to cause it, correct?

20 A. If the force was large enough, it will
21 cause that, yes.

22 Q. And again, that would not be
23 instantaneous, that would take some amount of time,
24 however you measure it? You wouldn't see it happen
25 in one snap in a millimicrosecond, correct?

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1 MS. NAKAHARA: The question is the
2 millimicrosecond.

3 A. No, I don't think it would take a
4 millimicrosecond.

5 Q. Okay, I'm not asking you to calculate
6 exactly how long it would take. Of course it would
7 depend upon velocities and other factors at the
8 time, and that would tend to vary the time arrival
9 of the impact of one pad to the next from a
10 condition where you would assume a static condition
11 where there's an instantaneous transfer of energy.
12 Do I need to rephrase that?

13 A. Please, I appreciate if you can be very
14 specific.

15 Q. Okay. One of the concerns you addressed
16 I believe in your testimony yesterday was the
17 potential for non vertically propagating waves to
18 arrive at different pad groups at different times.
19 And in the same line I'm asking you whether if a
20 seismic force was to be directed or to arrive at
21 two adjacent pads at approximately the same time,
22 would that be fairly reasonable?

23 A. I think it's fairly reasonable.

24 Q. If there was to be a crushing of the
25 soil cement between those pads, then that would

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1 delay the timing at which the impact of one pad
2 would arrive at the adjacent pad, correct? It
3 wouldn't arrive at the same time as the seismic
4 wave that hits the two pads, correct?

5 A. I'm sorry. I cannot follow your
6 thinking. I don't understand the question.

7 Q. Seismic waves travel at great
8 velocities?

9 A. The velocity that the soil material has
10 at the site, yes.

11 Q. And it travels in cycles?

12 A. There are different frequencies
13 traveling in the wave, yes.

14 Q. If a seismic wave or seismic force was
15 to arrive at two adjacent pads, as you've
16 indicated, virtually simultaneously, correct?

17 A. Yes.

18 Q. Then the impact of one pad due to that
19 seismic force, or the motion of that pad due to
20 that seismic force would be somewhat delayed before
21 the impact of that pad being in motion would arrive
22 at the adjacent pad, correct?

23 A. I'm sorry again. I don't follow your
24 question. I just do not understand.

25 MS. NAKAHARA: May I ask a clarifying

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1 question? Are you talking about wave with
2 different angle of incidence, or talking about --

3 MR. TURK: No.

4 MS. NAKAHARA: -- pad-to-pad interaction?

5 MR. TURK: Pad-to-pad interaction.

6 THE WITNESS: Let me explain. Maybe
7 this helps. The pad-to-pad interaction as analyzed
8 by Dr. Soler, the reason you have pad-to-pad
9 interaction has nothing to do with the wave
10 arriving at different times. All waves are
11 arriving at the same time. The reason he has
12 pad-to-pad interaction in his model is because one
13 pad has larger mass, larger wave, and the
14 neighboring pad has a different wave, lighter. As
15 a result, the movement of the pads are different,
16 maybe slightly different. And that causes these
17 additional loads being transmitted to the soil
18 cement.

19 Q. (By Mr. Turk) Did Dr. Soler take any
20 credit in his analysis for the potential crushing
21 of soil cement between the pads?

22 A. I don't think so, no.

23 Q. Incidentally, the 2,300 kips that was
24 discussed previously, is that a combination of the
25 inertial load and the seismic force? I'm sorry.

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1 What does that represent, in your mind?

2 A. After asking Dr. Soler questions, he
3 indicated that the forces in the spring at the
4 bottom of the pad are the total loads.

5 Q. Let me state my question in statement
6 form. Maybe I just misunderstand what's happening
7 here. The seismic force that arrives from the
8 seismic source at two adjacent pads --

9 A. Seismic waves.

10 Q. The seismic wave. -- will arrive at
11 essentially the same moment at both adjacent pads.

12 A. Very well.

13 Q. The concern that I understand you to
14 express is that in addition to the seismic wave and
15 the force that that causes upon the structure upon
16 the pad, in addition to that you may get some
17 additional force imparted to a pad due to the
18 adjacent pad's motion in the direction of that pad
19 of interest. Is that your concern?

20 A. Let me reiterate the concerns I have.
21 Maybe that helps what we have said in the past.
22 One had to do with the incline waves, and that
23 incline wave, even if you assume all pads are
24 loaded equally and they're all symmetric, the
25 effect of incline wave is to create asymmetric

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1 loading acting on the pads.

2 Now, this effect is less when you deal
3 with individual pad dimensions. The interval time
4 is very close. But when you look at groups of pads
5 with larger plan dimensions, then their arrival
6 time and delay time could be larger. So that
7 effect would create additional interaction between
8 these groups of pads. This, in my view, has not
9 been addressed or analyzed by any fashion in these
10 documents.

11 Q. The question I'm asking about today is
12 not non vertically propagating waves as
13 Ms. Nakahara clarified, but I'm asking about the
14 pad-to-pad interaction issue. In summary, my
15 understanding, and I'll ask you to tell me if this
16 is correct, is that because the soil cement will
17 experience this crushing, assuming the force
18 transmitted from one pad to the adjacent pad is
19 strong enough, that that force from the adjacent
20 pad will not arrive at the pad of interest
21 simultaneously with the seismic wave that has
22 reached those pads. There will be some slight
23 delay, correct?

24 A. I don't think that analogy is quite
25 right. The seismic wave arrives, the casks

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1 vibrate, the pad vibrates. At a specific time
2 during the shaking, let's say 30 seconds of
3 shaking, there is a moment that the loads in within
4 the two pads in soil cement would reach its maximum
5 value. That moment may be in the middle of the 30
6 seconds, maybe during 10 seconds after shaking, 15
7 seconds after shaking. It all depends. I cannot
8 see how come the sequence that with the arrival
9 time of the wave, it has arrived and the load has
10 reached its maximum and shaking is going on.

11 Q. There's a cycling going on, essentially,
12 because the wave is not just a steady constant
13 force being applied, but it's a series of --

14 A. Of course, yes. It is moving back and
15 forth. And one of those cycles is of course when
16 the soil cement reaches its maximum value.

17 Q. Is it correct to say that there is no
18 direct additive effect where you can state that if
19 a certain seismic wave arrives, that at precisely
20 that moment a force will be imparted from one pad
21 to the next due to that cyclic seismic wave? Can
22 you agree with that or you can't?

23 A. I'm afraid you cannot -- it's a very
24 complex situation, a lot of interaction going on
25 with the soil and soil cement.

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1 MR. TURK: I thank you. I have nothing
2 else. I apologize if that was a little lengthy,
3 but it's difficult to get a handle on it.

4 (The Board confers off the record.)

5 JUDGE FARRAR: The board has no
6 questions. Is there any redirect by the State?

7 MS. NAKAHARA: I have a few.

8 JUDGE FARRAR: Well, I could be dead
9 wrong here, but your witness didn't concede
10 anything, so what more have you got to ask him?
11 Now, maybe my characterization is too flip, but
12 we've got a bunch of witnesses here we're trying to
13 get to.

14 MS. NAKAHARA: That's fine, your Honor.
15 They're just minor points.

16 JUDGE FARRAR: Okay. Well, but, I mean,
17 I don't want to cut you off from asking them.

18 MS. NAKAHARA: That's fine.

19 JUDGE FARRAR: But we don't need to hear
20 him say again what he's already said. If there's
21 something new you want him to say, we'll have him
22 say that. But --

23 MS. NAKAHARA: I would like to ask one
24 question.

25 JUDGE FARRAR: Go ahead.

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REDIRECT EXAMINATION

BY MS. NAKAHARA:

Q. Dr. Ostadan, Mr. Travieso-Diaz asked you a question about factors of safety and the need to meet a factor of safety based on consequences. In your engineering practice, is it typical to disregard factors of safety established by codes or guidance based on a consequence?

A. No, it is not typical. In fact, I think it will not be considered proper engineering if you disregard factor of safety.

JUDGE FARRAR: Hold on a minute. Now that I look at my notes and see how long two sets of cross went on, don't feel compelled to listen to what I said before. So go ahead and ask whatever you need to ask.

MS. NAKAHARA: No, that's fine. That was the main point I wanted to make.

JUDGE FARRAR: You sure?

MS. NAKAHARA: Yes.

JUDGE LAM: I share Judge Farrar's sentiment that Dr. Ostadan is a capable witness more than willing and able to defend himself on the

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1 stand, so then I think Ms. Nakahara is doing the
2 right thing by just asking you one question.

3 JUDGE FARRAR: Because the more you ask,
4 the more the other guys get to ask in response.

5 MS. NAKAHARA: Unless you're trying to
6 give me a hint.

7 JUDGE FARRAR: No, but I try not to ever
8 cut people off, but just --

9 MS. NAKAHARA: I understand, your Honor.

10 JUDGE FARRAR: I sense we've gotten what
11 we can from this witness. Then let's --

12 MR. GAUKLER: Your Honor, I do have a
13 few brief points I need to make with Dr. Soler in
14 terms --

15 JUDGE FARRAR: Wait. We're not to
16 Dr. Soler yet. Then we can dismiss Dr. Ostadan or
17 remove him from the hot seat for now?

18 MS. NAKAHARA: Yes, your Honor.

19 JUDGE FARRAR: Thank you, sir.
20 Appreciate your testimony. So now Mr. Gaukler, you
21 want --

22 MR. GAUKLER: A few brief points to make
23 with Dr. Soler.

24 JUDGE FARRAR: Which we would call --

25 MR. GAUKLER: To respond to some of the

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1 things Dr. Ostadan said.

2 JUDGE FARRAR: Which is so far into the
3 chain of rebuttals that it doesn't even have a
4 name. Go ahead.

5 MR. GAUKLER: That is probably correct,
6 your Honor.

7
8 DR. ALAN I. SOLER,
9 called as a rebuttal witness, having previously
10 been sworn, was examined and testified as follows:

11
12 JUDGE FARRAR: Dr. Soler, do you recall
13 previously you were sworn?

14 THE WITNESS: Yes, I do, your Honor,
15 many times.

16
17 DIRECT EXAMINATION

18 BY MR. GAUKLER:

19 Q. Dr. Soler, I'm going to ask you a few
20 brief questions about your analysis that has been
21 the subject of discussion today. First of all, you
22 heard Mr. Diaz read into the record claims that
23 Dr. Ostadan had made in his previous testimony in
24 terms of interactions between pads, i.e., that
25 there would be loads created by out-of-phase motion

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1 and these would impact the pads. Correct?

2 A. Correct.

3 Q. And the purpose of the model that you
4 developed was to maximize those loads to test that
5 thesis; is that correct?

6 A. Correct.

7 Q. And was it ever a purpose of your model,
8 modeling that you did to evaluate the adequacy of
9 the structural design of the pad?

10 A. No.

11 Q. Now, what steps did you take in order to
12 provide a maximum force pad-to-pad interaction
13 force being represented by the soil cement?

14 A. First of all, I made sure that there was
15 the greatest mass difference between the two pads,
16 assuming that there was at least one cask on each
17 pad. Secondly, I maximized the Young's Modulus of
18 the soil cement.

19 Q. Excuse me, Dr. Soler. With respect to
20 one cask on one pad and eight casks on the other
21 pad?

22 A. It's the maximum mass difference.

23 Q. Okay. So that would match the
24 out-of-phase motion?

25 A. Correct.

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1 Q. Go ahead.

2 A. Secondly, I assumed a maximum value for
3 the Young's Modulus of the soil cement. This would
4 maximize the stiffness and therefore maximize the
5 force on the spring.

6 Thirdly, I did not assume any force
7 transfer between the soil cement directly into the
8 soil. Any forces developed in the soil cement
9 between the pads went directly to both pads on
10 either side of that spring.

11 And lastly, I did not assume any damping
12 in the soil -- in the springs that represented the
13 soil cement between the pads.

14 Q. And the purpose was to maximize this
15 pad-to-pad interaction?

16 A. All four of those will maximize that
17 force.

18 Q. Now, you heard Dr. Ostadan express
19 concern in his testimony about this one -- the pad
20 with the one cask on, I think he said it was about
21 1,500 kips for the pad and the casks. Is that
22 approximately --

23 A. That sounds about right.

24 Q. And he stated you have 1,900 kips of
25 force, pad-to-pad interaction force --

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1 A. That's correct.

2 Q. -- acting upon it, and you couldn't see
3 how you wouldn't have some type of problem with
4 that. Do you remember that testimony?

5 A. Yes.

6 Q. What did your model show in that
7 respect?

8 A. My model showed that the force in the
9 soil underneath the pad and the soil springs
10 underneath the pad did not exceed 2,300 kips.

11 Q. Now, what did it show with respect to
12 the stability of the casks?

13 A. It showed that the movement of the cask
14 was the same order that we have been obtaining in
15 all analyses using the 2K earthquake.

16 MR. GAUKLER: No further questions.

17 JUDGE FARRAR: Mr. Turk?

18 MR. TURK: One quick one.

19

20 CROSS-EXAMINATION

21 BY MR. TURK:

22 Q. Dr. Soler, you say you assume no damping
23 in the springs between the pads. Does that mean
24 you took no credit for any potential crushing of
25 the soil cement?

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1 A. That is correct.

2 MR. TURK: That's it.

3 JUDGE FARRAR: State?

4 MS. NAKAHARA: I have a couple.

5 JUDGE FARRAR: Go ahead.

6

7

CROSS-EXAMINATION

8 BY MS. NAKAHARA:

9 Q. Dr. Soler, in your attempt to maximize
10 the pad-to-pad interaction with the one pad, one
11 cask, adjacent to the pad with eight casks loaded
12 on it, what position is the single cask on the
13 adjacent pad?

14 A. In terms of my notation that I've
15 consistently used, it is in location No. 5.

16 Q. And what is your basis for selecting
17 that particular location?

18 A. I asked Mr. John Donnell from PFS had he
19 decided how they would load pads in what sequence.
20 He said most likely they would load the first cask
21 as close to the center of the pad as they could so
22 as to minimize any eccentricities. I had a choice
23 of four locations that would fit that bill. I
24 arbitrarily chose position 5.

25 Q. Do you know if PFS will have a license

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1 condition that requires PFS to load in the center
2 of the pad initially?

3 A. I do not know.

4 Q. And assuming PFS would not load in the
5 center of the pad, what would be the worst case for
6 pad-to-pad interaction for the location of a single
7 cask?

8 A. In my engineering judgment, I think it
9 is immaterial where you put that first -- that one
10 cask on the pad. My primary reason for this model
11 was mass driven, not location driven.

12 Q. Did you conduct any analyses with a
13 single cask located in what you have used as the
14 first position?

15 A. Only with respect to the 10,000-year
16 earthquake. One of the simulations in the beyond
17 design basis report was a single cask in position
18 number one. The rest of the pad was empty.

19 Q. I'm sorry, let me clarify: with the
20 pad-to-pad interaction.

21 A. No. I've only run the cases in that
22 report.

23 MS. NAKAHARA: Thank you. I have no
24 further questions.

25 JUDGE FARRAR: All right, Mr. Gaukler,

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1 do you have any?

2 MR. GAUKLER: No, I have no follow-up.

3 JUDGE FARRAR: All right, then we're --

4 Dr. Soler, you're once again excused momentarily.

5 Where are we now? Dr. Wen --

6 MR. GAUKLER: We're ready to call our
7 next witness, Dr. Wen Tseng.

8 JUDGE FARRAR: Should we jump right into
9 that?

10 MR. GAUKLER: I would suggest taking a
11 short break.

12 JUDGE FARRAR: It's almost 20 after.
13 Let's come back at half past and see how much
14 progress we can make.

15 (A recess was taken.)

16 JUDGE FARRAR: Dr. Tseng, you've been
17 sworn before, so consider yourself still under
18 oath, please.

19

20

DR. WEN S. TSENG,

21

called as a rebuttal witness, having previously

22

been sworn, was examined and testified as follows:

23

24

DIRECT EXAMINATION

25

BY MR. GAUKLER:

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1 Q. Dr. Tseng, do you have in front of you a
2 document entitled Rebuttal Testimony of Wen S.
3 Tseng on Section D of Unified Contention Utah L/QQ
4 dated June 7, 2002?

5 A. I do.

6 Q. Was this testimony prepared by you or
7 under your supervision?

8 A. Yes.

9 Q. Do you adopt this testimony as being
10 true and correct of the rebuttal testimony in this
11 matter?

12 A. Yes.

13 MR. GAUKLER: Your Honor, I move that
14 the rebuttal testimony of Wen Tseng be bound into
15 the record as if read.

16 JUDGE FARRAR: Any objection from the
17 State?

18 MS. NAKAHARA: No objection, your Honor.

19 JUDGE FARRAR: Staff?

20 MR. TURK: No, your Honor.

21 JUDGE FARRAR: Then the testimony will
22 be bound in as if read.

23 (Rebuttal testimony of Dr. Wen S. Tseng
24 follows.)

25

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