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OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

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

APPLICANT'S RESPONSE TO STATE OF UTAH'S MOTION IN LIMINE TO STRIKE APPLICANT'S PREFILED DIRECT TESTIMONY FOR UNIFIED CONTENTION UTAH L/QQ

Pursuant to 10 C.F.R. § 2.730(c) and the Order (General Schedule Revisions) of the Atomic Safety and Licensing Board ("Licensing Board" or "Board") of September 20, 2001, Private Fuel Storage, L.L.C. ("PFS" or "Applicant") files this response to "State of Utah's Motion In Limine to Strike Applicant's Prefiled Direct Testimony of Unified Contention Utah L/QQ ("State Motion"). In its Motion, the State of Utah ("State") seeks to strike all of Applicant's prefiled direct testimony on Unified Contention Utah L/QQ ("Contention Utah L/QQ") on the grounds that the testimony was filed inexcusably late. Alternatively, the State moves that the Board strike portions of the testimony of Krishna P. Singh and Alan I. Soler and portions of the testimony of Paul J. Trudeau and Anwar E.Z. Wissa, alleging that the testimony is unreliable. As explained below, the State's motion is wholly lacking in merit and should be denied.

I. DISCUSSION

A. Motion to Strike Applicant's Entire Pre-filed Testimony

The State argues that PFS's pre-filed direct testimony on Contention Utah L/QQ should be struck in its entirety because it was filed "inexcusably late" and as a result the State has been prejudiced. The State asserts as "[o]f particular concern" that "PFS had

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many hours to read, review and have its witnesses analyze the State's prefiled testimony prior to the time PFS filed its testimony" and therefore PFS "had the opportunity to change its testimony in response to the State's testimony." Both the State's Motion and its underlying concern are wholly unfounded.

As the Board is aware, the State and the Staff, as well as PFS, completed their electronic filings of the pre-filed direct testimony on Contention Utah L/QQ well after the April 1, 2002 midnight deadline. The State and the Staff (other than the Staff's exhibits) completed their electronic filings around 4:00 a.m. EST on April 2, 2002. Although PFS did not finalize its filing (with the filing of its key determinations) until somewhat after 6:00 p.m., all of PFS's pre-filed testimony was filed before 10:00 a.m. EST.[1] Thus, while PFS's filing was obviously completed later than the State's or the Staff's, the filing of PFS's actual testimony was not completed that much later, and the differences in filing time may be attributed in large part to the considerable length of some of the Applicant's pieces of testimony, which required additional time for final corrections and proofing of changes, checking of citations, etc.[2] Also, needless to say, productivity declined exponentially as PFS counsel and staff worked through the morning and into the afternoon of the following day to complete the filing.[3]

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[1] PFS began filing its testimony at approximately 5:30 a.m., with the filing of two of PFS's eight pieces of testimony along with their prefaces. The remaining six piece of testimony were served between 8:20 a.m. and 9:40 a.m. Four of these pieces of testimony (along with their prefaces) had in fact been ready to serve more than two to three hours earlier but had not been sent due to an oversight.

[2] For example, the last piece of testimony to be filed by PFS, that of C. Allin Cornell, is 53 pages long. The testimony of Krishna P. Singh and Alan I. Soler is 97 pages long.

[3] The last portions of the filing to be completed (other than various exhibits) were two testimony prefaces and the key determinations. PFS counsel deferred work on the witness prefaces and key determinations until after the testimonies had been completed because of the lack of witness involvement in their preparation. Initially, PFS counsel held up serving completed testimonies until the prefaces were completed so the prefaces could be served with the respective testimonies, but eventually decided against that approach for two testimonies for which prefaces had not yet been completed in order to not delay further their filing.

The State's concern that PFS's witnesses may have reviewed the State's testimony and changed their testimony accordingly is unfounded. The State's and the NRC Staff's filings were sent to PFS's witnesses for the first time on April 3, 2002, long after the PFS filing had been completed. Nor did PFS counsel review any portion of the State's testimony prior to completing the PFS filing. The Board and the State can rest assured that counsel's *sole* and *overriding* interest as the morning and day wore on was to complete the PFS filing and leave the office as soon as possible.[4]

Thus, as surely was the case with the State and the Staff, PFS was working as expeditiously as possible to meet the midnight deadline after what had been a compressed timeframe for discovery and testimony preparation. Regrettably, that did not occur, due to the volume and complexity of the testimony, the process of making final changes and corrections with the witnesses, the need for final proofing and checking of those changes, the process of checking and correcting citations, gathering the exhibits, and inserting final exhibit numbers, and the need to prepare supplementary witness prefaces and key determinations. Throughout, Applicant was working diligently to complete its filing and did not seek, nor gain, any litigation advantage by having received (but not read) the State's pre-filed testimony. Thus, there is no basis for the State's extraordinary request to strike all of the Applicant's pre-filed testimony, and the request should be denied.

B. Motion to Strike Portions of Dr. Singh's and Dr. Soler's Testimony

In the alternative, the State seeks to strike two portions of the Testimony of Krishna P. Singh and Alan I. Soler on Unified Contention Utah L/QQ, April 1, 2002 ("Singh/Soler Testimony") as being unreliable under Federal Rule of Evidence ("FRE")

[4] The only portions of the State's and the NRC Staff's filings reviewed by PFS counsel were the key determinations. The purpose of this review was to establish the length of those filings and ascertain how strictly the other parties had adhered to the five page limitation on key determinations suggested by the Board.

702.[5] The first is testimony at Questions 40 and 112 to 121 regarding use of the Visual-Nastran ("VN") program to conduct additional cask stability analyses to respond to claims advanced by the State's witnesses in Contention Utah L/QQ and related discovery. The second is testimony at Questions 60 and 61 regarding analyses of pad flexibility that Holtec has performed for another project. According to the State, this testimony of Dr. Singh and Dr. Soler should be stricken because it is "based on facts and data that are not contained in their testimony" and because "documents relating to those facts data and methodology have not been produced to the State." The State's requests to strike testimony of Dr. Singh and Dr. Soler are not meritorious and both should be denied.

1. Under Applicable Legal Principles the State's Motion is Unfounded

Applicant notes at the outset that the State has supplied no legal basis to strike the expert testimony of Dr. Singh and Dr. Soler. It is well established that expert testimony is admissible in an NRC proceeding if it (1) assist[s] the trier of fact and (2) [is] rendered by a properly qualified witness.[6] Likewise, opinions of an expert witness based on scientific principles, acquired through training or experience and data derived from analyses or by perception are admissible as evidence.[7] Moreover, an expert witness may testify about analyses performed by other experts due, *inter alia*, to the impossibility of an expert deriving all background data from experiments that the expert personally conducted.[8]

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[5] The Federal Rules of Evidence are not directly applicable to NRC proceedings. Indeed, it is axiomatic that ". . . strict rules of evidence do not apply in administrative proceedings . . . ." Long Island Lighting Co. (Shoreham Nuclear Power Station, Unit 1), LBP-82-107, 16 NRC 1667 (1982). However, the FRE may be turned to for guidance in particular cases. Southern California Edison Co. (San Onofre Nuclear Generating Station, Units 2 and 3), ALAB-717, 17 NRC 346, 365 n.32 (1983).

[6] Louisiana Power and Light Co. (Waterford Steam Electric Station, Unit 3), ALAB-732, 17 NRC 1076, 1091 (1983); Philadelphia Electric Co. (Limerick Generating Station, Units 1 and 2), ALAB-808, 21 NRC 1595, 1602-1603 (1985).

[7] Philadelphia Electric Co. (Limerick Generating Station, Units 1 and 2), ALAB-819, 22 NRC 681, 720 at n.52 (1985).

[8] Limerick, 22 NRC at 718 (citing Wisconsin Electric Power Co. (Point Beach Nuclear Plant, Unit 2), ALAB-78, 5AEC 319, 332 (1972)).

Further, under FRE 703 an expert may express an opinion based on information that has not been admitted at trial, even if the evidence may otherwise be inadmissible, if it is "of a type reasonably relied upon by experts in the particular field in forming opinions or inferences upon the subject, the facts or data need not be admissible in evidence."[9] Thus, contrary to the State's primary thesis, expert testimony need not contain an exhaustive listing of supporting facts and data on which the expert relies, and thus there is no legal basis for the State's Motion.[10]

2. The State Has Provided No Factual Basis for Striking Dr. Singh's and Dr. Soler's Analyses Using the VisualNastran Program

The State has also provided no factual basis on which to strike the eleven questions and answers (Answers 40 and 112 through 121) of Dr Singh's and Dr. Soler's testimony concerning the cask stability simulations run to refute the deficiencies alleged by the State's witnesses. These additional simulations were run using the VN program as described in the testimony of Drs. Singh and Soler (see Answers 114-118). The State has twice had the opportunity to depose Drs. Singh and Soler on use of the VN program,[11] and makes no claim in its Motion that the VN program in any way produces unreliable results.[12] Further, as acknowledged by the State, it has been provided with a formal

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[9] See, e.g., United States v. Arias, 678 F.2d. 1202 (4th Cir. 1982), cert. denied, 459 U.S. 910 (1982); see also, United States v. Lundy, 809 F.2d 392 (7th Cir. 1987).

[10] The State's claim that the testimony should be stricken because relevant documents have not been produced is a discovery issue and not one of admissibility. Further, as discussed below, the State has been provided with the relevant documents concerning the additional VN simulations and authorization has been sought from TVA to make available to the State the relevant information from the TVA calculations.

[11] Deposition of Drs. Singh and Soler, March 6, 2002 ("Singh/Soler, March 2002 Dep.") at Tr. 26-30, 42-45, 87-91, 107-108. The VN program was also the computer algorithm used in Holtec Report No. HI-2012780, Dynamic Response of Free-Standing HI-STORM 100 Excited by a 10,000 Year Return Earthquake at PFS, Nov. 9, 2001, which was one of the subjects of the November 2001 Deposition of Drs. Singh and Soler. See Deposition of Drs. Singh and Soler, November 15-16, 2001 at Tr. 68, 71-73, and 86-89. (Excerpts of the two depositions referenced in this Response are attached.) In addition, the State also generally explored at both depositions Holtec's modeling methodology.

[12] Indeed, the State's witnesses in their testimony suggest that Holtec should have used the VN program instead of DYNAMO in analyzing cask stability for the PFSF. State Testimony of Dr. Mosher R. Kahn and

Holtec report providing the bases and calculations for the variables used in the VN simulations.[13] Despite having ample opportunity to examine Drs. Singh and Soler regarding the VN program and the Holtec methodology generally, and being provided with the specific data and assumptions used, the State nevertheless inappropriately seeks to have the testimony stricken.

The State's Motion is also clearly overreaching. Indeed, the State only cites a *single* alleged infirmity in a *single* sentence of a *single* answer. Specifically, the State asserts that the portion of Answer 120 which states that results of the VN simulation using a 2,000-year return period event "agree with the results predicted by DYNAMO" is without basis. Even if true – which it is not – it would provide no basis for striking the eleven questions and answers describing the VN analyses.

Moreover, the State appears to be moving to strike this particular piece of testimony simply because it disagrees with the expert opinion of Dr. Singh and Dr. Soler that the results of the VN analyses for the 2000-year event agree with the results obtained by DYNAMO.[14] As such, the State's attempt is entirely inappropriate. Experts are entitled to give an opinion within their field of expertise. And there is no question about the expertise of Drs. Singh and Soler. In contrast to the State's witness, Dr. Kahn – who has never before analyzed the stability of large freestanding objects, such as the HI-STORM

Dr. Fahrang Ostadan on Unified Contention Utah L/QQ, Part D (Cask Stability), April 1, 2002 at Question and Answer 26 ("Kahn/Ostadan Testimony").

[13] See State Motion at note 5. The State was provided with a slightly revised version of the calculation by electronic mail on April 19, 2002. PFSF Beyond Design Basis Scoping Analyses, Holtec Report No. HI-2022854, Revision 1, April 19, 2002. ("Holtec Beyond Design Basis Scoping Report").

[14] See Khan/Ostadan Testimony at Question and Answer 26. There Dr. Kahn suggests – with no analyses whatsoever – that DYNAMO will give incorrect results for the PFSF 2000-year design basis earthquake because it is a small angle deflection program not capable of handling large deflections, as is the VN program. See Singh/Soler March 2002 Dep. at Tr. 107-108. Not only does Dr. Kahn provide no analysis to support this claim, it is an entirely new claim that had not been previously raised by Dr. Kahn in either his December 2001 report or in his March 5, 2002 deposition.

100 casks[15] – Dr. Soler has run numerous such analyses using both DYNAMO and VN.[16] Further, Drs. Singh and Soler have provided specific documentary evidence of the basis for their conclusion, in the form of a simulation of the 2000-year seismic event using the VN program showing only small cask movements (on the order of inches and not feet as claimed by the State's witnesses).[17] Thus, the State has offered no valid basis for striking the legitimate expert opinion stated in Answer 120 of the agreement between the VN and DYANMO models, much less the other testimony contained in Answer 120 and in Answers 40, 112 through 119, and 121.

Having asserted no other specific deficiency with the VN analysis, the State's claim to exclude all of the testimony of Drs. Singh and Soler concerning the additional VN cask stability simulations rests solely on the State's bald assertions that the testimony is "not based on known facts and data, or reliable application of principles and methods to the facts and data." State Motion at note 5. These bald assertions have been refuted in the discussion above. As noted, the State does not take issue with the reliability of the

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[15] See Applicant's Motion to Strike the Testimony of Dr. Moshin R. Khan on Unified Contention Utah L/QQ, April 15, 2002.

[16] See Singh/Soler March 2002 Dep. at. Tr. 91 (Visual Nastran); Singh/Soler Testimony at Answers 27-28. Dr. Singh provides general technical oversight to all of Holtec's activities, (Singh/Soler March 2002 Dep. at Tr. 12-14), and is also capable of concluding that the two programs show general agreement.

[17] See PFS Exhibit OO. (While the compact disc containing the actual simulations was correctly labeled as PFS Exhibit OO, the Exhibit was incorrectly identified in the Singh/Soler testimony in Answer 119 as PFS Exhibit MM. The testimony will be corrected at the hearing to reflect the correct exhibit number.) Further, the Holtec Beyond Design Basis Scoping Report provides the State with the actual measurement of the maximum displacement for cask 1 (the cask in the lower left hand corner of the simulation) of 3.70 inches which compares to a maximum displacement of 3.08 inches predicted for this same cask using DYNAMO under identical assumptions. The maximum angle of rotation for this cask is 0.916 degrees using VN and 0.741 degree using DYNAMO, both far from the 29.3 degree angle at which the cask would tip over. See Holtec Beyond Design Bases Scoping Report at 20-21. This concrete evidence of the basis for Dr. Singh's and Dr. Soler's opinion that the VN and DYNAMO models provide comparable results for the 2000-year PFSF design basis earthquake stands in stark contrast to the wholly unsupported allegation of the State's witness, Dr. Kahn – who has never before performed such analyses and who has performed no analyses here using DYNAMO or VN – that DYNAMO and VN may not give comparable results for the design basis 2,000-year return period earthquake. See Kahn/Ostadan Testimony at Question and Answer 26.

VN program methodology and indeed suggests that the VN program should have been used for all of the PFSF cask stability analyses. Further, the State has been provided with the formal Holtec report for the additional simulations providing the underlying data, assumptions, and calculations, and has twice before deposed Dr. Singh and Dr. Soler on the use of the VN program and the Holtec methodology generally.

In short, there is no legal or factual basis for striking Dr. Singh's and Dr. Soler's testimony concerning their additional analyses using the VN program methodology to refute the alleged deficiencies asserted by the State's witnesses.[18] To the extent that the State believes that this testimony is in some respect unreliable or incorrect, it is free to seek to establish that fact in cross-examination or rebuttal.

3. The State Has Provided No Basis to Strike Dr. Singh's and Dr. Soler's Testimony Concerning their TVA Pad Flexibility Analysis

The State also seeks to strike Questions and Answers 60 and 61 of Dr. Singh's and Dr. Soler's testimony regarding analyses of pad flexibility that Holtec has performed for the Tennessee Valley Authority ("TVA") for a proposed Independent Spent Fuel Storage Installation at the Sequoyah Nuclear Power Plant. The bases for striking this testimony are essentially the same as those raised regarding the VN testimony discussed above, namely that "the TVA pad flexibility report is not included as an exhibit to the testimony nor has [it] been produced to the State" and therefore the opinions regarding the TVA analysis "are not based on facts or data that are offered into evidence" and "the reliability of the methods" used to reach these opinions "are unknown; and the conclusions drawn therefrom are unreliable." State Motion at 5. For the reasons already dis-

[18] Nor would the State be prejudiced (as claimed in its Motion at 4) if the testimony concerning the additional VN simulations is not stricken. The State is familiar with both the use of the VN program as well Holtec's methodology generally, having had the opportunity to depose Drs. Singh and Soler twice. Further, the State was provided with the specific assumptions used in the analyses in Dr. Singh's and Dr. Soler's testimony and has also been provided with a formal report on the analyses.

cussed above, the State's request to strike this testimony lacks a legal underpinning, since expert opinion need not be based on facts that are in evidence.

The State's factual assertions are also flawed for largely the same reasons discussed above. The State has deposed Drs. Singh and Soler with respect to the analysis of pad flexibility that Holtec had conducted for TVA. See Singh/Soler March 2002 Dep. at Tr. 50-57. No limitations were placed on the State's examination. If there was any failure by the State to delve into the particulars of the methodology or data underlying the TVA analyses, such a failure is of the State's own doing and does not warrant striking the testimony. Moreover, the State is free to explore on cross-examination – as it was during the deposition – questions going to the methodology or data underlying the analysis.[19]

C. The Sulfate Analysis Results are Accurately Presented in the Testimony of PFS Witnesses Trudeau and Wissa

Finally, the State moves to strike in its entirety Answer 64 of the pre-filed direct testimony of Paul Trudeau and Anwar E. Z. Wissa on soils issues.[20] The State alleges that a table included as part of Answer 64 "is misleading and unreliable because it does not contain all of the sulfate test results from PFS's soil cement testing program." State Motion at 5. However, the table is neither misleading nor unreliable.

Answer 64 focuses entirely on those soils of interest for purposes of manufacturing soil cement and cement-treated soil for use at the PFSF site. From the start, Answer 64 states that "[p]reliminary testing of the site soils for the presence of sulfates indicates

[19] PFS has not provided a copy of the relevant portions of the TVA calculations to the State because they are proprietary to TVA and Holtec has not yet received authorization from TVA to produce them. Holtec and PFS are in the process of seeking such authorization and will provide to the State information from the calculations relevant to the issue of pad flexibility if and when authorization from TVA is obtained. Holtec and PFS are diligently pursuing with TVA the grant of such authorization and it should be known shortly whether such authorization will be granted by TVA.

[20] Joint Testimony of Paul J. Trudeau and Anwar E. Z. Wissa on Section C of Unified Contention Utah L/QQ, dated April 1, 2002 ("Trudeau/Wissa Testimony").

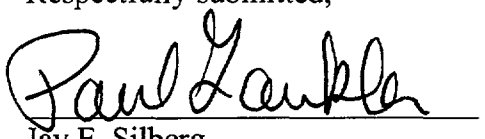
that very low levels of sulfates are present in the eolian layer of soil that will be used to fabricate the soil cement or cement-treated soil." Trudeau/Wissa Testimony at A64. A table follows this statement presenting all soil sample results from a depth of zero to two feet (i.e., the eolian layer of soil). Immediately following the table, the answer states:

> [T]he above table excludes the tests on two samples, drawn from depths of 2 to 4 feet, which showed higher levels of sulfates. These were likely Layer 2, Upper Bonneville clays, which PFS does not intend to use for making soil cement or cement-treated soil.

Thus, the table is neither deceptive – since it describes the sulfate tests results for the soil layer that will be used to construct the soil cement or cement-treated soil – nor is it incomplete, since it contains all samples taken from a depth of zero to two feet, which is the layer of interest. Nor is the testimony in any way misleading, since it clearly alerts the reader that two other samples were taken, that those samples "showed higher levels of sulfates," and that those samples were "drawn from depths of 2 to 4 feet."[21] Moreover, to the extent that the State believes that the table is in some respect misleading or unreliable, it is free to seek to establish that fact in cross-examination or rebuttal.

Thus, this part of the State's Motion is also non-meritorious and should be denied.

Respectfully submitted,



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Dated: April 22, 2002

[21] Inclusion of the results of sulfate testing for the two samples taken at depths of below the eolian layer could have been misleading or confusing to the reader, because it may have suggested that PFS intended to manufacture soil cement from soils from those depths.

COPY OF TRANSCRIPT

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of	) Docket No. 72-22
	) ASLPB No. 97-732-02-ISFSI
PRIVATE FUEL STORAGE L.L.C.	)
	) TELEPHONE DEPOSITION OF:
(Private Fuel Storage Facility)	) **KRISHNA P. SINGH** and
	) **ALAN I. SOLER**
	) (Utah Contention L, Part B)

VOLUME II

Friday, November 16, 2001 - 11:26 a.m.

Location: Office of the Attorney General
160 East 300 South, 5th Floor
Salt Lake City, Utah

Reporter: Vicky McDaniel
Notary Public in and for the State of Utah

1 here. But if you will now look at the actual motion of
2 the Applicant's Motion for Summary Disposition of Part
3 B of Utah L on page 17.
4 A. (DR. SOLER) Okay, I'm on page 17.
5 Q. And hopefully the statement's on there. I'm
6 not sure whether my pagination's correct. On my page
7 16 it starts, "However, even taking the contention's
8 allegation at face value, they do not set forth an
9 issue of material fact requiring litigation at a
10 hearing because the SSC's of the PFSF are capable of
11 accommodating the higher earthquake loadings that the
12 state contends should be applied." For the HI-STORM
13 100 cask, what higher earthquake loadings can the
14 HI-STORM 100 cask withstand?
15 A. (DR. SOLER) What's your definition of
16 withstand that you want me to respond to?
17 Q. Not result in an increase in dose at the
18 fence line at a PFS facility.
19 A. (DR. SOLER) I would certainly be able to
20 claim at this point that the earthquake used in report
21 2012780 meets that criteria.
22 Q. Would you restate that number? I'm sorry.
23 A. (DR. SOLER) HI-2012780. The title of the
24 report is Dynamic Response of Freestanding HI-STORM 100
25 Excited by 10,000-Year Return Earthquake at PFS.

1 believe Dr. Singh thought that the ground motions at
2 Diablo Canyon for an anchored HI-STORM cask were in the
3 range of .9 to 1 g.
4 A. (DR. SOLER) I believe that's a correct
5 statement.
6 Q. Okay. Do you know what the return period
7 earthquake is for the .9 to 1 g ground motion at Diablo
8 Canyon?
9 A. (DR. SOLER) I do not.
10 Q. Okay. Do all sites that use HI-STORM 100
11 unanchored casks fit within the certificate of
12 compliance for the HI-STORM 100 as an unanchored cask?
13 A. (DR. SOLER) All sites that would be an
14 exception of PFS, the answer to that is yes.
15 Q. Okay, thank you. If you will refer back to
16 the Motion for Summary Disposition. On my page 17, in
17 the paragraph that starts, "indeed, the cask
18 manufacturer." If you will look at the next sentence
19 that says, "Even if one assumes hypothetically that the
20 casks do tip over, the accelerations imparted upon the
21 casks are within design allowables and do not
22 significantly affect the integrity of the casks or the
23 canisters containing spent fuel."
24 Will you please define what is meant by "do
25 not significantly affect the integrity of the casks"?

1 A. (DR. SOLER) By that I meant that, based on
2 my examination of the motion of the casks when subject
3 to this 10,000-year return period earthquake, that if
4 they did tip over, the conditions under which they
5 would tip over would not be significantly different
6 from the hypothetical tipover analysis that was carried
7 out as part of our general license. And therefore,
8 since the conclusions we reached there met design
9 allowables, meaning that the fuel accelerations did not
10 exceed our design-basis limits, I extrapolated that to
11 the 10,000-year earthquake.
12 Q. And can you explain what you mean by
13 conditions not significantly different between the two
14 scenarios?
15 A. (DR. SOLER) The hypothetical tipover
16 analysis that's required by Part 72 assumes that the
17 cask is at what is called center of gravity over
18 corner, and by some unknown means it begins to rotate
19 to a horizontal position. When it gets to a horizontal
20 position it has a certain velocity and a certain
21 angular velocity, and then the analysis that occurs is
22 what is the response of the system after it hits the
23 ground at that initial velocity and initial angular
24 velocity.
25 Based on my 10,000-year analysis that is

1 recorded in the report that I previously cited,
2 2012780, it is my opinion that the velocity and the
3 angular velocity, if one hypothetically assumed that
4 tipover did occur, would not be significantly different
5 from what it was in the hypothetical analysis that was
6 part of the license.
7 Q. Okay. In your opinion do you believe under
8 the ground motions for a 2,000-year return period at
9 the PFS site that a HI-STORM 100 cask would rock under
10 those ground motions?
11 A. (DR. SOLER) Would you like to more
12 precisely define what you mean by rock?
13 Q. Tip.
14 MR. GAUKLER: I have a standing objection
15 with respect to this design basis. Go ahead and ask
16 the questions. I won't object again, have a standing
17 objection throughout.
18 MS. NAKAHARA: Okay, thank you.
19 A. (DR. SOLER) What do you mean by rock?
20 Q. That the bottom of the cask, a portion of
21 the bottom of the cask would lift up from the surface
22 of the concrete pad.
23 A. (DR. SOLER) So your question is do I
24 believe that that will happen under a 2,000-year
25 earthquake?

1 the HI-STORM 100 casks would experience cask-to-cask
2 impacts?
3 A. (DR. SOLER) I have not.
4 Q. And then further in that paragraph you
5 state, "The maximum accelerations experienced by the
6 casks are well below the design-basis limits set by the
7 HI-STORM FSAR." Do you recall what those maximum
8 accelerations are in the FSAR?
9 A. (DR. SOLER) I'm going to go refer back to
10 the report 2012640 and see if there is an exact number
11 in there.
12 There is no exact number quoted in there,
13 but my recollection is it was not too much different
14 from a number that was quoted in one of the earlier
15 reports which I do not have in front of me, so I can't
16 quote what that number is.
17 Q. Do you recall which report?
18 A. (DR. SOLER) I would suspect it might be the
19 original 2,000-year seismic or the earlier one.
20 Q. Okay, thank you. The earlier one being the
21 deterministic?
22 A. (DR. SOLER) Deterministic, yeah.
23 Q. In paragraph 15 of your declaration, is it
24 correct that this paragraph is attributed to you?
25 A. (DR. SOLER) Yes.

1 Q. In the first sentence you say, "A recent
2 analysis of a single storage cask on an ISFSI pad
3 subject to specified input accelerations from a newly
4 postulated 10,000-year return period seismic event has
5 demonstrated that the cask will experience larger
6 rotations." And is this recent analysis the Holtec
7 report HI-2012780?
8 A. (DR. SOLER) Yes.
9 Q. And it's correct that the difference in
10 rotations are the numbers that you just looked up? Is
11 that correct?
12 A. (DR. SOLER) Well, no, they're
13 displacements. If you wanted to calculate an angle of
14 rotation, you'd have to take that number and divide by
15 the height of the cask and calculate the inverse
16 tangent of the angle.
17 Q. And did you calculate the rotation?
18 A. (DR. SOLER) Not in angular form, no.
19 Q. For the 10,000-year return period?
20 A. (DR. SOLER) I did not calculate the angle
21 specifically.
22 Q. Or for a 2,000-year return period?
23 A. (DR. SOLER) I don't believe that we
24 actually calculated the angle. In the case of the
25 earlier earthquakes, it was small enough to be

1 insignificant and not worth computing.
2 Q. Okay, thank you. Also in that paragraph you
3 state in part, or not in part, in whole, "This recent
4 analysis assumed a conservative estimate of the
5 coefficient of friction between the base of the cask
6 and the top of the surface of the ISFSI pad of 0.8 in
7 order to maximize the propensity of the cask to tip."
8 A. (DR. SOLER) Correct.
9 Q. Now, you used the 0.8 as a conservative
10 estimate. Do you believe -- in your opinion, would the
11 cask and the pad have a consistent co-efficient of
12 friction once it begins to slide, if it began to slide?
13 A. (DR. SOLER) Well, generally speaking, at
14 that high level of co-efficient of friction you will
15 not get sliding, you will see tipping. So I'm not sure
16 that I've answered your question, but for the cask --
17 I'll rephrase my answer this way. For the cask to
18 slide, the co-efficient of friction between the cask
19 and the pad will have to be a lot lower.
20 Q. And do you know -- have you analyzed at what
21 co-efficient of friction the casks will slide on the
22 storage pad?
23 A. (DR. SOLER) All I can say is that I know it
24 will slide for .2, based on previous analyses.
25 Q. Also in paragraph 15 you essentially state

1 that at a 10,000-year return period the HI-STORM 100
2 will not overturn. Is that correct?
3 A. (DR. SOLER) That is correct.
4 Q. And is that statement based on the same
5 report, HI-2012780?
6 A. (DR. SOLER) Yes.
7 Q. Okay, thank you. Is there anything else,
8 any other calculations that support your opinion that a
9 HI-STORM 100 cask would not overturn at a 10,000-year
10 return period ground motion at the PFS site?
11 A. (DR. SOLER) No, there's just this one
12 report.
13 Q. Okay, thank you. If you will look at
14 paragraph 17 of your declaration.
15 A. (DR. SOLER) 17 or 7?
16 Q. 17.
17 A. (DR. SOLER) Okay, gotcha.
18 Q. You state, "Since a single cask subjected to
19 the 10,000-year earthquake does not overturn, there is
20 no need to consider the possibility of impact among
21 casks which in any case is highly improbable since the
22 casks as they oscillate will tend to move in phase with
23 each other." What is the basis for your statement that
24 the casks will oscillate in phase with each other?
25 A. (DR. SOLER) All of my previous work having

COPY OF TRANSCRIPT

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of	) Docket No. 72-22
	) ASLPB No. 97-732-02-ISFSI
PRIVATE FUEL STORAGE L.L.C.	)
	) TELEPHONE DEPOSITION OF:
	)
(Private Fuel Storage Facility)	) **KRISHNA P. SINGH** and
	) **ALAN I. SOLER**
	)
_____	) (Utah Contention L/QQ)

Wednesay, March 6, 2002 - 9:12 a.m.

Location: Office of the Attorney General
160 East 300 South, 5th Floor
Salt Lake City, Utah

Reporter: Vicky McDaniel
Notary Public in and for the State of Utah

1 instruct the witnesses not to answer, but I have that
2 continuing objection for the record.
3 MS. NAKAHARA: Okay, your objection is
4 noted. And for the record, the State takes a different
5 position whether the design -- the seismic response and
6 design analysis for the HI-STORM 100 cask system falls
7 within parts C and D of the consolidated Contention
8 L/QQ.
9 Q. (BY MS. NAKAHARA) Dr. Singh, what role did
10 you have in developing multi-cask response at PFS's
11 ISFSI document from a 2,000-year seismic event?
12 A. (DR. SINGH) I provide general overview and
13 consulting support to people who do the work.
14 Q. And the next document, Dr. Soler, do you
15 have in front of you a Holtec document entitled
16 "Evaluation of the Confinement Integrity of a Loaded
17 Holtec MPC Under a Postulated Drop Event"?
18 A. (DR. SOLER) Yes, I do.
19 Q. And is it correct that you are a reviewer of
20 this document?
21 A. (DR. SOLER) Yes.
22 Q. And what -- as your role as a reviewer, what
23 did that entail?
24 A. (DR. SOLER) Taking the completed work,
25 checking it, of course, for grammar and general

1 cohesiveness, and also checking that the input data was
2 correct, that the model followed accepted engineering
3 principles and that the results made sense.
4 Q. And Dr. Soler, what was your role with
5 respect to this document? I'm sorry, Dr. Singh.
6 A. (DR. SINGH) My role is the same in every
7 work that's done in the company in the areas where I
8 have direct expertise. I review the work, and the
9 engineers who do the work, they can consult with me on
10 different aspects of the solution. And I'm generally
11 familiar with the work done because of the interaction,
12 but I don't do the work myself. And I very seldom
13 serve as a direct reviewer of the document.
14 Q. And the third document, Dr. Soler, do you
15 have in front of you a Holtec document entitled
16 "Dynamic Response of Freestanding HI-STORM 100 Excited
17 by 10,000-Year Return Earthquake at PFS"?
18 A. (DR. SOLER) Yes.
19 Q. And are you the principal author for this
20 document?
21 A. (DR. SOLER) Yes, I am.
22 Q. And Dr. Singh, what was your involvement
23 with this document?
24 A. (DR. SINGH) My involvement, Ms. Nakahara --
25 do you like to be called Ms. or Mrs.? How do you like

1 to be addressed?
2 MS. NAKAHARA: It doesn't matter -- Ms.
3 A. (DR. SINGH) My involvement in all these
4 documents has been uniform in respect of providing
5 consulting assistance, discussing the theoretical and
6 methodological aspects of the solution, and providing
7 general guidance to the others.
8 Q. And I forgot to make a copy of a fourth
9 document entitled "Evaluation of the Confinement
10 Integrity of a Loaded Holtec MPC under a Postulated
11 Drop Event."
12 A. (DR. SINGH) Oh, you do have it.
13 A. (DR. SOLER) You already mentioned that or
14 asked that.
15 A. (DR. SINGH) I don't think so.
16 Q. And that document -- okay. What about the
17 "PFSF Site Specific HI-STORM Drop Tipover Analysis"? I
18 don't have that document, correct?
19 A. (DR. SINGH) Correct, you don't.
20 A. (DR. SOLER) Yes.
21 Q. Are you familiar -- Dr. Soler, are you
22 familiar with that document?
23 A. (DR. SOLER) I'm familiar with that
24 document, yes.
25 Q. Did you have any role with that document?

1 can evaluate in your model?
2 A. (DR. SOLER) There is a current limit set by
3 the dimension statements in the FORTRAN code, but that
4 limit could be changed simply by modifying the
5 dimension statements. With the size capability of
6 computers now, your only restriction is the time it
7 would take to do a much larger system.
8 Q. The preprocessor that automatically
9 calculates spring constants, has it been verified with
10 another mathematical model?
11 A. (DR. SOLER) That particular code was simply
12 a tool and was verified by actually doing a sample
13 calculation and checking it manually to see that it
14 gave you the same results that you got from a hand
15 calculation. It was simply a program enabling you to
16 avoid doing a lot of things manually.
17 Q. Is it correct that you used a different
18 model for the 2000-year analysis at PFS versus the
19 10,000-year analysis?
20 A. (DR. SOLER) A different computer code, but
21 essentially the same model. In other words, if your
22 definition of model is that I have an MPC that is
23 inside an overpack and that overpack is sitting on a
24 pad or portion of the pad and that pad or the portion
25 of the pad is being excited, then the models are the

1 same; the algorithm, the engine by which the program
2 solves the problem is different.
3 Q. And why did you use a different algorithm?
4 A. (DR. SOLER) The 10,000-year earthquake was
5 a beyond design basis earthquake. We fully expected
6 from our previous results at other plants that the
7 2,000-year earthquake would give us what I will loosely
8 call small deformation results, in other words, that we
9 would not show extremely large rotations of the cask
10 during the motion.
11 The code which you have labeled as a lumped
12 mass model is a small deformation code in that it does
13 not -- it's not capable without modification of
14 modeling the potential for a cask to execute a large
15 rotation.
16 The 10,000-year earthquake, being beyond the
17 design basis, was a scoping analysis, and therefore it
18 was quite likely to expect that we would experience
19 large rotations of the cask, and therefore we used a
20 program that was capable of managing that kind of a
21 motion.
22 Q. And what program did you use?
23 A. (DR. SOLER) It's called Visual NASTRAN
24 Desktop. It used to be called Working Model, but there
25 was a corporate takeover.

1 Q. And do you have a name for Holtec's code
2 that you developed?
3 A. (DR. SOLER) It has over the years gone by
4 various names depending upon whether it was in the wet
5 storage arena. In wet storage it was known as
6 DynaRack. In early dry storage work it was sometimes
7 called DynaCask. Lately, to avoid confusion, we have
8 taken to calling it Dynamo.
9 Q. If I can remember to call it Dynamo, you'll
10 know that I'm talking about your -
11 A. (DR. SOLER) I'll know what you're talking
12 about.
13 Q. Okay. And I just have to remember that.
14 A. (DR. SOLER) Let me add a little bit more
15 just to avoid confusion. Internally and in some
16 references it was also known as MR-2, the MR standing
17 for "multi-rack" at the time.
18 Q. So is it correct that Dynamo without
19 modification cannot be used to evaluate the 10,000-year
20 ground motions at PFS?
21 A. (DR. SOLER) I believe that it would give
22 erroneous results.
23 Q. Is it correct that you did not use Dynamo
24 for the Diablo Canyon cask stability analysis?
25 A. (DR. SOLER) That is correct.

1 Q. And was that for all revisions of the cask
2 stability analysis?
3 A. (DR. SOLER) Yes. We did not use Dynamo for
4 anything at Diablo Canyon that has been submitted to
5 the NRC for their site license.
6 Q. And did you use Visual MASTRAN?
7 A. (DR. SOLER) Yes.
8 A. (DR. SINGH) NASTRAN.
9 A. (DR. SOLER) Yes. That's N, with an N,
10 NASTRAN, not MASTRAN.
11 Q. I'm sorry. Thank you. And what model did
12 you use in the Energy Northwest cask stability
13 analysis?
14 A. (DR. SOLER) Dynamo.
15 Q. And for Tennessee Valley?
16 A. (DR. SOLER) Dynamo.
17 Q. Approximately what range of zero period
18 accelerations do you believe Dynamo is capable of
19 processing?
20 A. (DR. SOLER) I would say, without having
21 pushed it, but I -- to the extent that zero period
22 accelerations imply a certain cask motion, I would not
23 hazard a guess as to the upper limit on Dynamo. I
24 would have to run it and check on the results. And if
25 those results remained in what I would call the small

1 rotation range, then I would accept the results from
2 Dynamo. However, the reason for not using Dynamo for
3 the 10,000-year earthquake was simply at the outset I
4 expected large rotations to validate the results from
5 Dynamo.
6 Q. And when you say "large rotations" --
7 A. (DR. SOLER) I'm talking qualitatively in
8 the range of, say, 20 degrees, 15 degrees or higher.
9 Q. In your last deposition I asked whether
10 Holtec's computer code, which I didn't ask it as
11 Dynamo, but --
12 A. (DR. SOLER) A lumped mass model.
13 Q. Yes.
14 A. (DR. SOLER) Okay.
15 Q. Had been compared to other nonlinear codes.
16 And is it correct to characterize your answer that
17 portions of the NRC had compared it to portions with
18 respect to wet storage?
19 MR. GAUKLER: Objection. I'd like to have
20 you show the witness the question and answer before you
21 ask whether that is the correct characterization.
22 A. (DR. SOLER) Do you want me to look at the
23 stuff in yellow?
24 Q. No. Starting right there and through there
25 (indicating).

1 Off the record.
2 (Discussion off the record.)
3 A. (DR. SOLER) Okay, now ask your question
4 again.
5 Q. Is it fair to characterize your response in
6 the last deposition, or I guess in general that NRC had
7 compared portions of what I now know as Dynamo for wet
8 storage to other nonlinear codes?
9 A. (DR. SOLER) Well, I'm not sure what the NRC
10 has done independently, but as part of a number of
11 submissions for particular utilities in wet storage
12 applications, we were of course asked questions by the
13 NRC staff reviewer, and previous to the submittal we
14 were also sometimes asked questions by the utility
15 reviewers before submittal. And if you take all of the
16 submittals that we've made since when we started and
17 through the wet storage period, there have been a whole
18 range of problems considered. And there of course is a
19 validation report that's been issued with different
20 classical problems, both linear and nonlinear. Their
21 "exact" solutions or their numerical solutions from
22 other sources were compared with the results that we
23 would get for the same problem.
24 So while you could not say that a particular
25 wet storage submittal was completely modeled by another

1 program and compared with the results that we got,
2 portions of the program were compared by testing the
3 problem that had been done in the literature, or, in
4 one case, a finite element model using ANSYS that was
5 made up by a utility to characterize all of the
6 features like nonlinear springs and gap elements that
7 was in their model.
8 Q. You mentioned a validation report. Is this
9 a formal document that's submitted to NRC?
10 A. (DR. SOLER) Yes, I believe it's in the
11 public document now.
12 Q. And approximately how large is that
13 validation?
14 A. (DR. SOLER) Like that (indicating). I
15 believe, maybe I'm wrong, but we submitted at one time
16 a table of contents to that report.
17 Q. Did you submit a validation report with the
18 TSAR?
19 A. (DR. SOLER) No.
20 Q. Dr. Singh, do you want to add?
21 A. (DR. SINGH) May I supplement the response?
22 Q. Yes.
23 A. (DR. SINGH) One of the essential
24 undertakings we have in nuclear plant design and
25 analysis activities is to ensure that the computer

1 Q. With respect to Dynamo, do you directly
2 apply ground acceleration time histories, or do you
3 have to make some modifications to the time histories?
4 A. (DR. SOLER) We directly apply the
5 acceleration time history with a change of variables.
6 Q. And what do you mean "with a change of
7 variables"?
8 A. (DR. SOLER) Well, you can either treat a
9 seismic problem by assuming that the ground is moving
10 with some displacement time history and forcing through
11 the connection to the ground or friction and gap
12 elements, forcing the racks to move, or you can make a
13 change of variables and assume -- not assume, and make
14 everything relative to a fixed ground. And in that
15 case the forces are applied to the rack or to the cask
16 in the form of acceleration time histories, the ones
17 you have, times the mass of the particular component.
18 Based on the questions yesterday, I believe that that's
19 what was done in the Altran report, too.
20 MS. NAKAHARA: How about if we take a
21 ten-minute break.
22 (Recess from 10:39 to 10:56 a.m.)
23 Q. (BY MS. NAKAHARA) Dr. Soler, I have a few
24 more questions to ask about the mathematical codes.
25 What is the difference between Dynamo and Visual

1 NASTRAN that allowed Visual NASTRAN to accommodate
2 potentially large rotations?
3 A. (DR. SOLER) Okay. Well, if you write the
4 equations of motion of a system and restrict it to
5 small rotations, you can simplify the equations.
6 In a nutshell, the Dynamo code does not
7 alter the equilibrium equations step by step. It
8 assumes to always satisfy equilibrium based on the
9 original configuration.
10 The Visual NASTRAN code was written from the
11 outset to accommodate large motions, falling objects
12 that could tumble, turn over, bounce. Therefore, it
13 did not make internally any simplifications to the
14 equations that are presumably programmed at the site.
15 So if you attempt to take a code that is written for
16 small deflections and blindly just apply it and get a
17 result that would indicate large deflections, either
18 your program will blow up on you or it will just give
19 you ridiculously large results that have no physical
20 meaning, or it will simply give you wrong results that
21 you may think there's a physical meaning to it. So you
22 have to be careful to make sure that you don't pose to
23 a code a problem that has a chance of going outside the
24 range of validity of the code.
25 Q. And how can you ensure that the results for

1 the PFS 2,000-year return period using Dynamo are
2 accurate results?
3 A. (DR. SOLER) If I take, say, the peak
4 displacements that are predicted from any of the runs,
5 we're talking about numbers on the order of three
6 inches, say; and if I take three inches, which is a
7 maximum excursion laterally and assume the worst, that
8 the bottom of the cask was somehow pinned and it was
9 rotating, which is usually the case with a .8
10 coefficient of friction, if you take three inches and
11 divide by the height of the cask, which is 231 inches,
12 and calculate that angle, that angle is very small and
13 it's a commonly accepted number that would tell you
14 you're still in a small deflection range.
15 Q. Jumping to the cask stability analysis for
16 Diablo Canyon, were all cask stability analyses for
17 unanchored casks conducted with Visual NASTRAN?
18 A. (DR. SOLER) Well, all analyses that were
19 submitted to the NRC were for anchored casks and were
20 conducted with Visual NASTRAN.
21 Q. What about the scoping analysis that you
22 conducted for unanchored casks?
23 A. (DR. SOLER) The scoping analyses which were
24 most likely a few years ago we're talking were analyzed
25 with Dynamo, perhaps internally Visual NASTRAN, but I

1 don't think so. I think all of our results were
2 submitted in the scoping analysis using Dynamo.
3 Q. Do you suspect large rotations at Diablo
4 Canyon for the unanchored cask analysis?
5 MR. GAUKLER: Objection. "Large" is
6 undefined.
7 Q. Did you expect rotations that would
8 invalidate Dynamo's results at Diablo Canyon in your
9 scoping analysis for unanchored casks?
10 A. (DR. SOLER) Subject to my checking what we
11 actually submitted to PG&E, my recollection is that the
12 motions that we were getting for unanchored casks in
13 our scoping analysis were not to the level that we
14 would have said the program is predicting stability
15 when an instability really occurs.
16 Q. Do you recall what the horizontal
17 displacement for an unanchored cask in your scoping
18 analysis for Diablo Canyon?
19 A. (DR. SOLER) No. I'd have to check that. I
20 guess the only thing I would say at this point is, we
21 would not have submitted anything to PG&E which talked
22 about hundreds of inches.
23 Q. Do you recall what the uplift, if any, was
24 in the scoping analysis for Diablo Canyon?
25 A. (DR. SOLER) I don't recall.

1 the pad of course I believe is about seven or eight
2 foot thick and anchored into rock. We had no direct
3 involvement in designing the pad. Our inputs were
4 provided to us at the pad.
5 Q. With respect to Tennessee Valley, did you
6 assume the storage pads were rigid?
7 A. (DR. SOLER) No.
8 Q. And will you explain the difference between
9 why you assumed they were not rigid at Tennessee Valley
10 versus PFS?
11 A. (DR. SOLER) At the client's request at
12 Tennessee Valley they asked us to examine the effects
13 of including pad flexibility in a model.
14 Q. And what did including pad flexibility show?
15 A. (DR. SOLER) It was a very small effect,
16 second order.
17 Q. When you say "second order," can you explain
18 what you mean?
19 A. (DR. SOLER) Well, that's generally a term
20 used when you have a result for one set of assumptions
21 and then you, say, modify those assumptions, in this
22 case to incorporate pad flexibility, and you find that
23 the final results that you get don't change much and it
24 really wouldn't matter which set of assumptions you
25 would use.

1 A. (DR. SINGH) Let me put it in practical
2 terms. Say if you wanted to measure the distance
3 between these two walls and you have a tape measure.
4 All right? You measure the distance and say, this is
5 15 feet 6 inches. And somebody says to you, measure it
6 more accurately, so you will get yourself a tape
7 measure and a caliber. With caliber you determine it's
8 ten-thousands of an inch more. That's the second order
9 effect, the measure meant by the caliber. It did not
10 really change the overall information you had based on
11 the tape measure. Okay?
12 So when he says second order effects, he
13 means the additional small, minor refinement in the
14 solution that otherwise it's -- that it's no
15 consequence, no import to the conclusions that one
16 would draw from that particular work. Right?
17 A. (DR. SOLER) Well, I don't know whether
18 you -- you were okay with the tape measure. I'm not
19 sure whether you added anything after that.
20 Q. With respect to your analysis that Tennessee
21 Valley using a flexible pad versus a rigid pad -- and a
22 rigid pad, do you believe the second order results --
23 A. (DR. SINGH) Effects.
24 Q. -- effects in the results would be the same
25 for the PFS facility?

1 A. (DR. SOLER) Yes. Well, let me see if I --
2 are you asking me whether or not I would expect to get
3 a -- that the effect of including flexibility of PFS
4 would result in a second order change?
5 Q. That's actually a better question. Why
6 don't you answer that one.
7 A. (DR. SOLER) I would expect it to be second
8 order, yes.
9 Q. Now, is that based on your engineering
10 judgment or based on the results from Tennessee Valley?
11 A. (DR. SOLER) Both.
12 Q. And would the increase in ground motion at
13 the PFS site, the increased ground motion at the PFS
14 site have any effect on whether you would expect the
15 differences from a flexible pad versus a rigid pad to
16 be second order?
17 A. (DR. SOLER) At the risk of confusing the
18 issue even further, the second order effect may be
19 amplified or attenuated a little bit, the stronger the
20 earthquake. But the main effect, of course, is also
21 getting larger, presumably. So if you characterize the
22 effect as sort of the ratio of, say, the difference
23 between including flexibility or not including
24 flexibility divided by the major result, that ratio
25 probably will not change too much. Both numbers might

1 go up a little bit or down a little bit depending upon
2 the strength of the earthquake.
3 A. (DR. SINGH) Percentage effect would be the
4 same. And by the way, the pad at PFS is 50 percent
5 thicker than the pad at TVA. The PFS pad is much
6 thicker and therefore much stronger than the Tennessee
7 Valley Authority pad.
8 DR. SOLER: Is it 50 percent?
9 DR. SINGH: Two feet at TVA.
10 DR. SOLER: Is it three feet or 30 inches?
11 I can't remember.
12 DR. SINGH: Three feet.
13 DR. SOLER: Okay, then it's 50 percent
14 thicker.
15 Q. (BY MS. NAKAHARA) Would the concrete
16 strength of the pad affect the flexibility?
17 A. (DR. SINGH) Of course.
18 Q. What, if you can recall, is the concrete
19 strength used at Tennessee Valley?
20 A. (DR. SINGH) It hasn't been built yet, but
21 it will be comparable.
22 Q. Did you assume the storage pads at Energy
23 Northwest were rigid in the --
24 A. (DR. SOLER) Yes.
25 MS. NAKAHARA: Can we go off the record for

1 a second?
2 (Discussion off the record.)
3 Q. (BY MS. NAKAHARA) Dr. Soler, please look at
4 Exhibit 13, which is Applicant's Objections and
5 Responses to the State of Utah's Fourteenth Set of
6 Discovery Requests Directed to the Applicant, dated
7 February 19th, 2002. Are you familiar with this
8 document?
9 A. (DR. SOLER) Yes, I am.
10 Q. Please turn to page 21, which is PFS's
11 response to Interrogatory 7.
12 A. (DR. SOLER) Which page?
13 Q. Twenty-one.
14 A. (DR. SOLER) All right.
15 Q. And will you look at this response and tell
16 me whether you were responsible for this response.
17 A. (DR. SOLER) I would say that I'm
18 responsible for a portion of it.
19 Q. How about the paragraph marked as (10)?
20 A. (DR. SOLER) Ten, the -- I'm responsible to
21 that to the extent that, let's say, the last three
22 sentences, I received data from other people.
23 Q. This is a long, convoluted process to
24 basically ask you whether the last sentence of that
25 paragraph, which refers to second order effects, is

1 basically the same definition that you gave earlier for
2 second order effects.
3 A. (DR. SOLER) Meaning the definition I gave
4 today is --
5 Q. Yes.
6 A. (DR. SOLER) Yes.
7 Q. And have you conducted any other
8 calculations or analyses other than the Tennessee
9 Valley calculations which confirmed, assuming the pad's
10 flexible, would result in what you would term second
11 order effects?
12 A. (DR. SOLER) No. TVA is the only place
13 where we conducted that.
14 Q. Dr. Soler, we are on page 21 and 22 of
15 Exhibit 13, which is the Applicant's Objections and
16 Responses to the State of Utah's Fourteenth Set of
17 Discovery Requests Directed to the Applicant,
18 concerning the Applicant's response to Interrogatory
19 No. 7. And is it correct that you are in part or in
20 full responsible for this response?
21 A. (DR. SINGH) Are you asking me?
22 Q. Yes.
23 A. (DR. SINGH) Okay. Yes, I'll participate in
24 this finding.
25 Q. Dr. Soler, were the -- was the flexibility

1 of the cask pad in the Tennessee Valley cask stability
2 analysis that considered a flexible pad, was it in the
3 similar range shown in the International Civil
4 Engineering Consultants analysis?
5 A. (DR. SOLER) Well, I think you're comparing
6 apples and oranges there. Every structural analysis,
7 seismic structural analysis of the pad and the way we
8 have done it in TVA and for PFS consists of two parts.
9 One is to develop a dynamic model, which is where we're
10 talking about Dynamo, and use that dynamic model to
11 predict the time history of forces between the cask and
12 the pad. Once you have that time history, you then go
13 to a static finite -- static or dynamic finite element
14 model of the pad itself, and you pose those forces on
15 the pad and demonstrate that you would satisfy the
16 standard codes for qualifying a concrete, reinforced
17 concrete structure.
18 So in PFS there were two separate analyses:
19 the Holtec analysis to determine the time history of
20 the forces at the pad-cask interface, and the ICEC
21 analysis which took those forces and determined the
22 structural response of the pad. And of course, doing
23 the structural response, you do predict elastic
24 deformation.
25 For TVA at Holtec the analysis is

1 essentially done the same way, in two parts, except
2 that a different program is used for structural
3 analysis of the pad. You take our results out of
4 Dynamo, come up with bounding forces and moments that
5 we predict, and impose those bounding forces and
6 moments on the ANSYS model which we use to satisfy the
7 American Concrete Institute requirements or the plant
8 specification requirements on reinforced concrete
9 structures.
10 So in that vein the two analyses are
11 similar, the two sets of analyses are similar. But the
12 structural analysis was done with two different codes.
13 Q. Is it correct they calculate in the soil
14 spring and damping if you assume the pads were rigid?
15 MR. GAUKLER: Objection, lack of foundation.
16 He can answer if he can.
17 A. (DR. SOLER) We, Holtec, did not compute the
18 soil strengths. There was design input data to us.
19 Same thing with damping.
20 MR. GAUKLER: Damping of the soil, correct?
21 A. (DR. SOLER) Soil damping, yes.
22 Q. And where did you get that data from?
23 A. (DR. SOLER) Geomatrix.
24 Q. Is it correct that you assumed the friction
25 across the base of the storage cask and the pad

1 really a function of the orientation of the cask.
2 A. (DR. SINGH) The angle of the vertical axis
3 of the cask, axis of the cask with respect to the
4 vertical and the total downward slope together
5 determine how many springs are engaged.
6 Q. Did you consider other stiffness values in
7 analyzing cask stability at PFS and whatever's
8 referenced in the '97 report?
9 A. (DR. SOLER) Well, the '97 report and all of
10 the values accounted for in the Dynamo solutions, that
11 stiffness value stayed constant. Over the course of
12 time and some of our work with Visual NASTRAN, we took
13 a different approach that led us to essentially the
14 same order of magnitude. The approach we took in at
15 Diablo Canyon and I believe in the 10,000-year
16 earthquake run for PFS was that we said, instead of
17 looking at it from the point of view of deflecting an
18 infinite concrete block and deriving the spring
19 constant that way, we took the other approach of
20 saying, if I took this mass, 360,000 pounds, and I
21 imagined it oscillating as if it were a linear system,
22 that the spring constant I would choose would be such
23 as to ensure that the lowest natural frequency was
24 above 33 hertz. So I would accurately -- so I would be
25 consistent with modeling the system as a rigid system.

1 Now, having gone through that calculation,
2 you can then ask yourself the physical question, now
3 that I have those springs, what is the static
4 deflection I would see? And it's again very small.
5 So the number we came out with for our
6 Visual NASTRAN model, that only had -- that did not use
7 36 springs around the periphery. It used a lesser
8 number, because the way the CAD model constructed the
9 model, it only had what they call 16 facets. So that
10 we developed the spring constant the same way, but it
11 basically started from a different approach. Instead
12 of looking at a classical solution for a semi-infinite
13 half space, it simply said, suppose I want this simple
14 cask rigid body; if it oscillated in a pure vertical
15 motion as a linear system, it's going to oscillate 33
16 Hz motion. And what kind of a spring constant does
17 that give you, and does that show you that if you
18 simply put it down on the table or on the pad, it's not
19 going to leave a hole in the table or a dent in the
20 table. I would not expect that on physical grounds
21 from what I know about putting objects like a cask on a
22 concrete pad.
23 Q. Do you recall what the vertical contact
24 stiffness, the total vertical contact stiffness for the
25 Visual NASTRAN --

1 A. (DR. SOLER) I believe I can get that out of
2 the 10,000-year report. And on page A-1 of that report
3 the total weight is 360,000 pounds, and I stand a
4 little corrected because there are 24 facets in the CAD
5 model and the spring constant is 1.67×10^6, and the
6 total would be -- multiply that by 24. So the total
7 number there is, let's say -- probably about 36×10^6.
8 It's roughly a period of -- I guess four to four and a
9 half years has elapsed since we started our first
10 analysis. Our methodology for computing the spring
11 constant, especially with this program, has been
12 refined by our experiences with Diablo Canyon.
13 Q. Did you run Dynamo with the same contact
14 stiffness that you used for the visual --
15 A. (DR. SOLER) No.
16 Q. Did you calculate the total vertical contact
17 stiffness values in a similar manner as were PFS Dynamo
18 analysis in your Tennessee Valley cask stability, if
19 you recall?
20 MR. GAUKLER: Focus on a clear answer if you
21 can.
22 A. (DR. SOLER) I would say I can't recall at
23 this point in time, especially since I was the reviewer
24 and that's ongoing, whether we have updated our
25 thinking about the choice of spring constants. But let

1 me say that the underlying principle of choosing that
2 spring constant is effectively to make it stiff enough
3 so that in a static scenario it does not predict that
4 the cask or whatever it is you're dealing with will sit
5 on the pad and give you a visible deformation to the
6 naked eye, if you will.
7 Q. Do you recall how the total vertical contact
8 stiffness values were calculated for Energy Northwest?
9 A. I could only hazard a guess, because I'd
10 have to review the report.
11 Q. What about for Diablo Canyon?
12 A. (DR. SOLER) Diablo Canyon, for the anchored
13 casks, the vertical contact stiffness for compression
14 of the concrete pad was computed based on the
15 semi-infinite model, if you will, and then divide it up
16 around the number of nodes.
17 Q. I think you've already tried to explain
18 this, but will you explain again why you used the
19 semi-infinite model calculation for Diablo Canyon which
20 also uses the Visual NASTRAN model when you used a
21 different method for PFS?
22 A. (DR. SOLER) Their independent consultant
23 who acted as a reviewer was comfortable with that, and
24 it was his engineering opinion that it didn't much
25 matter how you calculated the value as long as you got

1 a value that was high enough.
2 A. (DR. SINGH) I will put it this way: as long
3 as the value is consistent to the physics of the
4 problem.
5 Q. Am I correct that the two stiffness values
6 that were used for PFS, one using the semi-infinite
7 model method, that there's an order of magnitude
8 difference?
9 A. (DR. SOLER) There's about a factor of 10.
10 I think that's a fair statement.
11 Q. What impact, if any, do you think that would
12 have on --
13 A. (DR. SOLER) That would have minimal impact
14 on the results.
15 Q. And why is that?
16 A. (DR. SOLER) Simply my experience in running
17 a large number of Visual NASTRAN simulations, that you
18 get to a certain point and the exact value of the
19 contact stiffness washes out in the results, that you
20 don't -- can't make a one-to-one correlation as soon as
21 you get to a high enough value.
22 Q. How can you ensure that using the total
23 vertical stiffness that you used for the PFS 2000-year
24 cask stability analysis will not cause Dynamo to
25 artificially treat the solution as linear?

1 get the result of the model, what we are looking at is
2 the actual deformed surface of either or both bodies,
3 however they end up. So you would not be able to back
4 calculate the local stiffness used at that point.
5 Q. How did you model fuel assemblies in the
6 seismic model?
7 A. (DR. SOLER) Are we off the drop report, or
8 are we still in the drop report?
9 Q. We're still -- we're off.
10 A. (DR. SOLER) We're back to seismic, then?
11 MR. GAUKLER: Dynamo.
12 MS. NAKAHARA: Yes.
13 A. (DR. SOLER) The fuel assemblies
14 individually were not modeled. The total mass of the
15 fuel was assumed to move with the MPC and essentially
16 to be attached to it. So we did not model individual
17 fuel assemblies and their motion. All we incorporated
18 was the totality of the mass of all the fuel.
19 Q. Did you use impact damping from the fuel
20 assemblies inside the cask when you modeled the MPC?
21 A. (DR. SOLER) No, because we didn't model the
22 fuel separately. So we neglected that.
23 Q. Hypothetically, is Dynamo capable of
24 graphically illustrating cask tipover as a result of
25 seismic ground motion?

1 A. (DR. SOLER) No, because Dynamo is not a
2 large -- the equations built into Dynamo are equations
3 which would be modeled by the data you put in, are only
4 small deflection equations, and therefore what you
5 would most likely predict if you tried to just run it
6 and not examine your results is that you would predict
7 some unreasonably large displacement but not
8 necessarily the cask physically tipping over. Just
9 could not count on the accuracy of the result that you
10 got being indicative of what really could be happening.
11 Q. Have you ever analyzed an unanchored cask
12 under seismic ground motions that you believe would tip
13 over?
14 A. (DR. SOLER) Yes.
15 Q. For what facility?
16 A. (DR. SOLER) It was a -- really a solution
17 for a cask, a HI-STAR using a 1.5 horizontal g load
18 from a Reg Guide 160 earthquake. And in fact, it is
19 the subject of a SMIRT paper. The paper itself did not
20 discuss the use of -- well, it discussed the use of
21 Dynamo, but it doesn't discuss the use of Visual
22 NASTRAN. However, the presentation did discuss the
23 differences that you would get if you used a small
24 deflection program to try to predict a large deflection
25 response. And when I use the word "deflection" here, I

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

CERTIFICATE OF SERVICE

I hereby certify that copies of the "Applicant's Response to State of Utah's Motion In Limine to Strike Applicant's Prefiled Direct Testimony for Unified Contention Utah L/QQ" and referenced excerpts from the Depositions of Dr. Singh and Dr. Soler were served on the persons listed below (unless otherwise noted) by e-mail with conforming copies by U.S. mail, first class, postage prepaid, this 22nd day of April, 2002, and with hard copies to be provided to the Board and parties at the hearing on April 23, 2002.

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