UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	Docket No. 72-22-ISFSI
PRIVATE FUEL STORAGE, LLC	)	ASLBP No. 97-732-02-ISFSI
(Independent Spent Fuel Storage Installation)	)	January 30, 2001

STATE OF UTAH'S RESPONSE TO APPLICANT'S MOTION FOR SUMMARY DISPOSITION OF UTAH CONTENTION L

Pursuant to the Licensing Board's Order of January 4, 2001 and 10 CFR § 2.749, the State responds to the Applicant's December 30, 2000 Motion for Summary Disposition of Utah Contention L. This response also includes the State of Utah's Statement of Disputed and Relevant Material Facts ("Material Facts"), and is supported by the Declarations of Dr. M. Lee Allison, Dr. Walter J. Arabasz, Dr. Steven Bartlett, and Dr. Farhang Ostadan, attached hereto as exhibits 1-4, respectively.

Applicant's Motion for Summary Disposition is not warranted because there are still genuine issues of material fact relevant to the contention, and under 10 CFR § 2.749 the Applicant is not entitled to summary disposition as a matter of law.

Background

The Board admitted Contention Utah L[1] in its entirety. Contention L generally asserts "[t]he Applicant has not demonstrated the suitability of the proposed ISFSI site

[1] Contention Utah L and its bases were admitted in their entirety by the Licensing Board in LBP-98-7, 47 NRC 142, 191, 253, *aff'd on other grounds*, CLI-98-13, 48 NRC 26 (1998).

because the License Application and SAR do not adequately address site and subsurface investigations necessary to determine geologic conditions, potential seismicity, ground motion, soil stability and foundation loading." State's Contentions on the Construction and Operating License Application by Private Fuel Storage, LLC for an Independent Spent Fuel Storage Facility (November 23, 1997) ("State's Contentions") at 80.

Utah L and its bases are founded on 10 CFR Part 72, including the requirement to analyze seismicity using deterministic methodology, as required by 10 CFR Part 100, Appendix A. Most of the procedural background relating to Contention Utah L involves PFS's request to be exempted from complying with Part 72 and Part 100 Appendix A.

On April 2, 1999, the Applicant applied for an exemption from the requirements of 10 CFR § 72.102(f)(1), requesting approval to conduct a probabilistic seismic hazard analysis instead of a deterministic analysis as required by Part 72.[2] In response to the Applicant's exemption request, the State made three attempts to amend Utah L by modifying Basis 2 to require either the use of a probabilistic seismic hazard analysis with a return period of 10,000 years as required by NRC's Rulemaking Plan, SECY-98-126,[3] or compliance with the deterministic approach currently required by 10 CFR 72.102(f)(1). The State's first two

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[2] Request for Exemption to 10 CFR 72.102(f)(1), Seismic Design Requirement, Docket No. 72-22/Tac No. L22462, Private Fuel Storage, Private Fuel Storage L.L.C, addressed to Mark Delligatti at NRC's Spent Fuel Project Office.

[3] "Rulemaking Plan: Geological and Seismological Characteristics for Siting and Design of Dry Cask Independent Spent Fuel Storage Installations, 10 CFR Part 72," SECY-98-126 ("Rulemaking Plan").

attempts, one[4] filed after PFS's exemption request, and the other[5] filed after the Staff issued its first Safety Evaluation Report ("SER") (December 15, 1999), were dismissed by the Board as not being ripe because the Board held that the State must wait until the Staff officially made its decision whether to grant the exemption request.[6] The State filed its third request to modify Basis 2 on November 9, 2000[7] after the Staff had issued its final SER (October 6, 2000). The State also requested that the Board certify the question to the Commission if the Board finds it does not have jurisdiction over PFS's exemption request. State's 3rd Utah L Modification Request at 5-6. The Board has not yet ruled on the State's request.

LEGAL STANDARD

Pursuant to 10 CFR § 2.749, a party is entitled to summary disposition if "there is no genuine issue as to any material fact" and the party "is entitled to a decision as a matter of law." Id. at (d). The burden of proving entitlement to summary disposition is on the movant.[8] Because the burden of proof is on the proponent, "the evidence submitted must

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[4] *See* State's Motion Requiring Applicant to Apply for Rule Waiver Under 10 CFR § 2.758(b) or in the Alternative Amendment to Utah Contention L (April 30, 1999).

[5] *See* State's Request for Admission of Late-filed Modification to Basis 2 of Contention Utah L (January 26, 2000).

[6] *See* LBP-99-21, 49 NRC 431 (1999) (the Board also denied State's motion requiring PFS to apply for the rule waiver); and LBP-00-15, 51 NRC 313 (2000).

[7] *See* State's Request for Admission of Late-filed Modification to Basis 2 of Contention Utah L (November 9, 2000) ("State's 3rd Utah L Modification Request").

[8] Advanced Medical Systems, Inc. (One Factory Row, Geneva, Ohio 44041), CLI-93-22, 38 NRC 98, 102 (1993).

be construed in favor of the party in opposition thereto, who receives the benefit of any favorable inferences that can be drawn."[9] Furthermore, if there is any possibility that a litigable issue of fact exists or any doubt as to whether the parties should be permitted or required to proceed further, the motion must be denied.[10] Summary judgment may also be denied or continued if the opposing party demonstrates in its affidavits that it cannot present facts essential to justify its opposition.[11]

ARGUMENT

I. The PFS ISFSI Site Is One of Great Geologic Complexity and PFS Has Not Conducted an Integrated and Unified Approach to Its Geologic Investigation and Analysis of the Site.

The PFS site is one of great geologic complexity. The site lies within the western boundary of the Intermountain Seismic Belt (ER (Rev. 5) 2-6.23); it is approximately nine km west the Stansbury fault, an acknowledged capable fault (Coppersmith Dec. ¶¶ 3 & 13) that dips to the west and is projected beneath the PFS site. ER (Revs. 2&4) at 2.6-1 and -2. During its 1998 site investigation, PFS's contractor, Geomatrix, discovered two formerly

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[9] Sequoyah Fuels Corp. and General Atomics Corp. (Gore, Oklahoma Site Decontamination and Decommissioning Funding), LBP-94-17, 39 NRC 359, 361, *aff'd* CLI-94-11, 40 NRC 55 (1994).

[10] General Electric Co. (GE Morris Operation Spent Fuel Storage Facility), LBP-82-14, 15 NRC 530, 532 (1982).

[11] 10 C.F.R. § 27.49(c); Long Island Lighting Co. (Shoreham Nuclear Power Station, Unit 1), CLI-86-11, 23 NRC 577 (1986). *See also* Cleveland Electric Illuminating Co (Perry Nuclear Power Plant, Units 1 and 2) ALAB-443, 6 NRC 741, 755 (1977): "[S]ummary disposition is a harsh remedy. It deprives the opposing litigant of the right to cross-examine the witness, which is perhaps at the very essence of an adjudicatory hearing. In such circumstances -- even in administrative proceedings where the rules of evidence may be relaxed -- it is important that a movant for summary disposition be required to hew strictly to the line set out by our Rules of Practice."

unknown capable faults, informally named the East Fault (.09 km east of the site) and the West Fault (2 km west of the site). Id. at 2.6-2. In addition, there are other seismogenic faults in the Skull Valley region, notable the Springline Fault to the north and the East Cedar Mountain Fault to the west. Coppersmith Dec. ¶ 13.

PFS's initial investigation of the site in 1996 was very preliminary. PFS conducted approximately 24 borings in the pad emplacement area and access road and PFS's contractor, Geosphere, did some seismic refraction and reflection work. ER at 2.6-9 (Rev. 2) and 12 (Rev. 7). Another contractor, Geomatrix Consultants, Inc., conducted a more detailed geotechnical investigation in 1998. In reviewing Geosphere's work, Geomatrix expressed concerns about the resolution of the seismic survey and associated uncertainties with respect to the depth to bedrock and the shear wave velocity profile beneath the site. *See* letter from Kevin Coppersmith, Geomatrix, to John Donnell, Stone & Webster (February 20, 1997), attached hereto as Exhibit 5.

Geomatrix claims that its geologic investigation of the PFS site was "comprehensive and integrated." *See* Coppersmith Dec. ¶¶ 7, 8-10. But it was neither, and as a result, the site has not been adequately characterized. For example, from the Geosphere seismic refraction data, PFS assumed an average velocity in the soil profile to be 750 ft/sec. In 1999, PFS (through yet another contractor, Cone Tec) conducted seismic cone penetration tests ("SCPT") at the site. The SCPT data contradicts the seismic refraction data because it shows a velocity profile in the uppermost soil layer to be approximately 540 ft/sec. *See* SAR Fig. 2.6-28. Yet, Geomatrix and other PFS contractors have used the higher velocity data as input to their seismic analysis of the site and have ignored the lower SCPT velocity data. By

ignoring the difference in velocity data, PFS's contractors have inadequately and inappropriately analyzed the seismic conditions at the PFS site. *See* Section V below. The State's experts, Dr. Steven Bartlett and Dr. Farhang Ostadan testified about these issues in detail during their November 2000 depositions. *See* Bartlett & Ostadan Tr., attached hereto as Exhibit 6; Ostadan Dec. ¶¶ 12-13; Bartlett Dec. ¶ 17.

A seismic investigation is usually phased, and each subsequent phase tries to resolve issues from the preceding phase. Bartlett & Ostadan Tr. 92. PFS's approach, however, has been to isolate each study by discipline without adequate mechanisms or procedures in place to share and use data consistently across disciplines. *See e.g.*, Trudeau & Chang Tr., attached hereto as Exhibit 7, at 145-198. This led to a non-comprehensive and non-integrated study of the site. At times PFS appears to have conducted work merely to satisfy questions raised by NRC without evaluating how that work fitted into the overall investigation. In the subsurface investigation, for example, the borings conducted in 1998 were PFS's lead investigative tool. When PFS conducted its SCPT test, it appeared to be in response to questions from NRC instead of being part of a comprehensive and integrated study.[12]

At last, PFS seems to have recognized it has not conducted a "comprehensive and integrated" seismic investigation. On December 11, 2000, PFS advised the NRC that test data previously collected at the PFS site "may not have been fully integrated into the geotechnical assessment of the site." Letter from John Parkyn, PFS, to Mark Delligatti,

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[12] Testifying about the SCPT data, Dr. Bartlett stated: "I'm not sure I get a sense in reading the documents why some things were being done and why they were doing additional borings and investigations, other than just to satisfy a few questions from the NRC." Bartlett & Ostadan Tr. 92.

NRC (December 11, 2000), attached hereto as Exhibit 8. PFS submitted to NRC a follow-up letter on December 22, 2000, advising that the omitted data "will have an impact to the project licensing basis" and require a license amendment to reflect "changes in the PFS [facility] design basis ground motion and dynamic stability analyses based on new shear and pressure wave velocity profiles being developed for the site." Letter from John Parkyn to Mark Delligatti (December 22, 2000), attached hereto as Exhibit 9.

NRC Staff recognized the importance to safety of PFS's proposed additional analyses relating to the geophysical characterization of the site. The NRC has advised PFS that PFS's proposed amendment to its SAR will delay NRC's issuance of the final Environmental Impact Statement and will necessitate additional documentation of NRC's safety conclusions reached in the SER or a supplement to the SER. Letter from E. William Brach, NRC, to John Parkyn (January19, 2000), attached hereto as Exhibit 10. As discussed in the following sections, the new analysis being conducted by PFS has a significant and direct impact on Contention L.

II. PFS Has Not Conducted Its Surface Faulting Study in a Comprehensive or Integrated Manner, Thereby Creating Gaps in the Data and Unreliable Interpretative Results.

The State has designated experts for various portions of Contention L. Dr. Allison is the State's expert for Basis 1 (seismic reflection and capable faults); Dr. Arabasz for Basis 2 (seismic hazard analysis); and Drs. Bartlett (geotechnical and soils analysis) and Ostadan (soils and soil structure interaction) for Basis 3.[13] Each is eminently qualified to testify as an

[13] *See* State's Objections and Response to Applicant's Second Set of Discovery Requests with respect to Groups II and III Contentions (June 28, 1999) at 7; Objections and

expert on the matters that are the subject of their respective declarations, each with extensive experience and education on those matters. *See* Allison Dec. ¶¶ 1-3, Arabasz Dec. ¶ 1, Bartlett Dec. ¶¶ 1-3, and Ostadon Dec. ¶¶ 1-4.

PFS attempts to paint the State's experts with too broad a brush by suggesting that any unresolved issues in Contention L are based on subjective belief or unsupported supposition. PFS Motion at 3-4. As support for this statement, which attempts to impugn all the State's experts, PFS cites to the Coppersmith Declaration ¶¶ 27-31, 46. The cited declaration, however, relates only to certain issues raised by Dr. Allison. It has no relationship whatsoever to any of the other three State experts. Moreover, PFS's disagreement with Dr. Allison's conclusions are not grounds for disqualifying him as an expert. The Supreme Court has dismissed concerns about the new, more lenient Federal Rule of Evidence 702 resulting in admission of faulty science by noting that "[v]igorous cross-examination, presentation of contrary evidence, and careful instruction on the burden of proof are the traditional and appropriate means of attacking shaky but admissible evidence." Daubert v. Merrell Dow Pharmaceuticals, Inc., 509 U.S 579, 596 (1993). As the Fifth Circuit has noted, "the trial court's role as gatekeeper is not intended to serve as a replacement for the adversary system." U.S. v. 14.38 Acres of Land Situated in Leflore County, Missisipi, 80 F.3d 1074, 1078 (5th Cir. 1996).

Furthermore, PFS inappropriately tries to claim the expertise of State's witness, Dr.

Responses to Applicant's Fourth Set of Discovery Requests to Intervenors State of Utah and Confederated Tribes (Jan. 31, 2000) at 4.

Arabasz, as a proponent that PFS has satisfied Contention L, Basis 1.[14] In an attempt to shore up the surface faulting aspect of Geomatrix's study, PFS claims that Dr. Arabasz has endorsed Geomatrix's work. *See e.g*, PFS Motion at 6-8. During his deposition, however, Dr Arabasz testified that his careful review of the Geomatrix report was restricted to vibratory ground motion hazard and that his familiarity with Basis 1 is cursory. Arabasz Tr., excerpts attached hereto as Exhibit 11, at 34-36[15]; PFS Exh. E at 96-97, and 109. Further, Dr. Arabasz testified that he has expertise relevant to surface faulting, but that aspect of Contention L had been assigned to Dr. Allison and he deferred the issue to him. Exh. 11 (Arabasz Tr.) at 35.

PFS's claims that it has used an integrated approach to evaluate both the vibratory ground motion and surface fault displacement are wrong. PFS Material Facts ¶ 4. PFS has not used the soil velocity data obtained from seismic cone penetration tests in order to convert the seismic reflection data to show depth of marker beds, such as the Promontory soil and key geologic horizons within the Lake Bonneville sequence. Allison Dec. ¶ 7.

PFS's approach has not been comprehensive. PFS asserts that because the structural grain of the valley appears to run northwest, geological structure of other orientations do not need to be determined or investigated. But PFS has ignored the east-west Pass Canyon and

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[14] PFS's attempt to rely on Dr. Arabasz's expertise directly contradicts PFS's broad, generalized and unsupported claim that the opinions of the State's technical experts are not based on reasoned scientific or technical judgment. PFS's wants to have it both ways: confer expert status on the State's witnesses when they agree with PFS's position but disrepute them when they challenge PFS's position.

[15] PFS Exhibit E contains excerpts from Dr. Arabasz's deposition, including pages 4 through 33, and 37 through 45 but Exhibit E does not include pages 34-36.

the topographic embayment at the east-west trending Rydalch Pass, which are anomalies to the assertions that the structural grain of the valley runs northwest. Allison Dec. ¶ 8.

In another failure to integrate its approach, Geomatrix collected no seismic tie line to correlate the PFS 1998 lines among themselves or with the Geosphere and GSI lines. All of the PFS 1998 lines were shot in an east-west direction; without any perpendicular lines to tie into those east-west lines, Geomatrix's interpretation of the data is unreliable. Nor are the placement and number of seismic lines adequate to determine the length of the East or West faults. Allison Dec. ¶ 9.

III. PFS Has Not Satisfied the Concerns Raised by the State in Basis 2.

PFS considers Basis 2 to be restricted to whether or not PFS employed the Sommerville methodology in its seismic hazard analysis and has threatened to file a motion to strike if the State attempts to raise any other issue under Basis 2. PFS Motion at 9-10 and 10 n. 16.

PFS's reading of Basis 2 is too simplistic. Basis 2 is framed by the wording of Contention L: "The Applicant has not demonstrated the suitability of the proposed ISFSI site because the <u>License Application and SAR do not adequately address site and subsurface investigations necessary to determine</u> geologic conditions, <u>potential seismicity</u>, <u>ground motion</u>, soil stability and foundation loading." State's Contentions (November 23, 1997) at 80 (*emphasis added*). Basis 2 consists of two parts. The first part relates to the site being subject to ground motions greater than those anticipated due to spatial variation in ground motion amplitude and duration because of near surface traces of potentially capable faults, and the statement is supported by a citation to Sommerville, et al. The second part relates to

PFS's failure to adequately assess ground motion in compliance with 10 CFR § 72.102(c). Section 102(c) requires sites, such as the PFS site, to be evaluated for "soil instability due to vibratory ground motion." For sites west of the Rocky Mountain Front, the Applicant must evaluate vibratory ground motion by conducting a deterministic seismic hazard analysis in accordance with Part 100, Appendix A. 10 CFR § 72.102(f)(1). Thus, Basis 2 relates to whether or not PFS has conducted an adequate deterministic seismic hazard analysis.

PFS has not conducted a fully deterministic seismic hazard analysis that meets the deterministic requirements of 10 CFR Part 100 Appendix A. *See* Staff's Objections and Responses to the "State of Utah's Sixth Set of Discovery Requests Directed to the NRC Staff (Utah Contention L)" (February 14, 2000), Response to Requests for Admissions 1 and 2 at 7-8. *See also* State's Material Facts ¶¶ 13-14.

The Board should uphold this portion of the State's contention because PFS's vibratory ground motion analysis is not in compliance with current Part 72 regulations. For the Board to find that PFS is nonetheless entitled to prevail because the Staff intends to grant PFS an exemption from the deterministic seismic hazard analysis requirements, the Board must find that it has jurisdiction to consider the exemption request. The State finds itself in a procedurally impossible position. The State can show that PFS does not meet the Part 72 deterministic seismic hazard analysis requirements but that is not the standard that will eventually apply to the PFS. The State has attempted to amend Basis 2 on three separate three occasions to address PFS's exemption from Part 72. After the first two attempts, the State was told that it was too early. *See* Background above. The third attempt is still pending before the Board.

As discussed in the following section, PFS's seismic hazard analysis, under any NRC regulatory standard, is inadequate because it does not evaluate conflicting shear wave velocity data in the uppermost soil layer.

IV. PFS's Present Failure to Account for Conflicting Data and Future Revision to Its Design Basis Ground Motion Has Such a Direct and Significant Impact on Basis 2 and Basis 3 that the Board Should Deny PFS's Motion for Summary Disposition.

Regardless of whether PFS is required to conduct a deterministic or probabilistic seismic hazard analysis, PFS's seismic hazard analysis is inadequate because it does not evaluate conflicting shear wave velocity data in the uppermost soil layer. *See* Arabasz Dec. ¶ 8; Ostadan Dec. ¶ 9. Geomatrix relied on shear wave velocities of approximately 750 feet per second obtained from the 1996 seismic refraction data. Ostadan Dec. ¶ 9. Later seismic cone penetration testing data show that the mean shear wave velocities in the shallow soil layer are approximately 540 feet per second. Id.

Once the seismic input or design basis ground motion has been developed based on seismicity and geologic conditions at the site, engineers take that motion and apply it in their analysis; the engineer must decide at which point in the soil profile this motion should be introduced (*i.e.* the control point). If the soil profile has a thin soft layer, the design motion should be specified at the top of the competent material at a point just below the soft layer. Ostadan Dec. ¶ 10. Once the proper control point is established, the engineer must then evaluate the effect of the ground motion on the soil profile above the control point. There is, thus, a disciplinary interface between where the seismologist's analysis ends and the engineer's begins.

The State's experts have testified that there are two ways that PFS could correct its failure to evaluate the incompatible soil velocity data. Either Geomatrix could re-analyze its calculations to account for the conflicting data or PFS could introduce the ground motions that Geomatrix developed by putting it in the soil column where the shear wave velocity of 750 ft/sec was measured. Ostadan Dec. ¶ 11. PFS has done neither. Failure to perform these re-evaluations makes the surface design basis ground motion uncertain and the correct seismic loadings imparted to the shallow soil profile and the foundations undefined.

The State's seismologist, Dr. Arabasz, agrees that the point at which the developed ground motion should be introduced in the soil profile at the PFS site is an engineering decision and he has deferred the issue to Dr. Ostadan. Arabasz Dec. ¶ 8. Furthermore, the result of PFS's failure to evaluate the conflicting shear wave velocity data has other implications (*e.g.*, on all calculations that use the design basis ground motion as an input, such as the soil and foundation stability analyses), which are discussed in Section V below.

The Youngs Declaration ¶ 8, Exhibit C to PFS's Motion, states "PFS ... will be revising its design basis ground motion based on new shear and pressure wave velocity profiles and dynamic soil properties being developed for the site." *See also* PFS Motion at n. 3. Moreover, it is apparent from the Youngs Declaration that PFS is still collecting site data (*i.e.* acquisition of some additional downhole velocity data). Youngs Dec. ¶ 9.

Dr. Youngs describes various steps, (a) - (e) involved in developing site specific design basis ground motions. The third step, Step (c), is the characterization of the strong ground shaking that potential future earthquakes may produce. Id. ¶ 9. Dr. Youngs advises that PFS's revised design basis ground motion not only directly affects Step (c), but it also

requires changes to Step (d) (computation of 2,000 year return period ground motion) and Step (e) (adjustment of ground motion for near-fault effects), but he implies that Basis 2 and Basis 3 are unaffected by these significant changes. Id.

The State disputes Dr. Youngs's assertion that the revised design basis ground motion will not affect Basis 2 or Basis 3. It is obvious Step (c), the development of the design basis ground motion, relates directly to Basis 2. By looking at the recitation of proposed future changes that PFS will need to make to its SAR (*e.g.*, seismic wave propagation, soil profiles for use in soil-structure interaction, storage pad analysis, seismic loads, etc.), is it equally as obvious that the future changes will directly affect Basis 3 too. *See* Parkyn's Dec. 22, 2000 letter, Exhibit 9; *see also* Bartlett Dec. ¶ 17.

PFS's collection of new data and apparent substantive re-evaluation of its geophysical characterization of the ISFSI site by themselves, raises significant doubt that the parties should be required to proceed further and, at this time, the Board should deny PFS's Motion for Summary Disposition for Basis 2 and 3. Morris, 15 NRC at 532 (1982) (if there is any possibility that a litigable issue of fact exists or any doubt as to whether the parties should be permitted or required to proceed further, the motion must be denied). Moreover, PFS's re-evaluation is not merely procedural but affects the safety consideration at the PFS site. *See* Brach's letter, Exhibit 10.

V. In Addition to Relying on Non-conservative Assumptions, PFS's Investigation Does Not Satisfy the Concerns Raised by the State in Basis 3.

In order to fully inform the Board regarding Basis 3, a hearing is warranted on the complex technical and safety considerations that relate to PFS's subsurface investigation,

sampling and analysis, and testing for engineering analysis. The technically complex issues raised by the State in Basis 3 are significant especially when considered in the context of the non-conservative assumptions PFS intends to rely upon in its seismic analysis of the site.

A. PFS Has Not Considered Other Factors that Affect the Non-conservative Assumptions PFS Relied upon in Its Seismic Analysis of the Site.

Since its initial application to the NRC, PFS has updated its soil profile. *See e.g.*, Trudeau Dec., Exhibit 2, which describes five soil layers. The CPT and boring data revealed a more complex soil layering system than the first phase of PFS's investigation indicated. Generally, the two uppermost layers are of concern to the State with respect to the sliding and bearing capacity of the soils to resist seismic forces. The uppermost layer, Layer 1, consists of Eolian Silt approximately three feet thick underlain by Layer 2, consisting of approximately seven feet of upper Bonneville, predominantly clays characterized as silty clay/clayey silt. Bartlett & Ostadan Tr. 472.

PFS proposes a bold and untried strategy of a soil-cement mixture in Layer 1 under the storage pad, which PFS asserts will provide an adequate factor of safety against sliding and bearing capacity. SAR (Rev. 9) at 2.6-60. Trudeau & Chang Tr. 152. There are no detailed calculations or field testing to demonstrate that this novel concept will function as PFS's speculates. Trudeau & Chang Tr. at 149-51. The only discussion of the soil-cement concept is contained in approximately one page of the SAR. SAR, Rev. 9 at 2.6-60. PFS claims that this cursory description is adequate to describe the anticipated properties of the material, and in any event, the State's concerns will be addressed at a future date, when PFS considers design specification. Trudeau Dec. ¶ 30.

There is absolutely no objective basis for PFS's claim that the soil-cement will offer the required resistence to seismic loads and perform as an integral soil-cement mat. Bartlett Dec. ¶ 23. PFS has admitted that the soil-cement strategy is still at the conceptual stage. Exhibit 7, Trudeau & Chang Tr at 148; State's Mat. Fact ¶¶ 45, 51. To the extent that PFS is relying on satisfying the State's concerns at some future date, this in and of itself should be a sufficient ground for denying PFS's Motion. *See* Morris, 15 NRC at 532 (1982). Furthermore, there are significant unresolved critical design concerns that PFS has not considered, such as the strength and performance of the soil-cement mat under torsional and bending earthquake forces, the permeability of the soil-cement mix, and shrinkage and cracking of the soil cement as the mix cures, dries and is exposed to long-term, ambient environmental conditions. *See* Trudeau & Chang Tr. 145-52; Bartlett Dec. ¶ 24; Utah Material Facts ¶¶ 47, 51, 57, 73.

Another bold philosophy at the PFS ISFSI is Holtec's assumption that the casks will slide on the pad in a controlled manner during a large earthquake. There is no other redundancy built into Holtec's expected design. But such a bold assumption has no margin for error. Ostadan Dec. ¶ 26. This issue relates to Basis 3 because Holtec's assumptions are relied upon in PFS's analysis of the soils to resist seismic loads. Id.

In this case, Holtec's assumptions are negated by the potential that cold bonding between the cask and the pad may occur over time. When two large bodies (cask and pad) are in contact, some local deformation and redistribution of stresses may occur at the points of contact which would create a bond, and this would not allow the cask to slide on the pad or move smoothly during an earthquake. Thus, Holtec's assumption that sliding will reduce

the seismic forces is incorrect. In this instance, the seismic loads would be greater than assumed and it is questionable whether the soils beneath the pad will have the capacity to sustain that additional load. Ostadan Dec. ¶ 26.

B. PFS Has Not Satisfied the Concerns Raised by the State in Basis 3.

There are a number of significant concerns raised by the State in Basis 3 that have not yet been resolved by PFS's investigation and analysis. PFS asserts that many of the State's concerns are not contained within Basis 3. PFS Motion at 10. Obviously PFS wishes that were the case since its investigation is so flawed and is ongoing. But PFS's wishes are not legal arguments; PFS's absurdly narrow reading of Basis 3 should be rejected.

The remaining major failings in PFS's subsurface investigations, Basis 3 subpart a, include PFS's failure to conduct deep hole drilling to establish the location of bedrock and to measure soil velocity data to that depth. Utah L at 83; Bartlett & Ostadan at 92.

Moreover, PFS has not conducted a site specific investigation and laboratory analyses that show that soil conditions are adequate for the proposed foundation loading. Utah L at 85. PFS cannot support its claims that the soils are reasonably uniform in the horizontal direction. PFS Motion at 12. Even within Layer 2 of the new soil layering system, the CPT data suggest significant variation exists in the CPT tip stress measurements from CPT sounding to CPT sounding. The Applicant has made no geostatistical analysis of this variation to determine an adequate horizontal spacing for sampling to acceptably define the variation. Also, the variation in CPT tip stress has not been used to understand the potential variability in engineering properties obtained from the laboratory test program. State's Material Fact ¶ 30; Bartlett & Ostadan Tr. 471 - 506; Bartlett Dec. ¶ 25.

. Also, PFS maintains, without objective evidence, that natural cementation has lead to an apparently high shear strength for the Layer 2 soils. Trudeau & Chang Tr. 75-78. However, PFS has not demonstrated that cementation is substantial and is uniform throughout Layer 2 and can be relied upon to resist seismic forces. PFS's lack of investigation has led to a poor understanding of cementation and its role in affecting the undrained shear strength, particularly at the large strains that will be introduced by the design basis ground motion. Bartlett & Ostadan Tr. 129-130. Further, PFS has not considered another possible mechanism for the apparently high shear strength values seen in Layer 2. The higher shear strength values may be caused by dessication (drying) of the surficial, clayey soils at the time of sampling and testing. Such soils will manifest a high shear strength; however, upon rewetting, or increase in soil moisture, the shear strength will decrease. PFS has not investigated the effect that potential changes in moisture content have on increasing or decreasing the undrained shear strength. Bartlett Dec. ¶ 19; Bartlett & Ostadan Tr. 129-30. *See also* PFS Motion at 12-14. PFS's analysis of the geochemical effects and the environmental conditions at the site that may affect the moisture content of the soil is rudimentary. Utah L at 84; *see also* Utah Material Facts ¶¶ 40, 49, 61, 68 and 69; Bartlett Dec. ¶ 18.

PFS's sampling and analysis, Basis 3 subpart b, are inadequate to characterize the site or to ascertain the soil conditions to determine the reliability of the foundation system to earthquake loading. PFS Motion at 15-16.

PFS has not performed the required density of spacing as outlined in NRC Regulation Guide 1.132, "Site Investigations for Foundations of Nuclear Power Plants," for

the pad emplacement area. Nor has PFS performed continuous sampling for each major structure as recommended by Reg. Guide 1.132 Part C6. Sampling.

PFS has not considered the potential spatial variation of key soil properties (e.g., shear wave velocity, undrained shear strength) in a systematic way in its field investigations and design calculations. Because variation and uncertainty has not been treated in a consistent and statistical manner, it is not possible to determine the reliability of the soil and foundation systems to earthquake loading. Utah L at 85; Bartlett Dec. ¶¶ 9-10. For example, the foundation stability calculations for the pad emplacement area and Canister Transfer Building have not accounted for the potential variation of shear strength in Layer 2. Bartlett Dec. ¶ 13. Cone penetrometer tip stress values have been taken across the PFS site that suggest spatial variation (both vertical and horizontal); however, no statistical assessment of the impact of this variation has been made on the factor of safety against dynamic sliding and bearing capacity. Moreover, PFS has based the seismic design of the foundation systems for the pad emplacement area on very limited laboratory testing from one borehole. PFS has not demonstrated that this single datum is representative of the foundation soil for the entire pad emplacement area. Utah L at 85 Such extreme under-sampling may be subject to severe bias and could potentially lead to overestimation of the shear strength capacity available to resist earthquake forces. Bartlett Dec. ¶¶ 11-12.

Further, PFS has not adequately characterized the properties of the Bonneville Deposits under levels of strain that are anticipated by the design basis earthquake. Utah L at 87. *See* Utah Material Fact ¶ 17; Bartlett & Ostadan tr. 451-452, 506. PFS has conducted stress-controlled cyclic triaxial tests to measure the collapse potential of the Bonneville

sediments under cyclic earthquake loading. SAR at 2.6-100 (Rev. 11). PFS maintains that it has conducted stress controlled triaxial tests to quantify the reduction in shear stress due to free-field ground motion. PFS Motion at 25-26. However, PFS has not performed strain-controlled, cyclic triaxial testing at large strain to show that the shear modulus and damping values used in development the design basis ground motion are appropriate for lightly to moderately cemented soils. Utah L at 86; Bartlett Dec. ¶ 28.

Probably the most glaring shortcoming in PFS's soils investigation and analyses is in the quantification of how the soils and foundation systems will perform under anticipated static and dynamic loading. Utah L at 90 and 92. PFS segmented its geotechnical analysis and design by various disciplines; by doing so, PFS has failed to integrate its various investigations and analyses into a consistent and unified design package. Ostadan Dec. ¶ 8.

PFS's analyses are inadequate to accurately model the expected behavior of the foundation soils under dynamic loading. Utah L at 85. PFS, for example, has not adequately or accurately evaluated the effects of cold bonding, fling, or incline waves on the expected behavior of the soils and foundation under dynamic loading. *See e.g.*, Ostadan Dec. ¶¶ 17-27; Bartlett Dec. ¶¶ 20, 22. Further, PFS has not conducted an adequate or complete investigations to determine the properties of the various materials underlying the site. Utah L at 86. PFS has not considered that a significant portion of the undrained shear strength of the Bonneville Sediments is already mobilized by free-field ground motion; hence significantly reducing the amount of shear strength capacity remaining to resist foundation sliding under dynamic forces. Ostadan Dec. ¶ 28.

The scope of PFS's investigation been insufficient with respect to the

characterizations of soils at depth and the correlations of the seismic refraction data with the SCPT data. Utah L at 86. *See* Bartlett Dec. ¶¶ 13-17. PFS initially collected seismic refraction data which suggested the shear wave velocities in the uppermost soil profile to be approximately 750 feet per second (ft/sec). Later and more continuous SCPT data show the shear wave velocities to be 540 ft/sec, thus contradicting the seismic refraction data. The SCPT data also demonstrates that the uppermost soil layer is a soft thin layer. PFS used the SCPT data to revise calculation of the soil strain-compatible soil properties for soil-structure interaction but it has failed to use the SCPT to revise development of the design basis ground motion. Ostadan Dec. at ¶¶ 9-12.

PFS has insufficient relevant test data to support the selection of design parameters. Utah L at 86. Because the development of the design basis ground motion did not recognize the soft thin upper soil layer, PFS's engineers have inappropriately introduced the design motion at the ground surface instead at a point of below the surface on top of a competent soil layer. Ostadan Dec. at ¶¶ 10-11.

PFS has inaccurately or inadequately characterized the basis for the selection of samples or conducted relevant tests to determine the soil's physical characteristics due to anticipated loading or the duration of loading during a seismic event. Utah L at 87. In particular, Holtec's analysis of the pad-cask system and invalid assumptions that Holtec relied upon create significant unresolved safety concerns. Design and stability of the foundation and the supporting soil system are functions of the dynamic forces that will be imparted to them. Thus, Holtec's analysis is important because Holtec's calculation generates the seismic loads that would be acting on the pad and the soil system. Ostadan

Dec. ¶¶ 20-21.

The Holtec calculation, *Multi Cask Response at the PFS ISFSI from 2000 Year Seismic Event* (Holtec International) (Aug. 20, 1999) creates numerous and significant concerns that affect the entire design package. First, Holtec placed the input motion in the wrong location when it conducted its dynamic analysis of the cask and the pad. Ostadan Dec ¶ 22. Second, Holtec assumed that seismic waves would arrive at the foundation structure vertically and failed to take into account that seismic waves may arrive at an angle which would cause larger rocking and torsional vibration than Holtec assumed. Id. Third, Holtec's nonlinear analysis inappropriately relied on one set of time histories instead of at least three. Id. ¶¶ 16 and 22. Fourth, Holtec failed to account for frequency dependency of soil springs and damping coefficients for the pads. Ostadan Dec ¶ 22. Finally, Holtec used the invalid assumption that the storage pad would act as a rigid mat when, in fact, other PFS calculations show the pad will be flexible. Id. Thus, PFS cannot demonstrated the capability of the soil's physical characteristics to withstand anticipated loading or the duration of loading during a seismic event. *See also* Bartlett ¶ 21.

PFS has not shown that the static and dynamic engineering properties of the soils were properly determined and that reasonable and conservative values were used in the design. Utah L at 89. *See* Utah Material Fact ¶ 92. Holtec has a bold design that has no redundancy built into it. Holtec assumes that the cask and pad will slide in a controlled manner during a large earthquake and that this will reduce the seismic loads on the pads and soils below. Because there is no redundancy in Holtec's expected design the failure of the casks to slide will impart forces greater than anticipated to the pad, the pad foundation, and

the soil system. Holtec for example, has not considered the effects of cold bonding where over time local deformation and redistribution of stresses may occur and create a bond between the cask and the pad and hence transfer larger dynamic forces that was anticipated by PFS in analyzing the dynamic stability of the foundation soils.. Ostadan Dec. ¶ 26.

PFS has not explained how the developed data were used in the design analysis, how the test data were enveloped for design, and why the design envelope is conservative. Utah L at 89. PFS used the wrong parameter (*i.e.*, spectral acceleration) in estimating the foundation loading in the stability analysis and this incorrect assumption may require the use of a design spectral acceleration value close to or in excess of 1 g. Ostadan Dec. ¶ 27.

The PFS site is one of seismic complexity. PFS has not adequately or accurately assessed potential earthquakes and resulting ground motions, especially with respect to incline waves, variation in phasing of the time histories and "fling." Utah L at 90. PFS incorrectly assumed that propagating waves from an earthquake would arrive vertically but failed to consider that waves would arrive at an angle. Ostadan Dec. ¶ 22. Nor has PFS used a sufficient number of time histories in its nonlinear analysis of the casks on the pad, to take into account the sensitivity of the nonlinear analysis to phasing. Ostadan Dec. ¶ 18. In addition, PFS has ignored the effects of "fling" (*i.e.*, a large pulse of energy delivered in a short burst). Id. ¶ 17. PFS's failure to accurately or adequately assess these effects in its analysis of soils, soil-structure or design basis ground motion has serious safety implications because the magnitude and frequency of those forces may be greater or different than those anticipated by PFS's analysis.

PFS has inadequately analyzed the overturning of the canister transfer building by

ignoring the effect of the rotational mass moment of inertia, by ignoring the effect of coupling between two horizontal directions, and by incorrectly assuming the mass center of the building to be at the center of the mat. Ostadan Dec. ¶ 29. PFS's calculations do not demonstrate why the design envelope is conservative or whether PFS correctly applied the developed data in its design analysis. Ostadan Dec ¶ 29.

PFS has made no attempt to compare the site specific data with the published data. For example, PFS has not conducted strain-controlled cyclic triaxial tests to determine the large strain shear modulus and damping values for the Bonneville Clay. Utah L at 90-91; *see also* Bartlett Dec. ¶ 28.

Finally, the tests conducted to date by PFS do not allow a reviewer to make a reasonable judgment about how the soil will perform under anticipated static and dynamic loading of the short and long term conditions. Utah L at 92. Ostadan Dec.; Bartlett Dec.

CONCLUSION

The subject matters of PFS's motion and this response are extremely complicated and technical; even people in other technically oriented disciplines have a hard time grasping them. This complexity is another reason to deny Applicant's motion; the Board should avail itself of the opportunity to hear testimony from and question experts from both sides before drawing its conclusions.

For the reasons stated above, PFS is not entitled to Summary Disposition and the State requests the Board to set this matter for hearing.

DATED this 30th day of January, 2001.

Respectfully submitted,

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CERTIFICATE OF SERVICE

I hereby certify that a copy of STATE OF UTAH'S RESPONSE TO APPLICANT'S MOTION FOR SUMMARY DISPOSITION OF UTAH CONTENTION L was served on the persons listed below by electronic mail (unless otherwise noted) with conforming copies by United States mail first class, this 39th day of January, 2001:

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	Docket No. 72-22-ISFSI
	)	
PRIVATE FUEL STORAGE, LLC	)	ASLBP No. 97-732-02-ISFSI
(Independent Spent Fuel	)	
Storage Installation)	)	January 30, 2001

STATE OF UTAH'S STATEMENT OF DISPUTED AND RELEVANT MATERIAL FACTS

In support of its Response to Applicant's Motion for Summary Disposition of Utah Contention L, the State submits this Statement of Disputed and Relevant Material Facts.

BASIS 1

1. The State disputes PFS Material Fact Basis 1 ¶ 5 to the extent that PFS implies that PFS has complied with Reg. Guide 1.165 and Standard Review Plan ("SRP") 2.5.1 (basic geologic and seismic information); SRP 2.5.2 (evaluation of vibratory ground motion); and SRP 2.5.3 (evaluation of surface fault displacement). PFS has not adequately evaluated vibratory ground motion. *See* PFS's letter to the NRC dated December 22, 2000 ("PFS Dec. 22, 2000 letter"), submitted to the Atomic Safety and Licensing Board on December 28, 2000, by PFS's counsel, Jay E. Silberg. Furthermore, the State disputes PFS evaluation of vibratory ground motion and surface fault displacement. *See* Utah Material Facts 2-11.

2. The State disputes PFS Material Fact Basis 1 ¶ 12. There is no support that the two trenches referred to in ¶ 6 of the Coppersmith or ¶ 9 of the Clark Declarations are each 250 feet long. *See* Volume 1, Final Report, *Fault Evaluation Study and Seismic Hazard Assessment* prepared by Geomatrix Consultants, Inc. for the Private Fuel Storage Facility, dated February 1999, p. 8 (Exh. 2 to Coppersmith Decl.).

3. The State disputes PFS Material Fact Basis 1 ¶ 4. PFS's has been neither integrative and nor comprehensive. For example, PFS did not use the soil velocity data obtained from seismic cone penetration tests in order to convert the seismic reflection data to show depth of marker beds such as the Promontory soil and key geologic horizons within the Lake Bonneville sequence. Allison Dec. ¶ 7.

4. The State disputes PFS Material Fact Basis 1 ¶¶ 8, 11, 50 and 54. The east-west Pass Canyon is an anomaly to the structural grain of the valley runs northwest. Another anomaly to the northwest structural grain is the topographic embayment at the east-west trending Rydalch Pass. PFS has not shot enough seismic lines to analyze the anomalies to its claim that the only structural features of the valley run northwest. Allison Dec. ¶ 8

5. The State disputes PFS Material Fact Basis 1 ¶ 14. PFS has not shot an perpendicular line in a north-south direct to correlate its interpretation of the east-west seismic lines. Moreover there are an insufficient number of east-west seismic lines to determine the length of the East Fault or the West Fault or intervening faults. Allison Dec. ¶ 9.

6. The State disputes PFS Material Fact Basis 1 ¶ 18. PFS has not analyzed that the East and West Faults may be listric and could cause the secondary faults found at the site to flatten out and create surface rupture. Allison Dec. ¶ 9.

7. The State disputes PFS Material Fact Basis 1 ¶ 31 to the extent that PFS claims that the faults are laterally discontinuous. No data has been collected or presented to locate the ends of the faults. Allison Dec. ¶ 9.

8. The State disputes PFS Material Fact Basis 1 ¶ 41. The Wasatch fault, for example, demonstrates that a new faulting may occur on an unidentified strand of an existing fault. *See* Black, B.D., Lund, W.R., Schwartz, D.P., Gill, H.E., May, B.H., 1996, "Paleoseismic Investigations on the Salt Lake City Segment of the Wasatch Fault Zone at South Fork, Dry Creek and Dry Gulch Sites, Salt Lake County, Utah," Utah Geological Survey Special Studies 92, 22 p.

9. The State disputes PFS Material Fact Basis 1 ¶ 51. PFS has not shot any perpendicular tie lines to correlate the data it obtained from the east-west seismic lines. Allison Dec. ¶ 9.

10. The State disputes PFS Material Fact Basis 1 ¶ 52. The placement and number of seismic lines is inadequate. Allison Dec. ¶ 9.

11. The State disputes PFS Material Fact Basis 1 ¶ 54. See Material Facts above. Allison Dec. ¶ 7-9.

BASIS 2

12. The State disputes PFS Material Fact Basis 2 ¶ 1.[1] PFS has not quoted basis 2 in its entirety. Basis 2, as admitted, states:

> **2. Ground motion.** The site may also be subject to ground motions greater than those anticipated by the Applicant due to spatial variations in ground motion amplitude and duration because of near surface traces of potentially capable faults (the Stansbury and Cedar Mountain faults). Sommerville, P.G., Smith, N.F., Graves, R.W., and Abrahamson, N.A., Modification of empirical strong ground motion attenuation relations to include the amplitude and duration effects of rupture directivity, *in* 68 Seismological Research Letters (No. 1) 199 (1997). Failure to adequately assess ground motion places undue risk on the public and the environment and fails to comply with 10 CFR § 72.102(c).

State's Contentions on the Construction and Operating License Application by Private Fuel Storage, LLC for an Independent Spent Fuel Storage Facility (November 23, 1997) at 74.

13. The State disputes PFS Material Fact Basis 2 ¶ 3. While the Applicant may have "appropriately" implemented the methodology of Somerville et al., the Applicant has not adequately assessed the design basis ground motions in terms of achieving adequate conservatism in its analysis. Arabasz Tr. at 57-58; 63-64. Arabasz Dec. ¶ 7.

14. PFS has not conducted a fully deterministic seismic hazard analysis as required by 10 CFR § 72.102(f)(1) and, by reference, 10 CFR 100 Appendix A. Instead, PFS has submitted two seismic analyses identified as "deterministic" but which used a hybrid methodology that incorporated probabilistic elements and accompanying uncertainties in the treatment of the seismic sources and other inputs to the analyses. Arabasz Tr. at 46-47, 58; Arabasz Dec ¶ 7.

15. The Staff admitted that the Deterministic Seismic Hazard Analysis performed by Geomatrix Consultants, Inc., as reported in Appendix 2 of the PFS 1997 Safety Evaluation Report and as updated by Geomatrix in Updated of Deterministic Ground Motion Assessment (April 1999) "did not meet the deterministic requirements in 10 C.F.R. Part 100 Appendix A." Staff's Objections and Responses to the "State of Utah's Sixth Set of Discovery Requests Directed to the NRC Staff (Utah Contention L)" (February 14, 2000), Response to Requests for Admissions 1 and 2 at 7-8.

16. In developing its design basis ground motions for the probabilistic seismic hazard analysis, PFS did not account for seismic cone penetration test ("SCPT") data obtained in 1999 which show that the average shear-wave velocity in the uppermost 10 feet

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[1] PFS has not sequentially numbered its material facts; at this point PFS starts re-numbering its material facts.

of the soil profile underlying the PFS site is about 540 feet per second. Instead, PFS used lower resolution data obtained earlier from seismic refraction surveys to assign an average shear-wave velocity of 750 feet per second to the uppermost 45 feet. Whether PFS is required to perform a deterministic or probabilistic seismic hazard analysis, failure to account for the SCPT data could result in incorrectly characterizing earthquake ground motions at the ground surface for the purposes of engineering design and dynamic analysis. Arabasz Dec ¶ 8; Bartlett & OstadanTr. at 316-320 and 335-36.

BASIS 3:

Part a: Subsurface investigations

17. The State disputes PFS Material Fact Basis 3 ¶ 4. *See* Utah Material Facts ¶¶ 18-22.

18. The Applicant has not performed the density of boring as outlined by U.S. NRC Regulatory Guide 1.132, Appendix C, "Site Investigations for Foundations of Nuclear Power Plants". Bartlett & OstadanTr. at 95-96.

19. The Applicant has not considered shear strength anisotropy in the design of the foundation system. BartlettTr. at 300-308.

20. Discrepancies in seismic cone penetration test ("SCPT") shear wave velocity data and seismic refraction data have not been resolved in the determination of the design basis ground motion. Bartlett & OstadanTr. at 316-322, 466; *see also* PFS's Dec. 22, 2000 letter to revise design basis ground motion.

21. The Applicant has not performed strain-controlled, cyclic triaxial testing of the Bonneville Deposits to determine the behavior of these soils under earthquake loading at the level of strain anticipated by the Design Basis Earthquake. Bartlett & OstadanTr. at 451-452, 506.

22. The Applicant has not adequately quantified potential variation in the undrained shear strength across the PFS site from the laboratory test program. Bartlett & OstadanTr. at 471-476, 504-506, 512, 550-551. *See also* Bartlett Dec. ¶ 16.

23. The State disputes PFS Material Fact Basis 3 ¶ 5. The information gathered by PFS as to the site's subsurface conditions is inadequate to support the design of the facility. Exhibit 9; Bartlett Dec ¶¶ 9,10.

24. Uncertainty remains regarding shear wave velocity data and their application to design. Bartlett & OstadanTr. at 300-02; Bartlett Dec. ¶ 17.

25. Uncertainty remains regarding the stress-strain behavior of the Bonneville

Deposits at large strain. Bartlett & OstadanTr. at 300-01.

26. Uncertainty remains in the potential variation of the undrained shear strength for the Bonneville Deposits across the PFS site. Bartlett & OstadanTr. at 303-04; Bartlett Dec. ¶ 15

27. Potential shear strength anisotropy in the Bonneville deposits has not been considered in the design of the foundation system. Bartlett & OstadanTr. at 300-01.

28. The State disputes that PFS's geologic characterization of the site is "unambiguous." *See* PFS Material Fact, Basis 3 ¶ 9. *See* Utah Material Facts ¶¶ 14-17; *see also* Utah Material Facts ¶¶ 2-11.

29. The State disputes PFS Material Fact Basis 3 ¶ 12. A grid pattern for placing borings may be reasonable and may be a common approach for the first phase of investigations but the State disputes that such a grid pattern implies any adequacy in the density of sampling. The State disputes the adequacy of spacing borings at 600 feet apart. Bartlett & OstadanTr. at 91-94, 538; Bartlett Dec. ¶ 9.

30. The State disputes PFS Material Fact Basis 3 ¶ 13 that the soil properties at the PFS facility site are reasonably uniform in the horizontal direction. Even within layer 2 of the new soil layering system,[2] the CPT data suggest significant variation exists in the CPT tip stress measurements. In addition, the Applicant has made no geostatistical analysis of this variation to determine an adequate spacing for sampling. Also, the variation in CPT tip stress has not been used to define potential variability in the undrained shear strength determined from the laboratory test program.. Bartlett & OstadanTr. at 471 - 506; Bartlett ¶¶ 10, 11.

31. The State also disputes that PFS did not need to establish a denser set of borings in the pad emplacement area than the one initially provided. PFS Material Fact Basis 3 ¶ 13. *See* Utah Material Fact ¶ 30; Bartlett & OstadanTr. at 91-94; Bartlett DEc. ¶ 12.

32. The State agrees that PFS has conducted sampling and testing additional to that initially conducted but the State disputes that such sampling and testing is considerable. PFS Material Fact, Basis 3 ¶ 14. *See e.g.*, Bartlett & OstadanTr. at 91-94.

33. The State disputes that PFS Material Fact Basis 3 ¶ 17 supports PFS's soils investigation of the pad emplacement and canister transfer building ("CTB"). Material Fact

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[2] *See e.g.*, Bartlett & OstadanTr. at 29, 30; Utah L tr. Exh. 53 (SAR, Rev. 8, Fig. 2.6-5).

¶ 17 asserts that PFS may conduct some borings in 2001, at an unknown depth and at unknown spacing in a generalized but non-specific location relating to non-safety related structures. Data from the proposed future borings, if any, in the vicinity of non-safety related structures has no relevance to the resolution of existing issues in the pad emplacement and CTB areas. Bartlett Dec. ¶ 26.

34. The State disputes PFS Material Fact Basis 3 ¶ 19. A depth of thirty feet may be adequate for shallow foundation over small areas but investigation to a depth of thirty feet is not adequate for determining the soil properties required for strong ground motion modeling of the soil column. Bartlett & OstadanTr. at 92, 127-28.

35. The State disputes PFS Material Fact Basis 3 ¶ 20 to the extent that PFS relies on published data to incorporate uncertainties into the development of design parameters used in PFS's analyses of soil-structure interaction. Moreover, PFS is in the midst of revising calculations relating to the design parameters in PFS's analyses of soil-structure interaction due to discovered discrepancies in the shear wave velocity data. *See* Exhibit 9; Bartlett Dec. ¶ 17.

36. While the cone penetrometer testing ("CPT") is useful for determining soil layering in the upper 35 feet it would have been more a useful if the CPT soundings were conducted before the borehole drilling, and the laboratory sampling program were planned after an initial evaluation of the CPT data.. Bartlett & OstadanTr. at 90-92. The State therefore disputes PFS Material Fact Basis 3 ¶ 21 to the extent that the sequencing of PFS's CPT after the borehole drilling and laboratory sampling program do not allow for investigation of other soil parameters at the site. Id.

37. The State disputes PFS Material Fact Basis 3 ¶ 22. The CPT data has more use than solely being "confirmatory." It gives information regarding the variability of key engineering properties in the horizontal and vertical direction. PFS has not quantified the CPT sounding variability, nor has PFS incorporated the potential variation suggested by the CPT data in determining engineering properties for use in foundation stability analyses. Bartlett & OstadanTr. at 471-506.

38. While PFS may have accurately characterized the thickness and extent for the upper 35 feet of soil profile, the composition of the upper 35 feet has not been fully characterized because CPT data does not directly measure the soil composition; it is inferred from the data. The State disputes PFS Material Fact Basis 3, ¶ 23 in that soil composition has not been resolved regarding the degree and nature of the cementation that PFS says exists in the Bonneville deposits. Bartlett & OstadanTr. at 129-30.

39. While there may not be uncertainty regarding the thickness or extent of various materials in the upper 35 feet, uncertainty still remains regarding the composition and engineering properties of these materials. PFS Material Facts Basis 3, ¶ 24. Bartlett &

OstadanTr. at 227.

40. The State disputes PFS Material Facts Basis 3, ¶ 25 in that PFS claims that "the top 30 feet or so of the profile are the only ones of interest from a geotechnical standpoint...." Use of the term geotechnical is too broad in this statement. Deeper sediments (*i.e.*, below 30 feet) are of "geotechnical" interest because their nature affects the ground response modeling, which is a "geotechnical" issue. The State disputes that PFS can restrict the geotechnical investigations to only the upper 30 feet. Bartlett & OstadanTr. at 92, 107, 127-28, 560.

41. The State disputes PFS Material Fact Basis 3 ¶ 26. *See* Utah Material Fact ¶¶ 39, 40.

42. The State disputes PFS Material Fact Basis 3 ¶ 28. First, the statement is not a material fact; it is a legal conclusion. Second, the Applicant has not followed Reg. Guide 1.132 "Site Investigations for Foundations of Nuclear Power Plants" regarding borehole spacing. Bartlett & OstadanTr. at 126-127; Bartlett Dec. ¶ 9. Also, PFS has not performed continuous sampling for each major structure as recommended by Reg. Guide 1.132 Part C6. Sampling. Id. Third, the State disputes that the characterization has resolved the following key issues regarding: shear wave velocity, shear strength variability, cementation, anisotropy, and degradation of shear strength due to earthquake cycling. *See* Utah Material Facts 18-22. Bartlett & OstadanTr. at 126-28; Bartlett Dec. ¶ 15.

43. The State disputes PFS Material Fact Basis 3 ¶ 29. The SAR does not discuss the effect of seasonal changes in moisture content of the soils and how changes in moisture content may affect the undrained shear strength of the soil. Bartlett & OstadanTr. at 130; Bartlett Dec ¶ 18.

44. The State disputes PFS Material Fact Basis 3 ¶ 31 that there is no potential for groundwater leaching at the PFS site. For example, some "geochemical" leaching of calcium carbonate may occur due to rainwater even though the amount of leaching may not be significant. Bartlett & OstadanTr. at 206

45. The State disputes PFS Material Fact Basis 3 ¶ 32 that potential weather-related geochemical effects will be eliminated by the use of soil cement under the pads and the installation of a surface rainfall collection system. The statement is pure conjecture and is not supported by any fact or objective evidence. The PFS soil-cement mat is still in the conceptual stage and there have been no tests or calculations relating to this concept. Bartlett & OstadanTr. at 216-17.

46. The capping of a soil layer does not preclude changes in moisture content because of capillary action and unsaturated flow of water through a fine-grained soil.

Bartlett & OstadanTr. at 216-218; Bartlett Decl. ¶ 19.

47. The soil-cement may also develop shrinkage cracks and other types of stress related cracks. Bartlett & OstadanTr. at 216-223; Bartlett Dec. ¶ 22. Furthermore, the undrained shear strength of unsaturated, fine-grained soils is affected by changes in the moisture content. Thus, variations in moisture content can change the undrained shear strength, which is a key design parameter for the PFS foundations. Id.

48. The State disputes PFS Material Fact Basis 3 ¶ 33 and Trudeau Dec. ¶ 30 as unsupported by any objective fact or analysis. Bartlett & OstadanTr. at 220-27.

49. The State disputes PFS Material Fact Basis 3 ¶ 34. Neither the actual nor "anticipated" properties of the soil cement mat have been adequately described. The SAR gives typical unconfined compressive strengths for soils treated with cement. PFS has admitted that it has not considered bending and tensional stresses that will develop in the soil-cement mat. TrudeauTr. at 147-152. No design values or test program has been implemented to explore these failure mechanisms and present strength properties germane to these modes of failure. Bartlett & OstadanTr. at 216-17.

50. The State disputes the relevance to PFS's Motion for Summary Disposition PFS's assertion that it may test soil cement and develop design specifications at some future unspecified date. *See* PFS Material Fact Basis 3 ¶ 35. The State disputes that this assertion offers any support to PFS's subsurface soils investigation. Bartlett Dec. ¶ 26.

51. The State disputes PFS Material Fact Basis 3 ¶ 35. While PFS may prepare design specification for the construction and testing of the soil-cement at the construction phase of the project, the State disputes that PFS has demonstrated that the soil-cement strategy will be sufficient to resist seismic loading. PFS has admitted that the design is still conceptual. TrudeauTr. at 148. There are design issues that PFS has not considered, such as the permeability of the soil cement mix, the behavior of the soil cement on seismic loading and shrinkage and cracking of the soil cement. Bartlett & OstadanTr. at 216-17; Bartlett Dec. ¶ 22.

52. The State disputes PFS Material Fact Basis 3 ¶ 36 because it contradicts the statements made by PFS in Basis 3 ¶¶ 31 and 32. In paragraphs 31 and 32 PFS precludes changes due to geochemical effects but in paragraph 36 PFS introduces the idea that some geochemical effects will occur, albeit slowly.

53. The State also disputes ¶ 36 in that the statement that the geochemical effects will develop so slowly that they will not impact the facility during its lifetime implies that one has some measure or knowledge of the rate of change occurring due to geochemical processes. None of these data has been presented by the Applicant.

54. The State disputes PFS Material Fact Basis 3 ¶ 37. While collapse of the partially cemented soil due to static loading may not be a major issue, the State disputes that the Applicant has demonstrated that these soils will not undergo a significant degradation of shear strength during earthquake loading. Bartlett & OstadanTr. at 185-86, 505-506; Bartlett Dec. ¶¶ 12, 20, 22.

Part b: Sampling and analysis

55. PFS's initial sampling and analysis program was woefully deficient. Bartlett Dec. ¶ 12; Bartlett & OstadanTr. at 235-39. A significant expansion of a woefully deficient laboratory test program does not imply that the current program is sufficient. *See also* PFS Material Fact Basis 3 ¶ 38.

56. The State disputes PFS Material Fact Basis 3 ¶ 43. The depth of bedrock is important for ground response modeling. Ground response modeling and its output is required to determine the seismic forces imparted to the foundations; hence the depth to bedrock is germane for geotechnical design. *See* Utah Material Fact ¶ 49.

57. The State disputes PFS Material Fact Basis 3 ¶ 44; Layer 1, in which PFS will place its soil-cement mix is also a concern. The soil cement stabilization proposed by PFS has not resolved all issues related to Layer 1. *See* Utah Material Facts ¶¶ 49-51; Bartlett Dec. ¶¶ 22, 23.

58. The State disputes PFS Material Fact Basis 3 ¶ 45. The characterization and stabilization of layer 1 is also important for the structural design of the facility. *See* Utah Material Facts ¶ 49-51; Bartlett Dec. ¶¶ 22, 23.

59. The State disputes PFS Material Fact Basis 3 ¶ 46. The adequacy of the number of samples is not supported by any geostatistical analysis. Bartlett & OstadanTr. at 237-240. The determination of adequacy of sampling has been made in an subjective manner. Id.; Bartlett Dec ¶ ¶ 9, 10.

60. The State disputes PFS Material Fact Basis 3 ¶ 47. While Layer 2 has a "monotonous" CPT tip resistance trace when compared with the other layers in the shallow profile, the State disputes that layer 2 is uniform. Significant variation does appear, even in this layer. *See* Utah Material Facts ¶¶ 30, 31; Bartlett Dec. ¶ 11.

61. The State disputes PFS Material Fact Basis 3 ¶ 48. It is sometimes appropriate to use the "least favorable measured property" for design in conducting an engineering analyses, but the State disputes that the value selected by PFS actually represents the lowest value for Layer 2. Layer 2 is the critical layer for sliding failure. There is no evidence whether the design values that PFS used were upper-bound, mean, or lower bound values because no formal assessment of variability has been done by PFS. Bartlett & Ostadan Tr. at 473. Moreover, when PFS's witness Paul Trudeau eventually admitted what

the design values used for Layer 2 represented, he characterized them as "mean values." TrudeauTr. at 97-98. Thus, PFS did not use "the least favorable measured properties" for the key layer because PFS only used "mean values." Bartlett Dec. ¶ 13.

62. The State disputes PFS Material Fact Basis 3 ¶ 49. The State disputes that the foundation stresses of the cask storage pads will be distributed over a "large soil volume." PFS's statement in ¶ 49 assumes that the cask storage pads and soil-cement mat will behave as an integral unit during earthquake motion. This has not been demonstrated by PFS and integral behavior (no cracking) may not be true. PFS has not considered the impacts of vertically propagating waves and the bending and torsional stress induced by such waves in the soil-cement mat. TrudeauTr. at 147. These bending and torsional stresses may be large enough to crack and fracture a non-reinforced soil-cement mat and the mat will not behave as an integral unit. Bartlett & OstadanTr. at 217, 222; Bartlett Dec. ¶ 22.

63. PFS has not considered the possibility of tension cracking forming in the soil-cement mat due to drying and other environmental factors (*e.g.*, freeze-thaw). Bartlett & OstadanTr. at 210, 222; Bartlett Dec. ¶ 23.

64. If the soil-cement mat cracks prior to the seismic event or fractures occur during earthquake motion, then the shear stress mobilized in the foundation will not be over a "large area," but may be restricted to a more localized area, that is, approximately the size of one storage pad. Bartlett Dec. ¶ 22.

65. The State disputes PFS Material Fact Basis 3 ¶ Basis 3 Par. 50. *See* Utah Material Facts ¶¶ 28-34. *See also* Bartlett & OstadanTr. at 179-80.

66. The State disputes PFS Material Fact Basis 3 ¶ 51. PFS's statement it is "conservatively using Layer 2 parameters to represent those for the entire top 30 feet of the profile" is unsupported because PFS must specify the parameter before the degree of conservatism or unconservatism can be determined.

67. The State disputes PFS Material Fact Basis 3 ¶ 54. The State disputes that PFS has resolved accounting for the anticipated loading and duration of loading. Moreover, PFS has not conducted strain-controlled cyclic triaxial testing to explore the possibility of shear strength degradation. Bartlett & Ostadan Tr. at 537.

68. The State disputes PFS Material Fact Basis 3 ¶ 59 in that, of the listed items in ¶ 59, only grain-size, water content, and Atterberg limits are parameters or properties; the remainder of the listed items are soil tests, and are not parameters.

69. The State disputes PFS Material Fact Basis 3 ¶ 60 to the extent that PFS asserts that resonant column tests are a form of strain-controlled cyclic triaxial tests. The two test apparatuses can be significantly different. Bartlett & OstadanTr. at 302; Bartlett

Dec. ¶ 27.

70. The State disputes PFS Material Fact Basis 3 ¶ 61, which is a conclusory statement that no "tests were needed beyond those carried out by PFS." For example, PFS needs to conduct strain-controlled cyclic triaxial testing, as well as triaxial extension tests, which PFS has not performed. Bartlett & OstadanTr. at 100-101, 105, 451-452, 506.

71. The State disputes PFS Material Fact Basis 3 ¶ Basis 3 Par. 62. PFS has not established the large-strain behavior of the Bonneville Clay. One such test to establish such behavior is strain-controlled cyclic triaxial testing, which PFS has not performed. *See* Utah Material Facts ¶ 70.

72. The State disputes PFS Material Fact Basis 3 ¶ 63. A percentage of the design value of the undrained shear strength will be mobilized by the free-field ground motion. Bartlett & OstadanTr. at 15-86. The degree of mobilization has not been estimated by PFS, nor has been accounted for in the seismic design of the foundation. TrudeauTr. at 135-136. Further, the design basis free-field ground motion is being revised by PFS (Exhibit 9); thus, PFS's statement is inconclusive and cannot be resolved until revised calculations supporting the new design basis free-field ground motion are presented. Bartlett Dec. ¶ 17.

73. The State disputes PFS Material Fact Basis 3 ¶ 69. Notwithstanding that PFS intends to use soil cement and install some type of surface water runoff collection system, and the facility may be located in semi-arid environment, over time changes in water content of the partially saturated, fine-grained foundation soils are still possible Bartlett & OstadanTr. at 206-07; *see also* Utah Material Facts ¶ 45-47. PFS has not analyzed the effects of changes in the moisture content caused by capillary action, unsaturated flow, or the permeability or potential for cracking of the soil-cement mix. Bartlett & OstadanTr. at 206-07, 216-17. The moisture content of the foundation soils, especially Layer 2, is critical because if the moisture content increases , the clays in Layer 2 may be susceptible to decrease in shear strength. Bartlett & OstadanTr. at 227; Bartlett ¶ 19.

74. The State disputes PFS Material Fact Basis 3 ¶ 71. A carefully designed laboratory testing program should also anticipate potential changes in "field conditions" with time. The moisture content of the foundation soils can change with time, even with a soil-cement mat placed over the pad emplacement area. *See* Bartlett & OstadanTr. at 129-130, 213-223; Bartlett ¶ 19. Changes in water content will occur with time, which in turn may affect the undrained shear strength of the clayey soils. Thus, the State disputes that it is sufficient for PFS to determine only the undrained shear strength for the foundation soils at the time of drilling; PFS must also anticipate potential changes in the moisture content and verify that changes in the moisture content do not significantly affect the undrained shear strength. PFS has not performed a laboratory test program that defines the correlation between undrained shear strength and moisture content. Bartlett ¶ 18.

75. The State disputes PFS Material Fact Basis 3 ¶ 76. Utah Material Fact ¶¶ 18-27.

76. The State disputes PFS Material Fact Basis 3 ¶ 86. PFS has not conservatively interpreted the shear wave velocity data. *See* Utah Material Fact ¶ 78. In addition, PFS has not considered the potential variability in the undrained shear strength in the design of the facility. Utah Material Fact ¶ 37.. Furthermore, PFS has not adequately defined the role of cementation in affecting the undrained shear strength of the soil. Utah Material Fact ¶ 38; Bartlett & OstadanTr. at 128-130. Moreover, PFS has not considered soil anisotropy. Bartlett & OstadanTr. at 300-302; Bartlett Dec. ¶ 15. Nor has PFS demonstrated that degradation of shear strength will not occur at the strain levels anticipated for the design basis ground motion. Utah Material Fact ¶ 54.

77. The State disputes PFS Material Fact Basis 3 ¶ 86. In the latest revision of the SAR, PFS included a shear key one-foot deep around the Canister Building to improve the shear resistance against sliding. In PFS's revised calculation, it is shown that the factor of safety is as low as 1.1. Calculation No. 05996-02-G(B)-13 *Stability Analyses of the Canister Transfer Building Supported on a Mat Foundation*, Rev. 3, Stone & Webster (6/19/00) at 13. This inadequate calculation relies on the passive resistance behind the one-foot shear key to develop the resisting forces against sliding. The State disputes that the passive soil and its reaction under the mat have been considered in the stability analysis of the building and design of the mat. Ostadan Dec. ¶ 28. *See also* Bartlett ¶ 17.

78. Other information contain in the SAR and supporting documents have not been conservatively interpreted to determine the design parameters. For example, the Applicant considered an average velocity of 750 ft/sec for the Holocene formation in order to develop the 2000-year motion. The Applicant's recent subsurface investigation using seismic cone penetration test ("SCPT") has shown a low velocity profile in the upper 10 ft as having a velocity of approximately 540 ft/sec (SAR Figure 2.6-28). In light of the new and refined SCPT data for the shallow soil layers, the State disputes that PFS may use the design motion at the top of the layer with a velocity of 540 ft/sec (*i.e.*, at the surface of the ground) (Calculation No. 05996.02-G(P018)-2, *Soil and foundation parameters for dynamic soil structure interaction analyses, for 2000 yr return period design ground motions*, Geomatrix Consultants (Aug. 10, 1999)). *See* PFS Material Facts ¶¶ 86, 95- 96. The State also disputes that PFS has specified the design motion at the top of the 750-ft/sec layer in the dynamic analysis of the foundations consistent with the assumption used in the development of the design motion. Bartlett & OstadanTr. at 316-20; Ostadan Dec. ¶ 9.

79. The State disputes PFS Material Facts Basis 3 ¶ 88 and Trudeau Dec. ¶ 63. The Applicant has not complied with NUREG-0800, SRP § 3.7.1, *Seismic Design Parameters*. In accordance with the SRP the variation in dynamic properties must be recognized in the design. To capture the variation and scattering of the data, the Applicant may change the

soil shear modulus by a factor of two. In this case the Applicant has varied the sheer modulus by a factor of one and a half. Bartlett & OstadanTr. at 128-29; Ostadan Dec. ¶ 14.

80. The State disputes PFS Material Facts Basis 3 ¶¶ 94 and 95 to the extent that the mere performance of additional tests suggests that the number of tests are sufficient, or that PFS's test data are accurate or adequate or have been accurately applied. Bartlett Dec. ¶¶ 9,10.

81. The State disputes PFS Material Facts Basis 3 ¶ 96. Exhibit 9. See Utah Material Facts above. The statements is ¶ 96 are mere conclusions.

Contention Utah L

82. The State disputes that PFS has satisfied the concerns raised by the State in Basis 3 of Contention Utah L. *See* Utah Material Facts ¶¶ 83-98.

83. The State disputes that the Applicant has conducted site specific investigation and laboratory analyses that show that soil conditions are adequate for the proposed foundation loading. Utah L at 85.

84. PFS segmented its geotechnical analysis and design by various disciplines; by doing so, PFS has failed to integrate its various investigations and analyses into a consistent and unified design package. Ostadan Dec. ¶ 8.

85. The States disputes that PFS's analyses are adequate to accurately model the expected behavior of the soil foundation under static and dynamic loading. Utah L at 85. PFS, for example, has not adequately or accurately evaluated the effects of cold bonding, fling, or incline waves on the expected behavior of the soil foundation under static and dynamic loading. *See e.g.*, Ostadan Dec. ¶¶ 17, 19, 22; Bartlett ¶¶

86. The States disputes that PFS has conducted adequate or complete investigations to determine the properties of the various materials underlying the site, especially with respect to the seismic response of the structures important to safety. Utah L at 86. *See e.g.*, Bartlett ¶¶ 20, 22. Nor has the scope of PFS's investigation been sufficient with respect to the degradation of soil strength, the characterizations of soils at depth, or the correlations of the seismic refraction data with the SCPT data. Utah L at 86. *See e.g.*, Bartlett ¶ 17.

87. PFS initially collected seismic refraction data which suggested the shear wave velocities in the uppermost soil profile to be approximately 750 feet per second (ft/sec). Later and more reliable SCPT data show the shear wave velocities to be 540 ft/sec, thus contradicting the seismic refraction data. The SCPT data demonstrates that the uppermost soil layer is a soft thin layer. PFS used the SCPT data to revise calculation of the soil strain-

compatible soil properties but it has failed to use the SCPT to revise development of the design basis ground motion. Ostadan Dec. at ¶¶ 9-12.

88. The State disputes that PFS has sufficient relevant test data to support the selection of design parameters. Utah L at 86. Because the development of the design basis ground motion did not recognize the soft thin upper soil layer, PFS's engineers have inappropriately introduced the design motion at the surface instead of below the surface on top of a competent soil layer. Ostadan Dec. at ¶¶ 10-11.

89. The State disputes that PFS has obtained representative undisturbed samples of each of the site soils to determine the soils dynamic properties, especially with respect to soil degradation curves. Utah L at 87. Bartlett & Ostadan Tr. at 99-101.

90. The State disputes that PFS has accurately or adequately characterized the basis for the selection of samples or conducted relevant tests to determine the soil's physical characteristics due to anticipated loading or the duration of loading during a seismic event. Utah L at 87. In particular, Holtec's analysis of the pad-cask system and invalid assumptions that Holtec relied upon create significant unresolved safety concerns. Design and stability of the foundation and the supporting soil system are functions of the dynamic forces that will be imparted to them. Thus, Holtec's analysis is important because Holtec's calculation generates the seismic loads that would be acting on the pad and the soil system. Ostadan Dec. ¶¶ 20-21. *See also* Bartlett ¶ 18.

91. The Holtec calculation, *Multi Cask Response at the PFS ISFSI from 2000 Year Seismic Event* (Holtec International) (Aug. 20, 1999) creates numerous and significant concerns that affect the entire design package. First, Holtec placed the input motion in the wrong location when it conducted its dynamic analysis of the cask and the pad. Ostadan Dec ¶ 22. Second, Holtec assumed that seismic waves would arrive at the foundation structure vertically and failed to take into account that seismic waves may arrive at an angle which would cause larger rocking and torsional vibration than Holtec assumed. Id. Third, Holtec's nonlinear analysis inappropriately relied on one set of time histories instead of at least three. Id. ¶¶ 16 and 22. Fourth, Holtec failed to account for frequency dependency of soil springs and damping coefficients for the pads. Ostadan Dec ¶ 22. Finally, Holtec used the invalid assumption that the storage pad would act as a rigid mat when, in fact, other PFS calculations show the pad will be flexible. Id. Thus, the State disputes that PFS has demonstrated the capability of the soil's physical characteristics to withstand anticipated loading or the duration of loading during a seismic event. Bartlett ¶ 21.

92. The State disputes that PFS has shown that the static and dynamic engineering properties of the soils were properly determined and that reasonable and conservative values were used in the design. Utah L at 89. *See* Utah Material Fact ¶ 91. Holtec has a bold design that has no redundancy built into it. Holtec assumes that the cask and pad will slide in a controlled manner during a large earthquake and that this will reduce

the seismic loads on the pads and soils below. Because there is no redundancy in Holtec's expected design the failure of the casks to slide will impart forces greater than anticipated to the pad, the soil-structure and the soil system. Holtec for example, has not considered the effects of cold bonding where over time local deformation and redistribution of stresses may occur and create a bond between the cask and the pad. Ostadan Dec. ¶ 26. *See also* Bartlett ¶ 21.

93. The State disputes that PFS has explained how the developed data were used in the design analysis, how the test data were enveloped for design, and why the design envelope is conservative. Utah L at 89. PFS used the wrong parameters in estimating the foundation loading stability analysis and these incorrect assumptions may require the use of a design value close to or in excess of 1 g. Ostadan Dec. ¶ 27. *See also* Bartlett ¶¶ 20, 25.

94. The PFS site is one of seismic complexity. The State disputes that PFS has adequately or accurately assessed potential earthquakes and resulting ground motions, especially with respect to incline waves, variation in phasing of the time histories and "fling." Utah L at 90. PFS incorrectly assumed that propagating waves from an earthquake would arrive vertically but failed to consider that waves would arrive at an angle. Ostadan Dec. ¶ 22. Nor has PFS used a sufficient number of time histories in its nonlinear analysis of the casks on the pad, to take into account the sensitivity of the nonlinear analysis to phasing. Ostadan Dec. ¶ 18. In addition, PFS has ignored the effects of "fling" (*i.e.*, a large pulse of energy delivered in a short burst). Id. ¶ 17. PFS's failure to accurately or adequately assess these effects in its analysis of soils, soil-structure or design basis has serious safety implications because the forces and the frequency of those forces may be greater or different than those anticipated by PFS's analysis.

95. PFS has inadequately analyzed the overturning of the canister transfer building by ignoring the effect of the rotational mass moment of inertia, by ignoring the effect of coupling between two horizontal directions, and by incorrectly assuming the mass center of the building to be at the center of the mat. Ostadan Dec. ¶ 29. These omissions and inadequacies in the canister transfer building Calculation No. 05996-02-G(B)-13 (*Stability Analyses of the Canister Transfer Building Supported on a Mat Foundation*, Rev. 3, Stone & Webster (June 19, 2000) do not support PFS's claims in the SAR that Calculation No. G(B)-13 determined the CTB to be stable with respect to overturning due to static and dynamic load conditions. SAR at 4.7-8e (Rev. 17). Nor does Calculation No. G(B)-13 demonstrate why the design envelope is conservative or whether PFS correctly applied the developed data in its design analysis. Ostadan Dec ¶ 29.

96. The State disputes that PFS has made an attempt to compare the site specific data with the published data. For example, PFS has not conducted strain controlled cyclic triaxial tests to determine the large strain shear modulus and damping values for the Bonneville Clay. Bartlett Dec. ¶ 28. Utah L at 90-91

97. The State disputes that PFS has made an attempt to compare the site specific data with the published data. For example, PFS has not conducted cyclic strain-controlled triaxial tests to determine the large strain shear modulus and damping values for the Bonneville Clay. Utah L at 90-91 Bartlett Dec. ¶ 14.

98. The tests conducted to date by PFS do not allow a reviewer to make a reasonable judgment about how the soil will perform under anticipated static and dynamic loading of the short and long term conditions. Utah L at 92. Ostadan Dec.; Bartlett Dec.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	Docket No. 72-22-ISFSI
	)	
PRIVATE FUEL STORAGE, LLC	)	ASLBP No. 97-732-02-ISFSI
(Independent Spent Fuel Storage Installation)	)	January 30, 2001

DECLARATION OF DR. M. LEE ALLISON

I, Dr. M Lee Allison, hereby declare under penalty of perjury and pursuant to 28 U.S.C. § 1746, that:

1. I am currently the State Geologist for the State of Kansas and held that same position for the State of Utah from 1989 to 1999. I have over twenty-five years experience in geological policy management, scientific research with emphasis on structural geology and geophysics, geological exploration, and consulting. My experience includes work with state, local, and federal agencies, university research organizations, major petroleum companies, and an aerospace research laboratory.

2. I hold a PhD., in Geology from the University of Massachusetts, and MS, Geology from San Diego State University and a BA, Geology (geophysics option) from the University of California, Riverside. My experience in interpretation of seismic reflection data was gained during my employment as a Exploration Geologist for the oil industry and during by employment as a senior geologist at the University of Utah Research Institute.

3. I have published numerous publications. A copy of my curriculum vitae is attached hereto which describes in greater detail my qualifications, training and publications.

4. I was designated as one of the State's testifying expert for this proceeding on June 28, 1999. I have reviewed the applicable sections of the Applicant's SAR, and updates thereof, relating to its geotechnical investigation of the proposed site, and relevant calculations, reports, and other documents prepared by the Applicant or its contractors and submitted to the NRC or produced to the State in discovery. I

have participated in answering the Applicant's discovery to the State as well as assisted in the preparation of discovery for the State directed to the Applicant. I am familiar with and have applied NRC regulations and guidance documents as they relate to geotechnical review.

5. I was deposed by counsel for Private Fuel Storage ("PFS") on October 25 and 26, 2000. I was present at the State's deposition of PFS's geotechnical witnesses, John Clark and Marc Sterling on October 24 and 25, 2000.

6. I have reviewed PFS's Motion for Summary Disposition for Utah Contention L (December 30, 2000), its Statement of Material Facts on Which No Genuine Dispute Exist, and all attachments thereto as they relate to Basis 1. I provide this declaration in support of the State of Utah's Response the PFS's Motion for Summary Disposition, Basis 1. The following statements in this declaration are based on my experience, training, and best professional judgment.

7. It is my opinion that PFS has not used an integrated approach to evaluate both the vibratory ground motion and surface fault displacement. For example, PFS has not used the soil velocity data obtained from seismic cone penetration tests in order to convert the seismic reflection data to show depth of marker beds such as the Promontory soil and key geologic horizons within the Lake Bonneville sequence.

8. PFS's approach has not been comprehensive. PFS considers only the structural grain of the valley that runs northwest. But PFS has ignored the east-west Pass Canyon and the topographic embayment at the east-west trending Rydalch Pass, which are anomalies to the assertions that the northwest structural grain of the valley is the only aspect of the structural geology that needs to be investigated.

9. Another failure in its "integrated" approach, is that Geomatrix collected no seismic tie line(s) to correlate the PFS 1998 lines among themselves or with the Geosphere and GSI lines All of the PFS 1998 lines were shot in an east-west direction and without any perpendicular lines to tie into those east-west lines, Geomatrix's interpretation of the data is unreliable. Nor are the placement and number of seismic lines adequate to determine the length and projected locations of the East or West faults and other unnamed faults.

Executed this 30th day of January 2001.

By: [signature]
M. Lee Allison, Ph.D., R.G.

M. LEE ALLISON
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EDUCATION

Ph.D., Geology, University of Massachusetts, Amherst, Massachusetts, 1986
M.S., Geology, San Diego State University, San Diego, California, 1974
B.A., Geology (geophysics option), University of California, Riverside, California, 1970

SUMMARY OF EXPERIENCE

Over twenty-five years experience in geological policy management, scientific research with emphasis on structural geology and geophysics, geological exploration, and consulting. Experience includes work with state, local, and federal agencies, university research organizations, major petroleum companies, and a national research laboratory. Professional skills include management of an organization with a budget of over $8 million, establishment and direction of a non-profit research organization, use of integrated geological and geophysical research methods, geological mapping and use of satellite imagery. Provided leadership to numerous advisory boards, councils and professional organizations on earthquake, geophysical, and oil and gas research. Author of technical and non-technical papers on geology, drilling, energy and mineral resources, and active fault zones. Frequent lecturer to symposia, workshops, council meetings, petroleum companies, and state and federally sponsored organizations.

PROFESSIONAL EXPERIENCE

UNIVERSITY OF KANSAS, Kansas Geological Survey, Lawrence, Kansas **1999-present**
State Geologist and Director

Direct one of the largest state geological surveys in the nation, with up to 160 employees and an annual budget of over $8 million. Provide oversight to the Energy Research Center and the Data Access and Support Center.

STATE OF UTAH, Department of Natural Resources, Salt Lake City, Utah **1989-1999**
State Geologist and Director, Utah Geological Survey

Direct the activities of one of seven divisions in the Department having a staff of 75 and an annual budget of over $5 million. Created the Geologic Extension Service and the Environmental Sciences Program. Oversaw a seven-fold increase in publication sales. Expanded UGS oil and gas program and initiated petroleum industry cooperatives. Started Strong Motion Instrumentation Program for earthquake recording.

WESTERN EARTH SCIENCE TECHNOLOGIES, INC. (WEST), Salt Lake City, Utah **1988-1994**
President

Directed non-profit consortium of 12 universities in six Rocky Mountain states engaged in oil and gas research. Created organizational structure as part of working committee and elected as first president. Contributed to establishment of scientific program for WEST. Based at Univ. of Wyo., Laramie.

UNIVERSITY OF UTAH RESEARCH INSTITUTE, Center for Dipmeter Research, **1988-1989**
Salt Lake City, Utah
Manager

Ex 26

Founded and directed the Center to perform multiple research projects for government and industry in subsurface borehole geophysics. Personally responsible for all technical and financial development. Secured major funding from Gas Research Institute and industry.

UNIVERSITY OF UTAH RESEARCH INSTITUTE, Salt Lake City, Utah **1987-1989**
Senior Geologist

Established an oil and gas research program at UURI. Developed assessment programs for Utah oil and gas fields and evaluation of Uinta Basin resources.

Supervised $7 million deep geothermal drilling operation while on Ascension Island in the south Atlantic. Monitored technical, administrative, and financial activities on a daily basis. Ran earthquake seismic network and carried out paleomagnetic field studies.

Supervised a multinational team of 50 personnel to demobilize and transport 1200 tons of drilling equipment from Ascension Island to the U.S. Coordinated activities among British island government, U.S. Air Force, and government and UURI contractors.

STANDARD OIL PRODUCTION COMPANY (SOHIO, BP), Dallas and Houston, Texas **1984-1987**
Exploration Geologist

Used integrated geological and geophysical methods to generate prospects in Oklahoma, Arkansas, Texas, Nevada, and Wyoming. Responsible for new exploration models in Wind River Basin, and Basin and Range province. Division consultant on dipmeter interpretation and remote sensing. Initiated exploration data exchange program between Kennecott and Sohio. Developed detailed structural analyses of Ouachita-Marathon uplifts.

CONSULTING GEOLOGIST **1981-1983**
Wellsite supervision and log analysis, San Joaquin Valley and Los Angeles Basin, California, under contract to industry. Trained company geologists in wellsite procedures and techniques.

JET PROPULSION LABORATORY, CalTech-NASA, Pasadena, California **1980**
Scientist II

Computer processing and interpretation of satellite imagery for petroleum exploration techniques. Participated in NASA-industry *Geosat* project.

STANDARD OIL CO. OF CALIFORNIA (CHEVRON), San Francisco, California **1974-1979**
Development Geologist and Exploration Geologist

Responsible for development geology of 40 oilfields in southern California. Wellsite geology in Alaska and California on- and offshore, exploration field work in Alaska. Registered lobbyist to City of Los Angeles. Seismic interpretation of southern Alaska. Responsible for mapping major geologic trends for Federal offshore lease sales.

STATE OF CALIFORNIA, Division of Oil and Gas, Inglewood, California **1971**
Junior Oil and Gas Engineer

Evaluated compliance with regulations for drilling operations in southern California. Carried out first environmental investigation of an oil field in California under a new law and established criteria for subsequent reviews. Produced geological maps published in "California Oilfields."

PROFESSIONAL ACTIVITIES

·*Learning from the Land*, Science Forum on the Grand Staircase-Escalante National Monument, Cedar City, Utah, Nov. 1-7, 1997; Field Trip Committee Chairman
•American Association of Petroleum Geologists, General Chairman, 1998 Annual Meeting
•Geological Society of America, General Chairman, 1997 Annual Meeting
•Utah Seismic Safety Commission, 1994 -present; Chair, Education and Awareness Committee, 1995-1997
•State Advisory Council on Science and Technology (Utah); Ex-officio, 1993-1999
•North American Commission on Stratigraphic Nomenclature (AASG representative), 1989-1992
•University of Utah Department of Geology and Geophysics Advisory Council, 1990-1996
•Steering Committee, 3rd International Reservoir Characterization Conference, 1991
•Interstate Oil Compact Commission, Enhanced Recovery Committee, 1991
•Utah Advisory Council on Intergovernmental Relations Earthquake Task Force, 1989-90
•Utah Earthquake Advisory Board, 1992-1994; Executive Committee, 1992-1994
•Utah Geographic Information Council, 1990-1995 (Acting Chair)
• Utah State Mapping Advisory Council, 1989-1999; Chair 1989-1996
Kansas Water Authority (ex-officio), 1999-present
Tertiary Oil Recovery Project (TORP- University of Kansas), Advisory Board, 1999-present
University of Kansas Center for Research Inc., Board of Directors, 1999-present
Kansas GIS Policy Board, 1999-present

OTHER EXPERIENCE

•California Army National Guard, 1970-1976: 185th Armored Division; 80th RAOC; 240th Signal Bn.
•News Director, KUCR-FM, Riverside, California, 1968-69
•Co-founder of Mission Control Computers (computer store), Santa Monica, California, 1977
•Grandeur Peak Neighborhood Association, Salt Lake City, Utah, co-founder and spokesperson, 1993

PROFESSIONAL ASSOCIATIONS

•American Association for the Advancement of Science, 1993-present
•American Association of Petroleum Geologists, 1989-present, (Astrogeology Committee member, 1988-present; General Chairman, 1998 Annual Meeting)
•American Geophysical Union: 1980-present
•Association of American State Geologists: 1989-present, (Energy and Minerals Policy Committee; Geologic Hazards Policy Committee; National Geologic Map Peer Review Panel, 1995-97; USGS Publications Transfer Committee, Co-chair; Ad Hoc Committee on the Future of the USGS, Chair; Secretary, 1999-2000)
•Association for Women Geoscientists: 1990-present
•Geological Society of America: 1974-present (General Chairman, 1997 Annual Meeting; International Survey Program Ad Hoc Committee, Chair)
•Nevada Petroleum Society: 1985-present
•Rocky Mountain Association of Geologists: 1983-1995
•Society of Professional Well Log Analysts: 1989-present
•Utah Geological Association: 1989-present, (Guidebook editor, 1990)
•Wyoming Geological Association: 1983-1995
Sigma Xi: 1999-present
Kansas Academy of Sciences: 1999-present
Kansas Geological Society: 1999-present

POLITICAL CAMPAIGNS

•Energy Advisor, Clifford for Congress, Houston, Texas, May, 1989-March, 1990
•Campaign Manager, Caprio for Congress, San Diego, California, 1974
•Press Secretary, Media Director, and Acting Campaign Manager, Caprio for Congress, San Diego, California, 1972
•City Precinct Chairman, Unruh for Governor, Riverside, California (population 150,000), 1970

CERTIFICATIONS AND RECOGNITION

•California Registered Geologist #3411
•Wyoming Professional Geologist #2974
•California Community College Teaching Credential
•*Ambassador Award*, Salt Lake Convention and Visitors Bureau, 1992
•*Baylor Brooks Award (Outstanding Alumnus)*, San Diego State University Geology Alumni Assoc., 1998
Honorary Member, Utah Geological Association, 1999

PROFESSIONAL AND TECHNICAL TRAINING

•1991 Technical Writing - Shipley & Assoc.
•1986 Interpreting Old E-logs - Standard Oil
•1986 Rock Mechanics - Geological Society of America short course
•1985 Balancing Cross Sections - Geological Society of America short course
•1979 Structural Geology Seminar - Chevron
•1978 Stratigraphic Seminar - Chevron
•1976 Linear Operator (seismic processing) - Chevron
•1975 Navigation School - Chevron
•1975 Formation Evaluation - Chevron
•1975 SCAT (dipmeter interpretation) - Chevron
•1974 Basic Chevron School (petroleum geophysics)

GRANTS AND CONTRACTS

Principal Investigator, 1994-1999, "Increased Oil Production and Reserves Utilizing Secondary/Tertiary Recovery Techniques on Small Reservoirs in the Paradox Basin, Utah", U.S. Dept. of Energy, $5,115,003

Principal Investigator, 1993-1998, "Increased Oil Production and Reserves from Improved Completion Techniques in the Bluebell Field, Uinta Basin, Utah", U.S. Dept. of Energy, $5,676,856

Principal Investigator, 1993-1998, "Geological and Petrophysical Characterization of the Ferron Sandstone for 3-D Simulation of a Fluvial-deltaic Reservoir", U.S. Dept. of Energy, $1,673,641

Principal Investigator, 1987-1989, "Geology of the Grassy Trail Creek Oil field", Utah Geological & Mineral Survey, $8,000

Principal Investigator, 1987, "Stratigraphic Heterogeneity from Dipmeter Logs," Gas Research Institute, $160,000

Principal Investigator, 1999-, Seismic Hazards in Skull Valley, Utah, Affecting Storage of High-level Nuclear Waste," Utah Department of Environmental Quality, cost reimbursable

THESES

Structural Analysis of the Tensleep Fault, Bighorn Basin, Wyoming, Ph.D., 1986, University of Massachusetts, Amherst, 314p., Dr. Donald U. Wise, advisor.

Geophysical Studies Along the Southern Portion of the Elsinore Fault, M.S., 1974, San Diego State University, 229p., Dr. Robert B. McEuen, advisor.

INVITED TALKS:

Cities Service Research, Tulsa, Oklahoma, March 8, 1984: *"Structural Analysis of the Tensleep Fault, Bighorn Basin, Wyoming."*

Conoco Research, Ponca City, Oklahoma, March 22, 1984: *"Structural Analysis of the Tensleep Fault, Bighorn Basin, Wyoming."*

Stephen F. Austin State University, Nacgodoches, Texas, March, 1984: *"Structural Analysis of the Tensleep Fault, Bighorn Basin, Wyoming."*

Sierra Club, Dallas, Texas, Spring 1986: *"Geology of the Moons of Jupiter."*

University of Utah, Dept. of Geology and Geophysics, Salt Lake City, Utah, January 5, 1989: *"Geology of the Moons of Jupiter."*

Utah Geological Association, Salt Lake City, Utah, January 9, 1989: *"Variations of Stress in the Basin and Range."*

Amoco Prod. Research, Tulsa, Oklahoma, March 2, 1989: *"Statistical Curvature Analysis Techniques/Borehole Breakouts."*

Conoco Research, Ponca City, Oklahoma, March 2, 1989: *"Statistical Curvature Analysis Techniques/Borehole Breakouts."*

Phillips Petroleum, Bartlesville, Oklahoma, March 3, 1989: *"Statistical Curvature Analysis Techniques/Borehole Breakouts."*

Bureau of Economic Geology, Austin, Texas, May 22, 1989: *"Variations of Stress in the Basin and Range."*

Shell Research, Houston, Texas, May 24, 1989: *"Statistical Curvature Analysis Techniques/Borehole Breakouts."*

Texaco Research, Houston, Texas, May 25, 1989: *"Statistical Curvature Analysis Techniques/Borehole Breakouts."*

Haliburton Logging Services, Houston, Texas, May 25, 1989: *"Statistical Curvature Analysis Techniques/Borehole Breakouts."*

Arco Research, Plano, Texas, May 26, 1989: *"Statistical Curvature Analysis Techniques/Borehole Breakouts."*

Oryx Energy Co., Plano, Texas, May 30, 1989: *"Statistical Curvature Analysis Techniques/Borehole Breakouts."*

Occidental Petroleum, Tulsa, Oklahoma, May 31, 1989: *"Statistical Curvature Analysis Techniques/Borehole Breakouts."*

Utah State University, Dept. of Geology, Logan, Utah, February, 1990: *"Variations of Stress in the Basin and Range."*

Professional Geologists of Utah, AIPG, Salt Lake City, February 7, 1990: *"Geologic Bills in the 1990 Utah*

Legislature."

Brigham Young University, Dept. of Geology, Provo, Utah, February 27, 1990: *"Variations of Stress in the Basin d Range."*

Bountiful Area Chamber of Commerce, April 18, 1990: *"Earthquake Hazards in Utah."*

University of Utah, Dept. of Mining Engineering, Salt Lake City, Utah, May 10, 1990: *"Variations of Stress in the Basin and Range."*

Petroleum Accountants Association, Salt Lake City, 1990: *"Oil and Gas Developments and Potential in Utah."*

Desk and Derrick Club, Salt Lake City, Industry Appreciation Night, November 12, 1990, *"Utah Petroleum Potential - New Horizons of Economic Opportunity."*

Chevron Oil Field Research Center, La Habra, California, November 13, 1990, Tar Sands Symposium, *Tar Sand Developments in Utah".*

American Society for Photogrammetry and Remote Sensing, Salt Lake City, November 29, 1990: *"The Utah Geographic Information Council."*

Dixie Geological Association, St. George, Utah, Founding meeting, January 30, 1991: *"New Directions in Utah Petroleum,"* keynote address.

Utah Association of Petroleum & Mining Landmen, Salt Lake City, March 7, 1991: *"New Drilling Techniques in Utah."*

Association for Women Geoscientists, Salt Lake City, April 17, 1991, Panel discussion on *"Affirmative Action in State Government."*

Utah Geological Association, Salt Lake City, Utah, April 22, 1991, *"Oil and Igneous Intrusions in Nevada: An Exploration Model for the Great Basin".*

Association of Desk and Derrick Clubs, Region VII Meeting, Salt Lake City, May 25, 1991, *"Earthquakes and the O Industry in Utah"* seminar.

University of Utah Dept. of Geology and Geophysics, Distinguished Lecture Series, October 31, 1991, *"Geology, Politics, and Scams: What's Happening in Utah."*

National Earthquake Prediction Evaluation Council, Alta, Utah, 1991, *"Earthquake Prediction in Utah."*

Utah Bar Association, Energy, Natural Resources and Environmental Law Section, Salt Lake City, January 7, 1992, *"Horizontal Drilling and Applications in Utah,"* Continuing Legal Education short course.

Salt Lake City Rotary Club, January 21, 1992, *"Earthquakes in Utah,"*

Utah Division of Water Rights, Dam Safety Workshop, Salt Lake City, March 19, 1992, *"Geological Failure of Dams Around the World,"*

Uinta Basin Symposium, Vernal, Utah, May 13, 1992, *"Uinta Basin: America's Energy Storehouse,"* keynote address.

Utah Association of Petroleum & Mining Landmen, Salt Lake City, Nov. 5, 1992, *"Horizontal Drilling and Coalbed Methane - New Exploration Targets in Utah."*

Desk & Derrick Club, Salt Lake City, April 12, 1993, *"Earthquakes and oil wells"*.

Southern Utah University, Dept. of Geology, April 20, 1993, *"The St. George earthquake of Sept., 1992"*.

Snow College, Dept. of Physical Sciences, April 21, 1993, *"The St. George earthquake of Sept., 1992"*.

AIME, Soda Springs, Idaho, April 22, 1993, *"The St. George earthquake of Sept., 1992"*.

Holladay Rotary Club, Salt Lake City, February 16, 1994, *"Implications of the Northridge Earthquake for Utah."*

Salt Lake City Rotary Club, April 5, 1994, *"Implications of the Los Angeles and Draney Peak Earthquakes for Utah,"*

Utah Association of Petroleum and Mining Landmen, Salt Lake City, March 4, 1995, *"Oil and Gas Developments in Utah."*

31st Annual Engineering Geology & Geotechnical Engineering Conference, Logan, Utah, March 30, 1995, *"Geologic Hazards: How Much Risk is Acceptable?,"* keynote address.

Assoc. of Engineering Geologists, Utah Section, Salt Lake City, August 16, 1995, *"Geologic Hazards: How Much R is Acceptable?"*

University of Utah Law School, Salt Lake City, October 9, 1995, *"Energy and mineral resources in Utah."*

Central U.S. Earthquake Consortium, Annual Meeting, St. Louis, MO, November 14, 1995, Panel discussion *"Role f Seismic Safety Commissions in Risk Reduction Efforts."*

Utah Association of Petroleum and Mining Landmen, Salt Lake City, January 4, 1996, *"Geology and gas potential f Utah's Ferron Sandstone."*

League of Women Voters, Bountiful, Utah, February 6, 1996, *"Utah Earthquakes."*

Chamber of Commerce, Bountiful, Utah, May 15, 1996, *"Utah Earthquakes."*

Utah Geological Association, Salt Lake City, February 10, 1997, *"Energy and Mineral Resources of the Grand Staircase -Escalante National Monument - the Politics of Geology."*

Kiwanis Club, Salt Lake City, March 20, 1997, *"Geo-politics of the Grand Staircase-Escalante National Monument."*

Wallace Stegner Center for Land, Resources and the Environment, University of Utah, Salt Lake City, May 15, 1997, *"Geography, geology, and mineral resources of the Grand Staircase-Escalante National Monument"*, Visions of the Grand Staircase-Escalante: Exploring the Future of Utah's Newest National Monument.

Utah Mining Association Annual Convention, Park City, Utah, September 18, 1997, *"Mining on Mars"*.

University of Nebraska, Lincoln, Nebraska, Stout Lecture Series, September 19, 1997, *"Geology and resources of h Grand Staircase-Escalante National Monument - the Politics of Geology."*

Brigham Young University, Provo, Utah, Dept. Of Geology, October 9, 1997, *"Geology and resources of the Grand Staircase-Escalante National Monument - the Politics of Geology."*

Geological Society of America, Annual Meeting, Salt Lake City, Utah, October 23, 1997, Panelist, Hot Topics

Debate, *"The New Grand Staircase-Escalante National Monument: Environmental Preservation vs. Resource Exploitation vs. Tourism."*

Colorado Plateau Field Institute, Utah Valley State College, Orem, Utah, November 12, 1997, *"Geology and resources of the Grand Staircase-Escalante National Monument."*

Mining and Metallurgical Society of America, Salt Lake City, Utah, January 6, 1998, *"Implications of the Global Warming Treaty for Utah Coal."*

San Diego State University Geology Alumni Association Annual Meeting, Banquet speaker, San Diego, CA, April 7 1998, *"Energy and Mineral Resources of the Grand Staircase-Escalante National Monument, Utah: A Study in the Politics of Geology."*

Assoc. Of Engineering Geologists, Utah Chapter, Salt Lake City, May 6, 1998, *"Geologic Hazards Issues Affecting Storage of Spent Nuclear Fuel in Skull Valley, Utah"* (with Barry Solomon)

Fractured Reservoirs Conference, Petroleum Technology Transfer Council, Salt Lake City, October 23, 1998, *"Predictions of subsurface fracture orientations using borehole breakouts: examples from the western U.S."*

Utah Assoc. Of Professional Landmen & Society of Petroleum Engineers (Utah Chapter) joint meeting, Salt Lake City, January 14, 1999, *"The Digital Geologic Resources Atlas of Utah,"* (with Douglas A. Sprinkel).

Utah Geological Association, Salt Lake City, July 12, 1999, *"Utah Geological Survey and Utah: The next 50 years."*

Kansas Geological Society, Wichita, September 23, 1999, *"Energy and Mineral Resources of the Grand Staircase-Escalante National Monument: the Politics of Geology."*

Dept. of Geology, University of Kansas, October 7, 1999, Colloquium *"Energy and Mineral Resources of the Grand Staircase-Escalante National Monument, Utah: the Politics of Geology."*

Geological Society of America Annual Meeting, Denver, Colorado, October 27, 1999, Panelist, IEE - Geology and Public Policy Forum, *"Creationism vs. Evolution in the Classroom: Should Geoscientists Make a Stand?"*

Geological Society of America Annual Meeting, Denver, Colorado, October 28, 1999, Hot Topics panelist, *"Evolution and Creationism: the Situation in Kansas."*

Dept. of Geology, Kansas State University, November 4, 1999, Colloquium *"Energy and Mineral Resources of the Grand Staircase Escalante National Monument, Utah: the Politics of Geology."*

National Science Foundation, Arlington, VA, March 15, 2000, *"Stealth Creationism: the Assault on Evolution in Kansas."*

Kansas Independent Oil and Gas Association (KIOGA) Annual Meeting, Wichita, Kansas, August 28, 2000, keynote address, *"Helping Producers Make Kansas Richer."*

Leadership Kansas, Hays, Kansas, September 15, 2000, *"Geology of Water, Oil, and Gas in Kansas."*

Geology Club, San Jose State University, Calif., October 9, 2000, *"Assault on Science: The Evolution Battle in Kansas."*

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Allison, M.L., & J.H. Whitcomb, 1975, *Elsinore Fault Seismicity; the September 13, 1973, Agua Caliente Springs, California, earthquake series, (abs),* Trans. Am. Geophys. Un. EOS, v56, #6, p398.

Allison, M.L., J.H. Whitcomb, C.E. Cheatum, & R.B. McEuen, 1978, *Elsinore Fault Seismicity: the September 13, 1973, Agua Caliente Springs, California Earthquake Series,* Bull. Seis. Soc. of Am., v68, #2, p429-440.

Parmentier, E.M, M.L. Allison, M.J. Cintala, & J.W. Head, 1980, *Viscous Degradation of Impact Craters on Icy Satellite Surfaces,* Lunar & Planetary Sci. Conf. XI, p857-859.

Allison, M.L., J.W. Head, & E.M. Parmentier, 1980, *Grooved Terrain on Ganymede; origin as flooded graben (abs),* I.A.U. Colloquium 57, The Satellites of Jupiter, #6-7.

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Head, J.W., M.L. Allison, E.M. Parmentier, & S. Squyres, 1981, *High-Albedo Terrain on Ganymede: Origin as Flooded Graben,* Lunar & Planetary Sci. Conf. XII, p418-420.

Wise, D.U., & M.L. Allison, 1981, *Topographic Lineament Analysis: Possible Stress Indicators on Planetary Surfaces,* Reports on Planetary Geology Program, NASA TM 84211, p377-379.

Wise, D.U., & M.L. Allison, 1981, *Topographic Lineament Domains and Possible Paleostress Field in the Rock Springs Uplift,* Wyoming (abs), Geol. Soc. of Amer., Abs. with Prog., v13, #7, p583.

Golombek, M.P. & M.L. Allison, 1981, *Sequential Development of Grooved Terrain and Polygons on Ganymede,* Geophys. Res. Lett. v8, #11, p1139-1142.

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Boyer, S.E. and M.L. Allison, 1987, *Estimates of Extension in the Basin and Range Province (abs),* Geol. Soc. of Amer., Abs. with Prog., v19, #7, p597.

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Hulen, J.B., J.Copp, M.L. Allison, and D. L. Nielson, 1988, *Fracture Permeability in the Coso Geothermal Systems, California (abs),* Trans. Am. Geophys. Un. EOS, v69, p1172.

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Allison, M.L., F.B. Henderson, and D.C. Peters, 1989, *Developments in Remote Sensing: Poster Session Overview (invited abstract),* AAPG Bull., v73, p327.

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Allison, M. Lee, 1989, *Guest Editorial (Utah earthquakes),* Utah Holiday magazine, Salt Lake City, Utah, December.

Nielson, Dennis L., M. Lee Allison, Michael C. Adams, Susan G. Stiger, Martin M. Plum, and Gary R. Berglund, 1990, Summary Report: *Ascension #1 Exploratory Well and Geothermal Powerplant Economics, Ascension Island, South Atlantic Ocean,* Univ. of Utah Research Inst., ESL-88047-PR, DOE/ID/12489-39, 35p.

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Allison, M.L., W.S. Snyder, and E.A. Erslev, 1990, *Interdisciplinary Research for Reservoir Characterization in* *Rocky Mountains - the WEST Approach (abs),* AAPG Bull., v74, p1313.

Hulen, J., M.L. Allison, S.J. Lutz, C.A. Bengston, M.A. Chan, D.L. Nielson, 1990, *Stratigraphic Heterogeneity from Dipmeter Logs, Ferron Sandstone, Central Utah (abs),* AAPG Bull., v74, p1329.

Chidsey, T.C., M.L. Allison, and J.G. Palacas, 1990, *Potential for Precambrian Source Rock in Utah (abs),* AAPG Bull., v74, p1319.

Allison, M.L., 1990, *Remote Detection of Active Faults Using Borehole Breakouts in the Heber Geothermal Field, Imperial Valley, California,* Geothermal Resources Council TRANS., v14, Part II, p1359-1364.

Allison, M. Lee, 1991, *Review of "Distribution of Proterozoic Hydrocarbon Source Rock in Northern Arizona and Southern Utah", by Steven L. Rauzi,* AAPG Bull., v75, p193.

Allison, M. Lee, and Susan J. Lutz, 1991, *Faulted Shoreline and Tidal Deposits of the Moenkopi Fm., Grassy Trail Creek Field, Utah (abs),* AAPG Bull., v75, p1122.

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Allison, M. Lee, 1998, *Mineral Resources of the Grand Staircase-Escalante National Monument* (invited abstract) GSA Abstracts with Programs, Pacific Section.

Allison, M. Lee, 1998, *Geography and Geology of the Grand Staircase-Escalante National Monument,* in Walker, J and S. George, (editors), Visions of the Grand Staircase-Escalante: Exploring the Future of Utah's Newest National Monument, Wallace Stegner Center for Land, Resources, and the Environment, University of Utah, p3-12.

Chidsey, T.C., Jr, D.A. Sprinkel, & M.L. Allison, 1998, *Hydrocarbon Potential in the Grand Staircase-Escalante National Monument, Southern Utah (abs),* AAPG Abstracts.

Valentine, M.J., J. Czarnecki, and M. L. Allison, in review, *Matuyama-Brunhes Transitional Magnetic Fields Recorded in Volcanic Rocks from Ascension Island,* submitted to Geophysical Research Letters.

Allison, M. Lee, 1999, *Review of "Geologic Highway Map of Arizona," by R..J. Kamilli and S.M. Richards,"* AGI Geotimes, v44, #5, p36-38.

Allison, M. Lee 1999, *The Utah Geological Survey and Utah: the Next 50 Years (abs),* Utah Geological Association Newsletter, v31, #7, p1-3.

Allison, M. Lee, 1999, *Scientists are the Solution,* in: "Kansas Rejects Evolution: A Response from the Geoscience Community," Geotimes, AGI, v44, #10, p22.

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	Docket No. 72-22-ISFSI
PRIVATE FUEL STORAGE, LLC (Independent Spent Fuel Storage Installation)	)	ASLBP No. 97-732-02-ISFSI
	)	January 30, 2001

DECLARATION OF DR. WALTER J. ARABASZ

I, Dr. Walter J. Arabasz, declare under penalty of perjury and pursuant to 28 U.S.C. § 1746, that:

1. I am Research Professor of Geology and Geophysics and Director, University of Utah Seismograph Stations, University of Utah, Salt Lake City, Utah. I have 30 years professional experience in scientific research, occasional teaching, consulting, and publishing articles in observational seismology, seismotectonics, and earthquake hazard analysis with a primary focus on Utah and the Intermountain West. Since 1977 I have routinely provided professional consulting services on earthquake hazard evaluations for dams, nuclear facilities, and other critical structures. During the past decade I have had major involvement in assessing vibratory and fault-displacement hazards for the high-level nuclear waste repository at Yucca Mountain, including peer review, review of technical reports, and serving on expert teams for seismic source characterization for probabilistic hazard analyses. My service on numerous national and state advisory boards and panels has included — relevant to this filing — serving on the National Research Council's Panel on Seismic Hazard Evaluation (1992-96), the Utah Seismic Safety Commission (currently as chair) since 1994, and numerous panels and work groups under the National Earthquake Hazards Reduction Program since the early 1980s. My curriculum vitae, was submitted as Exhibit A to my January 26, 2000 Declaration and gives greater detail about my professional qualifications, experience and publications.

2. I was designated one of the State's testifying expert with respect to Contention L, Basis 2, on June 28, 1999. I have reviewed the Applicant's SAR sections, and updates thereof, relating to its earthquake hazards investigation of the proposed site, and relevant calculations, reports, and other documents prepared by the Applicant or its contractors and submitted to the NRC or produced to the State in discovery. I have participated in answering the Applicant's discovery to the State as well as assisted in the preparation of discovery for the State directed to the Applicant. I am

also familiar with NRC regulations, Rulemaking Plan to amend Part 72, guidance documents, the methodologies for earthquake hazard evaluation and new developments pertaining to the latter.

3. I have reviewed the NRC Staff's preliminary and final Safety Evaluation Report ("SER") for the PFS facility, dated December 15, 1999 and September 29, 2000 respectively, as well as the Staff's Position on Utah L (April 28, 2000).

4. I assisted in the preparation of the State of Utah's Request for Admission of Late-Filed Modification to Basis 2 of Utah Contention L, filed on January 26, 2000 and the State's November 9, 2000 Request for Admission of Late-filed Modification to Basis 2 of Utah Contention L.

5. I was deposed by Private Fuel Storage ("PFS") on October 18, 2000. I was present at the State's deposition of PFS's seismic hazards witnesses, Drs. Kevin J. Coppersmith and Robert R. Youngs, held on October 19, 2000.

6. I have reviewed portions of PFS's Motion for Summary Disposition for Utah Contention L (December 30, 2000), its Statement of Material Facts on Which No Genuine Dispute Exist, and attachments that are relevant to Contention L, Basis 2, as well as the State's response thereto. I provide this declaration in support of the State Response to PFS's Motion with respect to Contention L, Basis 2.

7. In previous submissions to the NRC, I have stated that PFS has not conducted a fully deterministic seismic hazard analysis ("DSHA") as required by 10 CFR § 72.102(f)(1) and, by reference, 10 CFR 100 Appendix A. *See e.g.*, State of Utah's Objections and Response to Applicant's Second Set of Discovery Requests With Respect to Groups II and III Contentions at 33-38 (June 28, 1999); *see also* Exhibit 11, Arabasz Tr. at 46-49. The NRC Staff has acknowledged that the DSHA performed by Geomatrix Consultants, Inc. and reported in the 1997 SAR and their updated DSHA reported in April 1999 "did not meet the deterministic requirements in 10 CFR 100 Appendix A." NRC Staff's Objections and Responses to the "State of Utah's Sixth Set of Discovery Requests Directed to the NRC Staff (Utah Contention L)" (February 14, 2000), Response to Requests for Admissions 1 and 2 at 7-8. The importance of a valid DSHA, other than being required by current NRC regulations, is that it establishes a benchmark to which results of any probabilistic seismic hazard analysis ("PSHA") can correctly be compared. If the DSHA results reported by PFS did not meet NRC requirements, then they cannot validly be compared to PFS's PSHA results, such as done for the NRC Staff by Stamatakos et al., to evaluate the conservatism of the PSHA results.

8. In developing site ground motion adjustment factors for the design basis ground motion, Geomatrix did not account for seismic cone penetration test ("SCPT") data

obtained in 1999 which show that the average shear-wave velocity in the uppermost 10 feet of the soil profile underlying the PFS site is about 540 feet per second. SAR (Rev. 9) at 2.6-30 and Figure 2.6-28. It was only after my deposition that these data were brought to my attention. The soil profile used instead by Geomatrix is one in which the average shear-wave velocity of the topmost layer (45 feet thick) is 750 feet per second, with a range from about 700 to 790 feet per second. Geomatrix Report (February 1999) at F-8 and Figure F-4. The latter soil profile was based on lower resolution shear-wave velocity information from seismic refraction surveys reported by Geosphere Midwest in 1997. Failure to correctly account for the material properties of the uppermost soil layer would affect the outcome of the ground motion analysis, regardless of whether the analysis is deterministic or probabilistic. PFS may be re-analyzing this issue but to date they have not done so. *See* PFS's letter to the NRC dated December 22, 2000 ("PFS Dec. 22, 2000 letter"), submitted to the Atomic Safety and Licensing Board on December 28, 2000, by PFS's counsel, Jay E. Silberg. Because earthquake ground motion must be expressed in a way that can be applied to engineering analyses, the seismic input or control motion may have to be specified at an appropriate point in the soil profile beneath the site rather than at the ground surface. NUREG-0800 § 3.7.1(I)(1). I defer to the State's expert Dr. Ostadan for a more complete discussion of the implications of this issue. *See* Ostadan Dec.

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other than being required by current NRC regulations, is that it establishes a benchmark to which results of any probabilistic seismic hazard analysis ("PSHA") can correctly be compared. If the DSHA results reported by PFS did not meet NRC requirements, then they cannot validly be compared to PFS's PSHA results, such as done for the NRC Staff by Stamatakos et al., to evaluate the conservatism of the PSHA results.

8. In developing site ground motion adjustment factors for the design basis ground motion, Geomatrix did not account for seismic cone penetration test ("SCPT") data obtained in 1999 which show that the average shear-wave velocity in the uppermost 10 feet of the soil profile underlying the PFS site is about 540 feet per second. SAR (Rev. 9) at 2.6-30 and Figure 2.6-28. It was only after my deposition that these data were brought to my attention. The soil profile used instead by Geomatrix is one in which the average shear-wave velocity of the topmost layer (45 feet thick) is 750 feet per second, with a range from about 700 to 790 feet per second. Geomatrix Report (February 1999) at F-8 and Figure F-4. The latter soil profile was based on lower resolution shear-wave velocity information from seismic refraction surveys reported by Geosphere Midwest in 1997. Failure to correctly account for the material properties of the uppermost soil layer would affect the outcome of the ground motion analysis, regardless of whether the analysis is deterministic or probabilistic. PFS may be re-analyzing this issue but to date they have not done so. *See* PFS's letter to the NRC dated December 22, 2000 ("PFS Dec. 22, 2000 letter"), submitted to the Atomic Safety and Licensing Board on December 28, 2000, by PFS's counsel, Jay E. Silberg. Because earthquake ground motion must be expressed in a way that can be applied to engineering analyses, the seismic input or control motion may have to be specified at an appropriate point in the soil profile beneath the site rather than at the ground surface. NUREG-0800 § 3.7.1(I)(1). I defer to the State's expert Dr. Ostadan for a more complete discussion of the implications of this issue. *See* Ostadan Dec.

Walter J. Arabasz

Dr. Walter J. Arabasz

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NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	Docket No. 72-22-ISFSI
	)	
PRIVATE FUEL STORAGE, LLC	)	ASLBP No. 97-732-02-ISFSI
(Independent Spent Fuel	)	
Storage Installation)	)	January 30, 2001

DECLARATION OF DR. STEVEN F. BARTLETT

I, Dr. Steven F. Bartlett, hereby declare under penalty of perjury and pursuant to 28 U.S.C. § 1746, that:

1. I am an Assistant Professor in the Civil and Environmental Engineering Department of the University of Utah, where I teach undergraduate and graduate courses in geotechnical engineering and conduct research. I hold a B.S. degree in Geology from Brigham Young University and a Ph.D. in Civil Engineering from Brigham Young University. I am a licensed profession engineer in the State of Utah.

2. Prior to this University of Utah faculty position, I worked for the Utah Department of Transportation ("UDOT") as a research project manager and have held a number of other positions with UDOT and other employers where I have applied my expertise in geotechnical engineering, earthquake engineering, geoenvironmental engineering, applied statistics, and project management. My curriculum vitae was submitted in this proceeding with the State's Objections and Response to Applicant's Second Set of Discovery Requests with respect to Groups II and III Contentions (June 28, 1999). My updated curriculum vitae is attached hereto.

3. I have also worked as a consulting engineer for 1996-1996 for Woodward-Clyde Consultants in Salt Lake City, mainly as a geotechnical designer for the I-15 Reconstruction Project.

4. Prior to my position at Woodward-Clyde Consultants, I worked from 1991-1995 for Department of Energy's ("DOE") contractor, Westinghouse, at the DOE Savannah River Site ("SRS"), near Aiken, South Carolina. I was Westinghouse's principal geotechnical investigator on a multi-disciplinary team overseeing the

seismic qualification of the ITP/H-Area high-level radioactive waste storage tank farm for the SRS; the principal geotechnical investigator reviewing the Safety Analysis Report ("SAR") for the seismic qualification of Defense Waste Processing Facility ("DWPF"), which is a high-level radioactive waste vitrification and storage facility at the SRS, and the project manager for the design of a hazardous waste landfill closure at the SRS. I used NRC regulatory guidance documents for my review of these projects.

5. I was designated as one of the State's testifying expert for this proceeding on June 28, 1999. I have reviewed the Applicant's SAR sections, and updates thereof, relating to its geotechnical investigation of the proposed site, and relevant calculations, reports, and other documents prepared by the Applicant or its contractors and submitted to the NRC or produced to the State in discovery. I have participated in answering the Applicant's discovery to the State as well as assisted in the preparation of discovery for the State directed to the Applicant. I am familiar with and have applied NRC regulations and guidance documents as they relate to geotechnical review.

6. I was deposed individually and as a panel member with Dr. Farhang Ostadan by Private Fuel Storage ("PFS") on November 16 and 17, 2000. I was present at the State's deposition of PFS's geotechnical witnesses, Drs. Paul J. Trudeau and Thomas Y. Chang, held on November 14, 2000.

7. I have reviewed PFS's Motion for Summary Disposition for Utah Contention L (December 30, 2000), its Statement of Material Facts on Which No Genuine Dispute Exist, and all attachments thereto. I provide this declaration in support of the State of Utah's Response the PFS's Motion for Summary Disposition. The following statements in this declaration are based on my experience, training, and best professional judgment.

8. I have reviewed the State's Statement of Disputed and Relevant Material Facts (January 30, 2001), which includes citations to my deposition testimony. The opinions expressed in my deposition remain the same, and indeed, have been reinforced due to PFS's decision that it must perform additional geotechnical characterization which PFS states results from the need to include data it had previously failed to incorporate. *See* PFS's letter to the NRC dated December 22, 2000, submitted to the Atomic Safety and Licensing Board on December 28, 2000, by PFS's counsel, Jay E. Silberg. In addition to this declaration, the transcript of my deposition describes the concerns I still have with PFS's soils and subsurface investigation.

9. PFS has not performed the density of spacing as outlined in NRC Regulation Guide 1.132, "Site Investigations for Foundations of Nuclear Power Plants," for the pad emplacement area. Nor has PFS performed continuous sampling for each major structure as recommended by Reg. Guide 1.132 Part C6. Sampling. *See* Bartlett & Ostadan Tr. at 92, 107, 127-28, 560.

10. PFS has not considered the potential spatial variation of soil properties (*e.g.*, shear wave velocity, undrained shear strength) in a systematic way in its field investigations and design calculations. Because uncertainty has not been treated in a statistical manner, it is not possible to determine the reliability of the foundation system to earthquake loading. *See* Bartlett & Ostadan Tr. at 237-39.

11. The foundation stability calculations have not accounted for the potential variation of shear strength properties across the pad emplacement area. Cone penetrometer tip stress values have been taken across the PFS site that suggest spatial variation (both vertical and horizontal); however, no statistical assessment of the impact of this variation has been made on the factor of safety. *See* Bartlett & Ostadan Tr. at 240-52.

12. PFS has based the seismic design of the foundation systems for the pad emplacement area on very limited laboratory testing from one borehole. The applicant has not demonstrated that this single datum is representative of the foundation soil for the entire pad emplacement area. Such extreme under-sampling may be subject to bias and could potentially lead to overestimation of shear strength capacity available to resist earthquake forces. *See* Bartlett & Ostadan Tr. at 235-39.

13. The calculation for seismic sliding of the pads, Stability Analyses of Storage Pads, Cal No G(B)04 (Rev 6), Stone & Webster, uses an direct shear undrained shear strength value of 2.1 ksf obtained from borehole C-2. This undrained shear strength is described as a "lower bound estimate"of the undrained shear strength due to seismic loading. However, direct shear test results for this same layer underneath the Canister Transfer Building show an undrained shear strength of 1.75 ksf at a normal stress of 2.0 ksf. (2.0 ksf is the approximate vertical stress at the base of the cask storage pads.). Thus, 2.1 ksf does not represent a "lower bound estimate" of undrained shear strength for this critical layer and a potentially unconservative shear strength has been used in the design of the pads.

14. PFS has not compared the reasonableness of the undrained shear strength values obtained from the laboratory test program with correlations that are common in the geotechnical literature and commonly used in engineering practice.

15. PFS has not considered shear strength anistropy, which is common in these sediments, in determining foundation stability. *See* Bartlett & Ostadan Tr. at 186.

16. Properties of critical foundation layers should not be averaged with properties from other dissimilar layers. For example, Calculation 05996.02, G(B) No. 5-2, Rev. 2, Tables 2 and 3 average the soil properties for in the upper 30 feet of the profile. These averages are misleading because they include materials of dissimilar types.

17. The development of the design basis ground motion did not consider the shear wave velocity data obtained from the seismic cone penetrometer. Because these data have not been used, it is not possible to determine if the correct earthquake loading has been properly determined for the foundation soils. *See* Bartlett & Ostadan Tr. at 127. PFS has decided to re-evaluate its design basis ground motion. *See* Exhibit 9 All calculations that use the design basis ground motion as an input to the dynamic loading analyses will be affected by the revision and will need to be re-analyzed. For example, the change in design basis ground motion will affect the following calculations that I reviewed as part of my evaluation of PFS's soils investigation and analysis: Stability Analyses of Storage Pads, Calculation No G(B)04 and Stability Analyses of the Canister Transfer Building Supported on a Mat Foundation, Calculation No G(B)13.

18. PFS has not considered potential moisture content changes in the foundation soils with time and how these changes may affect the undrained shear strength used in design of the foundation systems. Unsaturated, fine-grained soils can derive a significant portion of their cohesion (*i.e.*, undrained shear strength) from matrix suction (*i.e.*, negative pore pressure) that forms in the soil due to partial saturation. Thus, the undrained shear strength of an unsaturated, fine-grained soil can be sensitive to changes in moisture content. PFS has not assessed how potential moisture content changes and the subsequent shear strength changes may impact the seismic design of the foundations. *See* Bartlett & Ostadan Tr. at 216-18.

19. The soil-cement strategy will not preclude changes in moisture content with time in the untreated native soils immediately below the pad foundations. The geotechnical literature discusses cases of change in moisture content in a foundation soil, even after it has been capped by a relatively impermeable barrier. For example, Holtz and Kovacs (1981) discuss this effect:

> A common occurrence is that a pavement or building is constructed when the top soil layer is relatively dry. The structure covering the soil prevents

further evaporation from occurring and the soils increase in water content due to capillarity; then the soil may swell.

An Introduction to Geotechnical Engineer, p. 186, Robert D. Holtz, and William D. Kovacs, Prentice Hall, Englewood Cliffs, New Jersey, 1981.

It is not my opinion that the soils at the PFS site are susceptible to swell. However, the important point from this statement is the capping of a soil layer does not preclude changes in moisture content because of capillary action and unsaturated flow of water through a fine-grained soil. Bartlett & Ostadan Tr. at 216-218.

20. Foundation stability calculations, Calculation No G(B)04, assume that the maximum inertial force transmitted to the foundation system and soils cannot exceed the friction force between the bottom of the cask and the top of the concrete pad. Based on an assumed upper limit of the coefficient of sliding friction of 0.8, the maximum inertial force transmitted to the foundation system has been limited in the design of the foundation to 0.8 times the combination of the static and dynamic normal forces. This assumption may not represent the upper bound for dynamic loading and inertial forces may larger than those used by PFS.

21. In the sliding analyses for the pad foundations, PFS has not considered the following items which could lead to higher dynamic loadings to the foundation soils than was used in the calculations: (a) the potential for cold bonding between the casks and the concrete pad; (b) the flexibility of the concrete pad during earthquake motion; (c) the affect that rocking has on concentrating the stress and potentially prohibiting sliding; (d) rocking coming from non-vertically propagating surface waves; (e) and other environmental changes that might change the assumed upper limit of the coefficient of sliding. *See* Ostadan Dec. ¶¶ 16, 22; Bartlett & Ostadan Tr. at 370, 374.

22. PFS states that the factor of safety against sliding of the pad foundation with in the soil-cement treated soil is above 1.1 when the unconfined compressive strength of the soil-cement is above 125 psi. However, PFS's proposed design assumes that the soil-cement mat is placed in compression only in the horizontal direction and that the soil-cement mat will behave as an integral mat during the earthquake and transfer seismic-induced shear stresses over a large area. PFS has not demonstrated the reasonableness of these assumptions. Further, PFS has not considered the following stresses and how they may impact the seismic behavior of the soil-cement mat. Bartlett & Ostadan Tr. at 210, 217, 222.

- Bending and tensional stresses introduced in the soil cement mat during the earthquake by horizontally propagating and inclined waves

- Stress concentrations at the pad and soil-cement mat interface due to non-uniform thickness and large differences in stiffness between the concrete pad and the soil-cement mat

- Shrinkage cracks that will develop in the soil-cement mat due to drying and other environmental conditions.

23. PFS's proposed soil-cement strategy to improve the dynamic sliding and bearing capacity of layer 1 for the pad emplacement area is still in its conceptual stage. In my opinion, PFS has not demonstrated that the soil-cement strategy will be sufficient to resist seismic loading. There are unresolved design concerns that PFS has not considered, such as the stresses and cracking addressed above. *See* Bartlett & Ostadan Tr. at 216-17. These issues cannot be resolved until PFS completes the design and demonstrates its adequacy with appropriate testing and calculations.

24. While PFS may prepare design specification for the construction and testing of the soil-cement at the construction phase of the project, the State disputes that PFS has demonstrated that the soil-cement strategy will be sufficient to resist seismic loading. PFS has admitted that the design is still conceptual. Trudeau tr. 148. There are design issues that PFS has not considered, such as the permeability of the soil cement mix, the behavior of the soil cement on seismic loading and shrinkage and cracking of the soil cement due to environmental factors. Bartlett & Ostadan tr. at 216-17. These issues cannot be resolved until PFS completes the design and demonstrates its adequacy with appropriate testing and calculations.

25. PFS has potentially used non-conservative estimates of the undrained shear strength in the dynamic bearing capacity calculations for the canister transfer building and has used data that is not located near this building.

    - A weighted average for the undrained shear strength of 3.18 ksf was used for the upper 28 feet of the profile based on a unconsolidated undrained ("UU") test of 2.2 ksf from borings #4 and C-2 and adjusting this value by 1.64 for the deeper soils from 12 to 28 feet. However, borings #4 and C-2 are not within the footprint of the Canister Transfer Bldg. Both are located more than 1000 feet away from the building.

- The CPT (CPT 37) used to adjust for the unconsolidated-undrained ("UU") shear strength for the deeper layer (is located within the footprint of the Canister Transfer Bldg., more than a 1000 feet from the location of the borehole for the UU testing. This distance is too far and makes the adjustment factor of 1.64 applied to the UU data meaningless.

See "Document Bases for Geotechnical Parameter provided in Geotechnical Design Criteria," Cal No. G(B)05, Rev 2, Stone & Webster; and Calculation No G(B)13.

26. PFS asserts that it may conduct some future borings in 2001 in a generalized but non-specific location relating to non-safety related structures. PFS Material Fact Basis 3 ¶ 17. Moreover in appears that PFS intends to acquire additional downhole velocity data. *See* Declaration of Robert Y. Youngs at 4, Exhibit D to PFS's Motion. This suggests that PFS has either not collected enough data to support its subsurface investigation or PFS's is improperly implying that such future data should be evaluated in this proceeding.

27. The resonant column tests performed by PFS are not a form of strain-controlled cyclic triaxial tests. The two test apparatuses can be significantly different. Bartlett & Ostadan tr. 302.

28. PFS has not adequately determined large strain modulus and damping values for dynamic analyses using representative sampling and testing for the upper 30 feet of the soil profile.

Executed this 30th day of January 2001.

By: [signature]
Steven F. Bartlett, Ph.D., P.E.

NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	Docket No. 72-22-ISFSI
PRIVATE FUEL STORAGE, LLC (Independent Spent Fuel Storage Installation)	)	ASLBP No. 97-732-02-ISFSI
	)	January 30, 2001

DECLARATION OF DR. FARHANG OSTADAN

I, Dr. Farhang Ostadan, hereby declare under penalty of perjury and pursuant to 28 U.S.C. § 1746, that:

1. I hold a Ph.D. in civil engineering from the University of California at Berkeley. I am a consultant in the field of soil dynamics and geotechnical earthquake engineering. I am also a visiting lecturer at the University of California at Berkeley and teach a graduate course on soil dynamics and soil-structure interaction. My curriculum vitae listing my qualifications, experience, training, and publications has already been filed in this proceeding. *See*, Exhibit No. 2 of the "State's Motion to Compel Applicant to Respond to State's Fifth Set of Discovery Requests" (December 20, 1999).

2. I have more than 20 years experience in dynamic analysis and seismic safety evaluation of above and underground structures and subsurface materials. I co-developed and implemented SASSI, a computer program for seismic soil-structure interaction analysis currently in use by the industry worldwide. I am also the technical sponsor of this program in collaboration with the University of California at Berkeley.

3. I have participated in seismic studies and review of numerous nuclear structures, among them Diablo Canyon Nuclear Station; the NRC/EPRI large scale seismic experiment in Lotung, Taiwan; the large underground circular tunnel for Super Magnetic Energy Storage; General Electric ABWR and SBWR standard nuclear plants; Westinghouse AP600 standard nuclear plant; Tennessee Valley Authority nuclear structures (Browns Ferry, Sequoyah, Watts Bar); and the ITP, RTF, and K-facilities in the Savannah River Site for the Department of Energy. I have published numerous papers in the area of soil structure interaction and seismic design for nuclear and other structures.

4. I was designated one of the State's testifying expert for this proceeding on January

31, 2000. I have reviewed the Applicant's SAR sections, and updates thereof, relating to its geotechnical investigation of the proposed site, and relevant calculations, reports, and other documents prepared by the Applicant or its contractors and submitted to the NRC or produced to the State in discovery. I have participated in answering the Applicant's discovery to the State as well as assisted in the preparation of discovery for the State directed to the Applicant. I am familiar with and have applied NRC regulations and guidance documents as they relate to geotechnical review.

5. I was deposed on a panel with Dr. Steven F. Bartlett by Private Fuel Storage ("PFS") on November 16 and 17, 2000. I was present at the State's deposition of PFS's geotechnical witnesses, Drs. Paul J. Trudeau and Thomas Y. Chang, held on November 14, 2000.

6. I have reviewed PFS's Motion for Summary Disposition for Utah Contention L (December 30, 2000), its Statement of Material Facts on Which No Genuine Dispute Exist, and all attachments thereto. I provide this declaration in support of the State of Utah's Response to PFS's Motion for Summary Disposition.

7. I have reviewed the State's Statement of Disputed and Relevant Material Facts (January 30, 2001), which includes citations to my deposition testimony. The opinions expressed in my deposition remain the same, and indeed, have been reinforced due to PFS's decision that it must perform additional geotechnical and foundation evaluations which PFS states results from the need to include data it had previously failed to incorporate. *See* PFS's letter to the NRC dated December 22, 2000 ("PFS Dec. 22, 2000 letter"), submitted to the Atomic Safety and Licensing Board on December 28, 2000, by PFS's counsel, Jay E. Silberg.

8. The major concern I have with PFS's geotechnical analysis of the site is that PFS has segmented the investigations and analyses by various disciplines and PFS has failed to integrate those various investigations and analyses into a complete and unified design package. While it is important to evaluate the individual components of PFS's investigations and analyses, it is critical to look at those issues as a whole. In using the soil properties for design, for example, PFS's engineers and seismologists used different variability factors for the same data. This disparate treatment of the data has caused inconsistent and inadequate consideration of the effect of soil variability for design.

9. PFS initially obtained seismic refraction data which suggested the shear wave velocities in the top 10-30 feet of the soil profile to be approximately 750 feet per second (ft/sec.). The later seismic cone penetration test ("SCPT") data shows that the mean value of shear wave velocities in the shallow layer is approximately 540 ft/sec. The SCPT data demonstrates that the uppermost layer at the PFS site is a

soft thin layer. Bartlett & Ostadan Tr. 316-320.

10. Basis 2 of Contention L relates to the development of ground motions. Once a design basis ground motion has been developed, engineers take that motion and apply it in their analysis; the engineer must decide at which point in the soil profile this motion should be introduced (*i.e.* the control point). If the soil profile has a thin soft layer, the design motion should be specified as an outcrop at the top of the competent material. NUREG-0800, Standard Review Plan ("SRP") § 3.7.1, *Seismic Design Parameters*; Bartlett & Ostadan Tr. 335.

11. In my opinion there are two correct ways that PFS could apply its ground motions. First, the seismologists from Geomatrix who developed the design basis motion could recognize the soil profile, including the slower velocity layer from the SCPT data, in their calculations. PFS, however, failed to account for the SCPT data in developing ground motions. Alternatively, PFS could recognize that the ground motions were developed for a soil profile that has a velocity of 750 feet per second in the upper layers. Then PFS could use the ground motion that Geomatrix developed by putting it in the soil column where the shear wave velocity of 750 ft/sec has been established. Bartlett & Ostadan Tr. 339.

12. The Applicant has not properly developed or employed the shear wave velocity data from the site. In developing the probabilistic ground motions, Geomatrix used shear wave velocities of 750 ft/sec. from the seismic refraction data for the shallow layer and not the mean value shear wave velocity value of approximately 540 ft/sec from the SCPT data. Bartlett & Ostadan Tr. 320. Furthermore, PFS has introduced the control point at the surface, not at the top of the competent layer (*i.e.*, approximately 30 feet below the surface of the site). Bartlett & Ostadan Tr. 335-36.

13. PFS did not re-analyze the seismic refraction data to ascertain whether the shear wave velocity values in the uppermost layer are less than those obtained in the seismic refraction data. Failing to choose the correct properties for the upper layers will impact the layers below and will probably result in greater velocities than those reported by Geomatrix. Bartlett & Ostadan Tr. 319-22. This is important because it may also impact the design motion generated by Geomatrix.

14. In the development of soil and foundation parameters, Calculation No. G(P018)-2 *Soil and foundation parameters for dynamic soil-structure interaction analysis, 2000-year return period design ground motions* (Aug. 10, 1999), Geomatrix varied the properties of the upper 30 feet by increasing and reducing the soil shear modulus by a factor of one and a half. Geomatrix conducted no statistical analysis to justify whether this variation is sufficient nor did Geomatrix follow NRC SRP 3.7.1 and vary the shear modulus by a factor of two. On the other hand, Geomatrix chose to change the properties below 30 feet, which Geomatrix considered to be less well known, by a

factor or two. Bartlett & Ostadan Tr. 330.

15. In the calculation of the seismic analysis of the Canister Transfer Building (Calculation No. 05996.02-SC-5, *Seismic Analysis of Canister Transfer Building*, Stone & Webster (Aug. 28, 1999)), Stone & Webster chose to vary the shear modulus by a factor of one and a half for all layers, shallow and deep. This is inconsistent with the assumptions made by Geomatrix for deep soil layers and is not sufficient for inclusion of soil variability.

16. Unexplained safety concerns still remain because Geomatrix limited the variability factor of 1.5 to the upper 30 feet but recognized that a larger variability was needed for the deeper layers. This is inconsistent with Stone & Webster's use of a variability factor of 1.5 for all layers. The adequacy of the soil investigation and variability of the soil properties are important design considerations. PFS needs to characterize the data to be able to capture the variance to establish the upper bound, lower bound, and mean of the soil shear modulus. Then a determination can be made whether a limited or larger variation should be considered. Bartlett & Ostadan Tr. 330-33.

17. Geomatrix developed time histories in Calculation No. G(PO18)-3 *Development of Time Histories for 2,000-Year Return Period Design Spectra* (August 24, 1999) (Bartlett & Ostadan Tr. Exh. 67), which needed to be compatible with the design response spectrum. PFS's efforts failed in part because PFS did not look at the entire design package, in particular the nonlinear analysis of the casks on the pad (prepared by Holtec) and impacts of pulses caused by "fling." Bartlett & Ostadan Tr. 346-354, 457.

18. Geomatrix prepared one set of time histories consisting of three components in Calculation No. G(PO18)-3. Based on my experience, the common industry practice for nonlinear calculations is to use at least three sets of time histories because the nonlinear analysis is sensitive to phasing. In order to cover the variation of the phasing in the design, a minimum of three (or sometimes four) time histories are used. This is an important safety consideration that PFS has failed to address. Bartlett & Ostadan Tr. 345-355.

19. Geomatrix has recognized that "fling" pulses should be included in the time history but PFS has no parametric study in the design package to reveal the impact of the pulses on the design. Such pulses could be symmetric, asymmetric, one-sided or two-sided. Bartlett & Ostadan Tr. 346.

20. PFS could address the effects of fling in two ways. It could go back and look at the dynamic analysis of the casks and the pads and the Canister Transfer Building ("CTB") and show whether those seismic responses are sensitive to pulses or not.

PFS has not done so. Alternatively, PFS could have used enough time histories (at least three), with variation in pulses, to ensure the responses are not sensitive to variation of time histories. Bartlett & Ostadan Tr. 350-51. PFS has not done this either. Therefore, PFS's failure to give adequate consideration to the variation in ground motion may have a significant impact on seismic loading of the foundations and the design.

21. I have significant concerns with Holtec's analysis of the pad-cask system and with the invalid assumptions that Holtec relied upon. This is important because stability and design of the soil-foundation system are a function of the dynamic forces that will be considered for design. In order to evaluate the adequacy of the foundation design and the bearing soil, it is critical to understand the nature of the loads and where they are coming from.

22. Holtec calculation, *Multi Cask Response at the PFS ISFSI from 2000 Year Seismic Event* (Holtec International) (Aug. 20, 1999), is an important calculation for the foundation pad design and the soil stability under the pads because it is this calculation that generates the seismic loads that would be acting on the pads. There are a number of concerns with the calculation that affect the entire design package. First, Holtec placed the input motion at the top of the soft soil layer profile when it conducted its dynamic analysis of the cask and the pad. As described in ¶¶ 11 and 12 above, this is inappropriate.

Second, because the PFS site is located close to a number of major active faults (within approximately four to six miles), seismic waves arriving at the foundation structure are not necessarily vertically propagating waves, which Holtec assumed them to be. Based on my experience and the literature, there is a distinct possibility that the waves may come at an angle, and waves at an angle tend to cause larger rocking and torsional vibration above and beyond what is captured by the assumption that the waves will be vertically propagating. Bartlett & Ostadan Tr. 359-60. PFS could correct this oversight by conducting parametric studies to determine the effect of waves arriving at an angle. But PFS has done no such studies.

Third, Holtec's nonlinear analysis may be sensitive to phasing of the input motion and thus multiple time histories should be used *See* ¶¶ 17-18 above.

The other concerns I have with Holtec's calculations, discussed in greater detail below, are: Holtec's calculation of soil spring and damping; the assumption that the pad will act as a rigid mat; and ignoring the pad to pad interaction and the sliding assumptions Holtec has built into the cask-pad system.

23. Calculations performed for the foundation spring and damping coefficients for the

CTB recognize these coefficients are a function of frequencies and show that they are highly frequency dependent. In Holtec's calculations, however, this aspect disappears and frequency dependency has been ignored.

24. Holtec also incorrectly assumed that the pad is rigid. The results generated by Holtec were given to another PFS contractor, International Civil Engineering Consultants ("ICEC") for a subsequent stress analysis of the pads. *See* PFS Calculation No. G(PO17)-2, *Storage Pad Analysis and Design* by International Civil Engineering Consultants (Sept. 23, 1999).

25. When ICEC applied the loading coming from the cask to the pad, they used the computer program, SASSI, which showed that the displacements varied by more than a factor of two and a half from one corner of the pad to the other. Calculation no. G(PO17)-2 at p. 214, table 5.2.5-1 shows that the vertical displacement of the pad varies by a factor larger than 2.5 from one node to the other. This is clearly an indication that the pad is not rigid and that Holtec's assumption is invalid. Thus, the soil spring and damping coefficients generated by Holtec and the assumption made for smooth sliding of the casks on the pad are not correct.

26. Holtec has the very bold philosophy that the cask will side on the pad in a controlled manner during a large earthquake. There is no other redundancy built into Holtec's expected design. But such a bold assumption is negated by the potential that cold bonding between the cask and the pad may occur over time. When two bodies (casks and pad) with each cask having a weight of approximately 350 kips are in contact, some local deformation and redistribution of stresses may occur at the points of contact which would create a bond, and this would not allow the cask to slide on the pad or move smoothly during an earthquake. Thus, Holtec's assumption that sliding will reduce the seismic forces is incorrect. In this instance, the seismic loads would be greater than assumed and it is questionable whether the soils beneath the pad will have the capacity to sustain that additional load. Bartlett & Ostadan Tr. 365-368, 370.

27. The overturning and sliding stability of the pads (SAR at. 2.6-59, Rev. 13 and the supporting calculation) are based on the maximum peak ground acceleration of 0.53g in the vertical direction. PFS has used the wrong parameters in estimating the foundation loading stability analysis. First, the ICEC calculations show that the pad will not behave as a rigid mat. Second, the natural frequency of the foundation in the vertical direction for the lower bound, mean and upper bound soil cases is in the range of approximately 5 to 8 hertz, depending on the soil case. The design response spectrum for those natural frequencies would require the use of a value close to or in excess of 1 g rather than the peak ground acceleration of .53 g used by Stone and Webster in its stability evaluation. Bartlett & Ostadan Tr. 378.

28. In the latest revision of the SAR, PFS included a shear key one-foot deep around the

Canister Transfer Building to improve the shear resistance against sliding. In the revised calculation it is shown that the factor of safety is as low as 1.1. Calculation No. 05996-02-G(B)-13 *Stability Analyses of the Canister Transfer Building Supported on a Mat Foundation*, Rev. 3, Stone & Webster (6/19/00) at 13. This calculation relies on the passive resistance behind the one-foot shear key to develop the resisting forces against sliding. The calculation is not adequate for the following reasons:

A shear strength value of 1.8 ksf has been used based on the laboratory test results. This assumption ignores the fact that part of the shear strength has already been mobilized (Calculation No. 05996.02-G(P018)-2, *Soil and foundation parameters for dynamic soil structure interaction analyses, for 2000 yr return period design ground motions*, Geomatrix Consultants (Aug. 10, 1999)) due to the free-field wave propagation, and the full soil shear strength is not available to resist the inertia load of the structure. Bartlett & Ostadan Tr. 185-86.

While the passive soil pressure is used on one side of the shear key, the static and seismic soil pressures acting on the other side of the mat and the key (6-foot thick) have been ignored.

Since the soil behind the face of the mat has low overburden pressure, the passive resistance will actually develop behind the key on the inner side of the mat where the overburden of the building confines the soil. The passive resistance under the mat mobilizes the passive zone and develops vertical loads acting locally under the mat. PFS's analysis is faulty because PFS has not considered the passive soil and its reaction under the mat in its stability analysis of the building and design of the mat.

29. In § 4.7.1.5.3 of the SAR, PFS relies on Calculation No. 05996-02-G(B)-13 for its assertion that it has "evaluated the stability of the Canister Transfer Building and determined it is stable with respect to bearing capacity, overturning, and sliding due to static and dynamic load conditions." SAR at 4.7-8e (Rev. 17). PFS has inadequately analyzed the overturning of the Canister Transfer Building. In Calculation No. 05996-02-G(B)-13 (*Stability Analyses of the Canister Transfer Building Supported on a Mat Foundation*, Rev. 3, Stone & Webster (June 19, 2000)), PFS has calculated a factor of safety of 1.13 for the overturning analysis but this calculation is inadequate for the following reasons:

For the stability analysis of the Canister Transfer Building (Calculation No. G(B)-13), seismic loads are obtained by multiplying the mass at each elevation by the acceleration response from the dynamic analysis, thus ignoring the effect of the rotational mass moment of inertia. The overturning moment should include the moment caused by the rotational mass moment of inertia at all elevations. PFS failed to consider the effect of rotational mass moment of inertia for the computation of the overturning moment which results in PFS under-estimating the

overturning moment.

PFS estimated seismic load by multiplying mass times acceleration but this ignores the coupling from the two horizontal directions. Seismic loads from the dynamic analysis of the building including the coupling from the two horizontal directions should be used in the stability analysis. PFS has ignored the effect of coupling between horizontal responses in the design and again has under-estimated the overturning moment.

To compute the resisting moment, PFS assumed the mass center of the building to be at the center of the mat and ignored the mass eccentricity at various elevations, which may have overestimated the resisting moment. The actual mass centers at each elevation should be used to compute the moment. PFS has failed to consider the actual mass centers in calculating the resisting moment.

From the above, I conclude that PFS cannot sustain its statement in the SAR. Further, the use of the developed data in PFS's design analysis does not demonstrate that the design envelope is conservative. *See* Contention Utah L at 89.

Executed this 30th day of January 2001,

By Farhang Ostadan

Farhang Ostadan, Ph.D., P.E.

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GEOMATRIX

February 20, 1997
Project 3801

US-184

NOTED S.M. MACIE MAR 3_ '97

Mr. John Donnell
Stone & Webster Engineering Corporation
7677 E. Berry Avenue
Engelwood, CO 80111-2137

Subject: Review of Draft Report "Seismic Survey of the Private Fuel Storage Facility, Skull Valley, Utah" by Geosphere Midwest, SWEC J.O. No. 05996.01

Dear John:

As per your request, we have reviewed the subject geophysical report and our review of that report is attached.. Our particular focus in this review was the degree to which the report provides information of importance to our deterministic ground motions assessment. This information includes the depth to bedrock and the shear-wave velocity profile beneath the site. We are particularly concerned with the resolution of the seismic survey in this respect and the associated uncertainties. In addition, we have reviewed the structural interpretations made of the seismic reflection profile.

The review was conducted by John Luttinger of Geomatrix and Bill Honjas of William Lettis and Associates. These individuals have considerable experience in conducting and interpreting seismic surveys.

If you have any questions concerning this review, please feel free to give me a call.

Sincerely,

Kevin J. Coppersmith
Project Manager

PFS-01035

CONDENSED TRANSCRIPT

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of:	Docket No. 72-22-ISFSI ASLBP No. 97-732-02-ISFSI
PRIVATE FUEL STORAGE, LLC	Deposition of:
(Independent Spent Fuel Storage Installation)	**DR. STEVEN F. BARTLETT** and **DR. FARHANG OSTADAN**
	Vol. I

Thursday, November 16, 2000 - 10:11 a.m.

Location: Offices of
Parsons, Behle & Latimer
201 S. Main, #1800
Salt Lake City, Utah

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

SHEET 1 PAGE 1

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APPEARANCES

For the Intervenor: Denise Chancellor, Esq.
ASSISTANT ATTORNEY GENERAL
Office of the Attorney General
160 East 300 South, 5th Floor
Salt Lake City, UT 84114-0873

For the Applicant: Mattias F. Travieso-Diaz, Esq.
SHAW PITTMAN
2300 N. Street, NW
Washington, D.C. 20037-1128

Also Present: Barry J. Solomon, Thomas Y. Chang, Paul Trudeau

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EXHIBITS

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EXHIBITS (Continued)

* * *

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PROCEEDINGS
DR. STEVEN F. BARTLETT
and
DR. FARHANG OSTADAN,
having been first duly sworn to tell the truth,
were examined and testified as follows:
EXAMINATION
BY MR. TRAVIESO-DIAZ:

Q. Good morning, gentlemen. Mr. Bartlett, will you state your full name for the record, please?

A. (Dr. Bartlett) Steven, with a V, Floyd Bartlett.

Q. And you, Mr. Ostadan?

A. (Dr. Ostadan) Farhang Ostadan.

Q. My name is Matias Travieso-Diaz. I'm an attorney representing PSFS in this proceeding. I'll be asking questions today with respect to what has been identified in this matter as Contention L.

Before we start, let me make sure that if you don't understand a question that I ask, please ask me to rephrase it, restate it or have it read back, whatever. And make sure that you don't answer a question unless you understand it fully.

Today you are testifying as a panel, and I will probably be directing questions to one of you.

That doesn't take away from the other the opportunity to add if you have something to add. Nevertheless, the only thing that I ask is that you don't confer before providing the answers. And I also ask that only one of you speak at a time so the record doesn't get confused. Is that understood?
A. (Dr. Bartlett) Yes.
Q. Since you are going to be testifying as a panel, could I ask as a preliminary question, what portions of what has been identified as Contention L do you regard yourself as being expert on so that we can define in advance your areas of expertise? You, Mr. Bartlett?
A. (Dr. Bartlett) Bases 2, 3, and 4.
Q. 2, 3, and 4. How about you, Mr. Ostadan?
(Dr. Ostadan) I can't cite the number on the basis I don't recall. But all those calculations and design parameters relating to loading of the foundation and ground motion, seismicity.
Q. Let me start asking questions of you, Mr. Bartlett. What is your current position and employer?
A. (Dr. Bartlett) I'm employed by the University of Utah. I'm an assistant professor in the Civil and Environmental Engineering Department.

Q. Do you have any other jobs aside from your position with the university?
A. (Dr. Bartlett) No.
Q. And your work in connection with what is known as Contention L, is that part of your university assignment?
A. (Dr. Bartlett) No, it actually began when I was working for the Utah Department of Transportation.
Q. Is this a separate employment for you?
A. (Dr. Bartlett) Yes. I changed employments in August.
Q. But you retain your responsibility for this work?
A. (Dr. Bartlett) Yes.
Q. So technically, right now you're working both for the university and as a separate matter in connection with this work?
A. (Dr. Bartlett) Yes, in contract with the state Attorney General's office.
Q. Any other thing like that that you're doing?
A. (Dr. Bartlett) No.
Q. Okay. Now, are you -- I take it you're familiar with the PFS project?
A. (Dr. Bartlett) Yes.
Q. When did you become involved with the PFS

project?
A. (Dr. Bartlett) My best recollection, the first team meeting we had as a panel with the state experts was sometime in spring of '99.
Q. When you say met the experts as a panel, who were the experts that met?
A. (Dr. Bartlett) The other experts that were part of Contention L.
Q. And those were?
A. (Dr. Bartlett) Let's see. At that time Dr. Lee Allison, geological survey; Barry Solomon, state geological survey. Denise Chancellor was there, Connie Nakahara, Dr. Walter Arabasz. And I believe Dr. Peschmann, but I'm not sure, from the University of Utah. That's the best of my recollection.
Q. And when you were retained to work on this matter, what were you asked to do?
A. (Dr. Bartlett) I was asked to review the geotechnical portions of Contention L.
Q. Who retained you?
A. (Dr. Bartlett) Initially on not our panel but I think another panel, the Department of Transportation was involved. I believe the name is Dave Miles. And through my immediate supervisor, Dave Miles found out that I had expertise in these areas and was

requested by UDOT management to join the panel.
Q. What have you done in connection with what's known as Contention L since the time you were retained? Just generally.
A. (Dr. Bartlett) What have I done?
Q. Yes. What activities have you carried out?
A. (Dr. Bartlett) Review of the SAR, review of the supporting calculations.
Q. Let me show you something that is already on the record, so I'm not going to introduce it as a new exhibit. But let me give you a copy. This is Exhibit 3.
For the record, Exhibit 3 is a State of Utah's Contentions on the Construction and Operating Licence Application by Private Fuel Storage, LLC for an Independent Spent Fuel Storage Facility. It is dated 23rd of November, 1997, and the exhibit actually only contains the portion of the document that deals with what's known as issue L, geotechnical.
Q. (By Mr. Travieso-Diaz) Do you have that document in front of you?
A. (Dr. Bartlett) I do.
Q. Have you seen this document before?
A. (Dr. Bartlett) Yes, I have.
Q. Are you familiar with it?

A. (Dr. Bartlett) Yes.
Q. What is the source of your familiarity?
A. (Dr. Bartlett) I've read through it and used it somewhat as the basis of my review. As a structure, I guess.
Q. When did you see this document most recently?
A. (Dr. Bartlett) Parts of it yesterday.
Q. Okay. So it's fresh in your mind?
A. (Dr. Bartlett) Reasonably.
Q. Now, let me ask you to take a look at page 83 of Exhibit 3. And near the top of the page there is a paragraph that starts with -- it's in bold characters and starts with a sentence that reads, "Characterization of subsurface soils." Do you see that?
A. (Dr. Bartlett) Yes.
Q. And there's a text that starts there, page 83, and if I'm not mistaken, runs all the way through page 92.
A. (Dr. Bartlett) Then I see on 92, 4, stability and foundation loading, yes.
Q. Is it your understanding that the text between pages 83 and page 92 is what's known within Contention L as Basis 3?
A. (Dr. Bartlett) Correct.

Q. And now, Section 3 has in turn three subsections: subsection A, entitled "Subsurface investigations." It starts on page 83 and runs through top of page 85 that has a new subsection, B, called "Sampling and analysis." Is that correct?
A. (Dr. Bartlett) Correct.
Q. And then there is a -- subsection B runs through page 89, and there is a subsection C entitled "Physical property testing for engineering analysis." Is that correct?
A. (Dr. Bartlett) The page was 89?
Q. Yes.
A. (Dr. Bartlett) Yes, I see that.
Q. All right. And your understanding is that these are the three subsections, if you will, of Section 3 --
A. (Dr. Bartlett) Yes.
Q. -- or Basis 3?
A. (Dr. Bartlett) Yes.
Q. Were you the author of any part of Section 3 of this document?
A. (Dr. Bartlett) No.
Q. There is a person by the name of Lawrence White that is mentioned on the first page, I think, of Exhibit 3. I believe it's the first page.

A. (Dr. Bartlett) Yeah, I see his name.
Q. Do you see his name?
A. (Dr. Bartlett) Yeah.
Q. Is Lawrence White the author of any part of the text of subsection 3 of Exhibit -- of Contention L?
A. (Dr. Bartlett) That I'm not sure. I've been told that this has been written by a combination of Lawrence White and Barry Solomon, so I'm not sure. But it's probably reasonable to assume that he wrote most of that, being a geotechnical.
Q. Do you know Mr. White?
A. (Dr. Bartlett) I've never met him.
Q. So I take it that you didn't have any communications with him with respect to this contention?
A. (Dr. Bartlett) None.
Q. All right. Are you aware that you have been designated by the State of Utah as an expert witness in this proceeding?
A. (Dr. Bartlett) I am.
Q. And on what aspects of the licensing of this facility are you expected to testify?
A. (Dr. Bartlett) The subsurface investigations, the laboratory sampling, the geotechnical and foundation analysis.
Q. Now, you said a moment ago that your

understanding is that the text of what's known as subsection or Basis 3 of Contention L was originated from Mr. White -- or Dr. White and Mr. Solomon?
A. (Dr. Bartlett) Yes.
Q. Do you -- and I take it Mr. White is no longer -- Dr. White is no longer among the experts in the group that you work with?
A. (Dr. Bartlett) That's correct.
Q. Do you have any knowledge of the circumstances that led to your replacing Mr. White?
A. (Dr. Bartlett) I had just been told the state no longer decided to retain him as a consultant. Other than that, I don't know.
Q. All right. Now, in getting prepared or in discharging your functions that you described a moment ago with respect to Contention L, what documents have you reviewed of those prepared by the applicant in connection with the issues that are part of Contention L?
A. (Dr. Bartlett) The Safety Analysis Report has been the basis of my review, the supporting calculations that are in the SAR that's a part, mainly 2.6. I don't believe I've gone beyond the SAR in supporting calculations, and attachments and appendices.
Q. From time to time we might refer to a

document, so maybe you have reviewed them and you'll be able to update that list. And I take it that you not only reviewed the SAR but you reviewed the periodical dates to it as to where it filed?
A. (Dr. Bartlett) **Yes, I did. As they came to us, I was reviewing the updates to the SAR.**
Q. Now, when you say that you reviewed the SAR and the calculations, do you mean also to include among those documents the reports or the documents that reflect SAR's investigations or laboratory tests?
A. (Dr. Bartlett) **I'm not sure what those other documents you're referring to are.**
Q. For example, do you review boring records?
A. (Dr. Bartlett) **I looked at the published boring logs, yes.**
Q. Do you look at lab test reports?
A. (Dr. Bartlett) **Yes.**
Q. Do you look at any such documents as lab reports of boring records that were not part of the SAR?
A. (Dr. Bartlett) **Some were provided to me I think in discovery, but at the time I don't recall going through them very extensively. I think I've focused my reading of the SAR in supporting calculations and the appendices that included the laboratory testing.**
Q. So if there were materials that were

provided in discovery that may have provided additional information, you have not seen them?
A. (Dr. Bartlett) **I've seen things that were provided in discovery. And the extent of my review may depend on how germane, what was provided, what I felt were key issues, and whether they shed any light into them or not. A project like this generates quite a bit of paperwork and memorandums and correspondence, and I have read some of them, yes. But in detail, no.**
Q. I'm sorry. If you see me cutting you off, cut me off, please.
A. (Dr. Bartlett) **Fair enough.**
Q. I asked you a moment ago, are documents prepared by applicant. Now, have you reviewed documents prepared by other parties? For example, have you reviewed documents prepared by the NRC?
A. (Dr. Bartlett) **I have looked at the NRC's Safety Evaluation Report briefly. I have also looked at the request for additional information.**
Q. Have you looked at any documents prepared by the state or any other party?
A. (Dr. Bartlett) **Yes, that's true. Our internal documents, yes, that we've prepared.**
Q. And I don't mean to ask you about, of course, communications with counsel, but what sort of

internal documents to the state have you reviewed?
A. (Dr. Bartlett) **Just drafts of discovery. And then anytime the SAR was updated as we were preparing, we would do our own review of the SAR and we would pass our SAR comments, if you will, amongst each other.**
Q. There has been testimony by other witnesses, both for the state and the applicant, to the effect that applicant has performed significant additional work in matters relating to Contention L since this Exhibit 3 was filed in November '97. Is it your understanding that that has also been the case with respect to what's called Basis 3 or issue 3?
A. (Dr. Bartlett) **There's been other work performed at the site.**
Q. And have you undertaken to review that additional work done by applicant since 1997 to determine whether the issues raised in November of '97 as part of Basis 3 have been addressed, resolved or modified?
A. (Dr. Bartlett) **I have reviewed the subsequent work. I've seen primarily in this case additional cone penetrometer testing, dilatometer testing, and subsequent laboratory testing as provided usually in the request for additional information.**

Did I answer all of your question?
Q. Yes. But now my question is, did you seek to -- in light of this new information that you have looked at, have you sought to review the text of Issue 3 as appears in Exhibit 3? And you can please do this with me now, to figure out if there is any portion of what is described between pages 83 and 92 of Exhibit 3 that is no longer applicable because it has been resolved or taken care of by subsequent reviews.
A. (Dr. Bartlett) **It may be difficult for me to find exactly the pieces that have been resolved, but I can tell you at least in generalities what I think has changed since the initial submission of Contention L to where we stand at this particular point in time.**
Q. Will you please do that?
A. (Dr. Bartlett) **Sure. I do not believe there are any issues of liquefaction at this site. Dynamic settlement does not appear to be a major issue at this site. The calculations supporting consolidation settlement and secondary consolidation settlement.**
Q. Anything else?
A. (Dr. Bartlett) **Not that jumps out at me at the moment.**
Q. Rather than forcing you to rely on your memory, could I ask you to take a minute to review,

actually go over and these ten pages. We may take a couple minutes break for to you do that, so if anything else comes to mind that you believe has been resolved, you can tell us.
A. (Dr. Bartlett) Sure.
(Recess from 10:30 to 10:36 a.m.)
Q. (By Mr. Travieso-Diaz) Do you need the question read back to you?
A. (Dr. Bartlett) Yes, please.
(The record was read: "A. It may be difficult for me to find exactly the pieces that have been resolved, but I can tell you at least in generalities what I think has changed since the initial submission of Contention L to where we stand at this particular point in time.
Q. Will you please do that?
A. (Dr. Bartlett) Sure. I do not believe there are any issues of liquefaction at this site. Dynamic settlement does not appear to be a major issue at this site. The calculations supporting consolidation settlement and secondary consolidation settlement.
Q. Anything else?
A. (Dr. Bartlett) Not that jumps out at me at the moment.")
Q. And then I asked, will you review the text of Basis 3 of Contention L that goes from page 83 to 92

of Exhibit 3 and tell me if any of the matters raised on those pages has been resolved, to your understanding.
A. (Dr. Bartlett) I want to refer to page 84. I do not wish to make a lot of comments on the geology and structural geology and engineering geology of this site because it's not my area of expertise, but there has been further work done in that, and so I'll defer you maybe to other experts about those particulars that are mentioned there -- structural geology, geological history, and engineering geology.
One thing on page 84, the estimation of thicknesses of the layers, and that I think has been resolved from an engineering standpoint by the cone penetrometer.
Q. Can you tell us where on page 84 you're referring to?
A. (Dr. Bartlett) Oh, it's the second line. It talks about uncertainties in estimation of the thicknesses of various materials.
Q. That's the second line from the top of the page; is that correct?
A. (Dr. Bartlett) Yes. I think the cone penetrometer gives us reasonable estimates of thicknesses and, from an engineering standpoint, the stratigraphy of the site.

Q. Sorry. So I understand your last comment: do you believe that from the engineering standpoint the stratigraphy of the site has been also defined?
A. (Dr. Bartlett) In the upper 30 to 35 feet where the cone penetrometer's been pushed, the stratigraphy and thicknesses of those units.
Q. Sorry. Are you finished with the answer?
A. (Dr. Bartlett) Are reasonably described as far as thickness.
The rest of 84 still talks more about geology, geochemical analyses. I will defer on speaking on those. So that would finish that page.
Under "sampling and analysis" on page 86, there's some discussions about not taking particular soil samples in -- I'm reading in the middle of the page where it starts "for example."
Q. The second sentence in the second paragraph of the page?
A. (Dr. Bartlett) The second sentence, yes.
Q. All right.
A. (Dr. Bartlett) Well, it's actually the third where it starts, "For example, the soil test data" --
Q. Okay.
A. (Dr. Bartlett) -- "did not include samples

taken from each of the soil strata, did not include each foundation of buildings or structures, and did not include the PMF diversion dike foundation, and did not evaluate compacted soils." There's been additional borings done that cover some of those areas.
Q. So do you consider that the concern expressed in that sentence is not applicable?
A. (Dr. Bartlett) Pertaining to not placing borings under certain areas, yes, or in certain areas.
On to page 87. Second sentence beginning with "The Applicant must obtain representative undisturbed samples of each of the site soils and determine their dynamic properties." We have seen additional testing done to determine the dynamic properties of certain soil layers. We're still not sure whether all layers have been sampled and tested. But there has been additional testing to determine dynamic properties.
Q. So the statement made in that sentence, "The Applicant must obtain representative undisturbed samples of each of the site soils and determine their dynamic properties," is that statement still applicable or not applicable?
A. (Dr. Bartlett) It's applicable to the extent that they have determined additional dynamic

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properties. Whether they have sampled all undisturbed samples from all layers, we would not agree with. Definition of layering may differ between your layering system and our layering system.
Q. All right, please go.
A. (Dr. Bartlett) Okay. On page 88 it's talking about, in the first full sentence on that page, "For example, throughout calculation number 04-3, the criteria for assignment of unit weight," and then it has, "typically used in all soil analysis (strength, consolidation, and dynamic response) are assumed." There's been enough characterization to define the unit weights, I think, of this profile.
Q. So again, is it your understanding that this sentence is no longer --
A. (Dr. Bartlett) Only dealing with unit weights.
Q. Only to the extent of units weights?
A. (Dr. Bartlett) Yeah, this is referring to -- just one moment. Let me read it. This is only referring to unit weight. Yes, the unit weights are needed for other analyses, but relating to unit weight, we think that has been resolved.
Q. And as you understand the sentence, it does refer to unit weights; is that correct?

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A. (Dr. Bartlett) Yes. It's talking about the criteria for assessment of unit weights, then it says typically used for soil analysis -- or all soil analysis, and those would be strength, consolidation, and dynamic response, are assumed. And I believe the current calculations are not using assumed values.
Q. Okay.
A. (Dr. Bartlett) And any other discussion in this paragraph about unit weights. I don't believe unit weights are a significant issue.
Q. So for example, the next sentence in that page that starts -- well, the next -- the sentence after next on that page that starts with "The justification of the values should be provided," is it your understanding that that refers to unit weights?
A. (Dr. Bartlett) Correct.
Q. And to that extent, that sentence has also been resolved?
A. (Dr. Bartlett) Pertaining to unit weights.
Q. Now, the next sentence, does it also pertain to unit weights, or is it a different thought? The one that starts with "calculation number 04-3."
A. (Dr. Bartlett) Yes, I see it. Just a moment. I think the remainder of this paragraph is trying to point out some discrepancies in unit weights

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between calculations, and I don't believe those would be major issues anymore.
Q. So would you say, then, the rest of this paragraph starting with calculation 04-3 is also resolved?
A. (Dr. Bartlett) Regarding unit weights, yes.
Q. Do you think it refers to anything else? I'm just trying to understand what --
A. (Dr. Bartlett) I don't believe so.
Q. Okay. All right, please go on.
A. (Dr. Bartlett) On the second -- the first full sentence on page 89 beginning with "For strengths conducted in the laboratory, full details must be given; for example, how saturation of the sample was determined and maintained during testing and how the pore pressures changed," that does not appear to be applicable, at least regarding the pore pressure changes, because we're dealing with unsaturated sediments.
Q. So I take it that your understanding is that this particular concern is no longer applicable because we don't have the type of soils to which it would apply?
A. (Dr. Bartlett) The saturation of the samples and measuring of pore pressures does not appear to be applicable in most instances for these soils.
The next sentence beginning, "For sites that

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are underlaid by cohesionless soils and sensitive clays that are or may become saturated, particularly at depths greater than 30 feet, the Applicant should show that all zones that could become unstable because of liquefaction or strain-softening phenomena have been sampled and tested to evaluate their ground-failure potential." As I said before in my general statement, I do not believe liquefaction is an issue. The strain-softening phenomena may still be an issue.
Q. So is it your testimony that this sentence is inapplicable to the extent that it refers to liquefaction?
A. (Dr. Bartlett) To liquefaction.
Q. But it may be applicable to the --
A. (Dr. Bartlett) Still strain-softening phenomena, yes. Applicable still to strain-softening phenomena.
Q. Okay.
A. (Dr. Bartlett) On page 90 beginning with the sentence about two thirds of the way down, "For example, the dynamic analyses presented instead use published information from 1970 which is extrapolated to the site without any basis for such extrapolation. The variation of shear modulus determined for testing cited in this reference is based upon a very small strain

derived from laboratory compacted loose to medium dense sand materials." I am going to defer that section maybe to Dr. Ostadan. That's the area of his expertise.
Q. May I ask you to stop for a second? Turn the exhibit over to Dr. Ostadan. Maybe this is a chance for him to help us out here.
Could you review, Dr. Ostadan, the sentence from page 90 that starts with "For example."
And Mr. Bartlett, how far do you believe that he should be reviewing? The sentence goes through --
A. (Dr. Bartlett) I think he should probably finish that and through the end of the paragraph.
Q. Which ends on the middle of page 91?
A. (Dr. Bartlett) Correct.
Q. So Dr. Ostadan, you are asked to review the sentence that starts with "For example, the dynamic analysis" on page 90, going through to the end of the paragraph on page 91. And tell us based on your understanding of what has been done whether the concerns raised in those sentences are still applicable.
MS. CHANCELLOR: He may need some time to review.
MR. TRAVIESO-DIAZ: Absolutely.
A. (Dr. Ostadan) Okay. Starting from the

sentence "for example," use of generic soil curves in the dynamic analysis.
Q. Could you for the record identify where you're reading from?
A. (Dr. Ostadan) I'm reading on page 90, the second -- the sentence that starts with "For example."
Q. Okay.
A. (Dr. Ostadan) Middle of the page. Analysis is still based on published information for soil curves. No, I do not think any of the points made until the middle of the page 91 is part of the analysis.
Q. Dr. Ostadan, I didn't have the opportunity to ask you this before. Is this opinion that you have expressed based on your review not only of the original SAR submitted by applicant but all of the dates and information?
A. (Dr. Ostadan) Yes, it is.
Q. So it is based on your understanding of the current state of the investigations and analysis performed by applicant?
A. (Dr. Ostadan) Yes, it is.
Q. Thank you. Dr. Bartlett, will you continue?
A. (Dr. Bartlett) Sure. Leading to the next -- well, the second paragraph on page 91 discussing void ratios. There have been additional work to

determine the void ratios at this site. The cause for the high void ratios still may be discussed. But there are cases that -- well, the request for additional information has addressed some of these high void ratios.
Q. Would you help me understand what your assessment of the status of this particular issue is? Will you explain to me whether you feel that the causes of the void ratios have been addressed, or what do you think has been resolved?
A. (Dr. Bartlett) I think this is pointing out that from the consolidation testing and other testing for void ratio that there are apparently some high void ratios for these soils, and additional void ratio measurements have been made. I'm not sure the applicant has completely described the reasons for these high void ratios, or at least to our satisfaction.
Q. So would it be fair to characterize --
A. (Dr. Bartlett) The additional void ratio testing has been done and characterization has been done, but the cause of the high void ratios still may be uncertain.
Q. Thank you. You answered the question before I asked.
A. (Dr. Bartlett) You're welcome.

Q. Could you please go on?
A. (Dr. Bartlett) I think that's -- let's see. Got one more paragraph, don't I?
The last paragraph talks about some standard types of engineering properties tests, and it cites, for example, "unit weights, porosity, compaction, etc., which should be performed for layer 1 and 2 soils."
As I've stated earlier, I do not believe unit weights are a significant issue here. Porosity is a function of void ratio, so we're really again talking about void ratio when we say porosity. We just discussed that matter. And compaction, though I don't recall seeing standard compaction curves for this site, I would assume those would be done when one would begin to develop a design. I do not believe those type of compaction issues are a problem.
Q. Sorry, I didn't hear you.
A. (Dr. Bartlett) That any issues relating to compaction or standard compaction curves will really be an issue here.
Q. Before I ask you my next question, so the record is clear: when you said the last paragraph, you meant the last paragraph of subsection 3 --
A. (Dr. Bartlett) In that subsection, correct.
Q. -- which is on top of page 92?

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A. (Dr. Bartlett) Yes, beginning with "Further, the Applicant performed only limited."
Q. Could you clarify for me what is meant in that paragraph that you just read by layer 1 and layer 2 soils?
A. (Dr. Bartlett) That I am not sure of.
Q. But you said earlier that you were not too sure of whether your definition of layers was the same as applicant's.
A. (Dr. Bartlett) That's correct.
Q. Could you elaborate on that?
A. (Dr. Bartlett) Our information and understanding of the layering of the system has changed since this document was published, and admittedly so. And as I recall in the earlier versions of the SAR we were talking about soils in the upper 30 to 35 feet and then a deeper, denser layer. And I'm assuming these mean for those -- that system. But now it seems we have progressed to the state where we've been talking about the upper layer and as many as possibly five subunits. So when it refers to layer 1 and, 2, I assume it's talking about the original layering as discussed in the SAR.
Q. But for purposes of the rest of our discussion today, when we speak of layers, do you mean

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the layers that were discussed in -- strike that question. Start a new question. Were you here yesterday when Mr. Trudeau and Dr. Chang gave their testimony deposition?
A. (Dr. Bartlett) Correct.
Q. Do you recall there being a discussion in their deposition of several layers that were identified against particular figures of the SAR?
A. (Dr. Bartlett) Correct.
Q. Now, for purposes of our discussion today, when we refer to layers, are you speaking for those layers that are now currently depicted in the SAR for the top 30 feet?
A. (Dr. Bartlett) Correct. In fact, we could bring the SAR out and identify them if you'd like.
Q. We'll do that very soon, but I just wanted to make sure we're speaking of the same --
A. (Dr. Bartlett) Since this document is historical, I think it's talking about an older layering system. The layering system has evolved.
Q. Thank you. I would ask you to keep this Exhibit 3 handy, since we'll be probably talking about it a lot more.
With whom, other than your legal counsel, have you discussed issues relating to Contention L in

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this proceeding?
A. (Dr. Bartlett) Of legal counsel?
Q. Apart from legal counsel.
A. (Dr. Bartlett) Oh, apart from legal counsel.
Q. Please.
A. (Dr. Bartlett) Could you restate the question?
Q. Okay. With what parties, other than the lawyers, have you discussed the subject of Contention L?
A. (Dr. Bartlett) My immediate supervisors for the Utah Department of Transportation. I've had -- I guess my supervisors now at the University of Utah have asked me questions about my involvement in Contention L. I've just told them what I'm doing, just more as in passing so they know where I'm at and what I'm about.
When you mean "besides," do you want also me to include those that are also state expert witnesses?
Q. Yes.
A. (Dr. Bartlett) Okay. That would also include, then, Dr. Lee Allison, Walter Arabasz, Jim Peschmann, Dr. Ostadan, Barry Solomon. I believe that's all.
Q. Now, what is your understanding of the respective roles of the experts that you mentioned in

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this proceeding?
A. (Dr. Bartlett) We've broken it up into different disciplines and expertise for our review. And Dr. Arabasz and Dr. Peschmann have taken the lead in the Basis 1, though we have had some comments and input into Basis 1 also. When I mean "we," myself and also Dr. Ostadan.
For the geology and geotechnical issues would be Barry Solomon, Lee Allison, myself, Dr. Ostadan.
Within that trichotomy, I guess, if you will, Barry would be reviewing the geology; I would be reviewing the geotechnical engineering related to the site characterization, the foundations; Dr. Ostadan would deal with issues of dynamic loadings and dynamic analysis and response. Finished.
Q. I didn't want to cut you off. You testified earlier that you did not consult with Dr. White.
A. (Dr. Bartlett) No, I did not.
Q. To the extent that Dr. White was the person who wrote this Exhibit 3, do you believe it would be useful for you to find out what he meant, for example, here in discussion of layer 1, layer 2?
A. (Dr. Bartlett) Yes, that would have been useful.

Q. And can I ask you why you didn't speak with him?
A. (Dr. Bartlett) I was never given the opportunity as part of the team in the project.
Q. Did you seek to contact Dr. White?
A. (Dr. Bartlett) No, I did not. He was no longer retained by the state.
Q. Explain to me what you mean by you were never given the opportunity.
A. (Dr. Bartlett) Well, normally when I would consult on something of this issue in these matters, I would consult with those that would be part of the project team. He was no longer part of the team. I didn't feel it would be appropriate to seek him out once he had been removed from the team.
Q. I see. You mentioned a little while ago that your first involvement, or earlier in your involvement with this project that there was a team meeting that you attended.
A. (Dr. Bartlett) That's my first recollection of, yes, getting together with the group.
Q. What happened at that meeting?
A. (Dr. Bartlett) Well, as usual, there were some introductions. There was a fair amount of discussion about the seismic refraction, reflection

data. I remember Dr. Allison was there and discussed that to some extent. Myself being new to the team, I didn't take a large part in that, of the conversations during the meeting. Dr. Arabasz was there. I'm sure there was some discussion of the design basis ground motions, how they were being developed, derived. Denise and Connie were there. That's my recollection. It was a year and a half ago, two years ago.
Q. Have there been subsequent meetings of that time among the state experts that are working on this Contention L?
A. (Dr. Bartlett) From time to time, but usually not quite that extent. That was the first really full panel meeting that I recall.
I do recall at that time I think someone else had made the recommendations that we may consider bringing in an expert in soil dynamics at that meeting.
Q. I'm getting ahead of the story. I want to pursue that Dr. Ostadan was not part of the team then.
A. (Dr. Bartlett) You'll get him later. Fair enough. This was before Dr. Ostadan was part of the team.
Q. All right. And you said you have had less --
A. (Dr. Bartlett) Yes, not -- not I think the

full team. It was different disciplines or expertise. Some of them were face-to-face meetings. Since some of us live in different areas, a lot of them were just phone conferences and calls.
Q. I take it that since Dr. Ostadan was retained to assist in this matter, you have consulted with him?
A. (Dr. Bartlett) Yes.
Q. Have you consulted with him frequently?
A. (Dr. Bartlett) Yes.
Q. What did you do to prepare for this deposition we're having today?
A. (Dr. Bartlett) For this deposition I focused most of my attention on reviewing the current SAR and its status, reading the revised calculations, looking at the data that are presented in the appendix, appendices of the SAR, reading some of the supporting reports. They're numerous, and I was selective about some of the reports. Reading Contention L, and preparing questions.
Q. Did you bring any documents today, to this deposition today?
A. (Dr. Bartlett) No, I didn't. Oh. Well, other than I do have some cone penetrometer logs I think that were given to you yesterday.

Q. Right. Apart from those cone penetrometer logs which we may talk about later today --
A. (Dr. Bartlett) Sure.
Q. -- have you prepared or generated any documents in connection with your review of Contention L?
A. (Dr. Bartlett) Define a document.
Q. Define a document?
A. (Dr. Bartlett) Yes.
Q. Well, any writing or either by electronic or other means that encompasses or presents your views that results in your analysis.
A. (Dr. Bartlett) Sure. Sometimes documents have different meanings. We have had project correspondence, mainly electronic. We have prepared questions and responses for discovery and prepared questions for deposition.
Q. Have you conducted any independent calculations or analyses or tests that pertain to the soils at the PFS site or any other issues related to Contention L?
A. (Dr. Bartlett) Please repeat the question.
MR. TRAVIESO-DIAZ: I don't think I can get it right. Can you read it back?
(The record was read: "Q. Have you conducted any

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independent calculations or analyses or tests that pertain to the soils at the PFS site or any other issues related to Contention L?")
A. (Dr. Bartlett) **Not calculations in the engineering sense. I've reviewed calculations, maybe done a few punch of the numbers of my calculator, made a few scribbles in margins and notes, but I have not performed really any substantive calculations.**
The others were --
(The record was read: "Calculations or analyses or tests that pertain to the soils.")
A. (Dr. Bartlett) **The analyses, no, not in the way I normally use analysis. And the last was --**
(The record was read: "Or tests.")
A. (Dr. Bartlett) **No, we've not performed any tests.**
Q. Perhaps my use of the word "analysis" was ambiguous.
A. (Dr. Bartlett) **Sure.**
Q. Let me try to clarify it. By analysis, I mean either what is no more considered by engineers as an analysis of the form, for example, of a calculation, and is reflected in writing that can be preserved and can be reviewed; or a laboratory analysis, if you will, of samples of materials. Either in those two forms of

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the word how you perform any analysis.
A. (Dr. Bartlett) **I did a page or page and a half calculations of undrained shear strengths based on my experience from other projects to see where this particular site would fall within my experience. No laboratory analysis. And again, a few scribbles in margins of things, but they're not really -- just checking numbers and things.**
Q. Well, that page or page and a half preparation, two questions about it. First question is, did you preserve it?
A. (Dr. Bartlett) **Yes. It's on my computer.**
Q. Can we have a copy of that?
A. (Dr. Bartlett) **Sure.**
Q. Second question is, well, what were the results of that calculation?
A. (Dr. Bartlett) **Do you mind if I at least refer to it when I --**
Q. Absolutely. I mean, if you don't have the answer now, we can --
A. (Dr. Bartlett) **I have my computer.**
MS. CHANCELLOR: Can we go off the record for a minute?
(Discussion off the record.)
(Recess from 11:24 to 11:28 a.m.)

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MR. TRAVIESO-DIAZ: So that we describe for the record what transpired when we were on the break, Dr. Bartlett has provided us a diskette containing the text of the calculations of which we referred in the last question and answer. We will be discussing that at a later point.
(Exhibit 48 marked.)
Q. (By Mr. Travieso-Diaz) Dr. Bartlett, I have introduced as an exhibit Exhibit 48 a document entitled Steven F. Bartlett, Ph.D., P.E., Vita. It consists of five pages and is dated October 2000. Do you have that document in front of you?
A. (Dr. Bartlett) **I do.**
Q. Is this an accurate summary of your educational and professional experience?
A. (Dr. Bartlett) **Yes, through October 2000.**
Q. Are there any additions or corrections since this document was prepared?
A. (Dr. Bartlett) **Let me look at the publications, see if I'm writing anything here lately.**
No, I don't see any.
Q. On top of the first page of Exhibit 48 you list a number of areas of emphasis, as you call them.
A. (Dr. Bartlett) **Uh-huh.**
Q. Will you review those and tell me which of

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them do you believe to be relevant to the matters discussed in Basis or Section 3 of Contention L?
A. (Dr. Bartlett) **Area of emphasis: geotechnical engineering, earthquake engineering, geoenvironmental engineering, applied statistics, and project management.**
Q. Sorry; project management?
A. (Dr. Bartlett) **Project management, yes.**
Q. Would you explain for the record the distinction that you draw between your expertise in geotechnical engineering and your expertise in earthquake engineering?
A. (Dr. Bartlett) **Earthquake engineering can be a very broad multidisciplinary area. And here in the area of emphasis of earthquake engineering would be relating to geotechnical earthquake engineering.**
Q. How would that relate to what we've been talking about as Basis 3 of Contention L?
A. (Dr. Bartlett) **Many of the issues related to Contention L are geotechnical earthquake engineering issues.**
Q. I'm sorry. Now I got confused because you said geotechnical earthquake engineering.
A. (Dr. Bartlett) **Correct. I'm limiting my expertise in earthquake engineering to a specific area**

within earthquake engineering, and that would be geotechnical earthquake engineering. I do not want to imply that I have expertise in structural engineering related to earthquakes.
Q. Now, how about the distinction you draw, if any, between geotechnical earthquake engineering on the one hand and geotechnical engineering on the other?
A. (Dr. Bartlett) Geotechnical earthquake engineering would be a subdiscipline within geotechnical engineering relating to earthquakes and how the soil and other earth or geosystems respond to that.
Q. And the broader category of geotechnical engineering, what does that comprise?
A. (Dr. Bartlett) Civil engineering.
Q. Can you tell me more as to --
A. (Dr. Bartlett) Civil engineering?
Q. No. Civil engineering, but what portion of civil engineering is what you describe as geotechnical engineering?
A. (Dr. Bartlett) It's a subdiscipline of civil engineering.
Q. What is included within geotechnical engineering?
A. (Dr. Bartlett) Generally relates to issues with soil mechanics, soils and foundation design, though

it has broadened in recent years more into geoenvironmental issues.
MR. TRAVIESO-DIAZ: Can I have the answer read back?
(The record was read: "A. Generally relates to issues with soil mechanics, soils and foundation design, though it has broadened in recent years more into geoenvironmental issues.")
Q. (By Mr. Travieso-Diaz) Will you take a look now at the right-hand side of page 1 of Exhibit 48, which has the general heading of Professional Experience. And here -- you list here on that column that starts on page 1 and I believe goes on to the right side of page 2 and 3 --
A. (Dr. Bartlett) Correct. It's a double column format.
Q. Exactly. Referring to the right-hand side of the first few pages, could you tell me for which of the projects listed there did your work fall under the category of geotechnical engineering?
A. (Dr. Bartlett) I'll just list them by bolded topic there.
Q. Okay.
A. (Dr. Bartlett) I-15 Design-Build Team. Value Engineering and Design Team, and that was for the

University Parkway Interchange. Private Fuels Storage Facility, Kennecott Utah Copper Tailing Impoundment Modernization Project, Wasatch County Water Efficiency Project, Bear River Pipeline, Cainville, C-a-i-n-v-i-l-l-e, Dam Investigation. DMAD, all capitalized, and Gunnison Bend Dam Investigations. Seismic Retrofit of Salt Lake City Waste Water Treatment Plant. Hurricane Bridge Foundation Investigation. ITP/H-Area Tank Farm Geotechnical Investigation and Seismic Qualification.
One more page here. Review Team for the Seismic Design of the Defense Waste Processing Facility. Department of Energy Savannah River Site Hazardous Waste Landfill Closure. RCRA/CERCLA Investigations. UDOT Region 2 Preconstruction Materials Engineer. I carried an engineering title at that time; however, I had not completed my degree.
And I think we'll stop there.
Q. Okay. Can I ask you to do the same thing with respect to those projects involving what you characterize as geotechnical earthquake engineering?
A. (Dr. Bartlett) Fair enough. Or a significant component that involves that?
Q. Yes.
A. (Dr. Bartlett) I-15 Design-Build Team,

Private Fuels Storage Facility, Kennecott Utah Copper Tailing Impoundment Modernization Project, Bear River Pipeline DMAD and Gunnison Bend Dam Investigations, Seismic Retrofit of Salt Lake City Waste Water Treatment Plant, ITP/H-Area Tank Farm Geotechnical Investigations; Review Team for the Seismic Design of the Defense Waste Processing Facility. That would be all.
Q. Now, one last list.
A. (Dr. Bartlett) Sure.
Q. Which of the projects listed on these first three pages would you -- will be your opinion that involve issues analogous to the ones that are raised on Contention L, Basis 3?
A. (Dr. Bartlett) Second page. ITP/H-Area Tank Farm Geotechnical Investigation; Review Team for the Seismic Design of the Defense Waste Processing Facility. Those are the most germane.
Q. Would you identify for the record with respect to the ITP/H-Area Tank Farm Geotechnical Investigation, what issues were raised in that particular work that were analogous to the ones involved in Basis 3 of Contention L?
A. (Dr. Bartlett) Sure. The issues were raised by the Defense Nuclear -- Defense Nuclear Facility Safety Board, which is a governing --

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governing -- was an oversight body within the Department of Energy. Those issues related to design basis ground motion, characterization of strong ground motion, dynamic response, liquefaction, collapse of calcarious materials, and the response to the structures to those different natural phenomena.

Q. Could you do the same thing for the work involving the Review Team for the Seismic Design of the Defense Waste Processing Facility?

A. (Dr. Bartlett) This facility, the review of this was to look at the SAR that was presented for that facility. Many of the issues would be somewhat similar, at least for the natural phenomena. But it was not actively under review by the Defense Nuclear Facility Safety Board. However, management wanted a review of what had been done in the SAR to see -- the SAR was quite old -- to see what needed to be updated, what additional information may need to be included in it. A summary report was written.

Q. I take it that with respect to the work that you just mentioned for the review team, your involvement consisted of seeing what needed to be done to bring the SAR up to date?

A. (Dr. Bartlett) Correct, relating to the geotechnical part of the SAR -- the foundations,

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foundation design, earthquake.

Q. Did your work involve performing new analysis of the performance of the structures under seismic and other conditions?

A. (Dr. Bartlett) No, but there was some liquefaction analysis done.

Q. Liquefaction not being an issue of concern of PFS; is that correct?

A. (Dr. Bartlett) No.

Q. And for the ITP/H work, you talked about reviewing issues having to do with the design basis ground motion, dynamic responses and so on. What did your work consist of?

A. (Dr. Bartlett) I don't know if I would characterize myself as really reviewing all of these. I thought the intent of the question was to tell you what the project involved and the issues.

Q. Exactly. And my question now is, what did you do?

A. (Dr. Bartlett) Where did I fit into that puzzle?

Q. Exactly.

A. (Dr. Bartlett) I see. It was a multi-disciplinary team, several people involved, so it was broken up into a process. My part of the process

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was the lead geotechnical engineer for Westinghouse. I have to now start introducing company designations, because there were also cross-company lines. The primary companies involved at the Savannah River site was Westinghouse and Bechtel. However, there are various and a myriad of subcontractors. But those were the two prime, with Westinghouse acting as the prime operations contractor, Bechtel as a construction contractor.

The particular group that I was functioning in was both a combination of Bechtel and Westinghouse employees. On the Westinghouse side, I was the lead geotechnical engineer. I think the report probably identifies me as principal investigator. I can't really remember. But I was responsible in reviewing the subsurface data that were collected for the engineering analysis, suggesting any possible new -- new data that may be needed to support the characterization and analyses, and completing portions of the analyses or at least overseeing portions of the analyses, though there were many people doing the analyses. For Westinghouse but not for Bechtel.

Q. I understand. And when -- specifically, what did you review?

A. (Dr. Bartlett) Our document that we were

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generating was a geotechnical investigation document that pieces would be excerpted and put into the SAR. So we were preparing the geotechnical report that would be later edited and included pieces into the SAR. So most of our emphasis was in the ITP I believe H Tank Farm Geotechnical Report. I'm not sure of the exact title. Probably can find it in my references.

Q. So that there's a better understanding of what you were doing, at least by me: was there an existing SAR? Was this new work?

A. (Dr. Bartlett) This was a new facility, at least the ITP facility.

Q. So to analogize it somewhat to PFS, the work that you did will be analogous in some ways to the work that the applicant did in preparing the initial SAR?

A. (Dr. Bartlett) Yes. There was a slight difference here. At Savannah River the particular facility was already in operation or beginning, close to the beginning of operation. So we were then looking at seismic issues that had been raised by the Defense Nuclear Facility Safety Board and putting that into SAR format for their review.

Q. And I take it that your function was to look at those issues and see how they affected the new facility that was going to be built?

A. (Dr. Bartlett) It was already there. The investigations -- the facility already existed, so there were investigations around an existing facility to update the SAR because of issues raised by the Defense Nuclear Facility Safety Board. So it's different in PFS that the facility was already essentially constructed. So we were doing investigations in and around the periphery. There were basically four buried tanks.
Q. So I take it one distinction would be perhaps that, with respect to PFS, things still can be done to change --
A. (Dr. Bartlett) Correct.
Q. -- what hasn't been constructed, whereas there you already had the tank --
A. (Dr. Bartlett) We had to deal with the initial geotechnical investigations that had been completed and try to strategically place our investigation in a very congested area in a tank farm, high level waste tank farm.
Q. I don't know that I asked you this. If I did, I apologize. With respect to the other project that we were talking about a moment ago, which I believe is the --
A. (Dr. Bartlett) Defense waste processing.
Q. -- defense waste processing. What did you

do?
A. (Dr. Bartlett) Again, that was another facility that was already constructed, and the SAR was quite old and there was a need to update it both to newer DOE criteria. And the initial was to review the old SAR, see if there were any obvious things that needed to be further done to demonstrate whether this facility was safe or not. But because the SAR for that facility, as I recall, it was reasonably new, reasonably being within -- it was five years old or so. Most of our review was favorable, except for the design basis ground motion had increased somewhat and we wanted to see what the effect was on that. So I think we -- I alluded that we did some liquefaction calculations, as I recall.
Q. Can we go back to your resume, which is Exhibit 48, for a second, to the first page. I see that you list -- the first three projects that you list there, as I understand it, they relate to work for or on Interstate I-15.
A. (Dr. Bartlett) First three projects listed?
Q. On the right-hand column of page 1.
A. (Dr. Bartlett) No. Those are professional experience. Some of them are projects, some of them are actually listing positions that I've held. The top

bullet is the assistant professor, civil and environmental engineering. That's my current position. So I wouldn't characterize that as anything to do with I-15, other than we are performing continuing research on I-15 in my position at the university.
The second one, yes, has to do with I-15 research. The Federal Highways Administration has funded research for the I-15 project, and I prior to coming to the university had spent approximately two and a half years in UDOT research overseeing instrumentation, mainly going into different embankments and foundation systems to observe both their construction and long-term performance, and also overseeing and managing projects that other universities were doing. The others would be Utah State University, University of Utah, and Brigham Young University, and any of their research projects. I was managing and overseeing, facilitating their research.
The I-15 Design-Build Team is, yes, directly related to I-15, and at that time I was employed by Woodward-Clyde and was a designer for a geographical location within the project, basically from 8th South to 2100 South. So if there are any problems in that part of the interstate, come and see me.
And that included design foundation

treatments, ground modification, slope stability, settlement considerations, geofoam fills, liquefaction, seismic modeling of embankments, and MSE wall systems. And for the record, that means mechanically stabilized earth.
Q. And there was one more project which --
A. (Dr. Bartlett) Yes. That is I-15 related. It's down in Utah County. That is the main interchange going to Brigham Young University. And that's being designed internally by UDOT, and they formed a value engineering team. And because of my experience with the I-15 design here in Salt Lake County, they requested I perform the geotechnical assessments of that, or at least look at the value engineering, join the value engineering team for that.
Q. I think that these three projects or these three assignments are in reverse chronological order, meaning that the research project manager is the most recent one?
A. (Dr. Bartlett) Yes. This is listed most recent at top, and then everything in this list goes chronologically to earlier dates.
Q. Maybe we can pinpoint the dates better.
A. (Dr. Bartlett) Sure.
Q. The first one of them listed as research

project manager, what dates were those?
A. (Dr. Bartlett) January '98 to August 2000.
Q. And the second one?
A. (Dr. Bartlett) I-15 Design-Build Team. That was while I was with Woodward-Clyde, so trying to think. Probably January '97 to January '98. About a year there.
Q. And last one, the Value Engineering and Design?
A. (Dr. Bartlett) That is not in chronological order. Maybe some are, and some are maybe just in order of importance. I don't know. But that value engineering was done also while I was working as a research project manager for UDOT.
Q. So the dates will be --
A. (Dr. Bartlett) The dates that I was employed by UDOT are while I was participating on this. I can't remember. It was a two-week assignment or so. Probably sometime in early 1999.
Q. So this value engineering was a two-week assignment?
A. (Dr. Bartlett) Yes. It's not a long assignment to join a value engineering team.
Q. Let's try to understand a little better what you did on these projects.

A. (Dr. Bartlett) Sure.
Q. The work as research project manager.
A. (Dr. Bartlett) Uh-huh.
Q. What did it entail?
A. (Dr. Bartlett) Research project manager means managing contracts and the research associated with those contracts. In this case it was overseeing mainly I-15 research, overseeing contracts with Utah State University, University of Utah, and Brigham Young University. Though I did start an in-house study while I was there at UDOT, and so I was also functioning as a PI for an in-house study too.
Q. Would it be fair, then, to say that your work for this research project as research project manager was more in a managerial capacity as opposed to doing what I would call hands-on design?
A. (Dr. Bartlett) There were no design, but no, it would not be fair to completely characterize me as a project manager. I filled both roles as a project manager and also principal investigator of a fairly major study, which I am currently still the principal investigator on.
Q. What study was that?
A. (Dr. Bartlett) We call it our Innovative Embankment and Foundation Treatment Study. It's a

long-term study to look at both the construction and performance of several foundation systems installed on I-15.
Q. Going to the I-15 design-build team project, what did your work there entail?
A. There I was a lead designer for a particular geographical segment of the interstate, again from 8th South to 2100 South. Because I am and was at that time a licensed engineer, I was supervising staff engineers in the design calculations that were going to support the geotechnical design.
Q. Now, when you made the design calculations, what type of calculations did you do?
A. (Dr. Bartlett) Did I do or did my staff do?
Q. Well, either do or supervise.
A. (Dr. Bartlett) Okay, fair enough. What I supervised were stability calculations -- slope stability calculations, I should say. Bearing capacity calculations. Design calculations to determine what drain spacings. Surcharge heights, looking at general layout of surcharges. Wick drains. We did some calculations involving geofoam. I think those are the major ones.
Q. Maybe I can ask you, so the record is clear, what you mean by wick drains.

A. (Dr. Bartlett) More correct terminology now may be prefabricated vertical drains.
Q. And which would those be?
A. (Dr. Bartlett) Those are a geosynthetic product that are made to install into clays to accelerate their primary consolidation.
Q. Okay. One more on this line. On Value Engineering and Design Team, you said that was a two-week assignment?
A. (Dr. Bartlett) Yes.
Q. What did you do?
A. (Dr. Bartlett) Reviewed their conceptual design of how they wanted to essentially reconstruct the interchange. There were issues again relating to stability, consolidation settlement and liquefaction, and at that point we were making recommendations on kind of project approach and looking at their project approach. And it was a formal process. We made our value engineering recommendations on things that they may do and consider and passed them on as kind of a report, and was dismissed. It's required by the Federal Highway Administration.
Q. Earlier on when I asked you about which projects you felt were most germane, if you will, to the issues raised on Basis 3, you didn't list any list of

the I-15 activities. Was that an oversight, or is there a reason?
A. (Dr. Bartlett) No. Well, those that are still most closely to the process that PFS is following are still the two that I listed as my experience at Savannah River. However, some of these other projects, particularly if they're local, have given me considerable experience I think in the soils and soil behavior of this area. So in conjunction with maybe those that -- I guess I could say they're germane in the sense that they help me understand the behavior of these soils.
Q. Let me ask you perhaps a difficult question to answer. In which ways are they not germane to PFS, or how do they differ such that you cannot draw experience from I-15 to PFS?
MS. CHANCELLOR: I'm going to object. That's a little broad. That's so broad, I don't know how he can answer it.
Q. (By Mr. Travieso-Diaz) Well, you can give me a start, otherwise I'll rephrase it.
A. (Dr. Bartlett) Well, one was building a major road, and it's transportation related. There are similar analyses, but some of the analyses that we did may not be germane. One would be slope stability.

There are no significant slopes at this site, so slope stability would not be germane to this project. I do not believe you're using any wicks, so wick drain design is not germane. Nor are you using any mechanically stabilized earth walls, so I do not believe that's germane.
Q. Was there a difference in the nature of the soils in the I-15 segment you worked on with respect -- beside the PFS site?
A. (Dr. Bartlett) Yes. I-15 soils are generally saturated, whereas the PFS soils are unsaturated.
Q. And in terms of strength, are they softer soils than the ones at the PFS site?
A. (Dr. Bartlett) That's what I was trying to determine in my offhand -- the quick calculations that I was doing.
Q. All right. Since I brought it up, can I ask, what was your conclusion based on your hand calculation?
A. (Dr. Bartlett) Should we go through it point by point?
Q. Well, give me a general conclusion.
Actually, I'll tell you what. Since we have it here, let me produce it as Exhibit 49.

(Exhibit 49 marked.)
A. (Dr. Bartlett) I think when I was doing this, I was focused on what currently is referred to as layer 2 at the PFS site.
Q. What is now currently described as layer 2?
A. (Dr. Bartlett) Yeah, what is currently described as layer 2. So I was trying to again understand the undrained shear strength at the PFS site in layer 2. And I believe most of these correlations except for -- well, we'll see if there's any exceptions. But a lot of these correlations are coming from the Manual on Estimating Soil Properties for Foundation Design, published by the Electric Power Research Institute.
For SPT data, one can get a rough idea of undrained shear strength based on penetration resistance. It's probably the most crude way of doing it. And in that upper layer I guess I looked at some of the blow counts there, found some, about five, and went to this chart that you see for SPT data and said, based on this chart, one might expect values between .5 to 1 ksf.
Q. For the record, when you reference the Terzaghi and Peck, who are you talking about?
A. (Dr. Bartlett) Well, it's actually EPRI

Manual Table 4-10, which I guess is referencing the original authors of this relationship, which is Terzaghi and Peck. Which particular reference that is, I am not sure. It may be soil mechanics and engineering practice, but I'm guessing.
Q. And this is a table that is derived from that --
A. (Dr. Bartlett) From Terzaghi and Peck. EPRI is just I think referencing the original work.
Q. Can I ask you to tell me, based on this calculation, what your conclusion was with respect to the relative strength of the soils at PFS vis-a-vis those at I-15?
A. (Dr. Bartlett) Not sure I really was trying to compare the PFS soils against I-15 soil strengths. I was using my background and knowledge to look at what the PFS soils are. I have not gone back and looked at the -- compared PFS soils against I-15 soils.
Q. If I recall, the reason we got into this is because I asked you, are the soils at PFS stronger than those at I-15, and you answered, that's what I was trying to determine in the calculation that I did. So that's what I'm --
A. (Dr. Bartlett) Okay.
Q. Now that you have the calculation and you

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looked at it and you know what the soils at I-15 were like, do you have a view as to whether --
A. (Dr. Bartlett) **Well, it's difficult because the alignment's 17 miles long. So I'm not going to speak for 17 miles of alignment. I guess, based on my experience, it appears that the soils at PFS, based on the data that I have been given, appear to be a little stiffer at the site of PFS.**
Q. Stiffer than the ones at I-15?
A. (Dr. Bartlett) **That's correct.**
Q. You were talking about -- a moment ago about the various design activities that you did in the project for which you were responsible for a section of I-15. Do you recall those questions?
A. (Dr. Bartlett) **Yes.**
Q. Now you talk about things like wick drains designs and so on. As you were performing those designs, were you supported by the work of other people who were doing, for example, soils investigations?
A. (Dr. Bartlett) **Most certainly.**
Q. And that was a different group of people from the one that was doing the design?
A. (Dr. Bartlett) **No, it was the same group. It's just different people within the group that are doing it, different people within Woodward-Clyde.**

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Q. I understand. But there was a group of people whose function, if you will, was to do soils investigations and --
A. (Dr. Bartlett) **No. Let me tell you how the design-build process proceeded on I-15.**
Q. Okay.
A. (Dr. Bartlett) **It may help you understand this. UDOT took the policy that it would be difficult for, because of the rapid nature which this project had to proceed, that it would be not -- one could not do the geotechnical investigation as part of the design process. So they provided the geotechnical investigations as documents to the winner, the eventual winner of the project. They were given to us as geotechnical investigations. We did not control that at all. They were completed by several consultant firms throughout the valley. So there was a geotechnical investigation report, if you will. I believe we provided that to you on CD ROM.**
Q. And was that arrangement in which a group of people, however selected, did the investigative work and another group of people did the design, is that common in the projects you have been associated with?
MS. CHANCELLOR: Objection. I think you're mischaracterizing his testimony.

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MR. TRAVIESO-DIAZ: I'm sorry. If I mischaracterized it, I stand corrected.
Q. (By Mr. Travieso-Diaz) If I understood what you just testified, in this particular project the geotechnical work had been assigned to a group of people and the design work was assigned to your group of people. Is that correct?
A. (Dr. Bartlett) **No.**
Q. Okay. Please correct me.
A. (Dr. Bartlett) **The geotechnical data were provided to us prior to the start of the contract.**
Q. And that geotechnical data had been performed by some other consultant?
A. (Dr. Bartlett) **Several consultants. Now, we also collected our own, "we" being Woodward-Clyde and our joint firm who was with us doing the geotechnical design, Terracon, we performed even subsequent analyses to covering gaps and uncertainties that we felt in what the baseline geotechnical reports had been provided to us. Is that better?**
Q. That I think is clear, for me, anyhow. And my question again would be, is it still correct to say that a group of people led by you were performing design functions, such as designing wick drains, and a different group of people, either within the same

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organization or other group, was doing the soils investigations?
A. (Dr. Bartlett) **The only soils investigations that were done after the award of the contract to Woodward-Clyde were some done by Woodward-Clyde and Terracon. They were again to begin to develop the design basis, but once we got into design, we had no time to be doing investigations parallel with design. We had to design with the information that had been provided.**
Q. I understand now. And those investigations still were done by different -- even within Woodward-Clyde, a different group of engineers or geologists or whatever they're called at the time doing the investigation as opposed to you?
MS. CHANCELLOR: Objection. He's testified as to that it was -- well, I think you've mischaracterized his testimony.
Q. (By Mr. Travieso-Diaz) Again, if I mischaracterized you, I apologize. My understanding was that -- correct me if I'm wrong in this characterization -- that A, there have been geotechnical investigations that have been done by a different group of people altogether before you were assigned to the project. Am I right so far?

A. (Dr. Bartlett) Correct.
Q. And B, there was some additional geotechnical work that was done by Woodward-Clyde --
A. (Dr. Bartlett) And Terracon.
Q. -- and Terracon.
A. (Dr. Bartlett) Correct.
Q. And my question to you is, that work that was done by Woodward-Clyde and Terracon, was it performed by a different team, if you will, or group of people from the ones led by you that were doing the design?
A. (Dr. Bartlett) We're all one firm. I don't understand this team concept.
Q. Let me ask the question a different way. Were different people involved in performing those geotechnical investigations that Woodward-Clyde did from the people like yourself that were involved in doing the wick drain design and the other design activities?
A. (Dr. Bartlett) Sometimes the subsequent geotechnical investigations done by Terracon and Woodward-Clyde were done by employees within Woodward-Clyde who later became designers as part of the team. We were 24 geotechnical engineers, some of us doing investigations, some of us doing design. That's the best way I can characterize it.

My particular responsibility was not to oversee investigations for this project. It was a designer, to take the data that was provided and design with it.
Q. All right. Then my other question earlier on that perhaps I didn't phrase properly was, in your experience not only with respect to I-15 but to other projects, is it common to have different groups of people, organizations, or experts, if you will, who are primarily concerned with soils investigations and developing soils there different from the individuals who are engaged in performing the design, based on your general experience?
MS. CHANCELLOR: I'm going to object because you haven't defined -- you're asking him for specifics about a general area, projects. And the question is a little --
MR. TRAVIESO-DIAZ: I believe that the question was phrased based on his experience on the projects that he has worked on.
Q. (By Mr. Travieso-Diaz) And if I said otherwise, please consider the question to be limited to your personal experience.
A. (Dr. Bartlett) I've worked in both systems where somebody that is not the designer is collecting

the information. I've worked in small firms where I have gone out and collected the data and used it in design. It depends on the team, the complexity of the project, and the nature of the personnel at the time.
So I've seen both. My experience generally is I at least have a fairly responsible role in the data that have been collected if I'm going to use it for design, except for the I-15 project. But that's kind of an oddity because it was a contractual document provided to us, and we did do some subsequent design -- excuse me -- investigations. I was not personally overseeing those investigations within the firm at that time.
MR. TRAVIESO-DIAZ: Can we go off the record for a second?
(Discussion off the record.)
Q. (By Mr. Travieso-Diaz) In the projects that you described a moment ago with respect to your experience, have you performed or directed the performance of borings at sites for which construction activities will be conducted later?
A. (Dr. Bartlett) Please repeat the question.
(The pending question was read.)
A. (Dr. Bartlett) Which projects?
Q. Of the ones that you have been -- that you have in your resume.

A. (Dr. Bartlett) On my resume. Yes, I have.
Q. For what projects did you do that?
A. (Dr. Bartlett) Research project manager for I-15, as the PI of the embankment study I have directed drilling and subsurface installation of instrumentation.
I-15 Design-Build Team, not for investigations for determining soil properties, but I did direct the borings and installation of instrumentation to monitor construction performance.
Wasatch County Water Efficiency Project, both borings and test pits, directed them. I was later removed from that project to go to the I-15 team, so I didn't see it to its completion.
Bear River Pipeline, there were no drilling at that time. Cainville Dam Investigations did involve drilling and collection of data, and likewise DMAD and Gunnison Dams. Likewise for the seismic retrofit of the Salt Lake Waste Water Treatment Plant. There were also boring and subsurface investigations for the Hurricane Bridge Foundation, likewise for the ITP Tank Farm Geotechnical Investigation, likewise for the hazardous waste landfill closure at Savannah River, likewise for RCRA/CERCLA Investigations for the various hazardous waste areas listed there, though some of them are in different phases. We plan them. I left the RCRA/CERCLA

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Investigations group before maybe all of them were carried out, but at least planned them, and some had been implemented or installed.
I think that's it, for the most part.
Q. Will you describe for the record how borings are conducted, general process for which a boring is done?
A. (Dr. Bartlett) Talking about drilling process?
Q. Yes.
A. (Dr. Bartlett) Do you want to know just in general, or specific types of drilling? There are many types and ways of doing drilling.
Q. Well, why don't you just list for us the types of drillings there are.
A. (Dr. Bartlett) In this area we sometimes use hollow stem augering. We do also rotary wash, a rotary mud drilling. Coring, double barrel coring. That's probably the most that I've been involved in.
Q. Which of these different types of borings are conducted for the specific purpose of taking soil samples?
A. (Dr. Bartlett) Hollow stem augering and rotary mud drilling.
Q. For what other purposes are borings

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conducted in addition to taking soil samples?
A. (Dr. Bartlett) Installing monitoring devices. We use several downhole devices to monitor performance, monitoring wells, pump tests for determining aquifer parameters. We do borings for injection in wells in soils.
Q. Do you also do borings to take measurements of soil properties?
A. (Dr. Bartlett) There's a type of -- you do borings to install devices to make in situ measurements.
Q. And that's what you mean by installation of monitoring devices?
A. (Dr. Bartlett) Yes. Well, there are devices that you place to monitor maybe some type of performance that may or may not really give you a property, but there's also in situ tests that you can do that will give you specific type of engineering properties. Some are for monitoring deformation or some other parameter that you're concerned about. Others are specifically for gaining data for design.
Q. Do you know whether the applicant at the PFS facility conducted borings at the PFS site?
A. (Dr. Bartlett) Yes, they did.
Q. What kind of borings did they do?
A. (Dr. Bartlett) That I can't -- probably two

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types, either hollow stem or mud rotor.
Q. Did you review the manner in which the applicant conducted those borings to determine whether he was in conformance with applicable industry standards?
A. (Dr. Bartlett) Applicable industry standards is a fairly wide topic.
Q. Well, let me ask you the question another way, then. Did you review the way in which applicant conducted its borings at the site?
A. (Dr. Bartlett) Not extensively.
Q. So I take it you have no issues related to the way the borings themselves were conducted?
A. (Dr. Bartlett) We initially raised some issues regarding disturbance; but as far as the drilling procedure, did it yield disturbed samples, there is some indications in a few samples of disturbance, but some samples looked fine.
Q. So is it your view that there is a concern with respect to the way those undisturbed samples were taken or not, or what is the state of your view?
A. (Dr. Bartlett) Could you please repeat the question?
Q. Yes. I think it was not proper to -- not worded very artfully. Let me try it again. Do you

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currently have a concern with respect to the manner in which undisturbed samples were taken by PFS in the process of doing borings at the PFS site?
A. (Dr. Bartlett) This is difficult, because the undisturbed samples were done with Shelby tube sampling, and the amount of disturbance is always relative. Again, some samples do appear fine, others do show signs of disturbance. But it's impossible to complete a geotechnical investigation without introducing some disturbance.
We have found for the Bonneville clays in the Salt Lake Valley, where we were sampling them with Shelby tube samples below the water table, that we have introduced significant disturbance to the Shelby tube samples. When I say "we," that means studies that were done by Woodward-Clyde and Chuck Ladd from MIT who they had on retainer to look at these issues.
The PFS site has unsaturated soils, and I'm not sure I can extend my knowledge in this valley in saturated soils to the unsaturated soil condition.
Q. Are you saying perhaps that the adverse experiences that you related with respect to the soils collection in the valley might not be applicable to the PFS site because of the different type of soil?
A. (Dr. Bartlett) Repeat the question.

MR. TRAVIESO-DIAZ: Please read it.
(The pending question was read.)
A. (Dr. Bartlett) I wouldn't characterize them as adverse. We have just noted that the state of the practice is Shelby tube sampling in this valley, and the state of the practice as done by most of the geotechnical firms in this valley has produced some indications of disturbance in the Shelby tube samples. That is based on an assessment by Chuck Ladd using radiography and looking at the consolidation behavior data. Whether I can apply that to PFS is that, quote, adverse conditions, I would not call them. Whether I can apply that knowledge to PFS site or not, I cannot at this time. I do not have the data or information to do that.
Q. Have you reviewed the results of tests performed on samples taken at the PFS site to determine whether the samples exhibited evidence of having been disturbed in the process of sample collection?
A. (Dr. Bartlett) A cursory review, and some did.
Q. And I take it that some did not?
A. (Dr. Bartlett) And some did not.
Q. Did you further review the ones that did exhibit evidence of disturbance to determine whether

those that were used as inputs -- the test results as inputs into the design process?
A. (Dr. Bartlett) I think that was some of our line of questioning yesterday to try to discover that.
Q. And what information did you garner from the discussion yesterday?
A. (Dr. Bartlett) I can't remember. It was too long of a day.
Q. Let me ask you one more question.
A. (Dr. Bartlett) I would have to probably, to answer that question, go back to the specific tests. And that's what we were trying to understand better yesterday is how certain types of tests and borings and where the results were applied.
Q. But right now you don't recall where that discussion led you?
A. (Dr. Bartlett) No, I don't. I'd have to research it.
Q. All right. Now, you referred to the fact that somewhat disturbed samples that were taken in the valley were taken at locations below the water table. Is that correct?
A. (Dr. Bartlett) The Bonneville deposits in this valley are below water table. Well, I should qualify that, because my design segment does not

encompass the full valley, so there are parts of the Bonneville clays that are in parts of the design, part of the design segment that Terracon did that may be above water table. But my experience in this valley with the Bonneville sediments were below water table.
Q. Were any samples taken at PFS below the water table?
A. (Dr. Bartlett) Oh, no. Not in the Bonneville.
Q. At PFS, I said.
A. (Dr. Bartlett) Well, I think water tables down to 120 feet. I think it was initial issue about whether borings went down to that depth. I can't recall in subsequent investigations whether we went below the water table 120 feet. But if we did, there was only a few boreholes that did.
Q. As you recall now, and we may talk more about this later, were any of the samples for which you saw test results in the SAR taken from below the water table?
A. (Dr. Bartlett) No, not to my knowledge.
MR. TRAVIESO-DIAZ: All right. Can we go off the record again?
(Discussion off the record.)
Q. (By Mr. Travieso-Diaz) Have you performed

or directed the performance of what is referred to as cone penetration tests?
A. (Dr. Bartlett) Yes, I have.
Q. And would you describe for the record what cone penetration tests are and what their purpose is?
A. (Dr. Bartlett) Cone penetration test is another type of in situ test where we push essentially a device, a sensor shaped like a cone. It has pressure transducer to measure the pressure at the tip. It also measures the side friction at the sleeve. Cone penetrometer testing can also involve a piezo cone, which has a pore pressure transducer to measure pore pressure changes due to shearing. It's pushed from a, we call it a cone rig, and used to determine stratigraphy and other engineering correlations with it to determine properties.
Q. I should have asked the question in two parts. It would have been easier, because I have to ask you again now. What information typically is obtained by geotechnical analysts of the cone penetration tests?
A. (Dr. Bartlett) The base information that comes from the cone is the tip stress, sleeve stress, and pore pressure transducers. One can also get shear wave velocities from a seismic cone. Those are the base data that come from this type of device.

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Q. And what design information or soil property information do you get from tip stress and sleeve stress?
A. (Dr. Bartlett) There are numerous correlations to engineering properties from those values.
Q. And those are?
A. (Dr. Bartlett) Shear strength, consolidation parameters, moduli, density, shear wave velocity. Well, the shear wave velocity is really measured directly. Maybe even the time of day if you're lucky.
Q. I take it you think these are useful tests?
A. (Dr. Bartlett) I think the cone is a useful test. It is useful specifically for determining stratigraphy. One of the challenges a geotechnical engineer has is stratigraphy, and it gives us a good idea of the layering of the system, its relative strengths. When one begins to correlate engineering properties, you have to be careful. And a prudent investigation includes both cone penetrometer data and other types of testing to confirm what the cone penetrometer is telling us. I use it.
Q. Do you know whether applicant conducted cone penetration tests at PFS?

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A. (Dr. Bartlett) It did.
Q. Based on your review -- well, did you review the way in which they conducted those tests?
A. (Dr. Bartlett) Please repeat the question. I'm sorry.
Q. Did you examine or review the manner in which those tests were conducted?
A. (Dr. Bartlett) They were performed by ConeTec, which is a vendor here locally. They did it according to common ConeTec procedure. I've seen other ConeTec reports. I didn't review it in detail. But we've also used the same people, "we" meaning UDOT and Woodward-Clyde.
Q. Do you have any concerns about the manner in which the cone penetration tests were conducted by ConeTec for applicant in this job, by that meaning PFS?
A. (Dr. Bartlett) Not particularly. One issue we have had with ConeTec in other sites, and it's probably not that important here, is that pore pressure transducers, they tend to have a problem with keeping their porous stone in the cone tip saturated, and we've noticed that their pore pressure data may not be necessarily reliable.
Q. Have you observed the problem here at PFS?
A. (Dr. Bartlett) No, not as much, because

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we're again above the water table. Though in some clays there still could be enough saturation that we could generate some pore pressures. And I would just say that if I did have a problem with the cone penetrometer data by itself and not the correlations with it is that the pore pressure data may not be reliable for unsaturated soils.
Q. Specifically with respect to the cone penetration test data collected at PFS, do you have a concern about the pore pressure data collection? Have you observed anything --
A. (Dr. Bartlett) I have a general problem with pore pressure data collected by ConeTec, and specifically in unsaturated soils. Yes, I do. I do not believe the data is reliable.
Q. But with respect to the data on this particular parameter collected by ConeTec at PFS, did you review it to determine whether your general concern about ConeTec applies also to their work on this parameter of PFS?
A. (Dr. Bartlett) I didn't make that specific review. I guess I would have probably prejudged that data.
Q. All right, fair enough. You said a moment ago that a prudent investigator would supplement the

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cone penetration test data with other types of tests.
A. (Dr. Bartlett) Correct.
Q. Did the applicant do that at PFS?
A. (Dr. Bartlett) Not the way I would do it, but they did do other investigations, yes.
Q. Would you explain for the record how what they did differs from the way you would do it?
A. (Dr. Bartlett) Normally when I plan an investigation I like to involve the cone penetrometer first. In that way, I do know the layering, the significant layers involved, and have somewhat of an idea of their relative performances and strengths and compressibilities. That then means I have a clear picture of what I'm going to do now when I come in and drill and take samples, and I can focus my investigation.
Also, one objection I had with PFS's investigation -- well, first is that the cone was not used first, it was used later. And also that the boreholes were -- the data from where the cone was collected versus where the borehole information are too far apart really to do any meaningful correlations. My experience is I like to keep a borehole in a cone when I do do a parallel investigation generally within five to ten feet of each other.

Q. Let me see if I understand your -- the difference between the process that you favor and what PFS did.
A. (Dr. Bartlett) That's correct.
Q. The differences are, and please correct me if I'm wrong, first, that you would rather have done the cone penetration test first, and PFS did them last?
A. (Dr. Bartlett) They did them not last, but they did it somewhere in the middle of the investigation.
Q. And second, you have selected the boreholes to be close to the cone penetration locations?
A. (Dr. Bartlett) Correct, because what we are then trying to do is later gather samples from those borings and correlate the results from the cone penetrometer to the results of the undisturbed sampling, or whatever we're doing in the borehole. It's not just undisturbed sampling. And when we get too far apart spatially, then one cannot be confident that what we've seen in the cone penetrometer can be correlated directly with what's been observed in the borehole.
Q. As you recall, if you recall, how far apart were the cone penetration tests performed of PFS vis-a-vis the boreholes?
A. (Dr. Bartlett) Well, there's several cones

and several borings. May I --
Q. You can -- if you want to refresh your memory by looking at the SAR --
A. (Dr. Bartlett) I would appreciate that. Okay. This is out of the SAR. I just photocopied this. I forgot I had that stuck in the front of the folder there. I'm looking at Figure 2.6-29.
Does anybody have an engineering scale with them today?
Q. You're asking a lawyer for that?
A. (Dr. Bartlett) I can approximate it, if approximate numbers are fine. Just do it --
Q. Yes, just give us an approximation.
A. (Dr. Bartlett) One inch is about 200 feet. Okay, referring to this figure, we see the CPT done in a grid.
Q. For the record, the CPT is --
A. (Dr. Bartlett) The cone penetrometer tests were done in a grid.
Q. All right.
A. (Dr. Bartlett) Okay. C-1 and CPT 39, C-1 being a boring, CPT 39 being a cone penetrometer sounding symbols. It's hard to say what their proximity are to scale, but the symbols are touching each other. I don't know if they're right on top of each other. So

I don't know how close those are, but reasonably close there.
C-2, which is a boring, it's close to CPT, probably three quarters of an inch. So three quarters of 200 feet. Help me, Farhang, with my math. 150. 150 feet away, I consider that too far away to be any meaningful correlation there.
CPT 32 and A-3, a quarter of an inch times two hundred, so a quarter of 200 would be 50 feet. Again, probably too far away to really try to correlate the two data.
Boring B-3 and CPT 20, maybe an eighth of an inch, so 25 feet. That's hard to tell whether, you know, when you begin to speak about how far away do we need to be before we can correlate data, that's a subjective thing. But my experience is I like to get them reasonably close, five to ten feet, whatever operationally you can do in the field. So I'd say it's not as close as I'd like to see.
C-3 and CPT 8 are a little more than a half an inch, so they're probably 120 feet apart. That's probably too far to try to correlate those two if we were to try to correlate them.
The canister transfer building investigation is much more dense, and there I do see attempts to try

to do this pairing of boreholes and CPT's. And I'll leave it at that.
Q. Based on your review of this Figure 2.6-29 of the SAR, would it be your conclusion that there is no uniform spacing between the borings and the CPT -- and the CPT locations?
A. (Dr. Bartlett) Correct. It doesn't seem that they're -- it's not consistent. So I would assume the grid was overlaid, the old boring grid, and there wasn't really any attempt to try to put CPT's adjacent to the borings in the storage pad area. So where they fell close to each other was just circumstance. However, I would not say that about the canister transfer building.
Q. So the record's clear: the area in which there is a variability, if you will, in distance between the borings and the CPT test is the area where -- the pad emplacement area?
A. (Dr. Bartlett) That's correct.
Q. And there is no such problem with the canister transfer building area in that the two sets of measurements, if you will, are close to each other?
A. (Dr. Bartlett) Well, I do see CPT's reasonably close to boreholes, reasonably close being maybe within 25 feet. However, there are CPT's and

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boreholes that are further apart. So I think when we start to begin to discuss whether they are close enough or not, we need to get to specific examples.

Q. All right. One more question on this line, as follows. Is it then your testimony that for the area of the pad emplacement area, in some instances the boreholes are as close as you like to see them to the cone penetration tests, but in many instances they're not?

A. (Dr. Bartlett) In a few instances they are, and in some instances they're not, Correct.

Q. And the same testimony will apply to the canister transfer building except that perhaps the two sets of measurements are generally closer?

A. (Dr. Bartlett) Yes. It appears just from a couple that are closely spaced that there was an attempt to try to correlate between borehole and CPT data.

MR. TRAVIESO-DIAZ: It's 12:45. Should we break?

(Lunch Recess from 12:45 to 1:48 p.m.)

MR. TRAVIESO-DIAZ: Back on the record.

Q. (By Mr. Travieso-Diaz) Dr. Bartlett, before we continue with the questions we had before lunch, I want to go back to something that we talked about briefly, and I didn't quite get all the questions

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answered at the time.

Do you recall that we were talking about disturbed versus undisturbed samples?

A. (Dr. Bartlett) I remember undisturbed, but -- we talked about disturbance. I don't know if we ever talked about disturbed samples.

Q. Well, let me just -- if I recall the testimony, one of the differences that you mentioned between the I-15 work that you did and the soils -- and the PFS soils is that in the I-15 investigation you often had to contend or had to deal with the fact that some samples were disturbed.

A. (Dr. Bartlett) Okay. I understand the question now.

Q. And you said that in contradistinction when you worked with I-15, some samples at PFS appeared to have been disturbed and others were not.

A. (Dr. Bartlett) Appeared to show signs of disturbance, yes.

Q. Exactly. The two questions that I forgot to ask were the following. What is the significance of a sample being disturbed? Does it affect your ability to rely on it, on things like strength or, you know -- well, I'll leave it at that.

A. (Dr. Bartlett) If we're talking about

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disturbance in fine-grained soils, the effects of disturbance can make the results -- effects of disturbance -- or disturbance, let's not say effects. Disturbance can affect the shear strength and consolidation properties, yes.

Q. Does it mean that if you determine that a sample is disturbed, that you don't rely on the measured or the tested values for consideration for strength?

A. (Dr. Bartlett) I tend not to, yes, because of the disturbance.

Q. How can you tell? Can you tell by looking at the test results?

A. (Dr. Bartlett) You can. Sometimes it's somewhat qualitative. There are some times that you can look at it quantitatively somewhat. But it's relative disturbance. It's all samples. Even undisturbed samples show some minor signs of disturbance. But it's somewhat a judgment call about whether a disturbance is enough to really majorly affect the results.

MR. TRAVIESO-DIAZ: Let me mark for the record this document that I will identify as Exhibit 50.

(Exhibit 50 marked.)

Q. (By Mr. Travieso-Diaz) For the record, the document that I handed you consists of three plots which are included -- taken from Attachment 6 to Appendix 2A

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to the PFS SAR. And they are plots of -- the first one is of shear stress versus axial strain for sample -- from Boring CTB-1, and the sample was taken on 4/30/99, or the test was taken -- no, it was 4/30/99. The second one is again a plot of shear stress versus axial strain, and the sample is CTB-5, and it was taken 4/29/99.

A. (Dr. Bartlett) Uh-huh.

Q. And the third one is a sample of strain in percentage versus vertical stress, and that sample is from Boring CTB-N or CTB-N, dated 4/12/99.

Could you look at these two plots and, if you can, and I'm not implying you can't, but if you can, can you determine whether any of those samples appear to be disturbed or significantly disturbed?

A. (Dr. Bartlett) The first one, and again I'm speculating because we're dealing with a very complex soil here in the upper profile. But the first one seems to rise to a peak rather rapidly and then have a marked drop-off in the peak strength upon axial strain. This does not appear to me really disturbance. However, it does indicate somewhat of a brittle behavior to this soil. The cause of why it's brittle I can only speculate.

Q. But would you -- so would you characterize this sample --

A. (Dr. Bartlett) That is undisturbed.
Q. Undisturbed. Take a look at the second one now.
A. (Dr. Bartlett) The second one is definitely disturbed.
Q. Okay. And the third?
A. (Dr. Bartlett) This is a consolidation test. The other prior two were shear strength tests. And let's see. What depth are we? 8.6 feet, so we're fairly shallow in the profile. Effective stress is going to be well under -- ksf. It does not appear to be disturbed markedly. It looks reasonable.
Q. Now, just so the record identifies the samples correctly, the first sample was taken at a depth of 8.4 feet; is that correct?
A. (Dr. Bartlett) That's correct.
Q. The second was one was taken at 26.7 feet?
A. (Dr. Bartlett) That's correct.
Q. And the third one was taken at 8.6 feet?
A. (Dr. Bartlett) That's correct.
Q. All right. Now, going back to the conversation we were having before lunch, and if I recall, we were talking about how did they program for taking samples that was from PFS different from the way you would prefer the tests to be conducted?

A. (Dr. Bartlett) Can I do it by giving you an example?
Q. Yes. You were telling me two things. Correct me if I'm wrong. One, that the order in which the cone penetration tests and the borings were done at PFS is different from the way you had done it.
A. (Dr. Bartlett) Correct. My -- when allowed by a project manager, because sometimes people are under real constraints to -- no matter what project you're on, that if given full charge of an investigation, my tendencies would be to use the cone penetrometer first. And I think I explained the reasons why I would do that. Okay?
Then if some of my objectives then were to try to correlate data, if you so chose, then I would place the borings in close proximity -- close being five, no more than ten feet from where the cones -- if my goal was to try to correlate between CPT and borehole data. And that's just the way I have been taught and tend to do those things.
Q. Other than those two particular features that we just talked about, is there any other way in which the sampling process was done at PFS that's different than the way you would like to see it?
A. (Dr. Bartlett) That's a very broad

question, because we have several issues with the sampling program, and we may have to spend time going through the full contention, if you so choose.
Q. Well, more generally, we're talking about the way that the program -- we talk first about the process for doing borings.
A. (Dr. Bartlett) Yes.
Q. And then we talk about the process of doing cone penetration tests. And I asked you before lunch, and I was trying to get back on track here again, whether apart from those two differences in methodology, if you will, is there any other general difference not specific for a given test?
A. (Dr. Bartlett) I see somewhat of a grid pattern. I'm not saying that's not appropriate or inappropriate. But the grid here is quite large, and the spacings between the boreholes is quite large. And I'd say likewise for the cone penetrometer. However, I tend to space my cone penetrometer data a little further apart.
It seems to me that the borings were the lead investigative tool that was used initially on. And then the reason for the cone, as we heard yesterday, was somewhat in response to request for additional information by the NRC staff to go resolve specific

questions that they had.
I think one has to also consider depth of investigation. One thing that was not done at this site is the drillings were not done down to bedrock. It's ambiguous how depth -- the depth of bedrock and types of analyses especially involve ground response -- well, at least my frame of reference is the Savannah River. We drilled several hundreds of feet down to bedrock and characterized the soil column all the way from bedrock. That was not done here, so the boreholes were all relatively shallow. We do not have real deep, or at least one or two very deep borings. So that remains an area of uncertainty to me.
There's been no -- investigations are usually phased. And in each subsequent phase you have issues that you're trying to resolve and what you're trying to do in those, and I'm not sure I get a sense in reading the documentation why some things were being done and why they were doing additional borings and investigations, other than just to satisfy a few questions from the NRC.
Q. With respect to your observation that the borings and the cone penetration tests are often or sometimes too far apart to be able to correlate the data, what is the significance of the fact that you

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might not be able to correlate the data as you would like to?
A. (Dr. Bartlett) Well, we saw yesterday that cone penetrometer data were used to adjust the shear strengths for layer 4, and if you get too far apart between the data which you're trying to adjust, your adjustment factors may be meaningless.
Q. You're saying, if I understand you, and correct me if I'm wrong, that to the extent that you want to be able to refer to cone penetration test data, to adjust some of the information that you get from the boring data --
MS. CHANCELLOR: Objection. Is this a question?
MR. TRAVIESO-DIAZ: Yes. I'm getting there.
Q. (By Mr. Travieso-Diaz) You might not be able to do so because the two sets of measurements are too far apart?
A. (Dr. Bartlett) Yes, correct. Because there's lateral variability in this direction, and the further you get apart, the less the data are correlated. So you run the risk of essentially developing correlations upon which there are no -- they don't correlate. So in other words, part of your distance that you space boreholes, whether they be CPT or SPT, is

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fundamentally based on your understanding of how much you think the soils are variable, particularly in the lateral direction.
Q. So I take it that to the extent that this presents a problem, it's only if you're trying to correlate for some reason to assess the data. Is that fair?
A. (Dr. Bartlett) I may have to think about that. I'll answer this way. Yes, if your main premise or what you're trying do in an investigation is correlation. To me, it's obvious that they have to be very close or reasonably close. If you're using the two types of data to supplement one another, I can see cases where they would not necessarily have to be in close proximity to each other. However, one then has to go back and consider the density of both types of data, because they are different types of data, and whether you're putting in the appropriate number of borings and sampling to fully characterize the site.
Q. How many cone penetration tests in your practice do you typically correlate to a single boring? Is there any ratio or any way you correlated the measurements?
A. (Dr. Bartlett) If I'm trying to correlate?
Q. Yeah.

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A. (Dr. Bartlett) So you're asking how many paired boreholes, CPT and boreholes would I do in an investigation to develop correlations?
Q. Yes. One to one? One to two? I don't know. I'm trying to get a sense for how you do the correlation.
A. (Dr. Bartlett) Well, let's see if this answers your question. If my purpose is correlating data from a borehole, I would always have a CPT adjacent to it.
Q. And to the extent that you are trying to correlate cone penetration tests and boreholes, typically how many of those do you do?
A. (Dr. Bartlett) It depends on the size of the facility. So there's a density issue now; how many data do I need. And different agencies, whomever you're working for, have different somewhat suggestions. I won't call them requirements. It's usually still left up to the discretion. But they have densities that they suggest to you.
Q. Is there any -- talking about agency requirements, is there any NRC guidance or regulations that control the spacing of the placement of boreholes?
A. (Dr. Bartlett) Yes, they are.
Q. Where would those be?

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A. (Dr. Bartlett) I believe they are found in Reg Guide 1.132, Appendix C, I believe.
Q. Did you review Appendix C or Reg Guide 1.132 to determine whether the program that was put in place at PFS comply with the requirements of that appendix?
A. (Dr. Bartlett) Yes, I did.
Q. And what was your conclusion?
A. (Dr. Bartlett) They did not.
Q. In which respect?
A. (Dr. Bartlett) There were not enough boreholes. May I qualify that?
Q. Okay.
A. (Dr. Bartlett) For the pad emplacement area. I'm not sure I would make that statement about the canister transfer building right now. I'd have to, again, look at the -- count the borings again in that footprint.
Q. So you're not sure?
A. (Dr. Bartlett) Right. And the reason I'm not sure is because when we divide -- when we split this project team up to do the review, I really primarily looked at the storage pad -- or emplacement pad area, excuse me, and Dr. Ostadan looked more at the canister transfer building. However, I have looked at the laboratory testing and boreholes from both areas.

Q. May I refer to Dr. Ostadan. Don't think I'm forgetting you. In your review of the canister transfer building, did you develop a view as to whether the number of boreholes that were drilled or that were done by PFS complies with Reg Guide 1.132?
A. (Dr. Ostadan) I did not specifically review the investigation performed for the canister transfer building to see whether it's in compliance with the NRC guidelines or not.
Q. Okay. Let's move to something else.
A. (Dr. Bartlett) Sure.
Q. I take it, as we discussed before, that one of the purposes of drilling boreholes is to take samples for later testing in the laboratory?
A. (Dr. Bartlett) Yes.
Q. And I take it that you have in fact gone through the process of first collecting samples and then having tested them or having them tested?
A. (Dr. Bartlett) Generally having them tested, because most of my commercial experience we did not have our own on-site laboratories. Those were sent to either others in the firm or laboratories which we were contracted with. But yes, I have taken samples to submit them for laboratory testing.
Q. What kinds of tests are typically run with

soil samples taken from projects such as the ones you have been involved with?
A. (Dr. Bartlett) What types of tests or samples?
Q. No. No. What type of tests are conducted in the laboratory with respect to samples taken from borings?
A. (Dr. Bartlett) Shear strength tests, consolidation tests, general Atterberg and classification tests. Once in a while permeability testing.
Q. Has, to your knowledge, applicant performed tests on samples taken from borings on the PFS site?
A. (Dr. Bartlett) Yes, they have.
Q. What kind of tests did they run?
A. (Dr. Bartlett) Regarding shear strength, to my knowledge, they've performed unconsolidated-undrained, UU tests; consolidated-undrained; direct shear. I believe that's all I recall as far as shear strength testing. Consolidation testing, and the oedometer, o-e-d-o-m-e-t-e-r. And then again typical classification tests that we would do -- moisture contents, Atterberg limits, those type of routine tests.
Q. In terms of the kinds of tests that the applicant performed, was there any category of tests

that they failed to perform that you wish they had?
A. (Dr. Bartlett) Restricting ourselves to laboratory testing, correct?
Q. Yes, restricting ourselves to laboratory testing for the moment.
A. (Dr. Bartlett) Okay. Yeah, I think a direct simple shear test. Some of that might be useful instead of the direct shear. Also strain controlled triaxial testing, cyclic triaxial testing.
Q. Why do you feel that they should have done strain controlled triaxial tests?
A. (Dr. Bartlett) We have issues with degradation, degrading of the strength and modulus of some of these soils at the level of strains that we see that have been produced by the earthquake. And really we cannot assess whether those degradations are real or not, because the type of testing they perform doesn't really lead us any. They performed --
I'm not sure quite what I said. Can I start again?
Q. Sure.
A. (Dr. Bartlett) Okay. Let me focus on first the direct simple shear test.
Q. Okay.
A. (Dr. Bartlett) The direct simple shear test

does not allow really any strain concentrations along one predefined plane. So it may give us a better indication of what the shear strength is across the entire sample. The direct shear test which was performed by the applicant tends to concentrate stresses on one predefined failure plane.
Now on to the strain controlled cyclic triaxial tests. Those would give us a better idea, or an idea, really, of how the stiffness or modulus and the strength may degrade or behave at the levels of strain that we see from the shake analysis.
A. (Dr. Ostadan) May I add to that?
Q. Yes, please.
A. (Dr. Ostadan) One of the points raised in Contention L was the soil properties used to take into account soil linearity or the so-called soil curves or generic curves. I have not seen in the package, in the calculation any laboratory data that was developed in order to come out with the site specific soil curves.
Q. Let me clarify your answer to make sure that you're saying what I understand you to be saying. Are you saying, Dr. Ostadan, that there is no data developed in the laboratory for specific soil properties for the PFS site?
A. (Dr. Ostadan) No, I'm not saying that.

Q. Or are you restricting yourself to a particular type of soil test?
A. (Dr. Ostadan) I'm restricting myself to a particular soil test. You asked -- your question was, what other tests should have been done in the laboratory. And my answer to that, in addition to what Dr. Bartlett said, is that cyclic triaxial tests could have been done to develop site specific soil curves as is stated in the Contention L.
Q. Is it your testimony that they did not conduct cyclic triaxial tests?
A. (Dr. Ostadan) They did not conduct cyclic triaxial tests to develop soil curves.
Q. I need you to explain the second part of the answer. What do you mean by "to develop soil curves"?
A. (Dr. Ostadan) Soil curves are used primarily in a ground response analysis, such as those done by the applicant here using computer program Shake, S-h-a-k-e. As shown in the calculation currently, the curves are generic curves, published in the literature.
Q. When you say that they should have run cyclic triaxial tests to develop soil curves, what would those curves be? Of what? In other words, how would you be plotting the curves?
A. (Dr. Ostadan) The curve have two branches,

actually. There are two types of information present in these curves. One is shear modulus of the soil and the function of shear strength, and it's in a linear curve that shows degradation of the stiffness versus the strain.
The second piece of the information is the soil material damping as a function of shear strength that generally shows an increase of damping versus strain.
Q. And your testimony is that these type of tests for the purpose of developing this type of curves were not done?
A. (Dr. Ostadan) Yes.
A. (Dr. Bartlett) May I add to my testimony?
Q. Please.
A. (Dr. Bartlett) One other test that we discussed a little bit yesterday is the types of triaxial testing that were done were all in compression. I believe also in helping to understand maybe the part of the failure surface that we look at when we look at general bearing capacity that's in -- it actually goes into extension. So the triaxial extension test too would appear to be appropriate for parts of that failure surface.
Q. So your testimony is that in addition to the

triaxial tests that they did in compression --
A. (Dr. Bartlett) Right.
Q. -- they should have done a similar test that was in extension as opposed to compression?
A. (Dr. Bartlett) Correct. And I would also add that we would -- we see a conceptual design of a soil mat that we need to also, instead of seeing compression of that soil cement, we also need to understand its behavior and tension. So we need tensile tests done on the proposed design of this soil cement mat.
Q. Let me ask you the following question. The simple shear test that you mentioned before, are these commonly performed in the industry? And we're talking about any of these tests, starting with the simple shear tests, specialized tests.
A. (Dr. Bartlett) The direct simple shear test, I'm not sure I could call it specialized, but it may be hard to find from a small commercial geotechnical laboratory. Larger laboratories in a fair amount of universities can perform these type of tests.
Q. Have you done any of these yourself in your program?
A. (Dr. Bartlett) I have not.
Q. How about the triaxial extension tests or

triaxial tests to measure extension? Are those commonly done in the industry, or are they sort of specialized?
A. (Dr. Bartlett) The apparatus can be made to do compression or extension. It doesn't matter.
Q. So it can be done with the same --
A. (Dr. Bartlett) It can be done, sure.
Q. All right. Have you done any such extension tests in the projects that you worked on?
A. (Dr. Bartlett) No, I stated earlier that I haven't worked in a geotechnical laboratory. Most of my career, those types of tests have been sent out. They were done for the I-15 project, yes.
Q. Any other projects that they were done for?
A. (Dr. Bartlett) Not that I recall. They were done specifically for the I-15 project to address the anisotropy in the Bonneville clay.
I take that back. I have been associated with the project, it's called the Kennecott Utah Copper Tailings Impoundment Modernization Project. Though my piece of that project was not to do stability analyses, I was involved in doing seepage analyses for that particular project. There were also triaxial extension tests performed.
Q. What type of information do you derive from those triaxial extension tests?

A. (Dr. Bartlett) The general shear failure surface is a curved envelope. So as that envelope changes its geometry or position, it puts the soil here -- right here underneath the foundation in compression. Here, then there's more of a shearing that's represented more like the direct simple shear failure mode. And then when we go up to near the surface and outward, the failure surface would daylight away from the building, and that puts the soil in extension, not compression. So we try to mimic through our testing program the different modes of failure throughout the failure plane.
Q. For what elements or what portions of your design do you seek these various types of information? Is it for bearing capacity or --
A. (Dr. Bartlett) Bearing capacity and slope stability is what I've used it for.
Q. You wouldn't need to do that for slope stability?
A. (Dr. Bartlett) You wouldn't have to do it at this site, but in general, yes, we did it for slope stability and bearing capacity.
Q. We were talking laboratory tests, and I needed to ask you, what source of in situ tests are typically performed in projects of the type that you're

involved with?
A. (Dr. Bartlett) Okay, at least I'll give you some that I've had some experience with. Besides the cone penetrometer, I think we could call that an in situ type of test. The dilatometer, the pressure meter. I guess we could call the vein shear test an in situ test. And I've done some permeability testing that are borehole types or in situ testing, but I'm not sure that those are particularly germane here.
Q. Now, which of these in situ tests were performed by applicant in its investigations of the PFS site?
A. (Dr. Bartlett) The cone penetrometer, the dilatometer, to the best of my knowledge.
Q. Is there any in situ tests that they did not perform that you wish they had?
A. (Dr. Bartlett) I haven't really looked at the dilatometer data. In some cases maybe pressure meter data might be as valuable, but at this point, no, I have no really strong feelings towards that.
A. (Dr. Ostadan) Can I add to that?
A. (Dr. Bartlett) Sure.
A. (Dr. Ostadan) After completion of the cone program, the layering at the site was revised from a two-layer system as was originally perceived, especially

for 30 feet, to a four-layer system.
The seismic refraction test, which is a field test that were performed, predates the seismic cone program. I think it would be prudent to attempt to do a seismic refraction, recognizing the four layers as they have been edicted now, in order to develop shear wave velocity profile in the upper layer across the site to recognize the variations of the shear wave velocity in the lateral direction for dynamic analysis.
A. (Dr. Bartlett) May I add to my testimony?
Q. Please.
A. (Dr. Bartlett) Dr. Ostadan jogged my memory about dynamic properties.
We mentioned -- I mentioned earlier this morning that characterization maybe in -- of a deep hole, and in other projects we've used a down-hole suspension logger to characterize deep shear wave velocities and found that type of data quite reliable and useful. So I guess another in situ testing would be suspension logging to get P- and S-wave losses in a deep hole.
Q. And is this a test that the applicant did not do?
A. (Dr. Bartlett) No, they did not do a deep hole suspension logging test.

Q. Again, what type of information do you feel that they failed to obtain that they would have gotten had they done all of these tests?
A. (Dr. Bartlett) Shear wave velocities for the deeper layers from a down-hole type of method. They used surface geophysical methods.
Q. Are you testifying that they obtained the data using a different methodology, different means?
A. (Dr. Bartlett) I am not going to testify on that, because that's really out of my area that I reviewed. I'm just thinking from a geotechnical perspective that quite often we develop ground motions up through a soil column, and one of the useful tools that we have found in the past is a suspension logger.
Q. You're not testifying as to whether what they did was adequate for the purpose of determining shear wave velocities?
A. (Dr. Bartlett) Not for -- no, that's out of my area. I choose not to.
Q. Okay. Let's talk very briefly about, as opposed to the tests that were done, the manner in which those tests that were done were conducted.
A. (Dr. Bartlett) Sure.
Q. Do you have any concerns or reservations with respect to the way that the applicant did those

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laboratory tests that you listed as they have been done?
A. (Dr. Bartlett) So we're talking about specifically the way the test was conducted?
Q. Right.
A. (Dr. Bartlett) One issue we raised yesterday a little bit about is being careful to not allow the sample to dry out. The reason why we're concerned about this, these are partially saturated soils, and any changes in moisture content can affect the shear strength, can raise the shear strength.
When we reviewed the direct shear, I was concerned about a sample being consolidated for -- or left for 90 minutes under consolidation weight before it was sheared. It seems like that the consolidation was done within a few minutes. We should have just went ahead and sheared it.
We cannot really determine the effect of that because we don't know, you know, whether there was really significant changes in the moisture content or not. But I would think that may have to be re-evaluated in partially saturated soils to make sure that we do not do anything to allow these soils to change moisture content.
There was some initial confusion I think at the beginning of the review of some of the first

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versions of the SAR about wetting, when we should wet, when we shouldn't, when we were looking at collapsible soils. But I think subsequent RAI's kind of cleared up what was going on with wetting and inundation and those type of things.
It would be nice to be able to measure matrix suction, but it's a difficult thing to do. These are unsaturated soils, and it would be nice to know what are those capillary stresses that are in these unsaturated soils, because these soils upon any changes in moisture content could be sensitive to that. Though I haven't had a lot of familiarity with that type of testing, either.
Do you wish to add anything?
A. (Dr. Ostadan) But maybe as a reminder, one point that was discussed yesterday was the concern about loss of moisture for the samples that was there over two years. And your question was, I believe, what difference you would have liked to see in the way the lab test was conducted. I would have gone out to take fresh samples and tested them.
Q. Do either of you -- I know that both of you have expressed a concern about the possibility that the samples may have lost moisture while they were waiting to be tested.

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A. (Dr. Bartlett) Correct.
Q. Apart from having a concern, does either of you have any evidence that would lead you to believe that that in fact occurred?
A. (Dr. Bartlett) We do not. But there are really, from what we understood yesterday, no data collected to prove either yes or no. So it's inconclusive.
Q. I recall that the testimony that I believe it was Mr. Trudeau gave yesterday was to the effect that these samples were sealed.
A. (Dr. Bartlett) Correct.
Q. Were kept sealed. Is that to you sufficient protection against the possibility of losing moisture?
A. (Dr. Bartlett) No. Seals can, especially after two and a half years in a laboratory, not be good, and there is a potential for drying out. I guess we can speculate whether they did or didn't; but in my common practice, to allow a sample to sit for two and a half years before I test it seems a long time. And the chance for drying or -- is increased just because of that long duration.
Q. With respect to your concern about the 90-minute wait before the actual shearing testing --
A. (Dr. Bartlett) Correct.

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Q. -- Do you -- are the concerns, again, what? That you may lose moisture while you are waiting those 90 minutes?
A. (Dr. Bartlett) Correct. I don't know if the shear box -- it's not airtight, and so it -- the samples are fairly thin, and if left for prolonged times, they can begin to dry out.
Q. Again, to both of you, aside from the concern that this may have happened, do you have any evidence that it did happen?
A. (Dr. Bartlett) We do not, other than the concern to not wait so long before one shears.
Q. I understand. One type of test that I heard mentioned yesterday that neither of you has referred to is resonant column tests. Is that a type of test you normally do in your soils work?
A. (Dr. Bartlett) Depends on the facility and the nature of what's going on. Resonant column testing -- and I'll defer to Dr. Ostadan; I'm going to just speak very briefly -- is done to develop the dynamic properties. And in some projects particularly that we've been involved in the past that involved nuclear safety issues, those types of tests have been done for those sites. If I'm doing a design that may not require nuclear safety issues, maybe one may not

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choose to do that type of test. So I guess it depends on the safety issues and the complexity of the project.
Q. Have you done that type of test in the projects that you have been involved with?
A. (Dr. Bartlett) Yes, we have done that.
Q. Which projects?
A. (Dr. Bartlett) The Savannah River site, the ITP project.
Q. And that was an NRC --
A. (Dr. Bartlett) That was DOE.
Q. DOE, I'm sorry. Yes. And did the applicant do resonance column tests?
A. (Dr. Bartlett) We were the applicant.
Q. I'm sorry. I'm switching horses on you. I apologize. I'm talking about PFS, did the applicant do residence column tests?
A. (Dr. Bartlett) Yes.
Q. And are these lab tests or in situ tests?
A. (Dr. Bartlett) They're lab tests.
Q. Okay. That wasn't clear. And do you have any concern about the way in which applicant did their resonant column test?
A. (Dr. Bartlett) I'm not an expert on the resonant column test.
Q. How about you, Dr. Ostadan?

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A. (Dr. Ostadan) I did not study the lab results, but I can state that those tests and those results were not used, and they were looking at the site specific soil curves for shake analysis.
Q. What is your understanding of the use to which the results of those tests were put?
A. (Dr. Bartlett) I'll speak first, and then he may add to that. As far as we can see, the results of the resonant column tests were not applied.
Q. You were talking a moment ago about NRC type projects, and that jogged my memory to ask you, has any of the -- have any of the projects that you have been involved with other than PFS been for a project that was performed under NRC supervision or jurisdiction?
A. (Dr. Bartlett) No, not under NRC supervision or direction.
Q. Did you seek to familiarize yourself with what the NRC requirements would be that would govern this -- the geotechnical work of PFS?
A. (Dr. Bartlett) Yes, at least as cited by the applicant in the documents, wherever they were. At least in my area of review, I would look at what was being cited and stated. While at the Savannah River site, though, we did not fall under NRC jurisdiction. We would also look at NRC Reg Guides and standard review

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plans in helping prepare our SARs. So yes, some five years ago I did look at those types of Reg Guides, 1.132, 1.138.
Q. And for purposes of familiarizing yourself with the NRC regulations that might apply or would apply to PFS, what do you do? How do you go about familiarizing yourself with those regulations?
A. (Dr. Bartlett) Well, the first approach I had is, as I read the SAR or places where either those guidelines were -- not guidelines -- where things were being cited from the NRC Reg Guides, that I would review that portion that's being cited to see its context in what is going on. My reading of 1.132 and 1.138, I have read probably a year and a half ago. I guess I don't really tend to refer to the guides until I have specific reasons for doing so. I find them -- that they have a lot of detail, and the best thing to do is when -- go to them for specific issues.
Q. Do you try to find out, for example, how Reg Guide 1.132 has been applied by NRC in other projects in which geotechnical issues to which the Reg Guide applied may have been used?
A. (Dr. Bartlett) I haven't had any involvements in -- for any other NRC projects, so I don't know how I could do that.

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Q. Did you try to research the available materials from the NRC to determine, for example, if there was another ISFSI in which soils investigations were going by 1.132, how the NRC applied that regulation to that particular facility?
A. (Dr. Bartlett) I have not done that.
Q. Okay. Can you address that?
A. (Dr. Ostadan) Well, I can recall based on experience one issue that surfaced a number of times in dealing with the NRC, that is, the density of boring and sampling. If I recall correctly, Reg Guide 1.134 calls for one boring for every 10,000 square feet. And this is a guide. And following behind this guide, I need to have good justification and be able to present a set of coherent and consistent data that justify additional boring were not needed.
Q. Did either of you undertake to determine whether the borings that we're doing at PFS comply with this guidance of one every 10,000 square feet?
A. (Dr. Bartlett) We answered that earlier.
Q. And the answer was --
A. (Dr. Bartlett) My evaluation for the pad emplacement area showed that they do not meet the requirement.
Q. They are spaced farther apart?

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A. **(Dr. Bartlett) They're spaced farther apart. The density of number of borings does not meet in compliance with that. We deferred I think our decision on that for the canister transfer building. I have to kind of look at that.**

Q. And as far as you recall from your review of the materials with respect to the license of PFS, has the NRC raised a concern with respect to the spacing of boreholes for PFS?

MS. CHANCELLOR: Objection. You're asking him to speculate about what NRC has done.

MR. TRAVIESO-DIAZ: Well, he has reviewed these materials. He testified he did. My only question is whether he has any recollection of the NRC raising this as an issue.

MS. CHANCELLOR: He can answer it to the extent that he knows.

A. **(Dr. Bartlett) I do not remember.**

Q. All right. You said that you reviewed the NRC regulations that were cited in SAR. I believe you said that. That is correct?

A. **(Dr. Bartlett) Yes, for the parts of the SAR that I reviewed.**

Q. Did you undertake to review other NRC regulations that might apply that were not in the SAR?

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A. **(Dr. Ostadan) Let me answer that while you're thinking. I did, several of the NRC documents that relates to my area of expertise. And I, unfortunately, cannot be specific with the SRP number. It's either 371 or 372, in which NRC specifically states that when you have a site with a thin, soft layer on the top, the design motion should be specified on top of the competence soil layer, and I believe this is the case here.**

Q. Any other NRC regulations that you reviewed apart from the ones that are specifically called for in the SAR?

A. **(Dr. Ostadan) I cannot recall.**

Q. Dr. Bartlett, let's go back to Exhibit 3.

A. **(Dr. Bartlett) Sure.**

Q. Exhibit 3 was -- we talked about earlier.

MR. TRAVIESO-DIAZ: So that you understand, I didn't ask the reporter to mark it because it's already in evidence, and it was put in the first day of the deposition.

MS. CHANCELLOR: But Dr. Ostadan has marked up that exhibit. He's made in some pencil marks on it.

MR. TRAVIESO-DIAZ: The copy that I have is mine.

MR. BARTLETT: This is mine. I've got it.

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MS. CHANCELLOR: Okay.

Q. (By Mr. Travieso-Diaz) Let's look at page 83, and first look at the paragraph following the caption 3, "Characterization of subsurface soils."

A. **(Dr. Bartlett) Uh-huh.**

Q. Do you have that?

A. **(Dr. Bartlett) Yes, I do.**

Q. Now, this paragraph indicates that "Perhaps the most significant shortcoming in the license application and SAR is the lack of any rigorous and detailed investigation of subsurface conditions that would be appropriate for any nuclear facility. The level of investigations presented is more typical of very preliminary studies for site screening efforts and not a detailed determination of site suitability for establishing design parameters."

A. **(Dr. Bartlett) Correct.**

Q. Now, in light of the work that you testified that the applicant has done since this paragraph was written in 1997, do you believe it still to be accurate?

A. **(Dr. Bartlett) Yes, we still have significant issues about the details of investigations that have been done for this facility.**

Q. All right. Let me hand over to you -- again, this has already been introduced as an exhibit.

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And for the record, I will identify this as Exhibit 6, and it is the Safety Evaluation Report concerning the Private Fuel Storage facility, Docket Number 72-22.

A. **(Dr. Bartlett) Uh-huh.**

Q. I believe this document was prepared in October 1999, although it doesn't have a date. You testified earlier that you did review this document; is that correct?

A. **(Dr. Bartlett) Yes. My review was just dealing with the issues with Contention L, so I have not gone all the way through the document.**

Q. I'm sorry. I mischaracterized the document. For the record, I need to clarify it. This document that you have is not the totality of the Safety Evaluation Report prepared by NRC. It's only that portion of the SER that deals with geology and seismology, as you can see from the fifth page in the document which has the number 2-24.

A. **(Dr. Bartlett) Correct.**

Q. With that clarification, would this have been the portion of the SER that you reviewed?

A. **(Dr. Bartlett) Portions of what I've been handed I have reviewed, yes.**

Q. So you didn't review the entire --

A. **(Dr. Bartlett) No, I did not. Some of**

these areas are outside my expertise.
Q. Now, we were talking -- please turn to page 2-24.
A. (Dr. Bartlett) 2-24, okay. 2-24.
Q. Yeah, 2-24 is the fifth page in the exhibit. And now, I believe that there is a number of bullets on page 2-24 that go on through 2-25 and perhaps to the top of 2-26 that appear to be a listing of various applicable NRC regulatory requirements.
A. (Dr. Bartlett) I see they're mostly in 10 CFR 72, yes.
Q. Are you familiar with any of these requirements? I don't believe you cited them before.
A. (Dr. Bartlett) I have a copy of 10 CFR 72. I had referred to it a couple times in the SAR. At least in my portions where it was quoted, I went and looked at the appropriate -- in the SAR. I have not done the same for the SER.
Q. Well, but my question was with respect to the specific regulations listed on these three pages. Starting with 10 CFR 72.90(A), did you review that particular regulation?
A. (Dr. Bartlett) Not recently, no. I don't know if I have. I did read 10 CFR 72 some time ago.
Q. And in your review of the applicant's work

on the geotechnical work at the PFS, did you try to compare what they have done versus the items listed on these two pages to see if the work appears to you to comply with the requirements?
A. (Dr. Bartlett) No, my major --
MS. CHANCELLOR: Objection. Calls for a legal conclusion.
MR. TRAVIESO-DIAZ: I'm asking whether he did it, not what the results of his review were.
A. (Dr. Bartlett) So you're asking me, did I go through bullet by bullet?
Q. No, no. My question is, in your review of the applicant's work, did you seek to compare what they did versus whatever these various regulations say to determine whether the work that was done was in compliance?
MS. CHANCELLOR: Objection. Again you're asking for a legal conclusion --
MR. TRAVIESO-DIAZ: No, I'm asking --
MS. CHANCELLOR: -- whether it was in compliance with the regulations.
MR. TRAVIESO-DIAZ: I asked him and I'll ask him again, and I believe it's a proper question, whether he did try to do a comparison to do what the applicant did on what the regulation calls for.

MS. CHANCELLOR: Your question was whether he believe that the applicant was in compliance with the regulation.
MR. TRAVIESO-DIAZ: Excuse me. Let me ask the question one more time.
My question was to him, did he review the work that the applicant did versus the regulations in an effort to determine whether they complied or not. The answer is either yes or no. He reviewed it or didn't. That's all I'm asking him.
A. (Dr. Bartlett) At what time frame?
Q. Well, you had have been working on this since 1999. From then to now.
A. (Dr. Bartlett) Right. So there were times during the review that I would refer to 10 CFR 72 to compare pieces. Have I gone through this exhaustive list, no.
Q. And did you in preparing for this deposition try to look at the work that applicant has done and relate it to and try to compare it to the items on these pages?
A. (Dr. Bartlett) No, not the items on these pages.
Q. Will you turn to page 2-46. That is like halfway through this document, maybe two-thirds of the

way through. And this page contains a section that has the caption 2.1.64.
A. (Dr. Bartlett) Correct.
Q. Titled "Stability of subsurface materials."
A. (Dr. Bartlett) Correct.
Q. Okay. Within the page there is a section with no number that is entitled "Geotechnical site characterization." Do you see that?
A. (Dr. Bartlett) I do.
Q. Now, in the first paragraph of that section, the NRC writes, "Geotechnical characterization of the site was performed through a combination of field and laboratory testing. The site investigation included 32 borings for sampling and standard penetration testing (20 in the pad emplacement area, 10 in the canister transfer building area, and 2 out on the access road)."
A. (Dr. Bartlett) Right.
Q. Now, do you disagree with the information that is presented by the NRC in these two sentences as to the number of tests that were done?
A. (Dr. Bartlett) We could take a moment and count them if you so wish. I haven't done that in my review.
Q. Did you in your review try to determine how many borings were done all together?

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A. (Dr. Bartlett) Yes, I counted them. I don't remember what the count was.
Q. Okay.
A. (Dr. Bartlett) So we can -- if we want, we can choose to count them. We can see if this is correct.
Q. Do you -- perhaps we'll do that at a break. For the moment, in the interest of time, do you have any reason to disagree with the numbers?
A. (Dr. Bartlett) No, not at this point. I'm not trying to be adversarial. I'm just saying I'd prefer, before I go on the record as saying these are correct, I'd like to count them.
Q. That's perfectly reasonable.
Okay. Again going down in the same paragraph, the NRC says in the next -- to the next sentence, "Also 39 cone penetrometer tests (CPT's) and 16 dilatometer tests were performed at locations described in Figures 2.6-18 and 2.6-19 of the SAR, Provision 13." Again, do you have any reason to disagree with those numbers?
A. (Dr. Bartlett) No. They appear to be at least in the right number. I can't verify them, but we could count them. But I don't think it's that important at this point.

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Q. Let's go now to page 2-48. And looking at the first full paragraph on that page, it reads, "The staff concludes that the geotechnical site characterization information presented in the SAR is adequate for use in other sections of the SAR to develop the design basis for the facility and perform additional safety analysis."
Do you see that? It's at the top of the page, before the section --
A. (Dr. Bartlett) Okay. Before the discussion of the stability of the cask storage pad foundation, yes.
Q. Do you agree or disagree with that statement?
MS. CHANCELLOR: Objection. First of all, you should ask if he has an opinion.
MR. TRAVIESO-DIAZ: Well, okay.
Q. (By Mr. Travieso-Diaz) Do you agree, disagree, or have no opinion with respect to that statement?
A. (Dr. Bartlett) I disagree with it.
Q. On what basis do you disagree?
A. (Dr. Bartlett) First, the site characterization to me involves more than just borings and numbers of boreholes that were put in the ground.

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We've already stated that, at least based on the density that we have seen at this site in the pad emplacement area, that it doesn't appear to follow Reg Guide 1.13 -- 1.132. Also, characterization to me involves -- when we say "geotechnical site characterization," then we are also doing testing, including laboratory testing, to define soil properties.
We have serious reservations about the number of laboratory samples that have been done for this particular facility. We see the design of the foundation system is being done on very limited numbers, in which we cannot tell whether these are high values, average values, or low values for the respective layers. It's difficult in reading the SAR whether we can determine based on the layering scheme where exactly these things were done. They have not been tabulated by -- layer by layer. One could do so, but it's extremely inconvenient.
We have reservations about the shear wave velocity data. We see some inconsistencies and cannot quite resolve which are right and which are wrong. Well, I won't say wrong. We shouldn't really use the word "wrong." But if there's any potential bias between the two data sets.
We have stated the applicant hasn't drilled

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any deep borings, at least geotechnical borings, down to the presumed bedrock somewhere between 800 and 500 feet. We don't know where it's at.
We see discussions of cementation in layer 2. We do not see any objective evidence to show the degree or amounts of cementation or the lack thereof.
I need to pause. I'm drawing a blank. Maybe Dr. Ostadan can add something.
A. (Dr. Ostadan) I only can add from experience. I think your expert testified yesterday that geotechnical engineers always like to have more data, and I think that is true. We're always constrained to the schedule and budget. However, we have a leverage in our practice if we don't get our wish granted to exercise and recognize the variation and potential scattering of data and bring that element into our design. I think in general that element of our practice has not been rigorously implemented here in the SAR.
Q. Can you explain what you mean? I'm not sure I follow you.
A. (Dr. Ostadan) Okay. Let me give you an example on ground response analysis. I think in our CSRP, and again, it's either 271 or 2, it requires that variation of dynamics of properties to be recognized in

the design. And it specifically states that unless -- and I don't remember wording exactly, but this is to the effect that a good amount of investigation has been performed. To capture the variation and scattering of the data, the applicant must change the shear margins by a factor of 2 in their design, meaning that they have to increase the shear modulus by a factor of 2.

Now, in this case in the calculation I have reviewed, applicant has varied the sheer modulus by a factor of one and a half.

Q. So pardon for interrupting, but so the record is clear: what calculation are you talking about specifically?

A. (Dr. Ostadan) I do not remember the calculation number. For example, the Geomatrix calculation for 1D shake analysis. I have not seen any statistical analysis of the dynamic sort of properties to justify the limited variation that was considered in the design.

A. (Dr. Bartlett) May I add now?

Q. Sure.

A. (Dr. Bartlett) One other I think important issue to us is in layer 2. We heard yesterday discussion about cementation in this layer that's maybe giving it some higher shear strength. Another possible

mechanism again for higher shear strength may be just simple changes in moisture content. We live in the arid west, and depending on the seasons, these shallow layers can be exposed to significant drying and significant wetting depending on environmental changes.

It would be useful to see if there are correlations going on between moisture content and undrained shear strength. It would be another mechanism that could cause these soils to be somewhat stiffer than my previous experience, but yet could, due to now unsaturated flow in the shallow surface, gain moisture content. They probably will never be resaturated, but gain moisture content and lose some of this apparent stiffness or strength. We don't understand whether this is occurring or not. The applicant has not investigated this and is using a mechanism of cementation to explain why these appear to be overconsolidated and stiffer in the upper part of the profile.

Another useful thing would be -- is to look at not only laboratory data, which has been the basis for design, but also look at other types of correlations to maybe resolve this issue.

Q. I'm sorry. I didn't mean to cut you off.

A. (Dr. Bartlett) Sure. And I think we've already mentioned again maybe the use of cyclic triaxial

strain testing to see if at certain levels of strain, does this either cementation or strength begin to degrade any.

These are not inclusive of maybe all my concern, but they're the best of what I can remember right now.

Q. And I take it they're probably the most important ones?

A. (Dr. Bartlett) That I recall right now, yes.

Q. Not holding you to the list. I'm trying to understand.

A. (Dr. Bartlett) Sure.

Q. Did you seek to look at what the NRC had done in the SER with respect to these various areas of concern to determine how the NRC had --

MS. CHANCELLOR: Could you clarify? Do you mean the SER that came out this October or the earlier SER?

MR. TRAVIESO-DIAZ: The document I have before us as Exhibit 6.

A. (Dr. Bartlett) Yes. At least related to some of these issues, stability of cask storage foundation, storage pad foundation, stability against bearing capacity failure under static loading, stability

against excessive settlement under static loading, stability against sliding under dynamic loading, stability against bearing capacity failure under dynamic loading, stability of the canister transfer building foundation. I'm not sure I looked quite thoroughly at the canister transfer building, because I -- conclusions in the SER, I do recall going through the cask storage pad foundation sections.

Q. Did the NRC raise any concerns in the areas that both of you have listed or any of the -- in any of the areas that the two of you have listed in the SER?

A. (Dr. Bartlett) No, and I was disappointed.

Q. Okay. Whether you were disappointed or not, was it fair to say you disagree with the treatment that the NRC gave to the various sections you just mentioned?

A. (Dr. Bartlett) I do. I'm not sure they understand key issues.

MR. TRAVIESO-DIAZ: This might be a good time to take a break.

(Recess from 3:04 to 3:16 p.m.)

Q. (By Mr. Travieso-Diaz) Okay, let's go back to Exhibit 3 again.

A. (Dr. Bartlett) Contention L.

Q. (By Mr. Travieso-Diaz) Okay. Again, let's take a look at now the paragraph that's numbered -- has

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the number "a" entitled "Subsurface investigations." You have that?
A. (Dr. Bartlett) Yes.
Q. Let's take a look at the first sentence in that paragraph that says that "The location plans for completed subsurface investigations, cross-sections, and profiles showing subsurface soil and rock layering at the site contained in the license application is deficient in that these data could not be compared with the Applicant's boring logs." Do you see that?
A. (Dr. Bartlett) Sure.
Q. Is this paragraph accurate today in light of the additional soils work the applicant has conducted?
A. (Dr. Bartlett) I'm struggling with in the sentence it refers to "these data." I'm not sure exactly what "these data" are referring to. Could be possibly to the location plans or maybe referring to the subsurface investigations, cross-sections, and profiles. I know I'm responsible for this, but I did not author it.
Q. That's why I was asking you earlier whether you talked to Mr. White to determine what he meant in the sentence.
A. (Dr. Bartlett) I would say the location plans seem adequate. I haven't seen any problems with

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the location plans showing borehole locations and cross-sections and whatnot.
Q. This sentence appears to raise a question whether you can correlate the location plans and the actual boring logs. Do you see that?
A. (Dr. Bartlett) I'm going to read on to see if I can get the sense of what's going on here.
A. (Dr. Ostadan) Can I answer?
Q. Sure.
A. (Dr. Ostadan) I believe the statement that is deficient, identifying rock layering at the site --
Q. Where are you reading from? The sentence that says "Profiles showing subsurface soil and rock layering at the site"?
A. (Dr. Ostadan) "-- and rock layering at the site."
MS. CHANCELLOR: It's the second line.
Q. Yes.
A. (Dr. Ostadan) Right.
Q. And what inference did you draw from that?
A. (Dr. Ostadan) I think we just didn't know where the rock is at the site.
Q. But this appears to say that you couldn't correlate that with the applicant's boring logs. That's what I'm trying to understand, what is being claimed

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here.
A. (Dr. Bartlett) I think when it uses the terminology "cross-section" and "profiles," comparing back to the applicant's logs, there are issues regarding whether one could determine the appropriate cross-section, layering, stratigraphy, if you will, from the boring logs. I would answer that at least in the zone where the cone penetrometer was performed, that layering, cross-sections, and profiles I assume is somewhat related to a cross-section, and still some two-dimensional view of the subsurface profile is -- at least for determining the layering at the site is sufficient.
Now, when we talk about the deeper profile, deeper than where the cone penetrometer could go, you probably still have difficulty determining the exact layering. The borings were done and sampled at approximately five-foot intervals, and we've already mentioned that they go to approximately a hundred feet. So there are deeper parts of the profile that remain undefined, and specifically "rock" is not defined.
Q. Since the author of this paragraph is not here, let's just try to look at some of the things that are said, see if we can make sense out of them.
A. (Dr. Bartlett) Sure.

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Q. I'm going to mark these two documents together for simplicity as a single exhibit, and that will be Exhibit 51.
(Exhibit 51 marked.)
Q. (By Mr. Travieso-Diaz) Let me define what I'm giving you for the record first. Just to make sure everybody has the right document. I have marked as Exhibit --
MS. CHANCELLOR: I've got two pages.
MR. TRAVIESO-DIAZ: I'm sorry. Let me identify what I have, and then you tell me what you do not have. Okay?
This document consists of three pages. First page is Figure 2.6-2, entitled Plot Plan and Locations of Geotechnical Investigations, Sheet 1 of 2, Revision 0.
MS. CHANCELLOR: I've got that.
MR. TRAVIESO-DIAZ: Okay, let's see. The second page is sheet 2 of the same drawing that I just identified. The third page of the exhibit is a different drawing. It's titled Figure 2.6-5, Foundation Profile A-A Looking Northeast, and it's Revision 0.
Now, does everybody have that?
Q. (By Mr. Travieso-Diaz) Dr. Bartlett, will you review these documents and confirm for me, if you

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can, that what I have given you is the location plot plan and the foundation profiles as they existed in the SAR when it was initially filed?

A. (Dr. Bartlett) **Well, it was a long time ago since I saw the initial SAR, but it looks consistent with what I remember from the original SAR.**

Q. And in the original SAR, if this is in fact, which I believe they are the documents --

A. (Dr. Bartlett) **They have Rev. 0, so yes.**

Q. And I take it that at the time there was only one foundation profile for the site, and that will be Figure 2.6-5?

A. (Dr. Bartlett) **Correct. That's as I recall it, yes.**

Q. And there was only one location plan, which is Figure 2.6-2, even though it was in two pages?

A. (Dr. Bartlett) **I can't find the second page of it. You're saying 2.6-2, one of two. I'm missing sheet 2.**

MS. CHANCELLOR: I have an extra sheet 2.

MR. TRAVIESO-DIAZ: Oh, that's what happened. She got one more.

MS. CHANCELLOR: Here it is.

I'd just like to make a comment that yesterday we introduced as Exhibit -- Exhibit 38, and I

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believe it's the same version, SAR Figure 2.6 -- it's revision 8. Beg your pardon.

MR. TRAVIESO-DIAZ: And also --

MS. CHANCELLOR: It's revision 8. I beg your pardon.

MR. TRAVIESO-DIAZ: I don't believe Exhibit 38 has a second sheet. This is the complete document.

MS. CHANCELLOR: You're right.

Q. (By Mr. Travieso-Diaz) So I take it that this was the document -- these were the two documents that characterized or contained the plot plan and the foundation profile at the time that the first sentence of paragraph A was written?

A. (Dr. Bartlett) **Yes, that would be correct.**

Q. Do you know how many location plans are there in the current version of the SAR?

A. (Dr. Bartlett) **No. I haven't counted those.**

Q. How many foundation profiles?

A. (Dr. Bartlett) **Foundation profiles, do you mean cross-sections?**

Q. Yes, you're right. Another was to Figure 2.6-5.

A. (Dr. Bartlett) **We could count them. I haven't counted them, but I do remember seeing them.**

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Q. There were more than one?

A. (Dr. Bartlett) **Yes, there were obviously more than one, yes. On the order of ten to fifteen, perhaps. I'd have to count them.**

Q. All right. This is not a test?

A. (Dr. Bartlett) **Fair enough.**

MR. TRAVIESO-DIAZ: I want to mark for the record what I will call Exhibit 52.

(Exhibit 52 marked.)

And again, I will describe for the record what Exhibit 52 is. It is a two-page document -- actually it's not a two-page document. I stand corrected. It's a three-page document comprised of the following parts. The first -- the first page of the document is Figure 2.6-2, Plot Plan and Locations of the Geotechnical Investigations, Sheet 1 of 2. And this is Revision 8.

The second page of the document is Figure 2.6-18 -- and by the way, all these references I'm making are to the SAR -- and is entitled Location of Geotechnical Investigations for Canister Transfer Building.

And the third page -- and this is Revision 6. And the third page is titled Figure 2.6-19, and it is titled Location of Cone Penetration and Dilatometer

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Tests. And again, that is Revision 8. Is that correct?

A. (Dr. Bartlett) **Yes, I see it.**

Q. Would you say that we now have in the current version of the SAR three location plans against the one that we have when the original SAR was filed?

A. (Dr. Bartlett) **Yeah.**

MR. TRAVIESO-DIAZ: All right. I am going to mark for the record as Exhibit 53 a document that actually consists of 14 pages together as a single exhibit.

(Exhibit 53 marked.)

And Exhibit 53 I will identify for the record as being Figure 2.6-5 of the SAR, entitled Pad Emplacement Area, Foundation Profile A-A', Sheet 1 of 14, Revision 8. The second page is Pad Emplacement Area, Foundation Profile B-B', Sheet 2 of 14. And I'm not going to identify the rest of them, but there are 12 more sheets that are part of Figure 2.6-5 of the SAR, and they're all marked Revision 8. Is that correct?

A. (Dr. Bartlett) **Correct.**

Q. And is it your understanding that Exhibit 53 represents what's available in the SAR now in terms of foundation profiles?

A. (Dr. Bartlett) **Yes, that's what I recall when I read this.**

Q. And these are the foundation profiles just for the pad emplacement area. Is that correct?
A. (Dr. Bartlett) **Yes, appear to be. I see the pads. I see them all labeled that way, so I have no reason to believe otherwise.**
MR. TRAVIESO-DIAZ: And I will mark as Exhibit 54 --
(Exhibit 54 marked.)
MR. TRAVIESO-DIAZ: I will identify for the record, Exhibit 54 consists of three drawings which are entitled as follows. Again, they are from the SAR. The first one is called Canister Transfer Building Foundation Profile 1-1' Looking North. The second one is entitled Figure 2.6-22, Canister Transfer Building Foundation Profile 2-2' Looking North. And the third one is 2.6-23, Canister Transfer Building Foundation Profile 3-3' Looking East. And they are all marked revision 6. Is that correct?
A. (Dr. Bartlett) **Correct.**
Q. And the documents that comprise Exhibit 54 are foundation profiles for the canister transfer building?
A. (Dr. Bartlett) **Correct.**
Q. As opposed to the ones in Exhibit 53 which were for the pad emplacement area?

A. (Dr. Bartlett) **That's correct.**
Q. If you take the documents that comprise Exhibit 53 and 54 together --
A. (Dr. Bartlett) **Sure.**
Q. -- and compare them to the document that was previously marked as Exhibit 52 --
A. (Dr. Bartlett) **Correct.**
Q. -- sheet 1, the first page. Strike that question, please.
Looking at -- try this again. You're looking at Exhibit 51. The last page of Exhibit 51, which, as we said earlier, was Foundation Profile A-A' Looking Northeast.
A. (Dr. Bartlett) **Okay.**
Q. Will it be fair to say that whereas in the original SAR there was only one foundation profile for the pad emplacement area --
A. (Dr. Bartlett) **Uh-huh.**
Q. -- there are now a total of seventeen foundation profiles for both the pad emplacement area and the canister transfer building?
A. (Dr. Bartlett) **Appears your numbers are correct.**
Q. All right. Now, looking at let's say the first page of Exhibit 53.

A. (Dr. Bartlett) **Yes.**
Q. Now, looking at that drawing -- pull it out for a second. I see that -- first of all, let me see if you can help me identify what this figure shows.
A. (Dr. Bartlett) **Well, I'll read you the title. We're on Exhibit 53, Figure 2.6-5, Sheet 1 of 14?**
Q. Correct, yes.
A. (Dr. Bartlett) **Pad emplacement Area Foundation Profile A-A', the figure shows what we would call a cross-section, which shows the -- at the surface the approximate depths of the pads. It's on an exaggerated scale, I can tell that. Then underneath that we see the CPT data presented and a layering system established for the CPT data. And in conjunction with that, I imagine superimposed on this cross-section, because they probably don't all fall on the same line, some nearby borehole data. And that comprises it looks like standard penetration testing, soil descriptions according to the Unified Soil Classification System, and some descriptions of these units based somewhat on the Unified Soil Classification Systems.**
I see that profile developed in the upper 30, 35 feet. Below that the cone penetrometer does not go. I assume probably because it hit refusal, could not

be pushed any deeper. And then the rest of the deeper stratigraphy is relied upon now by the borehole data itself. When I mean "the borehole data," I mean the SPT data and also the unified soil classification systems. Two of those boreholes terminate at approximately 70 feet. One goes down to approximately 100 feet, maybe the other one slightly deeper, 100, 110 feet. These are just guesses, at least looking at it quickly. And the layering is not as well developed, with question marks showing potential layering, but it's really not layered, at least by this drawing.
And that's about all I see.
Do you want to add to that, Dr. Ostadan?
A. (Dr. Ostadan) **No.**
Q. Before I ask you the next question, just to clarify, you used the word "refusal." Could you explain for the record what the word "refusal" means?
A. (Dr. Bartlett) **What refusal means is the people that perform the cone penetrometer test, when you get into very dense layers you have a chance of either damaging their device or their rig. So usually at their discretion they tell you whether they think they can penetrate this layer or if they need to maybe stop. And I'm assuming that the reason why this is terminating in the fairly shallow profile is because the sediments**

under that are denser, stiffer.
Q. How do you measure refusal? In terms of what?
A. (Dr. Bartlett) Well, they can tell you what the tip resistance as a refusal, but it's usually a judgment call by the operator knowing his equipment and his device when he runs a risk of seriously damaging his equipment. So he defines refusal himself. We usually don't. We do not like to damage their equipment, because they charge us for it.
Q. Obviously that means that the soil at that point is so hard that it's difficult to penetrate?
A. (Dr. Bartlett) It's much denser, yes. And it can be sometimes a function of penetration. Even though you get significantly deep, sometimes the layers may not be quite as dense, but you've lost a lot of your capacity to push just because of the depth and the side friction along the cone. So it's not always an indication of dense layers, but it generally is. Especially for a shallow investigation like this, I can tell. I know this rig has capabilities in softer sediments of going deeper. So it obviously I think hit refusal on this silty sand/sandy silt layer. And the blow counts show that they're reasonably high, quite high in that zone.

Q. I need to ask you a few more -- even though you did a good job, I need to ask you a few more qualifications for the person who looks at this drawing.
A. (Dr. Bartlett) Okay.
Q. First look at the legend on the right side, on the top right-hand side of the drawing. You see next to something that bears a square with a number 10 an arrow that says SPT N value?
A. (Dr. Bartlett) Yes, I do.
Q. Could you explain what that means?
A. (Dr. Bartlett) That is what we call the N value or blow count value from the standard penetration test.
Q. What does it measure?
A. (Dr. Bartlett) It measures the number of blows to drive the split spoon sampler up one foot.
Q. And I take it that there is more or less direct correlation between the N value and the hardness of the soil. Is that correct?
A. (Dr. Bartlett) Not sure I'd say hardness, but yes, density.
Q. Density. For example, a soil with an N of 10 would be less dense than a soil with an N of 135? Just looking at the legend.
A. (Dr. Bartlett) Yes. For the same depth and

same type of material, yes.
Q. Now, please tell me, as long as we're looking at that particular portion with the legend, I see that that legend correlates a number of black squares and a line with those N numbers.
A. (Dr. Bartlett) Correct. That just shows the intervals where the sample was -- the test was performed. And usually we would retrieve the sample and bring it to the surface, too, so that -- of where the sample was retrieved.
Q. Looking again for purposes of whoever reads this, at the first of the lines in -- starting from the left of the drawing, sitting underneath a caption, of which I will ask you in a minute, is a CPT-36?
A. (Dr. Bartlett) Yes, I see that.
Q. You see that line that goes down from what appears to be like 4460, and goes all the way down to like a little bit beyond 4460?
A. (Dr. Bartlett) That indicates the depth of the borehole.
Q. And now you have a series of numbers next to black squares, like a number 23 and then a number 13.
A. (Dr. Bartlett) Those are the SPT N values.
Q. Would that tell you or the reader that in that borehole they took a measurement, if you will, if I

can use that term, a little bit below 4460 and it took 23 blows, if you will, to advance the required distance?
A. (Dr. Bartlett) That is correct.
Q. And then they went down, it looks like maybe five more feet?
A. (Dr. Bartlett) I believe these are five-foot intervals, yes.
Q. And then they drew and it took 13?
A. (Dr. Bartlett) Correct.
Q. And all the way down to the last one, which was like a hundred, and then has a slash and then has 6 inches. By the way, greater than hundred, what does that mean?
A. (Dr. Bartlett) That means they counted a number of blows to drive it six inches. It was greater than a hundred, so they gave up.
Q. All right. So it took --
A. (Dr. Bartlett) That means it's very dense. For all practical purposes, you're beating your brains out trying to drive the sampler deeper, and there's no need to.
Q. Is that greater than a hundred in any way related to the refusal point that you mentioned before?
A. (Dr. Bartlett) Excuse me. The unit weight?
Q. No, the number greater than 100, the N

number greater than 100.
A. (Dr. Bartlett) **It means there was at least 100 blow counts in that six inches.**
Q. Is that in any way related to the refusal point that you mentioned before?
A. (Dr. Bartlett) **Well, you can get refusal in the SPT tube, but it's a different criteria that we would use for the CPT.**
Q. Let me ask you this. Could you by looking at this first figure -- by the way, from what hole was this drawn? Can you tell? Is there a label there that tells you which it is?
A. (Dr. Bartlett) **Because this is borehole data, it would be done for A-1.**
Q. All right. Would you expect that if you look at the borehole log for Borehole A-1 that you have essentially the same information as you see here in this line?
A. (Dr. Bartlett) **Correct, but more.**
Q. Of course, yes. So do you believe that to the extent that this first paragraph here on page 83a is talking about the inability to correlate boring logs and profiles, that that's no longer a problem, that you can do it by looking at this figure?
A. (Dr. Bartlett) **Yes, I sense some initial**

frustration that the reviewer had in trying to look at the plans, the cross-sections, and correlate them back to the borehole data.
Q. All right. But to the extent that that frustration may have been legitimate in 1997, is that a frustration today?
A. (Dr. Bartlett) **I haven't experienced that, no.**
Q. Okay. Let's finish trying to describe what this drawing is, because we'll be talking about it later. Now, you said that A-1, for the first one, characterizes or describes which particular borehole you're talking about.
A. (Dr. Bartlett) **Correct.**
Q. And then I see a little further down the page another vertical line that has B-2. Would that mean that that was for Borehole B-2?
A. (Dr. Bartlett) **Yes, it would be for B-2.**
Q. And then the next one I guess is C-3?
A. (Dr. Bartlett) **C-3, yes.**
Q. And the other one is D-4?
A. (Dr. Bartlett) **Correct.**
Q. Now, what does CPT-36 next to A-1 mean? If you know.
A. (Dr. Bartlett) **Spatially they must be**

fairly close. We could refer to where the cross-section's taken. Let's see. It's A-A', so we're now referring to Exhibit 52, Figure 2.6-2. And we see marked on that A-A', so that appears to follow pretty much diagonally across the pad area, meaning diagonally from northwest to southeast, following the line of the borehole data.
Q. Now --
A. (Dr. Bartlett) **And then the CPT data, I guess we could see how close it falls onto that cross-section line if we chose.**
Q. All right. Staying with this for a second just for clarification. You're saying that if we take a look at Exhibit 52, which is Figure 2.6-2, the current version for Revision 8, and I look on that drawing at where it is marked A-1, that point, which I take it represents a borehole?
A. (Dr. Bartlett) **Yes.**
Q. That point is the same point as or correlates to the point marked A-1 on Figure 53?
A. (Dr. Bartlett) **Yes, reasonably closely to the scale of the drawings we're looking at.**
Q. I understand. But if I was looking at these two sets of drawings and I wanted to correlate where Borehole A-1 was in my location plan vis-a-vis the

foundation profile, I just have to look at these two drawings and they will match that way?
A. (Dr. Bartlett) **Yes. One could easily determine for practical purposes where the boring falls on the plan view shown in Figure 2.6-2.**
Q. So you wouldn't have any difficulty correlating these two sets of drawings, and by that I mean, what's now Exhibit 52, page 1 and Exhibit 53, page 1, in terms of location?
A. (Dr. Bartlett) **In terms of location.**
Q. Okay. Now, can you do the same thing -- well, strike that. Finish first trying to describe what is here.
There is a continuous line, broken line, that starts a little above 4460 on the left and runs all the way to almost 4480 on the right.
A. (Dr. Bartlett) **I see it.**
Q. What does the line represent? Do you know?
A. (Dr. Bartlett) **That represents an inferred layer. Usually when they're being inferred, we dash them. If we're fairly confident about them, they would be solid lines. At least that's standard practice.**
Q. But I'm talking about the solid line at the very top.
A. (Dr. Bartlett) **I went above you, sorry.**

I'm one line down.
The solid line on top, the solid, thin line, represents ground surface.
Q. So that would be the undisturbed ground surface?
A. (Dr. Bartlett) Correct, at the time of the survey when these were prepared.
Q. And again, if you wanted to know what the surface looked like in terms of the topography, I don't know if that's the correct word, at the time that this survey was taken, you just need to look at this?
A. (Dr. Bartlett) Correct, to the nearest foot.
Q. All right. Now, again for purposes of understanding what's in this drawing, there is a set of dashed lines -- by the way, are you -- I don't know if this drawing allows us to make a determination, but would that be the actual grade at the time this drawing was made, or the anticipated grade of this area once construction is finished? If you know.
A. (Dr. Bartlett) That I might have to check into. I was assuming it was the grade at the time the drawing was prepared. It may represent the finished grade.
Q. Now, there is a series of what appear to be

rectangles throughout the start of the surface and go down a few feet?
A. (Dr. Bartlett) Correct.
Q. What would those rectangles represent?
A. (Dr. Bartlett) Those are projections of the pads into the cross-section.
Q. Why is it that some of them look bigger than the others?
A. (Dr. Bartlett) Because we're cutting at different angles across these.
Q. Oh, I see. Okay. Now to the question that I believe you were referring to. There is a dashed line that is sort of parallel to the surface, but it's, what, appears to be like five foot underground.
A. (Dr. Bartlett) I see it. Yes, I see it.
Q. What does that line represent?
A. (Dr. Bartlett) That represents an inferred layer boundary.
Q. And it's a boundary between what and what?
A. (Dr. Bartlett) Changes in material type.
Q. And is there something that identifies what -- do those layers have names?
A. (Dr. Bartlett) Yes, sir, their names.
Q. Okay. What are their names?
A. (Dr. Bartlett) The name above the line is

Eolian silt.
Q. And the name below?
A. (Dr. Bartlett) Is a silty clay/clayey silt.
Q. And those names appear to be reproduced throughout each horizontal band, like, for example --
A. (Dr. Bartlett) Downward?
Q. No, no. From left to right.
A. (Dr. Bartlett) Oh, yes. They're periodically reproduced. I imagine that's just for reader's ease. Though once in a while there may be lateral changes and we might see a change in those names.
Q. But in this drawing it appears --
A. (Dr. Bartlett) I don't see any of those in this type of drawing except when we get deeper.
Q. All right. And so that we can clarify what we have been talking about before and may be talking about later, I see one, two, three, four, five -- six continuous -- and by that I mean continuous going from left to right -- dashed lines, and then two lines that start a short distance and then they end.
A. (Dr. Bartlett) Correct.
Q. If you can explain what these various lines are, what they mean. Could you do it?
A. (Dr. Bartlett) The ones that start and then

terminate with question marks?
Q. We'll get to those. The other ones, would you -- your understanding be that the ones that do go from end to end are intended to represent what you call -- what do you call them? Inferred?
A. (Dr. Bartlett) Inferred layer boundaries, yes.
Q. All right. So this drawing would --
A. (Dr. Bartlett) -- infer that those are continuous across this cross-section.
Q. And it has essentially seven such layers?
A. (Dr. Bartlett) One, two, three, four -- five that I count that are continuous.
Q. Oh. You mean the one that starts -- there's one that starts off --
A. (Dr. Bartlett) I'm counting layers, not lines now.
Q. Oh, Okay. All right. So you believe five --
A. (Dr. Bartlett) Five layers.
Q. And those would be --
A. (Dr. Bartlett) Eolian silt; underneath it the silty clay/clayey silt; underneath it the clayey silt/silt; underneath it the clayey silt/silty clay; and underneath that, the silty sand/sandy silt.

That was a lot of soil description in a very quick manner.

Q. Okay. Now, if I recall, we were talking -- first of all, would you identify which of these layers that you mentioned about fall within the first 30 feet of subsoil?

A. (Dr. Bartlett) **Let's see -- 30, 35 feet. There would be all of those five that I just mentioned.**

Q. I thought that earlier we talked about there being four layers characterized for this site, and you mention now there are five.

A. (Dr. Bartlett) **I think we've added that silty sand/sandy silt at the bottom. Our discussions yesterday only went down to the depth of this clayey silt/silty clay. So -- but with the cone data there are really five I think we need to discuss. We may not have discussed them all yesterday.**

Q. But to correlate the conversations on both days --

A. (Dr. Bartlett) **Right.**

Q. -- what we're talking about here in this exhibit was a depiction of the four layers that were discussed yesterday --

A. (Dr. Bartlett) **Correct.**

Q. -- and an additional layer called silty

sand/sandy silt?

A. (Dr. Bartlett) **Correct. That underlays layer 4.**

Q. One more thing, I think, and then we can move on, which is, I see a wiggly line, if I can use the term, that starts on, say, for example, in Boring A-1, that starts at the first point of 23.

A. (Dr. Bartlett) **Yes, I see.**

Q. And goes down to almost 4430 and then branches out horizontally.

A. (Dr. Bartlett) **Right.**

Q. What does that line represent?

A. (Dr. Bartlett) **That is the tip resistance from the cone penetrometer.**

Q. All right. So that would be -- and for what cone penetrometer location would that be?

A. (Dr. Bartlett) **It is labeled CPT-36, and then underneath it it says 82 SW.**

Q. And what would be whatever that location for that cone penetrometer is, would represent, and that wiggly line represents the readings that you obtained for that location?

A. (Dr. Bartlett) **Correct, inferred onto this cross-section.**

Q. Just, again, out of interest in having the

record complete, what does it mean when that line branches out horizontally at the level between 4430 and 4440? Do you see what I'm talking about?

A. (Dr. Bartlett) **That is when the cone penetrometer has reached its maximum or its resistance, what we called refusal earlier.**

Q. This is where if you went farther you might break equipment?

A. (Dr. Bartlett) **Yes.**

Q. And you quit because when you get to the horizontal line you are risking not being able to get --

A. (Dr. Bartlett) **Continuing getting data and other issues.**

MR. TRUDEAU: Big bills.

Q. And I take it, then, that that layer of which you have that particular phenomenon, the soil is very dense?

A. (Dr. Bartlett) **It's very dense.**

Q. All right. Now, one more thing. I'm sorry. Just looking at the legend on the right.

A. (Dr. Bartlett) **Correct.**

Q. That wiggly line on the right, does that correspond to the wiggly lines on the left that we just talked about?

A. (Dr. Bartlett) **The only ones that I see on**

the left on the cross-section are to me the tip resistance, which is labeled QT. The other lines there, UD would refer to the pore pressure measurements, and FS would be the sleeve measurements, and I don't see those data projected on this -- excuse me. I need to look more closely. Sorry.

Q. May I invite you to look at B-2?

A. (Dr. Bartlett) **Yes, I see them now. The scale -- I just missed them because their -- their scale compared to the tip resistance is much different. I see them. They're not of much use, but I see them.**

Q. But in any event, that -- so the three sets of lines that you get across each of these cone penetration test holes represent the three parameters, if you will, in the case that you have three, that are obtained through the use of the cone penetrometer?

A. (Dr. Bartlett) **The three basic parameters, yes, right. For a piezo cone, p-i-e-z-o.**

Q. Piezometer?

A. (Dr. Bartlett) **Yes.**

Q. Only so the record is complete, is it true that the other 13 drawings that you have that comprise this set have analogous information?

A. (Dr. Bartlett) **They are, but they're colored.**

Q. They're colored. You have to ask --
MR. TRUDEAU: Bigger scale.
A. (Dr. Bartlett) And bigger scale, yes.
Q. You have to ask the applicant why they chose to have the one of them in black and white and the other one's in color.
A. (Dr. Bartlett) Obviously you had a big budget and you could afford color.
Q. As long as we're talking about color and we have some of these which are in color, what do you understand the colors to mean?
A. (Dr. Bartlett) They infer soil behavior types.
Q. All right. Bear with me one second.
Okay. If you will take a look now to Figure 2.6-19, which is the third page of Exhibit 52, the one that is entitled Locations of Cone Penetration and Dilatometer Tests.
A. (Dr. Bartlett) Correct.
Q. If you take -- and let's do this just for one. If you try to compare the figure in 2.6-19 against the Figure 2.6-5, sheet 1, that we just looked at --
A. (Dr. Bartlett) Correct, the cross-section.
Q. Yes. And if I tried to locate the cone test location CPT-36 that is listed on Figure 2.6-5 --

A. (Dr. Bartlett) Correct.
Q. I could go perhaps to Figure 2.6-19 and look at the top left corner of the drawing where it says SEIS, CPT-36, DMT-16?
A. (Dr. Bartlett) Correct.
Q. So I could again correlate the locations between the cone penetrometer tests and the foundation profiles just by comparing the two drawings?
A. (Dr. Bartlett) Yes.
Q. Now, these drawings that we have been looking at, and by that I mean Exhibit 52, 53, and 54, refer to either the pad emplacement area or the canister transfer building; is that correct?
A. (Dr. Bartlett) Correct.
Q. Is it correct to say that both the pad emplacement area and the canister transfer building are classified as safety-related structures?
A. (Dr. Bartlett) Yes.
Q. Are there any other safety-related structures at the PFS site that you know of?
A. (Dr. Bartlett) Not that I'm aware of.
Q. All right. Let's move on back to Exhibit 3.
A. (Dr. Bartlett) Exhibit 3, SAR -- I mean, the Contention L.
Q. Contention L, the one you didn't write.

Look at the second sentence in that paragraph --
A. (Dr. Bartlett) Yes.
Q. -- that says, "Structure specific cross sections and profiles were not prepared utilizing the boring logs."
A. (Dr. Bartlett) That is correct.
Q. Is that correct still today?
A. (Dr. Bartlett) That is.
Q. And do you consider that to be a deficiency in any way?
A. (Dr. Bartlett) The use here of "structure" implies to me now -- I'm speaking from my geological background, not my geotechnical background -- a structural cross-section where all elevations have to be preserved to show a potential offset or displacement within a section or to give the true geometries of those. These are not structural specific cross-sections according to that definition.
Q. What are you missing by not having this information?
A. (Dr. Bartlett) The projection -- it's been a number of years since I prepared a structural specific cross-section, and probably since Barry Solomon's here, he can maybe give you -- oh, excuse me.
Structure specific cross-sections now show

the -- any geological structure and the true elevations and layers of these with very minimal to no projections onto a cross-sectional line.
Q. All right. Apart from --
A. (Dr. Bartlett) So we're trying to now understand not only the layering system but the elevations and how they relate from one set of data to another. And these are not in geological terms structural cross-sections, these are geotechnical cross-sections.
Q. Do you know if any, as you called them I believe structural cross-sections, were prepared outside these drawings?
A. (Dr. Bartlett) There may have been. I guess the best place to look would be the Geomatrix report.
Q. Why don't we do that.
MR. TRAVIESO-DIAZ: Let's mark these as Exhibit what, 55.
(Exhibit 55 marked.)
I will identify for the record this Exhibit 55 consists of two drawings. The first one is entitled Map of North Wall Trench T-2, Private Fuel Storage Facility, Skull Valley, Utah, plate -- Geomatrix Plate 3. And the second one is Cross-Section D-D' Showing

Stratigraphy Inferred From Borehole Data Across Site, Geomatrix Plate No. 4.
And I will further identify for the record that one of these, which I believe is Plate 4, was previously marked as part of Exhibit 17, which I have here if anybody wants to refer to it. I didn't make copies of Exhibit 17 because the plates are in color and they are extremely hard and expensive to reproduce.
A. (Dr. Bartlett) Okay, budget wasn't big enough. We understand. We think in gray, various shades of gray.
Q. (By Mr. Travieso-Diaz) Exactly. What I'm saying is, it is not a true complete reproduction because it's not in color.
A. (Dr. Bartlett) Correct, but color may not be -- if we get any confusion about what is --
MS. CHANCELLOR: I've got an additional copy, too, of 17.
A. (Dr. Bartlett) Fair enough.
Q. (By Mr. Travieso-Diaz) Let's hope we don't have to go to that. But in any event, if you take a look at the two drawings that together have been marked as Exhibit 55, would you characterize this as being structural profiles of the type that you testified about a minute ago?

A. (Dr. Bartlett) I have not extensively reviewed this document. This is a trench wall log, but I think the Contention was referring more to development of structural cross-sectional maps from the borehole data. So I'm a little confused why you're asking that question for trenching.
Q. I don't know, because I don't understand the contention. What I'm trying to figure out is, what do you feel is missing, taking into account that you not only have the foundation profile that we talked about earlier, but that you have this additional information. I'm just trying to understand what else ought to be there that isn't.
A. (Dr. Bartlett) I think we've moved into the realm of the geology and geological interpretation, and so I'm reluctant to comment about the adequacy or inadequacy of what I've been shown. But it is a trench log and in its strictest sense is not a cross-sectional, structural cross-sectional -- structural cross-section.
Q. All right.
A. (Dr. Bartlett) Though it has some aspects similar to that, yes.
Q. Well, how about Plate 4, though? Is Plate 4 a structural cross-section? Does it have everything that you said should be there?

A. (Dr. Bartlett) Well, let's look. I see two parts to that: C-15, C-14. Are those labeled what those things mean? They appear to be labeled --
Q. Do you want to look at the colored one? Maybe you can make out better what it's saying or showing. Maybe I need to give you one more piece of information.
A. (Dr. Bartlett) Fair enough. How about the answer?
MR. TRAVIESO-DIAZ: Can we take a two-second break? Because I think that's in the other room.
A. (Dr. Bartlett) Fair enough.
Q. (By Mr. Travieso-Diaz) see, if you take a look -- we can say this on the record. It says, location of boreholes, test pits, and plates shown on Plate 1.
A. (Dr. Bartlett) Correct. So let's find Plate 1.
Q. In fact, my trusted expert here has -- this is part of Exhibit 17. I didn't copy it because I was not smart enough to figure out we needed it. Would looking at Plate 1 help you understand what the legends on Plate 4 are?
A. (Dr. Bartlett) We're still trying to figure out what these "C" labelings mean atop these lines.

Yeah, those.
MR. TRUDEAU: Those are borings, Geomatrix borings in their report.
A. (Dr. Bartlett) Okay, Geomatrix borings. Okay, now we understand that those mean borings.
Q. Well, in fact, perhaps if you look at Table 1, you will have something here that will help you.
A. (Dr. Bartlett) Okay. There they are. Sorry, we didn't see that. Okay, we see the C's on there now.
Q. All right. So the record is capturing this as it's going on, you were able to determine on Plate 4 that the legend there that had the series of figures with C dash numbers --
A. (Dr. Bartlett) Right.
Q. -- corresponded to boreholes drilled by Geomatrix?
A. (Dr. Bartlett) Correct.
Q. By the way, the Geomatrix trench that is shown on Plate 3 and the boreholes that are shown on Plate 4 and on Plate 1, those represent additional location in which geotechnical data was taken?
A. (Dr. Bartlett) I'm not sure I would characterize it as geotechnical data. Better characterized as geological data.

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Q. How about the trench? Let's look at the trench on Plate 3.
A. (Dr. Bartlett) Sure, why not?
Q. Do you want to look at the color one? I think that may be better.
A. (Dr. Bartlett) It might be.
Q. Plate 6. I have it here.
I'm going to get killed for doing this, breaking up an exhibit I might not be able to reconstruct here.
Okay, we'll go with the black and white.
A. (Dr. Bartlett) That's fine. I think we can understand it.
Q. The question is, isn't it a fact that Plate 3 shows you -- gives you information on, first, what the ground surface looks like or will look like before excavation and after?
A. (Dr. Bartlett) I do see the surface line. I'm not sure whether it was existing surface at the time of the investigation. Probably that's what I would assume it was.
Q. Now, going down from the surface line, there is a number of different shades of gray, because this is a black and white picture, profiles.
A. (Dr. Bartlett) I see that.

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Q. And you look at the legend down --
A. (Dr. Bartlett) Correct.
Q. Could you try to match, if you can, this legend with -- that has, as I believe, it talks about Eolian deposits --
A. (Dr. Bartlett) Correct.
Q. "Bonneville deep-water (blocky) facies"?
A. (Dr. Bartlett) Facies.
Q. Oh, facies, f-a-c-i-e-s.
A. (Dr. Bartlett) Correct.
Q. Would you say that this trench drawing shows you, at least for the area covered by the trench, what the different soil layers look like?
A. (Dr. Bartlett) Yes. It represents at least the geological interpretation of those layers, their thicknesses, and some minor features about their internal structure.
Q. All right. And could you correlate -- I guess we would not have a corresponding drawing, but would this set of, if you will, layers that are identified here, are they the same layers as are identified on Exhibit 53?
A. (Dr. Bartlett) They have slightly different names here. We could go through and check them if you would like. What I'm saying is the legend here that's

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presented in geological terms, I see terminology that's different than what I see on the engineering cross-sections.
Q. Would that be perhaps because differing groups of engineering disciplines may have different names for the same?
A. (Dr. Bartlett) That's not unusual.
Q. All right. Okay. Now, looking at this trench on Plate 4 --
A. (Dr. Bartlett) We have not talked to geologists that classify according to a unified classification system, and I don't think we ever will, so...
That was facetious.
Q. And tell me again, because I'm not sure I understand, what do you believe between Exhibits 51 through 54 and the materials that I show you on two 55 is missing in terms of information that would allow you to characterize the subsurface of the PFS site? Anything else that you think should be provided that is not there?
A. (Dr. Bartlett) Well, my focus has been on geotechnical data. So I'm not going to make any inferences about adequacy of these cross-sections based on geological terms. I do see the layering systems

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presented. I can infer their thicknesses from this and somewhat about significant features that the geologists mapped in their trenches, namely, fractures, in-field fractures. Seems that they were most interested in obtaining the strike and dip or the orientation of those, and then they did a rose diagram to figure out if there was any preferential orientation to this data. That's what I see.
Q. Now, let's go back again just so we can move to the bottom line. We were talking about the sentence in Exhibit 3 that said, "Structure specific cross sections and profiles were not prepared utilizing the boring log records." And you said that that is a true statement. And my question to you is, in light of all the information that I just displayed before you, does it matter? Or how does it matter? Is this a significant concern?
A. (Dr. Bartlett) When this Contention was written, structure specific cross-sections and profiles were not prepared using the boring logs or from the boring logs that were obtained during the first phase of the investigation. This Geomatrix report postdates that, postdates this statement; and whether structure-specific cross-section profiles were not prepared using the boring logs from the current data as

it now exists, including the CPT and the borings done by Geomatrix, the shallow borings we see, I'm going to defer whether we've really met that or not, because again, we're in the realm of geology and that's really outside of my review.

Q. Okay. I'm trying to understand, to what extent did you personally regard this statement here in Contention L?

A. **(Dr. Bartlett) I did not draft this statement.**

Q. I understand, but it's on the record now. I'm trying to get your interpretation as to how significant you considered this observation to be.

MS. CHANCELLOR: Objection. He already said he's deferred to somebody else.

MR. TRAVIESO-DIAZ: I'm asking for his opinion if he has one.

A. **(Dr. Bartlett) I think that along the lines of where the trenches were investigated, these seem to be reasonable and consistent types of data and presentation of them. Whether all borehole data including the geotechnical and geological investigations have been compiled and reconciled in site-specific structural cross-sections, I don't see that all here, but again, I haven't reviewed this report.**

Q. Well, assuming this statement is still true today, does it concern you? Is it something that causes you concern as to the state of the investigation of the site performed by PFS?

A. **(Dr. Bartlett) Probably not from a geotechnical perspective, but geologists have other reasons for wanting to know the orientation of these layers, which could infer dips, faults and other things. And so there -- these are not geotechnical cross-sections, they are geological cross-sections. I'm going to defer from trying to really say whether I -- what was the question? I'm not sure I'm answering it.**

Q. Okay. I only want to know, since you are the person who's explaining to us this contention, whether you personally have a concern with this particular observation made in this paragraph. That's all I want to know.

A. **(Dr. Bartlett) I personally don't have a concern. Others may on the team.**

Q. All right. And others will be who?

A. **(Dr. Bartlett) Barry Solomon, that prepared part of this document.**

Q. All right. Let's move to the next sentence on that page. It says, "Only a generalization of the boring logs were used to establish the site geologic

characterization." Do you believe that statement to be correct today?

A. **(Dr. Bartlett) I think what it means, a generalization of the boring logs was used to establish the site geological characterization. Again, since the words "site geological characterization," I'm going to defer.**

Q. Do you know whether it was true at the time it was written, was accurate at the time it was written?

MS. CHANCELLOR: Objection. You're asking him to speculate about --

MR. TRAVIESO-DIAZ: If he doesn't know, he can say easily, "I don't know."

A. **(Dr. Bartlett) I don't know if it was true. I don't know if --**

Q. Do you know if it's true today?

A. **(Dr. Bartlett) I do not know if it's true today. Again, the answer I think would be in the Geomatrix report to that question, and I have not reviewed it.**

Q. Would you believe that these two statements would relate more as you're talking about the geology of the site as opposed to --

A. **(Dr. Bartlett) Geotechnical.**

Q. -- geotechnical issues?

A. **(Dr. Bartlett) It seems to me that these are more geological, not geotechnical issues, yes.**

Q. Do you understand that the scope of Issue 3 to be addressing geotechnical issues?

A. **(Dr. Bartlett) Could you repeat the question?**

MR. TRAVIESO-DIAZ: Could you read it back?

(The pending question was read.)

A. **(Dr. Bartlett) Issue 3?**

Q. Yes, what we have begun to look at, discussion on page 83 of Exhibit 3.

A. **(Dr. Bartlett) I don't see, at least in the description of 3, geological or geotechnical used.**

Q. All right.

A. **(Dr. Bartlett) But in 3a, where they start referring to the sections, the words "geological" are used.**

Q. All right.

A. **(Dr. Bartlett) That's what I see.**

Q. Let's go to -- I'm sorry. I didn't mean to interrupt you. Let's go to the next sentence of this paragraph that starts on the bottom of page 83, goes up to the top of page 84.

A. **(Dr. Bartlett) Fair enough.**

Q. It says, "It is not possible to ascertain

whether or not all of the data collected, particularly data on zones of soft/loose conditions encountered in the explorations, have been used to characterize subsurface conditions and to establish design values."
Let me stop there for a moment. Is that statement that I just read you, this portion of the sentence, true today?
A. (Dr. Bartlett) **I have a hard time interpreting whether the sentence is true without completing the sentence.**
Q. The reason I stopped is because I believe that what follows, you already told us that was resolved. The sentence that starts after the "and," or the clause that starts after the "and." So that's why I stopped. You can read the whole sentence if you will.
A. (Dr. Bartlett) **Fair enough. If I could do that. I forgot that part, so...**
Q. I'm sorry. That's where I stopped.
A. (Dr. Bartlett) **I do not agree with your interpretation that everything that -- in the second half of that sentence that we have agreed that we are not concerned about.**
Q. Okay. In what respect do you believe that it is not possible to ascertain?
A. (Dr. Bartlett) **My characterization this**

morning, as I recall it, and I underlined this in pencil, so that's why I am going back to that, is that we -- it talks about uncertainties with the estimation of the thickness. And I agreed that I -- from these cone penetrometer data that there's not a great uncertainty in the estimation of thickness. But this sentence also talks about "and to establish design values." And so inasmuch as we're talking only about estimation of thicknesses of design value, I do not see any significant issues.
MR. TRAVIESO-DIAZ: Could you read the answer back again? I don't think I followed it entirely.
(The record was read.)
Q. (By Mr. Travieso-Diaz) Are you saying that you still believe that it is not possible to ascertain whether or not all data collected has been used to establish design values? Is that the part you have a problem with?
A. (Dr. Bartlett) **I'm sorry.**
MR. TRAVIESO-DIAZ: I'm sorry. I think I got it right, but could you read it?
(The pending question was read.)
Q. (By Mr. Travieso-Diaz) Can I rephrase the question?

A. (Dr. Bartlett) **Yes, please. I'm having a hard time with it.**
Q. If I understood your last answer, you said that to the extent that we're talking about the characterization of subsurface conditions, you don't have a problem that all data collected have been used to do that. But you are restricting yourself to that, and I presume that you meant that with respect to the use of those data to establish design values, you may still have a problem or a concern. Is that fair?
A. (Dr. Bartlett) **What I am stating is that thickness is a design value. We use it in calculations of settlements and other things. And inasmuch as thickness is a design value, the data that we have seem to be sufficient to estimate the thickness of the sediments, and I think I restricted that this morning in the upper 30 to 35 feet where the cone penetrometer data were collected. There are some uncertainties of thicknesses of layers deeper in the profile.**
Q. I think I understand now. Thank you very much.
Let's go to -- would you like to take a break now?
A. (Dr. Bartlett) **Your call. Yeah, it might be good for just a few minutes.**

(Recess from 4:31 to 4:42 p.m.)
Q. (By Mr. Travieso-Diaz) Before the break you mentioned something, I don't recall the precise words, to the effect that the boundary, the actual boundary between the layers was of some significance or some interest?
A. (Dr. Bartlett) **The thickness.**
Q. Of the layers?
A. (Dr. Bartlett) **Of the layers is a design value, because we have to use it in settlement calculations. We're also inferring how continuous in the vertical direction might be properties because those layers. So it is a design value, at least in the upper profile where the cone penetrometer's been taken. From a geotechnical viewpoint, the estimation of thickness throughout this pad emplacement area and the canister transfer building do not seem to be significant issues, but only with regard to the thickness.**
Q. All right. Let me show you another exhibit here.
(Exhibit 56 marked.)
I'm showing you what has been marked as Exhibit 56.
A. (Dr. Bartlett) **Correct.**
Q. And I will identify it for the record as

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being Section 2.6.1.12.1 of the SAR, entitled "Stability and Settlement Analyses--Cask Storage Pads." This section -- this exhibit goes from pages 2.6-46 to 2.6-54 of the SAR. And for the moment I'm going to ask you to look at page 2.6-49 and to the last paragraph on that page. Do you see that paragraph?
A. (Dr. Bartlett) **Beginning with "analyses"?**
Q. Exactly, yes. You have that.
A. (Dr. Bartlett) **Yes.**
Q. As I read this paragraph, it appears to say that in performing bearing capacity analysis, the applicant assumed that the top 30 feet of subsurface soil was uniform, and assigned to that layer the minimal value of strength measured in the tests that were taken on depths -- that were performed on samples obtained from depths of approximately 10 to 12 feet. Do you see that?
A. (Dr. Bartlett) **Yes, the UU test. I see that.**
Q. Correct. Is it your understanding that in fact based on this sentence and of what Mr. Trudeau testified yesterday, that that is what the applicant did?
A. (Dr. Bartlett) **They used a minimum value of the UU test with an undrained shear strength of 2.2 ksf.**

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That's the best of my recollection. We can review the calculation, but I don't think it's necessary.
Q. Assuming that in fact that is what they did, would any concerns as to whether the boundary between the various layers that are comprised in the upper 30 feet have any significance, at least insofar as this calculation is concerned?
A. (Dr. Bartlett) **I don't understand the question.**
Q. All right. This is what I understand applicant did. They measured strength in the layer from locations of depths of approximately 10 to 12 feet.
A. (Dr. Bartlett) **Correct.**
Q. And they selected the minimum value of strength that was shown by those tests.
A. (Dr. Bartlett) **Correct.**
Q. It's reported here as 2.2 thousand pounds per square feet.
A. (Dr. Bartlett) **Correct.**
Q. And they used that as the presumed strength of the entire top 30 feet of subsoil. Is that what they did?
A. (Dr. Bartlett) **That's apparently what they did.**
Q. All right. And assuming that's what they

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did, would that choice of design parameters resolve or address any concerns there might be with respect to what the thickness or the location or the layers that are comprised in the upper 30 feet would be?
Do you understand the question?
A. (Dr. Bartlett) **No.**
Q. Okay. Let me ask the question differently. Assuming that they picked the lowest value of strength that was available and what was perceived as being the least strong layer --
A. (Dr. Bartlett) **Okay.**
Q. -- okay? And they used that as their design value of strength in their analysis of bearing capacity.
A. (Dr. Bartlett) **Okay.**
Q. Assuming they did that.
A. (Dr. Bartlett) **Uh-huh.**
Q. Would that choice, that decision, resolve any concerns there might be, at least with respect to that calculation, as to what the relative locations or the various layers comprised the 30 feet would be? Do you care whether one layer is five feet or six feet or seven feet if you're going to take the lowest value and use it for all three?
A. (Dr. Bartlett) **Let me interpret what I read here.**

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Q. Okay.
A. (Dr. Bartlett) **That a sample was taken approximately 10 to 12 feet, presumably in layer 2. We must be careful when we look at that 10- to 12-foot depth to make sure that that was layer 2. Because it's my recollection layer 2 can sometimes end as shallow as eight feet. So there's a little bit of uncertainty of whether this exactly came from layer 2. So we first need to ascertain that.**
Then it's the minimum value coming from a set of UU tests where the state has always contended that the quantity and number of triaxial testing done in this area has been insufficient for a design facility of this size. I cannot tell whether it is the minimum value in layer 2. I have insufficient data to determine whether it's the minimum, maximum, mean, or if it even is actually from layer 2.
Q. All right. So -- and this becomes a hypothetical question because you don't have the answers to all these items that you said. But assuming hypothetically that the lowest value that was in fact measured in this upper 30 feet corresponded to the measurements of 10 to 12 feet and was this value 2.2, with those assumptions, assuming the things that you don't have to assume because you don't know --

MS. CHANCELLOR: I'm going to object. This is going to call for lots of speculation.
MR. TRAVIESO-DIAZ: Well, I would ask him -- I would like him to answer if he can.
Q. (By Mr. Travieso-Diaz) Assuming -- with those assumptions, would that design choice obviate the concern that you may have defined your layers not completely accurate?
A. (Dr. Bartlett) No. Because we discussed yesterday that even if we assume that the 2.2 ksf represents the minimum value for this layer and that we assume that the minimum is of layer 2, we talked about yesterday that there are still free field ground motions that have to be resisted by this particular structure and that some of this 2.2 ksf capacity will not be available, the full capacity will not be able to resist the motions of the structure. And we still have issues with this value even at 2.2 ksf.
Q. All right. Okay.
A. (Dr. Bartlett) Do you want to add to that, Dr. Ostadan?
A. (Dr. Ostadan) Yes. I think -- just a reminder, you discussed anisotropy and some cone penetrometer testing, and whether the shear strength under extension would be different or not.

A. (Dr. Bartlett) Yes, I remember now. Also an additional issue is the types of testing done were triaxial compression, and we've talked this morning and somewhat yesterday in our line of questioning about the need to consider anisotropy and that this 2.2 ksf may not represent the average shear strength mobilized along the failure plane.
Q. All right. Let's move to the first full paragraph -- first sentence in the first full paragraph of page 84 of Exhibit 3.
A. (Dr. Bartlett) Excuse me. Did we finish our discussion of the last sentence on 83? I don't recall.
Q. I believe so, because you talked about the first half of the sentence, and you have told me earlier in the day that the second half, having estimated the thickness, was no longer a concern.
A. (Dr. Bartlett) Yes. And restricted it to thickness, yes.
Q. So that's why I believe we have finished that section. So let's just move to the next one that says that -- I'm going to paraphrase it slightly -- that the SAR section 2.6 defining geologic features is not acceptable because the discussions, maps, profiles of the site stratigraphy, structural geology, geologic

history, and engineering geology are not complete and are not supported by investigations sufficiently detailed to obtain an unambiguous representation of the site geology.
Now, do you believe that sentence that I read you to be correct today?
A. (Dr. Bartlett) That's beyond my expertise and scope of review.
Q. Based on your expertise, is there any portion of that sentence that you believe to be correct today?
MS. CHANCELLOR: Objection. He already testified it's beyond his scope.
Q. From where you sit as the designated expert on this Issue 3, would that, the matters raised in that sentence, if true, be of certain to you?
A. (Dr. Bartlett) If they were true, they would be a concern to me.
Q. How would they be a concern to you?
A. (Dr. Bartlett) One must understand the geology of a site in performing the interpretation of what has occurred and the geological processes that have acted upon this site.
Q. All right. And you don't know in fact whether this assertion is still true. Is that correct?

A. (Dr. Bartlett) Right.
Q. All right. Now, the next sentence says, "The maps do not provide the requisite detail to evaluate the assumed geologic conditions stated in the text." First of all, can you help me, tell me what maps are being described here?
A. (Dr. Bartlett) Well, again, with using the adjective "geologic," I assume it would be referring to geologic maps.
Q. What would be -- what would geologic maps be?
A. (Dr. Bartlett) Mapping of the surficial geologic units.
Q. And do you know the extent to which those maps have been prepared since SAR -- since this contention was written?
A. (Dr. Bartlett) I have not reviewed those maps.
Q. All right. So you have no knowledge as to this particular sentence?
A. (Dr. Bartlett) That's correct.
Q. Assuming this sentence was correct, would it present a concern to you?
A. (Dr. Bartlett) Geologic maps can be used to interpret features, for example, faults or surficial

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geological features that could have implications and interest to the past history and potential future history of this site.
Q. Now, I'm going to ask you to read the next two sentences together, because I believe that -- and correct me, but I believe you need to read them together. The first sentence says, "The maps do not provide the requisite detail to evaluate the assumed geological conditions stated in the text." And then the next sentence says, "For example, only 25 borings were taken across the site, and from this a single generalized geologic profile in an obtuse angle across the canister fuel storage facility is presented." And the citation is given to SAR Figure 2.6-5.
A. (Dr. Bartlett) Correct.
Q. You see that?
A. (Dr. Bartlett) Yes, I do.
Q. Here's my problem.
A. (Dr. Bartlett) I see your problem.
Q. SAR Figure 2.6-5 I do not believe is a geologic map, is it?
A. (Dr. Bartlett) It's probably a profile, I would assume.
Q. In fact, let's just not assume. Let's take a look at -- never assume when you can prove. Let's

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take a look at Exhibit 51, and let's take a look at Figure 2.6-5, which is the third figure on the page.
A. (Dr. Bartlett) I see it.
Q. Okay. Does that look like a geologic map to you?
A. (Dr. Bartlett) No, that's a geotechnical cross-section.
Q. Right. And in fact, if now we look at the same Figure 2.6-5 as it sits today, it's 17 maps; is that correct? Or 14 and three maps.
A. (Dr. Bartlett) What I sense is happening here in this is that the geologist reviewed the original SAR and did not find the data that they needed to make their geological interpretations off of what is truly a geotechnical profile.
Q. All right. But what my concern is, are we talking here about a geological concern or a geotechnical concern? To the extent that he's talking about SAR Figure 2.6-5, that would indicate to me that he's talking about geotechnical, not a geological concern.
A. (Dr. Bartlett) And again, it may have been the only profile presented in the original SAR, and so it was perceived as both a geotechnical and a geological cross-section because it did show some type of layering.

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Q. All right. When it says here that "a single generalized geologic profile in an obtuse angle across the canister fuel storage facility is presented," can you go back again -- I'm sorry to keep going back to it, but let's go back again to that Figure 2.6-5.
A. (Dr. Bartlett) Sure.
Q. It's defined as Foundation Profile A-A' Looking Northeast, and if you will correlate for me perhaps with Figure 2.6-2 from the same exhibit.
A. (Dr. Bartlett) I see it, okay. The cross-sectional line, I see it.
Q. All right. Is the line A-A' on 2.6-2 at an obtuse angle? Is that what he's talking about?
A. (Dr. Bartlett) I believe so. On an angle that's not perpendicular or parallel to the main -- to the building.
Q. Assuming that that's what he's talking about, that he's concerned there's only one of these lines, isn't it true that you now have, just for the pad emplacement area, 14, and there are two diagonal cuts and like half of those go east/west and half of those go north/south?
A. (Dr. Bartlett) Correct. Those are geotechnical cross-sections.
Q. Well, what I'm trying to understand, and

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maybe you can help me, whether this concern now is still viable in light of all the additional information that we have.
A. (Dr. Bartlett) This, by using the term "generalized geological profile," to a geotechnical profile.
Q. Okay. If the wording of this particular sentence was changed from geologic to geotechnical profile, would you believe it's accurate today?
A. (Dr. Bartlett) In the extent that we've discussed our feelings of adequacy and inadequacy of the geotechnical profiles in this area, which we've had conversations, we've discussed those. Whether those same cross-sections meet the needs for a geological interpretation, I will not interpret that.
Q. From your standpoint, would those be sufficient?
A. (Dr. Bartlett) They may not be. They're geotechnical data, primarily, not geological data.
Q. But from a geotechnical standpoint, would they be sufficient?
A. (Dr. Bartlett) The cross-sections of the test?
Q. Yeah.
A. (Dr. Bartlett) We've discussed about their

adequacy, about delineating the stratigraphy in the upper five layers.
Q. Right, thirty feet.
A. (Dr. Bartlett) We've discussed some inadequacies we see even in the geotechnical perspective with depth.
Q. Below the top 30 feet?
A. (Dr. Bartlett) Yes, below the cone penetrometer data, CPT data.
Q. All right. And let's move on to the next sentence, that says, and I read, "The geologic profile cannot be correlated with surface topography, geological deposition soil characteristics, or seismic profiling completed for the site." Do you know whether that is an accurate statement today?
A. (Dr. Bartlett) Again, it uses the word "geological profile"; and inasmuch as I haven't really reviewed the main geological report for this site, which is the Geomatrix report, I defer from really answering any of those.
Q. And again, as you sit here today, would you consider this to be a concern to you?
A. (Dr. Bartlett) If one cannot correlate surface topography, geological deposition, soil characteristics, and deeper seismic profiling for the

site, it would be difficult to develop cross-sections that would show significant geological features, and those missing details could be important to this site.
Q. Okay. But to you is this a concern?
A. (Dr. Bartlett) From a geotechnical perspective?
Q. Yes.
A. (Dr. Bartlett) I'm not understanding that question. This is discussing geological data.
Q. Correct. I understand that you're not testifying as to what a geologist's concern might be with this statement. But as a geotechnical expert, would this statement in itself pose a concern to you?
A. (Dr. Bartlett) Yes. It might infer also, particularly with a couple aspects regarding seismic profiling, we also need some of those same types of data to develop shear wave velocity models. And so if those were incomplete, we would have difficulty also completing our analyses and characterizations.
It mentions soil characteristics. And even though -- if those soil characteristics are geotechnical, then I am concerned that they're -- that we need to better quantify the soil characteristics.
Q. Well, you would not turn to the geological profile to do that, would you?

A. (Dr. Bartlett) You bet I would.
Q. I thought you would be looking at the geotechnical profiles that we were looking at before.
A. (Dr. Bartlett) I'm also trained as a geologist, and I always look at a geological profile before I start my geotechnical investigations.
Q. Oh, so you have expertise in geology?
A. (Dr. Bartlett) I have a degree in geology.
Q. I see.
A. (Dr. Bartlett) But I am not the state's expert on that Geomatrix report.
Q. So your deferring on geology questions is not based on lack of knowledge, but it not your assumed role in this --
A. (Dr. Bartlett) I've practice as a geotechnical engineer for most of my profession. My geological skills are still there, but a little bit distant.
Q. Maybe you can help me, then, on the next sentence that says, "Details missing include the interrelationship of the subsurface conditions with the geologic history of the site." Would you just translate that for me and tell me what it means?
A. (Dr. Bartlett) I think what this is trying to do is establish the interrelationship of the

subsurface conditions and the profiles or cross-sections we talked about with the geological history: what are the geological origins of those units, what are their ages, how were they deposited, what are their characteristics from a geological perspective.
Q. To ask the question differently, would this mean a correlation with a particular subsoil level and the time in geological history in which that level was deposited?
A. (Dr. Bartlett) That's part of it, but it means more than that.
Q. What else does it mean?
A. (Dr. Bartlett) Could mean its physical characteristics. Could mean any anomalies or differences or subtle difference in this layering. Could mean also -- since it's a general term, subsurface conditions, it could mean faulting and fracturing or issues related to potential instability that's been recorded in the geological history of these sediments. It means many things.
Q. All right. Let's go back and take a look at Exhibit 50. I'm sorry, I didn't mean to cut you off. Are you finished?
A. (Dr. Bartlett) No, no. That's enough.
Q. Let's take a look at Exhibit 55. Black and

white version, Plate 3. Do you have that? Take a look at Plate 3. On the bottom left corner there is a section that is entitled "Unit Descriptions."

A. (Dr. Bartlett) Correct.

Q. And to my untrained eye it appears to correlate each of the subsurface soil layers to a particular period in geological history. Is that the way you read it?

A. (Dr. Bartlett) That is a geological interpretation of these measurements.

Q. Is that what the sentence we just read in Exhibit 3 was missing?

A. (Dr. Bartlett) I've lost the sentence.

Q. I'm sorry. We are talking about the last sentence on the first full long paragraph on page 84, which reads, "Details missing include the interrelationship" -- I'm sorry. You need to look at Plate 3, I believe.

A. (Dr. Bartlett) I need to quit looking at the SAR and get back to Contention L. Okay.

Q. Actually, while you're doing that, let me mark Exhibit 57.

(Exhibit 57 marked.)

For the record, Exhibit 57 is Section 2.6.4.1 --

A. (Dr. Bartlett) Correct.

Q. -- of the SAR entitled Geologic Features That Could Affect Foundations.

A. (Dr. Bartlett) I see that.

Q. All right. Taking a look at either Exhibit 55 or Exhibit 57 or both, will you tell me whether in fact the data that is asked for or identified as being missing in that sentence is no longer missing?

A. (Dr. Bartlett) Since it mentions earlier in the paragraph about an obtuse angle to the canister transfer building, I think we need to also check to see where these are physically. As I recall, these are down in the center of the storage pad. Again, I haven't reviewed the report.

MS. CHANCELLOR: What do you need, Steve?

DR. BARTLETT: That shows the layout of where these trenches are.

Q. (By Mr. Travieso-Diaz) Let me give you another document that may help you.

(Exhibit 58 marked.)

I am showing you also what is identified as Exhibit 58, which is Section 2.6.1 of the SAR. That goes from page 2.6-1 to 2.6-4, which is entitled "Basic Geologic and Seismic Information."

(By Mr. Travieso-Diaz) Using any one of

these three documents, either separately or together, would you give me your view as to whether in fact the interrelationship between the subsurface conditions and the geologic history at the site has now been provided? That's my question.

A. (Dr. Bartlett) Again, this is outside the area of my review.

Q. But you are a geologist and you can read the drawing like Plate 3 and see if it in fact ties --

A. (Dr. Bartlett) I can; but reading a report of this scope and extent takes time, and trying to give off-the-cuff interpretations, I may misrepresent this data. I can see geological data, I can see a trench log that's in the middle of the pad emplacement area. However, this paragraph that we've been focusing on in the middle of page 84 also discusses the collection of data in the area. Talks about a concern of no really geological data in the canister fuel storage facility. That would be the pad emplacement area that we've been talking about.

Q. Make I can ask the question more simply. Looking at the three exhibits that I've put before you, 55, 57, and 58 -- and 55 is Plate 3. Would you testify that in fact there is still missing information by applicant on the interrelationship of the subsurface

conditions for the geologic history of the site?

MS. CHANCELLOR: I'm going to object. That's been asked and answered.

MR. TRAVIESO-DIAZ: But he was also asked this sentence with the one before. I'm asking him specifically as to the statement that is made here, that there is no information on the interrelationship of the subsurface conditions for geologic history of the site.

Q. (By Mr. Travieso-Diaz) And my question is whether the documents that are put in front of you provide that information.

A. (Dr. Bartlett) I will tell you what I see, based on what's placed before me with no review.

MS. CHANCELLOR: I'm going to caution the witness that he shouldn't speculate.

A. (Dr. Bartlett) I see a trench log with geological data and interpretations of layers in the geological context. Whether these are adequate, inadequate, meets this, it's out of my area of review.

Q. Maybe you read more into my question than what I meant. I didn't ask you to opine to the adequacy of the materials that are put before you. My question was, this statement makes the assertion that that information doesn't exist. That's the way I read it. Do you read it the same way? "Details missing include

the interrelationship of the subsurface conditions with the geologic history of the site."

A. (Dr. Bartlett) **No, it doesn't infer the data are missing. It infers that the interrelationships are missing. The interpretation is missing of the data.**

Q. I'm sorry. Take a look, for example, at Plate 3 on Exhibit 55. Doesn't that plate contain an interpretation of the subsurface layers?

A. (Dr. Bartlett) **It contains an interpretation of data, but the geological data are many, not just the trench logs, and there's no really discussion of the interrelationship of the geological data.**

Q. Does the unit description on Exhibit 55, Plate 3 provide a correlation between each of the layers of soil that are presenting the top of the plate with a description of what also this document believed to be various geologic areas -- eras?

A. (Dr. Bartlett) **But that's not the complete interpretation of the interrelationship of all geological data, how they fit together.**

MS. CHANCELLOR: I'm going to have a continuing objection to this line of questioning. The witness has testified it's beyond his scope. You're asking him questions about documents he hasn't reviewed,

and I'm going to go on the record as either beyond the scope of his review or asked and answered.

MR. TRAVIESO-DIAZ: I'll go on the record as stating that to the extent that you have provided a witness who is going to be the expert in this contention, he ought to be able to address the matters raised in the contention unless they are dropped. And I think I have every right to explore whether he understands this particular sentence, which may or may not have been true at a time previous to today, and that's what I'm trying to find out. Because if his opinion is that this particular sentence is still true when it's litigated -- if he doesn't think it's true, then we don't need to go over it, and that's the reason I ask the questions. And I think I'm entitled to have an answer to the question. So that's my position on this, and that's what I'm asking.

DR. BARTLETT: Let's have a break.

MR. TRAVIESO-DIAZ: All right, let's have a break.

(Recess from 5:18 to 5:24 p.m.)

Q. (By Mr. Travieso-Diaz) If you can stand it, let me ask you one more question on this subject. As a geotechnical engineer, what use, if any, would you have for the geological history of a particular set of soil

layers? Do you use that information in any way?

A. (Dr. Bartlett) **You bet.**

Q. How?

A. (Dr. Bartlett) **Qualitatively in that it helps me understand the geological origins of this site; and being trained as a geologist, I can also infer something about their engineering properties.**

Q. And did you look at the Plate 3 that I showed you a moment ago when you were doing that, since it's useful to you?

A. (Dr. Bartlett) **It tells me something about, yes, the Bonneville sediments.**

Q. Did you look at it before I showed it to you today?

A. (Dr. Bartlett) **I was provided the Geomatrix report. I have it. Whether I looked at that particular plate or not, I'm not particularly sure. I guess I can't recall whether I distinctly looked at that plate.**

Q. You said that qualitatively it may be of some help to you. Quantitatively, in terms of your evaluations, do you use it in any way?

A. (Dr. Bartlett) **Quantitatively, no; but qualitatively, having also studied that same Bonneville -- the same set of Bonneville deposits in this valley, I could understand at least that they're in**

the same sequences, that they're roughly the same thicknesses. And also we've seen this Bonneville sediment, that it tends to have a clayier upper profile, more siltier intermediate profile, and then a deeper, clayier profile again. And that's consistent with my knowledge at the Bonneville here, and also in Skull Valley. But engineering-wise, no, because those are far enough apart that once you do site-specific investigations, you determine the properties.

Q. Thank you.

A. (Dr. Bartlett) **It fits in my framework the way the -- the world makes sense.**

Q. And having looked at table -- Plate 3 and in connection -- in conjunction with all the other drawings that you have looked, does that Plate 3 make sense to you compared to the other things that you have seen? Is there an inconsistency between the way that Geomatrix has characterized the subsurface conditions and the geologic history with what your analysis shows?

A. (Dr. Bartlett) **I haven't compared, obviously, the individual layerings and where Geomatrix has broken a layer corresponding where the geotechnical borings and layers have been broken. The Eolian deposits are on the surface; the geotechnical report identifies them as such. The Bonneville deposits are**

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not necessarily identified on the geotechnical reports as Bonneville. But we see a Bonneville deep-water facies that's described in geological context: light gray, mottled white; very fine sand-clayey silt; irregular coarse angular blocky structure; plastic, sticky; abundant ostracods; manganese, iron oxide staining, so on and so forth.

It seems consistent with what I would expect to be the upper Bonneville and probably layer 2 from the geotechnical report, but we could verify if these contact boundaries matched the geotechnical report, which I have not done.

We see another Bonneville deep-water facies underlying that described as pale brown, fine sandy silt; fines upward; upward bedded; thinly laminated, abundant ostracods. I'd have to check that. I'm not sure if that's layer 3 in our correlation. Possibly. And then the deeper layers.

But having a geotechnical profile and a geological profile, I think I could interpret between the two.

Q. All right. Now, let's look at now to the next sentence on Exhibit 3, which is in the last paragraph on the page. The sentence starts with "further." Let me read it for the record.

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"Further, the application does not discuss the geochemical effects of the environment (weather and rain water) on the physical and strength characteristics of the soil and rock at the ISFSI site, particularly if there is potential for geochemical weathering and leaching of soils and rocks at the storage site."

A. (Dr. Bartlett) Correct.

Q. Is this sentence that I read you accurate as of today?

A. (Dr. Bartlett) We discussed yesterday about the potential of cementation in layer 2. And mentioned that we had not seen any geochemical analyses for the amount of calcium carbonate, $CaCO_3$, subscripted 3. Also, the soils can have other leachable solubles. Whether the Geomatrix report discusses these or looks at those, I cannot comment on. I have not seen that in the geotechnical parts of the SAR. And is there a potential for weather and leaching of soils -- let's see.

One thing I want to make a comment, at least on the weather and rain on the physical and strength characteristics of the soils, as we talked about this being an unsaturated soil; however, it goes through repeated cycles of wetting and drying just due to surficial waters. Those can be runoff. They're not permanent, ponded waters. And we do believe these

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clays, particularly in layer 2, can be susceptible to drying and wetting which will change their physical strength.

The potential for geochemical weathering, that's probably implying some loss of cementation either of the soils or perhaps of the deeper rock, which I'm not sure what the deeper rock is here, whether it's calcarious.

And then again, and leaching of the soils, again, the loss of soluble salts and materials out of the soils.

Q. Let me first ask you -- I'm sorry. I'm not sure whether that answer, complete as it was, answered my question, which was, do you believe this paragraph to be still accurate up to this date?

A. (Dr. Bartlett) I believe there are still issues related to this paragraph.

Q. Now, going to the first part of the paragraph that says the application does not discuss various things that are following in the sentence that I read you. "The application does not discuss"; is that correct?

A. (Dr. Bartlett) My recollection of reading the geological section of the SAR, where I believe this would have been discussed, I cannot comment on that,

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because I did not in preparation for this deposition read I think the appropriate sections of the SAR to support this.

Q. I think you have before you Exhibit 57. Take a look at it. Would you look at Section 2.6.4.1 that starts on page 96 and goes to page 97.

A. (Dr. Bartlett) Correct.

Q. Does this section contain a discussion of geochemical effects of the environment at the site?

A. (Dr. Bartlett) Exhibit 57, correct?

Q. Yes.

A. (Dr. Bartlett) It discusses the potential for karst topography and says that "there is no history of karst development in the region." It says, "There is no evidence of any significant soluble mineral deposits in the unconsolidated materials," but then does not support with any suggestion that analyses and testing were done to support that statement.

And then it reports I guess that there is no evidence of soluble mineral deposits in the unconsolidated materials beneath the site for at least 20 -- let me state it again. There is no evidence of any significant soluble minerals deposited in the unconsolidated materials beneath the site to at least a depth of 225 feet. Again, I do not see any reference to

reports that would support that statement.

There are soluble mineral deposits in our soils, generally. And it says, "no record from water wells," and I'm not sure water wells do the proper geochemistry analyses. "In the valley indicates the presence of similar materials at greater depths." So it's using data in the greater realm of the valley. I'm not sure exactly the location of these water wells and how close they are to the PFS site.

And then it states, "Evaporites associated with the waning stages of Lake Bonneville and the Great Salt Lake were not deposited here as the area remained above the extent of saline stages of these lakes." It still doesn't preclude that there are other types of soluble salts in this soil.

Q. To make the discussion clearer between us, first, put aside for the moment the adequacy or the background that may exist for statements on Section 2.6.4.1.

A. (Dr. Bartlett) But that's my main point is I think we're not only discussing in this contention whether there are -- you asked me whether there are statements about that, but I'm saying the SAR does make statements about types of deposits that are potentially soluble, but --

Q. But please hear me out, because I'm asking you something different.

A. (Dr. Bartlett) Sure.

Q. The contention says the application does not discuss various things, and I'm showing you a document that appears to me to indicate that it discusses those sort of things; whether well or poorly is a different story. Is this a true statement as of today: the application does not discuss the geochemical effects of the environment?

A. (Dr. Bartlett) It essentially does not discuss the geochemical effects of the environment. It just basically says that there are no issues. There may still be issues with environment, geochemical effects of the environment on the physical strength and characteristics of the soil and rock. It's not just a matter of saying whether they are discussing them.

This sentence the way I read it implies that it does not discuss the effects. Effects, we talk about cause and effect. How does the rain water or the weather affect the physical properties and strength of these soils? It does not discuss that. It just goes on and doesn't discuss any potential effects on the soil. We've given you an example that the physical strength of the soil can be changed by -- due to moisture content on

the surficial, the surficial soils, and it doesn't discuss that.

I don't think we're just limited ourselves to karstic topography and evaporites. And I'm not sure -- I guess that's all I have to say.

Q. Let me ask you the following question. Do you know whether there are studies or analyses by a member of the PFS design team that provided information on which this paragraph was based?

A. (Dr. Bartlett) Please repeat the question.

Q. Yes. The paragraph that you have been referring to, the two paragraphs in Section 2.6.4.1.

A. (Dr. Bartlett) Correct.

Q. Do you know whether there are any analyses performed by someone on behalf of PFS that provides the basis for the statements that are made in these two paragraphs?

MS. CHANCELLOR: Objection. That's too vague. I mean, there's a stack of documents like -- there's an entire body of documents that's been generated by PFS. To ask him if somewhere in all the documents that PFS has produced whether there's any information to support this statement I think is overbroad.

MR. TRAVIESO-DIAZ: Excuse me, but I believe

the question was prefaced by the words "do you know whether there are." And I believe phrased that way, the question is not overbroad at all. Either he knows that there are or he doesn't know.

Q. (By Mr. Travieso-Diaz) Do you know whether there are such studies?

MS. CHANCELLOR: I'll still object, but you may answer.

A. (Dr. Bartlett) I do not know if there are studies supporting these statements. Normally when one makes statements one references reports or studies, and I see no referencing going on here. So I can only accept them at face value, not knowing the basis of what these statements are.

Q. Fair enough. Based on your personal experience, which I believe you talked about earlier of drafting SAR's, isn't it true that when you put information of this nature in an SAR, you are expected to have background material that provide the basis for the statement?

A. (Dr. Bartlett) Yes, and I referenced it.

Q. And do you know whether there are references for this section?

A. (Dr. Bartlett) Perhaps, but I can't correlate this paragraph with references that --

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generally we would cite the report and the year, or the appropriate appendix to review to see if these statements have basis.
Q. Let me ask you now as to the content of these two paragraphs as opposed to whether they exist. First question I have for you is, have you reviewed the meteorology of the PFS site?
A. (Dr. Bartlett) Meteorology?
Q. Yes.
A. (Dr. Bartlett) No, I didn't review that.
Q. Can you cite for me what the annual precipitation of the site is?
A. (Dr. Bartlett) Well, I live in the adjacent valley. It's somewhere around nine inches, plus or minus three or four.
Q. And the seasonal?
A. (Dr. Bartlett) And the seasonal --
Q. Yes.
A. (Dr. Bartlett) -- variations?
Q. Yes.
A. (Dr. Bartlett) I don't know the seasonal variations.
Q. Would you need to know the seasonal variations to determine the extent to which rain water may percolate down to --

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A. (Dr. Bartlett) No. It's really the snowfall that controls here, because we amass snowfall in the winter and in the spring we have a thaw, and our soils tend to get the moistest in the spring during the thaw when the snows melt. So we store six to eight months of snow in the mountains, and we get -- our soils get the wettest in the spring. Generally, except in odd years.
Q. We know that. Did you investigate the amount of snow melt, if you will, I think that's the proper term, that would be available in the typical spring at the surface of Skull Valley to percolate down to lower layers of the soil?
A. (Dr. Bartlett) No.
Q. So without that information, could you tell whether there is a concern about potentially having loss of cementation in the lower level?
A. (Dr. Bartlett) I don't have to be a meteorologist. These are clayey soils. I've driven on them and gotten stuck in them in the spring. So it seems to me -- fine, we can talk about whether there's meteorological cycles, but the shallow surficial levels do get wet during the spring and their moisture content changes.
Q. And they get wet from what? Snow runoff

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from the mountains?
A. (Dr. Bartlett) Snow runoff and, yeah, just melting and sheet flow sometimes. And sometimes large precipitation events that occur in April and -- March and April here when we're right on the verge between snow and rain.
Q. How far are the closest mountains to the site?
A. (Dr. Bartlett) Closest mountains to the site?
Q. Yes.
A. (Dr. Bartlett) Approximately six miles to the Stansburys. I don't know how far it is to the Cedar Hills Mountains.
Q. And basically you're familiar with this area you just testified about. Would you expect that that snow runoff from the mountains six miles away would create significant amounts of water at this site?
A. (Dr. Bartlett) Sure. You should have been in here in 1983 and '84 when we had 200 percent annual snow pack in our mountains. Everything was wet. I saw sheet flow over alluvial fans and flooding in several communities.
Q. By the way, let me ask you about specific area of the site, which is the pad emplacement area.

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A. (Dr. Bartlett) Sure.
Q. You're aware of the testimony that has been given, there is going to be soil cement built on --
A. (Dr. Bartlett) I am aware of that, yes.
Q. If you have soil cement underneath the foundations, would that tend to resolve your concern about potential loss of cementation of the layers below?
A. (Dr. Bartlett) I have really insufficient data to talk about that, but remember that we're talking about unsaturated flow, and it doesn't always have to be driven by sheets of water flowing over the surface. What can happen when you place a concrete foundation that provides a barrier to further drying -- what we would call evapotranspiration -- and simply due to capillary action of these soils, you can have migration, if you will, of water underneath these areas from the surficial waters. I've seen it before. I've placed things on the ground, come back later, and they're damp.
Q. Is it your testimony that it is a possible scenario that you will have water migrating some distance from the concrete, the soil cement pad?
A. (Dr. Bartlett) I'm not sure. We've talked about the soil cement mixture. It's at a conceptual stage. I know nothing about its permeability, its ability to be a barrier or lack thereof to water

underneath these pads. I cannot comment whether it's going to really effectively, if you will, stop any water from getting underneath these pads.

A. (Dr. Ostadan) May I add? I think your expert testified yesterday that this is at the conceptual stage. We did discuss the behavior of the soil cement on the seismic loading, and if I recall correctly, your expert testified that the bonding within the pad in the soil cement could potentially break if the stress exceeds the strength. We discussed shrinkage and cracking of the soil cement. So I believe all those issues would have a role in the topic we're discussing.

A. (Dr. Bartlett) I cannot hypothesize about whether this will really provide an impermeable barrier to such a large area.

Q. Let me ask you the following question. Have you designed soil cement structures?

A. (Dr. Bartlett) I have not.

Q. Is it your expectation that a soil cement foundation will be permeable, conduct -- will let water get through?

A. (Dr. Bartlett) I do not know.

Q. Okay. So you don't know. Let me ask you a different question. Are you aware that the design of the PFS facility as currently envisioned includes --

A. (Dr. Bartlett) May I add to your statement? However, you implied that it will -- permeability is not the only mechanism of transportation of water. There's still cracking, and there can be flow through cracks. And you've essentially created now -- if it is truly a low permeability barrier, you've essentially created what we would term a parking lot. And water can pond on any low spots if it is truly impermeable, and now migrate downward through the cracks.

So, you know, we're hypothesizing. We do not know much about how this is going to behave.

Q. One more question. I think this one we know about. Are you aware that part of the design of the PFS is a water collection system that will take that water back from the mountains that melt away from the structures? Are you aware that that is a design feature?

A. (Dr. Bartlett) Correct.

Q. And how do you postulate, then, that the water is going to get underneath the pad, underneath the canister building? How does it get there?

A. (Dr. Bartlett) Under the pads or canister building? Which one?

Q. Whichever. Okay, let's say the pads. If there is a water collection system around the perimeter

of the site that will collect the water that comes from the mountains or whatever.

A. (Dr. Bartlett) Let's go with the assumption, then, it's an impermeable barrier. Is that what you're wanting to do?

Q. I'm just saying it's a water collection system.

A. (Dr. Bartlett) No. I'm talking about what is the nature of the pad -- I mean, the soil cement mat, I think it was referred to yesterday. Is it permeable or impermeable? Let's just assume. I need to know whether -- we have to assume whether it's permeable or impermeable for this discussion.

Q. For the discussion of the water collection system?

A. (Dr. Bartlett) Yeah. You're asking me to conjecture about things, so I need to define the bounds of which I'm conjecturing.

Q. Do you believe it's a conjecture that there is going to be a water collection system at the site?

A. (Dr. Bartlett) I'm not worried about the water collection system right now because I'm going to introduce another mechanism for a way the water can get down, even if you have your water collection system in place.

Q. Please.

A. (Dr. Bartlett) Okay. Is the pad, the soil cement pads -- not the pads -- the soil cement mat that we talked about yesterday which we talked about being now continuous between all the pads, is it essentially permeable or impermeable?

Q. Your pick. You are the witness.

A. (Dr. Bartlett) I don't know. That's why I'm saying you haven't provided us the data to assess this, so I need to -- if we're going to conjecture, I need you to define the bounds of which we're going to conjecture.

Q. Well, but -- then let me ask you the question this way. Are you saying that the concerns of potential water infiltration and loss of cementation of the lower layers of the site is at this point conjecture?

A. (Dr. Bartlett) Please repeat it.

MR. TRAVIESO-DIAZ: Read it back. I never can say the same thing twice.

(The pending question was read.)

A. (Dr. Bartlett) I think we were talking about ways that water could get down through this soil cement system. You brought out the point that there is going to be a collection system for the surface runoff.

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If the soil cement itself is essentially impermeable, which I do not know, I have no data to either confirm or deny that, then it will essentially be a very continuous, large area. If due to cracking of that impermeable barrier, water will still penetrate through it. There is also water migration through cracks even through an impermeable barrier. If it is permeable, then it simply just permeates through.
Q. Explain to me or for the record how in your postulated scenario the water gets past the water collection system and gets underneath the pads.
A. (Dr. Bartlett) The water comes from snow that accumulates and melts in the spring.
Q. Yes.
A. (Dr. Bartlett) It's already got past your water collection system. It's resting in the whole pad emplacement area.
Q. You're saying now, talking about snow that is resting on the surface of the pad?
A. (Dr. Bartlett) Sure.
Q. And you're postulating that it's going to percolate?
A. (Dr. Bartlett) Melt.
Q. It's going to melt, it's going to become water.

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A. (Dr. Bartlett) And percolate.
Q. And percolate through the foundations --
A. (Dr. Bartlett) Either through cracks around, in the soil cement.
Q. So your postulation is that the water present on top of the pads will migrate through cracks through the foundations, and then it will reach the level below the foundation. Is that --
A. (Dr. Bartlett) May I hear the question?
(The pending question was read.)
A. (Dr. Bartlett) Not through cracks through the foundation. The foundation implies to me the pads themselves. We're talking about the soil cement mat that's around. It's either cracks in that soil cement mat or gaps that form between the pad foundations and the soil cement. We can't preclude that they're not going to form. We've talked about mechanisms of creating tensile cracking within that mat. It's a very large mat and it's unreinforced.
Q. Based on your experience, can you give me an estimate how long it would take to create a crack of the type you're describing on a concrete --
A. (Dr. Bartlett) Cementitious materials can crack upon drying. That's how they cure. Concrete cracks.

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Q. So you expect that there could be concrete cracks from the beginning?
A. (Dr. Bartlett) Well, these are not concrete cracks. They are soil cement.
Q. Soil cement cracks, yes.
A. (Dr. Bartlett) Yeah, as they dry, I'm sure.
Q. Are you postulating -- how deep do you postulate those cracks to be?
MS. CHANCELLOR: I'm going to object. We're really getting into the speculative area, because we're talking about a conceptual design. You're asking him based on his conjecture as to what this conceptual design is. Now you're asking him speculation on speculation to postulate how deep these cracks will be. I think we're just stretching the bounds too far.
MR. TRAVIESO-DIAZ: I understand your problem, but now you have to understand mine. He has expressed a potential concern, and I want to understand whether he has any actual basis today for that concern or whether it's a hypothetical concern. If he can tell me that it is all hypothetical, it may not become a concern once he knows how the designs develops.
A. (Dr. Bartlett) Cracks develop. We have concrete cracks. This has cementitious material in the soil cement. It can be susceptible to shrinkage,

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cracking. It may not be completely stabilized. It's a very large area. You have heavy equipment running over it.
I can -- we can continue to speculate mechanisms, but I think the important part is if it's part of your strategy that this is an impermeable barrier, then I believe that it would have to be demonstrated to us that it really behaves as that and it doesn't crack.
Q. And the crack would have to essentially run through the entirety of the soil cement?
A. (Dr. Bartlett) Not necessarily, no. It can come down and -- partly come down through one crack and then migrate laterally through differences in your lifts and then go to another. I mean, it doesn't have to be one vertical crack.
Q. So you have to assume also that the lifts are uneven for this to happen, that the lifts, that the concrete or soil cement lifts are uneven so the crack can propagate through them, or --
A. (Dr. Bartlett) Your initial materials that you're going to do this with are not purely homogeneous, so there will be differences in strength and characteristics of this. How significant those are, I do not know. But we also have tension cracks that will

form right at the soil cement/pad interface. There's a vertical face. Those are very dissimilar materials. I can see water migrating down that.
Q. One more question and we'll move to something else.
A. (Dr. Bartlett) Sure.
Q. Is it your experience that from the quality assurance standpoint when concrete placements are made that in fact inspections are made to make sure that the lifts exhibit no cracks or exhibit no discontinuities and that there are not significant cracks in the placements?
A. (Dr. Bartlett) I think we've been talking about post-construction cracking, not construction cracking. But I have no experience with construction cracking. It may occur, it may not.
Q. So the cracks that you're postulating will occur after the site is --
A. (Dr. Bartlett) Our last discussion over the last ten minutes has been really more post-construction.
Q. By the way, how long is this facility going to be in operation? Do you know?
A. (Dr. Bartlett) Well, that depends upon I guess a potential for renewal. But as long as maybe 40 years.

Q. And the phenomena we're talking about here, like geochemical weathering and migration of water through cracks, are these things that happen continuously or develop over time?
A. (Dr. Bartlett) They can happen relatively quickly. We have concrete bridge decks here on I-15 of high quality concrete that are already cracking and showing water coming down through concrete decks and appearing on the underside of decks through migrations from microfracturing. It's very common.
A. (Dr. Ostadan) I'd like to add to that. The condition of concrete cracking is also reflected in the guidelines of KSE 498 or 487, specifically asks for concentration to concrete cracking for design.
Q. Let me ask you the question now about the consequences of the phenomena that you have testified that could happen.
A. (Dr. Bartlett) Sure.
Q. Let me see if I understand. The concern would be that water through one of the various mechanisms that you have been talking about could get through to what layer of the soil?
A. (Dr. Bartlett) To layer 2, I think.
Q. What would be the significance of having the water reach layer 2?

A. (Dr. Bartlett) If the water gets there then the moisture content changes, and these clays then can be susceptible to loss of strength just due to increases of moisture content. That could affect the engineering stability calculations if these do intend to increase in moisture content with time versus what -- versus the time at which they were sampled. That's our baseline is what was the moisture content at the time at which they were sampled. The question we're asking is, are there potential for significant changes in water content, how may that affect the shear strength primarily of these clays.
Q. I believe you're familiar -- we haven't talked about it yet -- with the shear strength tests that were performed for the PFS site?
A. (Dr. Bartlett) I am.
Q. And I take it you're also familiar with the test results, with the results of those tests?
A. (Dr. Bartlett) I know in general what the values are of those tests. I'm not sure I could specifically cite for any individual facility what the design values are.
Q. No need.
A. (Dr. Bartlett) I know the range of about where they are.

Q. But my question actually was a different one.
A. (Dr. Bartlett) Oh, sure.
Q. Do you have any recollection as to whether the samples that were tested for strength had different degrees of moisture content?
A. (Dr. Bartlett) I haven't researched that through to see what the moisture contents were for the particular samples at the time they were tested. But again, that seems not -- the important question to me is not what they were when they sampled, but could they increase or decrease with time now due to environmental conditions.
Q. Yes, but let me ask you a different question, which is slightly different. I take it, then, that since you didn't look into the moisture content of the sample from this viewpoint, you cannot tell me now whether you make any difference in test of the strength of the sample that was tested, the degree to which it had higher or lower moisture content?
A. (Dr. Bartlett) Please repeat the question.
Q. Rather than having this poor court reporter try it, let me say it again.
You testified a moment ago that you didn't look at the test results with an eye towards the

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moisture content of the sample. Is that correct?
A. (Dr. Bartlett) I paid some attention to it, yes, but I can't recall definite conclusions about it because I wanted to see if these were plastic materials with higher water contents versus maybe non type of plastic materials with lower water contents.
Q. And as long as you're saying that, your recommendation was what?
A. (Dr. Bartlett) They're partially saturated. To what degree, I guess I could look at -- we saw a table yesterday of average saturations and water contents. We could refer to it in generalities to see what those were.
Q. So my question was -- the one that I didn't want to have read back again -- did you look at the extent to which, if any, there was a difference in the measured strength of the samples depending on the water content?
A. (Dr. Bartlett) No. That was one of the things we'd like PFS to do for us is to see if there is potential differences in strength due to water content.
Q. Okay. But you will agree with me based on your recollection that --
A. (Dr. Bartlett) They have a moisture content that corresponds to the sample.

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Q. Right.
A. (Dr. Bartlett) And they have done a test. What we are asking is, can that strength change with some changes in water content. PFS has maintained that we need to test it at the water content from which we retrieve the sample. That will assume the moisture content will stay constant with time. We are not sure that that's going to be true or not.
Q. My question was, from one sample to the next, assume Sample A had 20 percent higher water content than Sample B. Is there any difference that you can detect on the measure of strength of those two samples?
A. (Dr. Bartlett) With 20 percent changes in water content?
Q. Yes.
A. (Dr. Bartlett) Markedly. Not from your data, but yes, I can show -- I cannot show, but the water content will affect the strength of that sample.
Q. But based on the actual test data collected at the PFS site, do you have any recollection of comparing two samples with differing water content and detecting significant difference in strength?
A. (Dr. Bartlett) For these particular two samples?

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Q. Yes.
A. (Dr. Bartlett) Do we need to worry also about from which layers they are and also from what depths they're coming from? Because there's other factors besides water content that affects strength.
Q. Assume they're from the same layer, to narrow it down somewhat.
A. (Dr. Bartlett) So this is a hypothetical set of data? We're not taking about real data?
Q. No, I'm talking about real data that is reflected in attachments to the SAR. And you can tell me, if the answer is I don't remember, that you don't remember whether the amount of water content in the sample had a significant effect in the measure of strength. That's what I'm asking you.
A. (Dr. Bartlett) Give us a moment and we'll research that.
MS. CHANCELLOR: Can we go off the record for a minute?
(Discussion off the record.)
A. (Dr. Bartlett) The issue is, could potential higher moisture contents indicate themselves in lower undrained shear strengths for unit 2? Is that what we're --
Q. Yeah, for measured samples that you have

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data from for PFS.
A. (Dr. Bartlett) Correct. Let's go to Appendix B of Attachment --
Q. Are you just get a boring number, a boring sample?
A. (Dr. Bartlett) Can you do it from that? I'm looking at CTB-1. First figure --
Q. Do you have a sample number?
A. (Dr. Bartlett) Sample number U-3D. This sample has a water content of 47.9 percent. And also it's a consolidated-undrained triaxial test, we should say that. And we have plotted on the Y axis shear stress in kips per square foot. We have -- kips, k-i-p-s. Ksf. And on the X axis, axial strain percent. And we see that from the stress drain curves that the peak strength for this particular phi is somewhere between 2.8 and 2.9 ksf.
Now, in that same attachment, go to a -- and by the way, I might note it shows somewhat of a brittle behavior to me. It reaches a peak and drops off dramatically on larger strain.
When we go to Boring CTB-N, it's seven pages --
MR. TRUDEAU: Sample.
A. (Dr. Bartlett) -- U-2B. I should have

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added, too, the depth from the previous sample was 8.4 feet, so it's probably within layer 2. It's -- at least the depth range seems appropriate.
When we look at this sample, which has a water content of 65.4, the peak strength is a much larger strain, and it is at about 2.4 ksf.
Q. Does that mean that the second sample is stronger than the first?
A. (Dr. Bartlett) This means that the second sample is weaker than the first.
Q. I am reminded to ask you, if you look at the void ratios for the two samples, if there is a significant difference also in the void ratio?
A. (Dr. Bartlett) One is 1.73, one is 2.76.
Q. Could the higher void ratio in the second sample result in lower strength?
A. (Dr. Bartlett) It could. Generally also unstrained shear strength is correlated with void ratios, but the data are inclusive.
Q. Oh, one more question. We're talking about water infiltration. I presume that your concern is water coming from above, not water coming from below.
A. (Dr. Bartlett) No, it's not coming from the ground water.
Q. I wanted to get that clear.

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A. (Dr. Bartlett) Sure. We have that situation on buying beach front property.
Q. So that I understand one more aspect of your concern about water, your concern is that the soils will lose strength. Are you concerned that it will collapse altogether?
A. (Dr. Bartlett) In the sense we're using "collapse," I guess I'd better make sure you and I are using "collapse" in the right terminology, if collapse means something to me from --
Q. What collapse means to you, just to make sure we're not talking past each other.
A. (Dr. Bartlett) Collapse -- we do have collapsible soils in the west that are due to wetting and -- either collapse upon just wetting, or wetting and application of load, or just once in a while just the application of a load. I believe the main layer of concern for collapse was the Eolian silts.
Q. Layer 2 we were talking about?
A. (Dr. Bartlett) Layer 2 in my experience in the Bonneville is not really characterized as a collapsible soil. However, I must kind of reframe my knowledge to the Bonneville as a collapsible soil to this valley where it's saturated. But the Bonneville is not known as a particularly collapsible soil. However,

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we have talked about loss of shear strength due to straining, due to cyclic motion. Some people use that as collapse, too.
Q. Actually, it may sound like bragging, but I was using the term the way you were, so --
A. (Dr. Bartlett) Fair enough. So if we're restricting ourselves to collapsible soils in the sense of wetting and collapse under static loads. There was an RAI about this. I think our main concern was the Eolian deposits. Those would be treated with soil cement, and I assume that will fix that problem.
Q. I apologize. I was not paying attention but looking at something else.
Let us move on Exhibit 3 to paragraph B on top of page 85. I'm referring to the paragraph that starts with the letter b and the caption "Sampling and analysis." Going on to the second sentence, which I believe the first sentence -- well, just going to the second sentence.
A. (Dr. Bartlett) Okay.
Q. Starts with "However." Do you see that?
A. (Dr. Bartlett) Yes, I do.
Q. It says that "PFS's sampling program is not adequate in quantity (number of samples)" --
A. (Dr. Bartlett) Correct.

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Q. -- "and quality (suitable recovery of disturbed and undisturbed samples)," and there is a footnote, 20, which I'm not going to read, "to ensure that all materials that are critical for geotechnical evaluation of the site have been adequately sampled."
Is this a concern that's accurate today?
A. (Dr. Bartlett) As we still have issues regarding the number of samples that have been performed, particularly in regards to strength characterization, and the quality of sampling -- "suitable recovery of disturbed and undisturbed samples." Again, we've talked this morning about disturbed versus undisturbed samples. In this context "disturbed" I believe is meaning split spoon sampling, and "undisturbed samples" would be for this case the Shelby tube sample.
I'm not sure sample quality is a large issue to us anymore, but certainly the number of samples and how they represent the lateral variability of these materials throughout the pad emplacement area and the canister transfer building area are still issues.
Q. How about the suitable recovery of disturbed and undisturbed samples? Is that unusual for you still?
A. (Dr. Bartlett) I think the recovery is -- you lose samples, but it seems like there's -- for a

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particular borehole that disturbed and undisturbed samples were recovered and brought to the surface.
Q. Would it be correct if we -- to simplify this discussion that as far as this paragraph is concerned, your current area of concern is restricted to the quantity of samples being sufficient?
A. (Dr. Bartlett) And how representative that quantity --
MS CHANCELLOR: Could I clarify? Are you talking about the entire paragraph or just the sentence?
MR. TRAVIESO-DIAZ: No, no, the sentence.
MS. CHANCELLOR: You said paragraph.
MR. TRAVIESO-DIAZ: I misspoke, as I tend to do.
A. (Dr. Bartlett) The quality of the number of the samples, and it implies there to ensure that all critical materials have been properly represented and evaluated. So it's an assessment of not only the number, but is that number representative of the layer in its entirety throughout the whole area of the pad emplacement and canister transfer building.
Q. Fair enough. Now, could you describe a little bit more what the concern is as to the number of samples?
A. (Dr. Bartlett) There's been very limited

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sampling. Excuse me, not sampling. There's been very limited number of specific samples tested to determine shear strength properties and other types of engineering properties. We discussed this morning about the number of boreholes that should be required. We also believe there should be a representative number of samples from each borehole that are tested to fully characterize this. We appear to be basing our design on a few tests, very few tests that do not fully give us an idea of what's the variability of this, particularly layer 2.
Q. So the record is clear: are you saying that not enough samples were taken or that not enough samples were tested?
A. (Dr. Bartlett) Both.
Q. And as to the first part, as to the not enough samples were taken, how many more samples -- or how would you go about determining how many more samples you needed before you had an adequate sampling program?
A. (Dr. Bartlett) To answer that question, you have to really go into statistics and understand the variability and how many samples you have to take to capture that variability.
Now, in highly variable sediments, you have to take lots of samples. In homogeneous samples it's not as much. But there is a formal method of assessing

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variability in the lateral sense.
Q. You remember when we talked earlier about the statement in the SER as to the number of samples that were tested that you couldn't confirm?
A. (Dr. Bartlett) Sure.
Q. Could you give me today a number as to how many more of each type of samples you believe would be sufficient to make the sample program more adequate?
A. (Dr. Bartlett) My job is not really to determine how well you should characterize. I am saying right now I cannot make an assessment, based on the current data that's presented, whether these represent the soil properties throughout the emplacement area. So I would advise you to go back and look at what your potential variability is.
And there are still formal ways, they are called geostatistical methods, in which you can decide whether you have representative numbers of samples or not. But it's key to what is your lateral variation. And you have cone penetrometer data that suggest what is your potential for lateral variation. We have not seen any formal assessment of that data.
Q. In fact do you have a view as to whether there's lateral variation --
A. (Dr. Bartlett) I do.

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Q. -- across the site in terms of the soil calculations?
A. (Dr. Bartlett) I do. That's why I prepared the plots that we showed you yesterday -- gave you yesterday.
Q. All right. And what is your view?
A. (Dr. Bartlett) In the critical layer, at least for shear strength and sliding stability analysis, and Dr. Ostadan might have other comments beyond mine, that I try to get an understanding of the lateral variability of tip resistance in the key layer, layer 2.
Maybe if I look at my plots I can tell you roughly what those conclusions were about, what the potential lateral variability may be.
MR. TRAVIESO-DIAZ: I wasn't listening. I'm sorry. Can you read the answer back?
(The answer was read.)
Q. (By Mr. Travieso-Diaz) I'm sorry. When you said "look at my plots" --
A. (Dr. Bartlett) Those were plots that I prepared of -- kind of composite plots of the CPT data, and they were provided yesterday.
Q. That's what I was trying to understand.
A. (Dr. Bartlett) The hand drawn --
Q. That's where I lost you.

MR. TRAVIESO-DIAZ: Just go off the record for a second while we look for those.
Let's go back on the record.
I'm going to mark as Exhibit 59 a document that I cannot identify because I didn't prepare it, but I'm going to ask the witness to identify. I would say for the record that it consists of one, two, three, four, five, six, seven -- eight pages of plots, hand plots, and also further state for the record that this document was provided to me by Counsel for the state yesterday.
(Exhibit 59 marked.)
And for the record, the reason they're not colored is I couldn't get copies in color in the time we had, so we're going through black and white copies.
Q. (By Mr. Travieso-Diaz) Now, could you explain to us, identify what this Exhibit 59 is?
A. (Dr. Bartlett) These are the CPT data, and plotted is the tip resistance. These are actually data from the SAR that have been enlarged on a photocopier, and then I traced over them with a pen. It's just a way to try to see what is the variation from CPT to CPT across -- I think all CPT's are represented here. At least it goes to CPT-39. I did this roughly in groups of five, because if you get too many lines it gets

difficult to even understand what they mean.
Maybe it would be easier to do this plot by plot, if you so choose.
Q. Before we go plot by plot, let me see if we can get some description in the record of how this particular document was prepared. First, what was your original source for the preparation of these plots?
A. (Dr. Bartlett) Your diagrams in the SAR, CPT diagrams in the SAR.
Q. The diagrams, do you mean the foundation plots that we looked at before?
A. (Dr. Bartlett) No, these came from actually -- no, these did not come from the SAR. These came from the ConeTec report. Excuse me. These were the plots from the ConeTec and then enlarged on the photocopier.
Q. And when you say "from ConeTec," again, for the record, what is that you're talking about?
A. (Dr. Bartlett) The ConeTec report to provide the cone penetrometer data.
Q. So this is taken from the report done by the contractor that performed the cone penetration tests?
A. (Dr. Bartlett) That's correct.
Q. And this is a reproduction of those plots?
A. (Dr. Bartlett) This is -- yeah, hand

reproduction of those plots.
Q. Well, you said by hand reproduction. How did you do it?
A. (Dr. Bartlett) I simply took the plot, enlarged it on the photocopier, then laid an overhead transparency on top of it and traced down the tip stress.
Q. All right. Now, let's take a look at the first document in this package, which --
MS. CHANCELLOR: Could I just go on the record? What Dr. Bartlett actually prepared were transparencies, and what I gave you was a color photo of the transparency because I couldn't reproduce this transparency.
MR. TRAVIESO-DIAZ: Well, let me ask the witness so that we know what's the best source.
Q. (By Mr. Travieso-Diaz) Would the best source for the original copy of the record be the transparency as opposed to the color copy?
A. (Dr. Bartlett) The best source of the original?
Q. Yeah, the best --
A. (Dr. Bartlett) I would say the color photocopies. I think they're adequate. I don't think they've been distorted markedly.

Q. Fine. Now, let us look at the first of these sets of plots.
A. (Dr. Bartlett) Sure.
Q. For some reason, the way I have them, the first one is for CPT-6 through 10.
A. (Dr. Bartlett) No. Actually, the first one should be CPT-1 through 5.
Q. But the way that this document is numbered, the first one that appears is 6 through 10. On my copy, anyhow.
A. (Dr. Bartlett) Yeah, they're just out of order.
Q. All right. So you are directing my attention, then, to the last page of the exhibit?
A. (Dr. Bartlett) I always, just for some reason, want to start at one.
Q. No problem. Just so the record is clear as to what we're talking about.
A. (Dr. Bartlett) Let's go through the plot leg with CPT-1 through 5, and it's in brown in the color versions.
Q. Are all the plots in brown?
A. (Dr. Bartlett) All of the CPT-1 through 5 are all plotted in brown, yes.
Q. So you don't lose any quality just by having

black and white?
A. (Dr. Bartlett) No, I wouldn't think so. For our discussion it doesn't matter.
Q. Now, tell me, what were you seeking to accomplish in preparing this plot? Starting with the 1 on the last page of the exhibit.
A. (Dr. Bartlett) What I was trying to accomplish is understand kind of in a composite plot sense what are the ranges of tip stresses -- in layer 2 predominantly is where I was focusing my attention -- which varies, but can be roughly from three feet to eight to ten feet down.
Q. Okay. Now we need more clarification on the record. You have plotted on the vertical axis distances that, as I read them, are zero, 5 feet, 10 feet, 15 feet?
A. (Dr. Bartlett) Right. Those are depths below the ground surface.
Q. So ground would be zero?
A. (Dr. Bartlett) Ground would be zero.
Q. And 5 would be 5 feet below ground?
A. (Dr. Bartlett) Correct.
Q. And your testimony a moment ago is that, while you were concerned with layer 2, that would be where on this plot?

A. (Dr. Bartlett) For the first plot it looks like it's about -- beginning about three feet and ending somewhere around 10 feet.
Q. All right. So it's three to ten?
A. (Dr. Bartlett) Three to ten, approximately.
Q. Now, tell me what information you gathered by preparing this plot. What did you learn?
A. (Dr. Bartlett) First we can begin to see, at least for these five cone penetrometers which have been superimposed on each other, the beginning of the ranges of tip stresses in layer 2.
Q. And where in that particular figure, which is CPT-1 through 5, are you looking at? You're looking at what ranges of vertical location?
A. (Dr. Bartlett) In the vertical location we're looking still at the interval between 3 and 10 feet.
Q. And the horizontal location, what do you see? The horizontal I believe is pressure in tons per square foot. Is that it?
A. (Dr. Bartlett) Pressure is fine. Tip stress, yes.
Q. Tip stress, okay. And just describe for me what you learned or what you believe this plot shows.
A. (Dr. Bartlett) Well, for this particular

plot, if we look -- and, again, there's uncertainty with the thickness of the line, admittedly. This is the only color markers I had that work on transparencies, and it was important to me not only to look at one individual group, but I wanted to be able to superimpose different groups upon each other through the transparencies.
But if we look at this first one, CPT-1 through 5, at approximately three feet down just right underneath the silt layers, the low tip stress -- we're in units, so it looks like it must be -- 75 divided by 5 -- 15's. Anyway, we're in units of 15 TSF for each mark on this plot. And you can see a trace there at approximately 3 to 5 feet that has a tip stress slightly lower, around 15 PSF.
At the other side in that same three- to five-foot interval, we can see a layer that's picking up -- well, it has a resistance maybe more on the order of 40 -- excuse me, not 40. About 30, maybe slightly higher than 30. So that tells me that the tip stresses in that zone could vary by a factor of approximately 2.
Q. Okay. You're talking specifically at the width, if you will, that lies between the lowest edge on the left side of your plot and the highest or the one at extreme right of the plot for viewing depth?
A. (Dr. Bartlett) I'm trying not to look at

the edge of the lines, because this is a fat marker. So I'm looking at more the center of the line to the far left, and I'm looking somewhat at the center of the line to the far right through that interval.
Q. All right. Let's just take one particular location so we have it on the record clear. Let's take the location of 5 feet.
A. (Dr. Bartlett) Fair enough.
Q. All right. Read me what you believe this plot shows in terms of the range or value of TSF for the various CPT's.
A. (Dr. Bartlett) Again, about 15 TSF, and they're just slightly less than 30.
Q. Okay. You go down, say, to -- you come to a point of 7 feet.
A. (Dr. Bartlett) I see that.
Q. Okay. What's the variability there?
A. (Dr. Bartlett) It's a little bit less there. It's probably just slightly greater than 15 TSF, and maybe on the order of 25 TSF to the higher range.
Q. And going to the location of 10 feet, what do you see there?
A. (Dr. Bartlett) The lower bound is picked up again. It's probably now higher than 15 TSF, maybe approximately 20 PSF. That's the lower bound. The

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upper bound is 25 TSF.
Q. All right. One more question as far as understanding the plot. When you say CPT-1 through 5 --
A. **(Dr. Bartlett) Correct.**
Q. -- you are talking about specific locations of cone penetrometer tests?
A. **(Dr. Bartlett) That's correct.**
Q. And if we wished to figure out where this were, could we go to one of the earlier exhibits and try to --
A. **(Dr. Bartlett) Yes. They should correspond to the plan view that shows the CPT location.**
Q. Why don't you look with me at Exhibit 52. And I think you want to look at the last figure on that page, Figure 2.6-19.
A. **(Dr. Bartlett) Okay, found it. Last page.**
Q. Exhibit 52 has three pages, and the last one is labeled Figure 2.6-19.
A. **(Dr. Bartlett) We're referring to Figure 2.6-19 of the --**
Q. Correct.
A. **(Dr. Bartlett) Okay.**
Q. Is this a plot that will give you the location of the various cone penetration tests?
A. **(Dr. Bartlett) Yes.**

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Q. And the one that is listed -- the ones that are listed here, CPT-1 through 5 --
A. **(Dr. Bartlett) Correct.**
Q. -- would be the ones that are in this Exhibit, the Figure 2.6-19, where?
A. **(Dr. Bartlett) CPT-1 is down in the lower right-hand corner of the -- it would be the southeast quadrant of the pad.**
Q. So it would be the southeast edge of the pad?
A. **(Dr. Bartlett) Yeah.**
Q. Assuming that north is looking up, which I believe is the case.
A. **(Dr. Bartlett) That's true. There is a north symbol here, and it is up.**
Q. And CPT-5 would be not quite in the northeast edge but one layer below, if you will, along the lines that are marked 2 to 2'?
A. **(Dr. Bartlett) Correct. It's in the northeast quadrant on the far east side about in the middle.**
Q. All right. So you could correlate these various plots that you have made in Exhibit 59 to locations in Figure 2.6-19?
A. **(Dr. Bartlett) Yeah, one could corollate.**

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Q. Okay. In case someone wanted to do it, that's the way they would do it?
A. **(Dr. Bartlett) That's the way they would do it.**
MS. CHANCELLOR: Could we go off the record for a minute?
MR. TRAVIESO-DIAZ: Yes.
(Discussion off the record.)
Q. (By Mr. Travieso-Diaz) So my question, now that we know what you did, would you tell me what interpretation you made of this first figure, this figure -- let me clarify for the record. The last of the pages in Exhibit 59, which is the one that has the plots for CPT-1 through 5.
A. **(Dr. Bartlett) The reason I did this was to first understand the potential variability across the full pad emplacement area of the CPT data, particularly in layer 2.**
There were no really composite plots prepared in the SAR, and I had to kind of try to get a feel for that, so I just did that myself.
The reason why I did this is, we talked yesterday that undrained shear strength is and has been correlated with the tip resistance from the cone penetrometer. So somewhat in a relative sense, we can

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say that an increase in tip resistance by a factor of 2 should correspond to a factor of 2 increase in the undrained shear strength.
Q. Before you go on, let me see if I understand your testimony. Are you saying that there is a linear relationship between tip strength, if you will, or tip resistance and strength of the sample of the soil?
A. **(Dr. Bartlett) Yes.**
Q. And it's linear, as far you know?
A. **(Dr. Bartlett) Yes.**
Q. Do you have any -- can you cite to any reference or any source for that belief?
A. **(Dr. Bartlett) Yes. The EPRI manual that we discussed this morning does discuss those correlations.**
Q. And it's a linear relation?
A. **(Dr. Bartlett) Yes.**
MR. TRAVIESO-DIAZ: Why don't we break now.
(Deposition was adjourned at 6:42 p.m.)
* * *

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CERTIFICATE

State of Utah)
ss.
County of Utah)

I, Vicky McDaniel, a Certified Merit Reporter and Notary Public in and for the State of Utah, do hereby certify:

That the deposition of Dr. Steven F. Bartlett and Dr. Farhang Ostadan, the witnesses in the foregoing deposition named, was taken on Thursday, November 16, 2000, and that said witnesses were by me, before examination, duly sworn to testify the truth, the whole truth, and nothing but the truth in said cause;

That the testimony of said witnesses was reported by me in stenotype and thereafter transcribed into typewriting and that a full, true, and correct transcription of said testimony so taken and transcribed is set forth in the preceding pages;

That the same constitutes a true and correct transcription of said testimony so taken and transcribed and that the said witnesses deposed and said as in the foregoing annexed deposition.

I further certify that I am not of kin or otherwise associated with any of the parties of said cause of action and that I am not interested in the event thereof.

WITNESS MY HAND and OFFICIAL SEAL at Salt Lake City, Utah, this 28th day of November, 2000.

Vicky McDaniel, RMR
Utah License No. 87-108580

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Case: In the Matter of Private Fuel Storage
Docket No.: 72-22-ISFSI
Reporter: Vicky McDaniel
Date taken: November 16, 2000

WITNESS CERTIFICATE

I, Steven F. Bartlett, HEREBY DECLARE:

That I am the witness referred to in the foregoing testimony; that I have read the transcript and know the contents thereof; that with these corrections I have noted, this transcript truly and accurately reflects my testimony.

PAGE-LINE CHANGE/CORRECTION REASON

_____ No corrections were made.

Steven F. Bartlett

SUBSCRIBED and SWORN to at ,
, this day of ,
200 .

Notary Public

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Case: In the Matter of Private Fuel Storage
Docket No.: 72-22-ISFSI
Reporter: Vicky McDaniel
Date taken: November 16, 2000

WITNESS CERTIFICATE

I, Farhang Ostadan, HEREBY DECLARE:

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PAGE-LINE CHANGE/CORRECTION REASON

_____ No corrections were made.

Farhang Ostadan

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, this day of ,
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Notary Public

Case: In the Matter of Private Fuel Storage
Docket No.: 72-22-ISFSI
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PAGE-LINE	CHANGE/CORRECTION	REASON
100 - 16	Change linearity to nonlinearity	correction
102 - 2	change and the to as a	transcription error
102 - 3	change strength to strain	transcription error
102 - 3	change linear to nonlinear	transcription error
102 - 7	change strength to strain	transcription error
107 - 1	change 30 to upper 30	transcription error
107 - 2	change test to test	type
118 - 5	change 371 to 3.7.1	transcription error
118 - 5	change 372 to 3.7.2	transcription error
118 - 8	change competence to competent	transcription error
128 - 23	change our to NRC	transcription error
128 - 24	change 271 to 3.7.1	transcription error
129 - 5	change margins to modulus	transcription error
129 - 17	change sect to soil	transcription error

_____ No corrections were made.

Farhang Ostadan
Farhang Ostadan

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MARILYN A. ANO
Commission # 1129726
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Notary Public

Case: In the Matter of Private Fuel Storage
Docket No.: 72-22-ISFSI
Reporter: Vicky McDaniel
Date taken: November 16, 2000

WITNESS CERTIFICATE

I, **Farhang Ostadan**, HEREBY DECLARE:

That I am the witness referred to in the foregoing testimony; that I have read the transcript and know the contents thereof; that with these corrections I have noted, this transcript truly and accurately reflects my testimony.

PAGE-LINE	CHANGE/CORRECTION	REASON
page 226-13	change KSE to ASCE	transcription error
page 262-4	change zero to and	transcription error
page 282-12	change simplify to simply	transcription error
page 283-18	change gadget to graduate	transcription error
page 288-3	change a stiffer to stiffer	transcription error
page 288-3	change wetter to weathered	transcription error
page 290-17	change ratrofication to vetrification	transcription error
page 324-5	change an appropriate to inappropriate	transcription error
page 341-22	change cause to pulse	transcription error
page 349-3	change P to calculations	transcription error
page 349-5	change has stuff that to point	transcription error
page 356-11	change really to displacement	transcription error
page 357-6	change colors to coil	transcription error
page 359-16	change concentration to consideration	transcription error

______ **No corrections were made.**

Farhang Ostadan (signature)

Farhang Ostadan

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Page 360-15	change concentration to consideration	transcription error
Page 361-25	Change dash post to dashpots	transcription error
Page 362-1	change dash pots to dashpots	transcription error
Page 362-7	Change as to a	transcription error
Page 366-7	change this to the least	transcription error
Page 371-7	change cares to care	transcription error
Page 461-23	change incline to inclined	transcription error

_____ **No corrections were made.**

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CONDENSED TRANSCRIPT

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of:	) Docket No. 72-22-ISFSI) ASLBP No. 97-732-02-ISFSI
PRIVATE FUEL STORAGE, LLC	) Deposition of:
(Independent Spent Fuel Storage Installation)	) **DR. STEVEN F. BARTLETT** and) **DR. FARHANG OSTADAN**
	) Vol. II

Friday, November 17, 2000 - 8:40 a.m.

Location: Offices of
Parsons, Behle & Latimer
201 S. Main, #1800
Salt Lake City, Utah

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

CitiCourt
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SHEET 1

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A P P E A R A N C E S

For the Intervenor: Denise Chancellor, Esq.
ASSISTANT ATTORNEY GENERAL
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For the Applicant: Mattias F. Travieso-Diaz, Esq.
SHAW PITTMAN
2300 N. Street, NW
Washington, D.C. 20037-1128

Also Present: Barry J. Solomon, Thomas Y. Chang, Paul Trudeau

I N D E X

E X H I B I T S

E X H I B I T S (Continued)

* * *

P R O C E E D I N G S
DR. STEVEN F. BARTLETT
and
DR. FARHANG OSTADAN,
having previously been duly sworn to tell the truth,
were examined and testified as follows:
EXAMINATION (Continued)
BY MR. TRAVIESO-DIAZ:

MR. TRAVIESO-DIAZ: Good morning, gentlemen.
DR. BARTLETT: Good morning.
Q. I will address the next few questions to Dr. Ostadan. Dr. Ostadan, what is your position and employer?
A. (Dr. Ostadan) Bechtel.
Q. And what's your position?
A. (Dr. Ostadan) I'm a chief engineer at Bechtel.
Q. And chief engineer in any particular area?
A. (Dr. Ostadan) Geotechnical engineering department.
Q. Are you familiar with the PFS project?
A. (Dr. Ostadan) Yes. I have read the documents.
Q. What is the source of your familiarity?
A. (Dr. Ostadan) I have read the SAR, some of

the supporting calculations. Participated in discovery, answering questions and responding to questions, RAI's, and discussion with some of the experts retained by state.

Q. When did you become involved with the PFS project?

A. (Dr. Ostadan) In approximately summer of '99.

Q. And for what purpose were you retained?

A. (Dr. Ostadan) I think the state retained me for my personal expertise and experience as it relates to seismic design and foundation loading.

MR. TRAVIESO-DIAZ: I think this may be a good point for me to state for the record, although I have said it before, and this is no disrespect intended to you, Dr. Ostadan, that I am going to object to all matters relating to seismic design, foundation loads, soil-structure interactions, and related matters because I believe they're outside the scope of Contention L. And in my asking questions of Dr. Ostadan or his answering the questions does not constitute an admission on my part that this matter is relevant.

MS. CHANCELLOR: From the state's perspective, we have a disagreement with PFS as to the scope of Contention L, and we believe that seismic

designs and foundation loadings are contained within the contention, and your comment is noted.

MR. TRAVIESO-DIAZ: We have agreed to disagree on this.

MS. CHANCELLOR: That's right.

Q. (By Mr. Travieso-Diaz) Do you have before you, or maybe you had it a moment ago, Exhibit 3.

A. (Dr. Ostadan) Yes, I do.

Q. Do you recall, there were a number of questions about Exhibit 3 yesterday. Rather than repeating them in detail, let me ask you, you remember the discussion we had about Basis 3 of Contention L which is in Exhibit 3? Basis 3 goes from page 83 to page 92.

A. (Dr. Ostadan) I can't say I remember everything, but I remember some of it.

Q. My question is rather simple: are you the author of any part of that section of Contention L?

A. (Dr. Ostadan) No, I'm not.

Q. Okay. In discharging your role as an expert witness, you mentioned some of the things that you have been reading. But specifically to the charge of your role as an expert, what documents have you reviewed?

A. (Dr. Ostadan) I think I certainly reviewed Chapter 2 of the SAR. All sections that discuss,

present the results of calculation with respect to the seismic analysis, stability analysis of the foundation. And as I mentioned, the supporting calculation, number of calculations by Geomatrix consultants. Zero calculation by Stone & Webster. I believe one calculation by a civil engineering consultant. Calculation by Holtec. And there maybe one or two that I don't remember.

Q. When you referred to those calculations, are you aware that some of those calculations have been updated periodically since 1997 when Contention L was presented?

A. (Dr. Ostadan) Yes, I am aware of that.

Q. And you have sought to keep yourself up to date with the latest revisions and so on?

A. (Dr. Ostadan) Yes. I have reviewed the latest revision of the calculations.

Q. All right. As we discussed yesterday, you also reviewed the SER that was issued by NRC staff in October?

A. (Dr. Ostadan) Well, this was issued very recently, and I was busy preparing for this deposition. I glanced through it. I didn't really study it in depth.

Q. Now, you mentioned that you took part in

preparing discovery, both questions and answers?

A. (Dr. Ostadan) Yes, I did.

Q. Do you recall what discovery issues you were involved with?

A. (Dr. Ostadan) Well, again, in my area of expertise, again, issues related to seismic design, foundation loading.

A. (Dr. Ostadan) This wasn't meant to test your memory. Let me show you something that is already in the record as Exhibit 10, and I will identify what it is so that I know it's on the record.

For the record, Exhibit 10 is called State of Utah's Objections and Responses to Applicant's Second Set of Discovery Requests with Respect to Groups II and III Contentions. It is dated June 28th, 1999.

Would you review Exhibit 10 and tell me whether you were involved in the preparation of any portion of this exhibit.

Do you have a copy?

MS. CHANCELLOR: I think it would be helpful for Dr. Bartlett to have a copy.

Q. (By Mr. Travieso-Diaz) Dr. Ostadan, while you're reviewing the exhibit, may I direct your attention to the last page of Exhibit 10, which might be of help to you.

A. (Dr. Ostadan) Okay.
Q. Is the last page of Exhibit 10 an affidavit by Dr. Farhang Ostadan?
A. (Dr. Ostadan) Yes, it is.
Q. Is that you?
A. (Dr. Ostadan) That is me.
Q. So you signed that affidavit?
A. (Dr. Ostadan) Yes, I did.
Q. And that affidavit makes reference with respect to Exhibit 10 to discovery requests limited to soil dynamics and soil-structure interaction. Do you see that in the fourth and fifth line of the text of the affidavit?
A. (Dr. Ostadan) I see it.
Q. Would that be of help to you figuring out what portions of Exhibit 10 you were involved with?
A. (Dr. Ostadan) Yes. If you'd like me to go through this document and point out specifically.
Q. Yes. I would like to know which areas you contributed to so I don't burden you asking you things you didn't contribute to.
A. (Dr. Ostadan) Let me have some moments here. This is a fairly thick document.
MR. TRAVIESO-DIAZ: Steve, I'm going to be asking the same thing, so if you want to take time now

to look at it.
A. (Dr. Bartlett) Okay.
(Witnesses review document.)
A. (Dr. Ostadan) Well, I'm going to have a long answer for you. As I have mentioned, I have discussed some of the issues discussed in this document with other witnesses or experts retained by the state, and my input has been either directly or indirectly affected.
With respect to page 54, paragraph F, I recall discussion along those lines, although I do not claim to be the author of this paragraph, but I have expressed a view, my opinion on this subject.
Q. May I interrupt for a second?
A. (Dr. Ostadan) Sure.
Q. Who is the author of F, if you recall?
A. (Dr. Ostadan) I do not recall. I would suspect it's perhaps Dr. Arabasz.
Q. Okay. I'm sorry. Please go on.
MS. CHANCELLOR: Could I clarify one thing? When you said "authored," I mean, this was authored by an attorney.
Q. Okay, let me just clarify my last question, and perhaps that will change the answer or not. The main technical contributor to providing the substantive

information that went to form the item F. Does that change your answer? I'm sorry. Maybe you were too intent.
A. (Dr. Ostadan) I'm sorry.
MR. TRAVIESO-DIAZ: Could you repeat the last question that I asked in clarification to my previous one?
(The record was read.)
A. (Dr. Ostadan) Again, I do not know who authored this writing, but I would not say I am the main contributor.
Q. Okay. I'm sorry. Please go on.
A. (Dr. Ostadan) Sure. Okay. On page 55-I, I think I am the main contributor. Page 56-J, I certainly contributed. I don't know how to give the credit as to who's the main one here. I share the view being expressed here. All right.
On the same page, 56-K, yes, this is one of my comments. Page 57-L is my comment. 58-M, my comment. 58-N is my comment. 58-O is my comment. 59-P, my comment. And P is a fairly long section. 62-R is my comment.
Q. I'm sorry. Did you overlook Q, or is that not your comment?
A. (Dr. Ostadan) I'm sorry. Yes, this is my

comment too.
Q. Thank you.
A. (Dr. Ostadan) S is my comment. T is my comment. U is my comment. V is my comment. W, my comment. X is perhaps a joint comment with Dr. Bartlett, and it basically talks about the capacity, so I suspect that he's the main author. Y is my comment. Z is my comment. Now we are at AA. It's my comment.
Q. And that's on page 65?
A. (Dr. Ostadan) 65, yes. AB is my comment. AC is my comment. AD is my comment. AE is my comment. AF is my comment. AG is my comment. AH is my comment, AI is my comment.
Q. And those are on page 68?
A. (Dr. Ostadan) That's correct. AJ is my comment. AK is my comment, AL is my comment.
Q. And now we're on page 69?
A. (Dr. Ostadan) That is correct. AM is my comment, AN is my comment. AO on page 70, my comment. AQ is my comment.
Q. I'm sorry. Did you overlook AP?
A. (Dr. Ostadan) I'm sorry. AP is my comment. I already stated AQ is my comment. AR is my comment. AS, I don't recall. It might have been a joint comment

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with Dr. Bartlett.

Q. Would Dr. Bartlett have been the main contributor?

A. (Dr. Bartlett) As I recall, we both discussed this, so I guess --

Q. 50-50?

A. (Dr. Bartlett) We jointly authored this.

Q. All right.

A. (Dr. Bartlett) I can't remember who brought it up first.

A. (Dr. Ostadan) I can see on page 71, I don't think I contributed to this. Page 72, I don't recognize anything I have done. Same thing on 73. I don't recognize my contribution. 74, I don't recognize my contribution. Same applies to 75. 76, I don't recognize I have done anything. Same for page 77. Same for 78. And then we get to the affidavit section.

Q. You started your listing with item F, as I recall, and item F was on page 51. Does that mean that you didn't contribute to anything that preceded item F, from the early part of the document that we didn't talk about?

A. (Dr. Ostadan) I don't recognize any portion that I have contributed. I might have participated in some discussion and indirectly contributed, but I don't

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recognize any specific piece I have written.

Q. Now, to clarify the record as to one minor point. Item F that you referred to, which, if I recall, starts on page 55 -- no, 54, right?

A. (Dr. Ostadan) Yes.

Q. Is that item F part of a series of answers to an interrogatory or question that starts on page 51? Will you take a look?

A. (Dr. Ostadan) No. 8?

Q. Yes. Is that it?

A. (Dr. Ostadan) Well, it refers to No. 1 through 7.

Q. Let me read it for the record. The sentence that I'm referring to is in the middle of page 51, and it is labeled Interrogatory No. 8 on Utah L column. "Identify and fully explain any other deficiencies, not set forth in response to Interrogatory Nos. 1-7 above, claimed by the State in the geological, geotechnical or seismic analysis of the PFS site conditions, and the bases therefore." Is it your understanding that the input you provided starting on 54-F is part of the answer to the interrogatory?

A. (Dr. Ostadan) I think it could be, because it refers to 1 through 7, and there's a fairly general discussion of a lot of issues here. So I can't be

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certain, frankly. It could be.

Q. Let me ask you the following. You said -- this document is dated June 28th, 1999. Is that correct?

A. (Dr. Ostadan) That's correct.

Q. And your affidavit on the last page is dated June 15, '99?

A. (Dr. Ostadan) Yes.

Q. And you've testified that you have sought to keep yourself up to date with respect to calculations and other documents prepared by applicant from time to time?

A. (Dr. Ostadan) Yes, I have.

Q. Is there any of the items that you have referred to in your previous answer, starting with F on page 54, that doesn't need to be modified in any way as a result of what may have transpired between June '99 and today?

A. (Dr. Ostadan) Yes. I can visit these items one by one. I don't know how much level of detail you would like me to give you. It could be a very long answer.

Q. Well, I'll tell you what. What I was seeking is if, for example, you refer in any of these items to a calculation that doesn't exist anymore or

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whatever, it would be helpful to know that perhaps what was said then, it doesn't apply today.

Well, rather than doing it that way, why don't we wait until we hit each of them, and then we'll figure out whether in fact it needs to be modified.

A. (Dr. Ostadan) Very well. As you wish.

Q. Dr. Bartlett, could you do the same thing for me? I take it that you contributed to the answers provided with respect to Exhibit 10?

A. (Dr. Bartlett) Yes, I did.

Q. Could you tell us for the record what portions you were the author on? I'm using the author in the sense that I described earlier.

A. (Dr. Bartlett) Provided the technical content for the answer.

Q. Exactly.

A. (Dr. Bartlett) I had some input to the response to Interrogatory 3 on page 28.

Q. Excuse me. Which portion of Interrogatory 3?

A. (Dr. Bartlett) The response to Interrogatory 3.

Q. I'm sorry. I didn't ask the question properly. I see that the response to Interrogatory 3 --

A. (Dr. Bartlett) Oh, excuse me.

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Q. -- has a number of subparts.
A. (Dr. Bartlett) "A" subpart.
Q. "A," okay. But I take it there was somebody else that provided the main technical content for the answer?
A. (Dr. Bartlett) This was a discussion amongst the team at the time. Yeah, there were several people contributing to this response.
Now I'm on page 40. I am the author -- well, not the author. I contributed to the main technical content of the response to Interrogatory No. 5, the general response A, part B, C, D, E, F, G, H, I, J, K. Response to Interrogatory 6, part A, B, C. Response to Interrogatory No. 7, part A, part B. Response to Interrogatory No. 8, part A, part B, part C, D.
I think from there I think it's joint. These are mainly Dr. Ostadan.
Q. Will you look on page 54 at item E. I didn't see you mention that.
A. (Dr. Bartlett) I believe we both discussed this part.
A. (Dr. Ostadan) I believe I have parts in this discussion with E, yes.
Q. Was either of you the main technical author of E, or was there somebody else?

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A. (Dr. Bartlett) This is probably mostly Dr. Ostadan's, as I read it, based on his experience with North Ridge.
A. (Dr. Ostadan) Yes.
Q. Now, Dr. Ostadan, is there any other interrogatories --
A. (Dr. Bartlett) I had some I guess inputs to the response to document requests. I'm not sure if you would be interested in those or not.
Q. Let's skip those for the moment.
Dr. Ostadan, have you provided input to the response to any other interrogatories that you recall?
A. (Dr. Ostadan) Yes, I might have.
Q. Well, to make the discussion go easier, I have two documents here, which are also exhibits that have been previously introduced, which are Exhibits 12 and 13. No. 12 is the State of Utah's Objections and Responses to Applicant's Fourth Set of Discovery Requests to Intervenors State of Utah and Confederated Tribes, dated January 31st, 2000. And the second document is Exhibit 13 called State of Utah's Objections and Response to Applicant's Fifth Set of Discovery Requests to Intervenor's State of Utah and Confederated Tribes. I will hand these documents to you, but before I ask you to look at them, let me ask you a more general question.

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Is it your practice or has it been the practice of the state in answering these interrogatories to provide affidavits of the witnesses who provide input in the preparation of the interrogatories? In other words, you have provided input to the answers to these interrogatories, you have provided an affidavit to so state?
MS. CHANCELLOR: For the record, I'll object. Dr. Ostadan may not know what the practices for the state. He can answer to the extent that he knows from his experience.
MR. TRAVIESO-DIAZ: I'm trying to, for the record again, to avoid having an extended discussion of a document he may not have been a contributor to.
MS. CHANCELLOR: If you want, I can stipulate that when an expert has been involved we have asked for an affidavit.
MR. TRAVIESO-DIAZ: That's very helpful.
Q. (By Mr. Travieso-Diaz) So what I'm going to ask you, Dr. Ostadan, is to look at these two documents together since they were filed simultaneously on the same date, and ask you whether you find an affidavit for you with respect to either of them.

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A. (Dr. Ostadan) I'm looking at Exhibit 12 now.
Q. Do you find any affidavits attached to Exhibit 12?
A. (Dr. Ostadan) I'm looking through. No, I do not see anything in my exhibit here.
Q. Would you look at No. 13 now and see if there's any affidavits.
A. (Dr. Ostadan) Okay, I'm looking at No. 13 now.
Q. Yes, please.
MS. CHANCELLOR: Did Dr. Ostadan state that there wasn't an affidavit from him on Exhibit 12?
MR. TRAVIESO-DIAZ: He actually stated there were no affidavits whatsoever.
DR. OSTADAN: I didn't see that in this.
MR. TRAVIESO-DIAZ: Excuse me. There was an affidavit from you, perhaps, from counsel.
MS. CHANCELLOR: No, from Dr. Ostadan.
MR. TRAVIESO-DIAZ: On 12? My copy doesn't have it.
MS. CHANCELLOR: My copy has one.
MR. TRAVIESO-DIAZ: Well, that's interesting.
MS. CHANCELLOR: These are copies of the --

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DR. BARTLETT: Well, let's re-count them.

MR. TRAVIESO-DIAZ: Maybe I've got an incomplete copy. Can we go off the record for a second?

(Discussion off the record.)

MR. TRAVIESO-DIAZ: While we were off the record we established that the copy of Exhibit 12 that I handed the witness did not have what appears to be an affidavit by him, which was in the copy in the hand of the state's counsel. So I am going to repeat my question to Dr. Ostadan with respect to Exhibits 12 and 13. He's now using the copy provided by the state, and ask him first whether there's an affidavit from him on either of Exhibit 12 or Exhibit 13, and if there is, to go through the appropriate exhibit and tell me which portions he contributed to.

A. (Dr. Ostadan) With respect to Exhibit 12, yes, I do have affidavit.

MS. CHANCELLOR: Excuse me. Could I have just a copy so I can look at -- it doesn't matter if it doesn't have the affidavits. Am I taking your copy?

MR. TRAVIESO-DIAZ: I should have a copy here. Yeah, let me look. Yeah, I have other copies here.

A. (Dr. Ostadan) With respect to 13, I do not see any affidavits by me. I'm going over Exhibit No. 12, see which part has been done by me. On page 3 I provided my name and address.

I think on page 28, the strain rate of soil, bottom of the page, I recall some discussion with Dr. Bartlett. And I don't think I wrote this. He might have.

On page 30, factor of safety against sliding, again, I do recall discussion with Dr. Bartlett. I think he probably authored this.

On page 32, factor of safety against sliding of the pads, I do recall a discussion with Dr. Bartlett again. I don't remember who ended up writing this.

Q. Excuse me. Before we go on, there is another caption or paragraph on page 32 called "Factor of safety against bearing capacity."

A. (Dr. Ostadan) Yes, I did not. I'm only pointing out that the part that I either have directly or indirectly contributed to.

Q. Okay. I'm sorry.

A. (Dr. Ostadan) I don't recall any other portion.

Q. All right. Dr. Bartlett, let's go to Exhibit 12, as long as we're talking about it. Will you confirm or modify the sections that were mentioned that you contributed to?

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A. (Dr. Bartlett) Yeah, let's just go through them.

Q. All right.

A. (Dr. Bartlett) I see my affidavit. Going to page 26, requests for admission, response to admission 1, request No. 1. Response to request No. 2. Response to request No. 3, 4, 5, 6, 7, 8. Interrogatory No. 2. I'm not reading this right. Excuse me. Response to Interrogatory No. 1 on page 28, strain rate of soil, undrained shear strength. Factor of safety against bearing capacity and sliding I think we did discuss together. This is my writing, or at least main technical contributor to this. Settlement, soil cement.

On page 34 under the heading "Response to Interrogatory No. 2," I recognize some of my input to this, because I do see discussions of seismic analyses, depth to bedrock, collapsible soils mentioned there.

Q. Were you the main contributor to the response that appears to start on page 34 and goes on for --

A. (Dr. Bartlett) No. This then again appears to discuss data acquisition for the Bay Geophysical and Geomatrix interpretation. That does not appear. I would not be confident doing that. No, I don't recognize anything from here on out.

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Q. All right. And this question now is addressed to both of you. Would you go through Exhibit 13 and determine whether there's any portion that you contributed to.

(Witnesses review documents.)

A. (Dr. Ostadan) With respect to Exhibit 13, I don't believe I have any input.

Q. Thank you. How about you, Dr. Bartlett?

A. (Dr. Bartlett) Just a moment.

Q. Sure.

(Witness reviews documents.)

A. (Dr. Bartlett) Okay. I had some contribution to Response to Admission Request No. 2.

Q. Pardon me. So that the record is clear: where are you reading from?

A. (Dr. Bartlett) Page 6.

Q. Were you the main contributor to that response?

A. (Dr. Bartlett) No. I think there was some discussions about -- let's see -- I just recall a phone call on this, because the issue brought in the buildings and structures. And I can't remember really, frankly, who authored it. I do remember a phone call.

Q. But it was somebody else who authored that ?

A. (Dr. Bartlett) I believe so. I just

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remember discussions about it.
Let's see. Response to Admission Request No. 3, that appears to be my main contribution there. It's mine.
Response to Admission Request No. 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 37.
Q. Now, this is on page 22?
A. (Dr. Bartlett) This is on 22, correct. 38, I'm just unsure because there may have been talk -- there may have been discussion between myself and Dr. Allison on this.
Q. Would you or would Dr. Allison have been the main contributor to the answer, admittedly short?
A. (Dr. Bartlett) We're on 38, right?
Q. Correct, page 22.
A. (Dr. Bartlett) I guess in regards -- I see a "deny to competency for seismic modeling." I would not have done that portion. Admitted is "competency for shallow static bearing capacity and consolidation settlement." That would have been my input to that.
40 is mine, 41, 42, 43, 44. And that appears to be it.
Q. All right, thank you very much. Now, again, this question is addressed to both of you. Do you recall whether either of you provided input in any other

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state discovery responses with respect to Contention L apart from this that we have gone through?
A. (Dr. Bartlett) The only other thing I can recall that may have been, and I don't know whether it's captured specifically, was discussions about the 2,000-year return period.
A. (Dr. Ostadan) And my answer is, I simply don't remember. It's been a long process and a lot of documents.
A. (Dr. Bartlett) I was involved in similar discussions, but where it's found in this series of documents, I don't know if it's even part of this.
MR. TRAVIESO-DIAZ: Let me mark as Exhibit 60 a document.
(Exhibit-60 marked.)
Q. (By Mr. Travieso-Diaz) For the record, Exhibit 60 is a document that's captioned on the first page the name Farhang Ostadan. It consists of four pages, and it bears a date on the bottom of each page which reads 5/99.
Dr. Ostadan, do you recognize this document?
A. (Dr. Ostadan) Yes, I do recognize this.
Q. Could you identify it for the record?
A. (Dr. Ostadan) This is a brief summary of my resume.

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Q. When you say brief, is there any significant portion of your history that is not included here?
A. (Dr. Ostadan) I believe that a lot of -- not all of the projects I have worked on is reflected here. Some of my other professional activities are not listed and may not be important. This is intended to reflect my background and experience in the nuclear industry.
Q. Okay. Are you saying that the projects that are not included here are outside the nuclear industry?
A. (Dr. Ostadan) No. There could be other nuclear projects; however, I simplify didn't list all of them.
Q. Could you tell us of those cases, if any of they are relevant, we should be concerned about, which kind of projects you chose not to include?
A. (Dr. Ostadan) It's not a matter of choosing, it's a matter of really being brief. I've been proficient in this capacity for almost 20 years now, and some of the things I have worked on are simply not listed here. But I could think back and try to remember some if you wish.
Q. I only want to try and establish if you feel like the matters we discuss in Exhibit 60 are what you consider to be the most significant elements of your

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professional experience or not.
A. (Dr. Ostadan) I think perhaps I would like to cite a couple of things that might be of relevance. In addition to my professional work reflected here, I was co-author of a computer program called SASSI, S-A-S-S-I, that is now industry practice worldwide for soil-structure interaction analysis.
Q. If I could interrupt you for a second. Is that a program that is referred to on page 2 of your resume, page '79 to '83? I'm looking at Experience, top of the page.
A. (Dr. Ostadan) Yes, that is correct.
Q. Thank you.
A. (Dr. Ostadan) I also am now the technical sponsor of this program in collaboration with the University of California at Berkeley. I'm a visiting lecturer at the University of California at Berkeley. I do teach a gadget course on soil dynamics and soil-structure interaction. I'm a member of the Board of Journal of Geotechnical Engineering, American Society of Civil Engineers.
Q. With those additions, is this resume which bears a date of 5/99 up to date and complete, or is there other things that have transpired since you prepared it?

A. (Dr. Ostadan) I can't think of anything significant.
Q. All right. You have on page 1 under "Summary" a paragraph that describes your experience in various areas. Could you tell us which of the areas that are listed on the summary paragraph on page 1 of your resume you regard as being relevant to the issues of Contention L as you understand it?
A. (Dr. Ostadan) I would say dynamic analysis and seismic safety evaluation, up above, and underground structures and surface materials, subsurface materials.
Q. So is the first -- those in the first sentence after "15 years"?
A. (Dr. Ostadan) That's correct.
Q. It has a caption that says "15 years." Would you describes for the record what you mean by dynamic analysis?
A. (Dr. Ostadan) Dynamic analysis involves those set of calculations that are performed in order to generate seismic loading both for the structure and the foundation as well as the soil supporting the foundation.
Q. And seismic safety evaluations?
A. (Dr. Ostadan) This is the next stage after you obtain seismic responses. These are a series of

mostly simple calculations to develop a margin of safety against postulated failure scenarios.
Q. When you say "margin of safety," could you explain what margin of safety you're talking about? A margin of safety of what?
A. (Dr. Ostadan) That relates to really what failure mechanism we are talking about. If it's, for example, stability analysis of a foundation, margin of safety is typically expressed in terms of factor of safety against sliding and overturning.
Q. Actually, maybe I didn't pose the question clearly. When I said "margin of safety of what," I mean, you're talking about margin of safety in the design of the foundations or the structures as compared to the loads that were perceived?
A. (Dr. Ostadan) My emphasis would be on the foundation and supporting soil, yes.
Q. All right. Of the projects that you list, and I understand the list may not be complete, but the projects that you list under "Experience" on page 1 and going on to page 2 of your resume, which do you believe are most relevant to the issues that you are addressing in Contention L?
A. (Dr. Ostadan) Okay. I'm going to start from the lower paragraph, the last paragraph of page 1,

because they are specific here.
With respect to Diablo Canyon Nuclear Power Plant, generation of seismic loads, proximity of this unit -- nuclear unit to a major fault, issues related to characterization of ground motion, and how and in which form it should be used in the analysis.
With EPRI, again, issues with respect to ground response analysis, dynamic soil properties, soil-structure interaction, seismic soil pressure.
With respect to SMES, super magnetic energy, there was a -- more of a problem of dynamic soil pressure.
This General Electric ABWR, SBWR, and AP600, these are standard design that are intended to be built for a wide range of subsurface conditions. So it was a very broad study that was performed and involved a lot of various types of ground response analysis of foundation loading for various potential sites that could be out there.
For Tennessee Valley, these plants were built, and we were pre-evaluating the plan under some different seismic loading conditions, so it was seismic response of the structure and the foundation.
I will not go over the non nuclear ones. There are some here.

With respect to Savannah River project, ITP, RTF, K. K is a reactor, actually. There were a lot of issues that had to do with seismic stability of foundation and supporting soil and involved soil-structure interaction.
A couple of transportation project listed here. I will not go over them.
Q. I take it that the ones that you have mentioned you selected to bring up because they are nuclear projects?
A. (Dr. Ostadan) They are more relevant to the review I have done, yes.
Q. And I take it you think they are more relevant because they involve the application or the use of nuclear-related regulations?
A. (Dr. Ostadan) Exactly.
Q. Now, with respect to the first project that you mentioned, Diablo Canyon, how does the work that you did at Diablo Canyon relate to the issues that you address in Contention L?
A. (Dr. Ostadan) One important resemblance within these two projects is the fact this unit was found after it was built to be close to a major fault, Bosgri Fault, H-o-s-g-r-i, capable of, if I'm not mistaken, magnitude of seven, seven and a half

earthquake. So in that regard it was similar.

The site condition was quite different. It was a much -- a stiffer site, in fact, wetter rock. But issues relating to characterization of ground motion, amplitude, phasing, whether or not the waves could strike the foundation at an angle or arrive vertically, resonance or lack of surface waves, adequate characterization of dynamic soil properties for the purpose of soil-structure interaction analysis.

Finally, performing soil-structure interaction analysis in order to develop seismic loads.

Q. And with respect to the EPRI work that you did?

A. (Dr. Ostadan) Yes. That EPRI study was a really well known study in our field. It was a research work that was work that was funded by U.S. NRC, EPRI and Tai Power. The objective of that study was to build a scale model of a nuclear structure, in this case it was a containment building, in a highly seismic area of Taiwan and record the motion in the ground in the structures as well as other responses, such as soil pressure, pore water pressure, etc., and then invite number of companies and teams from academia to participate in the prediction of the response of this test. And the idea there was to assess the adequacy of

the kind of programs that we use, the modeling techniques we adopt, the methods and the tools we use to characterize dynamic soil properties, and see how accurate they are now that we have a recorded motion from the structure.

I was member of a team that was invited to participate. And the study was a full-blown SSI study, and we used the computer program SASSI, among other programs that we had. And it was a full-blown SSI analysis, as I indicated, involving ground response analysis modeling of the structure, soil-structure interaction, and prediction of response.

Q. And what role did you play in that EPRI study?

A. (Dr. Ostadan) I was responsible for the ground response analysis and soil-structure interaction. And for the record, the results of the study are in voluminous EPRI reports I think in the mid 80's, 90's.

Q. Have you done any work, seismic work or any other work, in the Skull Valley area of Utah --

A. (Dr. Ostadan) No, I haven't.

Q. -- prior to working for PFS?

A. (Dr. Ostadan) I have not.

Q. Have you done any work involving nuclear facilities in Hanford, Washington?

A. (Dr. Ostadan) Yes. I have participated in some projects there, nuclear caliber projects.

MR. TRAVIESO-DIAZ: Let me mark this. I believe it's 61.

(Exhibit-61 marked.)

MR. TRAVIESO-DIAZ: What I have marked as Exhibit 61 is a study or a document entitled "Validation of the Geomatrix Hanford Seismic Report for Use on the TWRS Privatization Project." It is dated March 17, 1999. It consists of approximately 115 pages.

Q. (By Mr. Travieso-Diaz) First of all, do you recognize this document?

A. (Dr. Ostadan) Yes, I do.

Q. What is this document?

A. (Dr. Ostadan) Well, in brief, this relates to a project that the Department of Energy initiated to build -- design, build, and operate a retrofication facility in Richland, in Hanford, Washington, Hanford site. The contractor at the time was British Nuclear Fuel, and Bechtel was subcontracted to BNFL. There was a joint team of engineers involving various activities there.

The specific document we are looking at here, Exhibit --

Q. Sixty-one.

A. (Dr. Ostadan) -- 61, addresses a previous study that was performed by Geomatrix for the site as a whole, that they developed ground motion for different return periods and different locations of the site. And we used that study in order to develop a design basis motion for this retrofication facility called TWRS, which, by the way, the name has changed ever since. This project came to stop for a number of contractual issues. It is on hold. I understand the DOE is issuing or has issued RFP for continuation of the design and perhaps construction. We have no activity at this time.

Q. It appears that among the list of authors on page 1 of Exhibit 61 there is a Farhang Ostadan. Is that you?

A. (Dr. Ostadan) That's correct.

Q. So you were one of the authors of this document?

A. (Dr. Ostadan) I contributed. I will not say I was the main author or main contributor, as you can tell here. The reason is, this is basically a seismological study that Geomatrix did, and a seismologist from Bechtel, Joe Litehiser, was the main author, as reflected here.

My contribution here was to look at the amplification factor that Geomatrix considered in their

analysis in order to include the effect of soil on ground motion.
MR. TRAVIESO-DIAZ: I'm sorry. Could you read back the answer?
(The record was read: "My contribution here was to look at the amplification factor that Geomatrix considered in their analysis in order to include the effect of soil on ground motion.")
Q. What was the purpose of the work that led to the preparation of this report? What was your team asked to do?
A. (Dr. Ostadan) **The question to our team was, well, should we use Geomatrix motion for this facility.**
Q. And in a word, what was the answer that the people gave?
A. (Dr. Ostadan) **I think we agreed to use Geomatrix' motion with some slight modification.**
Q. And in the preparation of the report, what role did you play?
A. (Dr. Ostadan) **As I said, the part that relates to issues to soil properties and amplification due to soil is the part I participated in.**
Q. Why don't we turn to the Executive Summary, which I believe is on page Roman Numeral vii. Do you see that?

A. (Dr. Ostadan) **Yes.**
Q. The first paragraph of the executive summary says -- I'm going to read only the first couple of sentences in the interest of time -- "The purpose of this report is to provide an independent validation of the seismic" --
A. (Dr. Ostadan) **I'm sorry. I'm not on that page. All right, please go ahead. I'm sorry, yes.**
Q. I'll start again.
A. (Dr. Ostadan) **Go ahead.**
Q. The first paragraph of Executive Summary reads, "The purpose of this report is to provide an independent validation of the seismic hazard analysis completed for the Hanford Site by Geomatrix Consultants. The 2,000-year return period ground motions predicted by Geomatrix for the 200 East Area are an integral part of the seismic design basis for the TWRS-P Project." Is that what you understand the team was asked to do?
A. (Dr. Ostadan) **I think it is, yes.**
Q. Now, on the next paragraph, I'm going to skip the first two or three sentences. I'm going to go to the last sentence in the paragraph that says, "We conclude that the Geomatrix report addresses and incorporates all the questions raised in the earlier reviews, that its conclusions match well the latest

independent estimates of the Hanford Site earthquake hazard, and that the seismic source model developed by Geomatrix is state-of-the-art and is consistent with current data." Do you see that?
A. (Dr. Ostadan) **I see that.**
Q. Was that the consensus, conclusion of the team?
A. (Dr. Ostadan) **With the recognition of the fact this -- essentially all seismological topics beyond my expertise, but it's my understanding that was the final conclusion, yes.**
Q. And you had no reason to disagree with this conclusion in this paragraph?
A. (Dr. Ostadan) **No. It's not my field.**
Q. The next to the last paragraph on the page, it starts with "during," and again I will read it. "During the course of our validation effort we have had the benefit of several technical discussions with many of the scientists who worked on the latest (and earlier) version of the Geomatrix report with DOE personnel and consultants." This paragraph suggests in this sentence that members of your team had discussions with members of the Geomatrix team. Is that correct?
A. (Dr. Ostadan) **I think so, yes.**
Q. Did you take part in those discussions?

A. (Dr. Ostadan) **Some of it, yes.**
Q. Do you recall which members of the Geomatrix team you had discussions with?
A. (Dr. Ostadan) **Mr. Bob Youngs.**
Q. Based on those discussions, did you have the occasion to form an opinion as to the personal competency of Dr. Youngs and/or other members of the Geomatrix team?
A. (Dr. Ostadan) **I do have great deal of respect for Mr. Bob Youngs and other team members I know at Geomatrix, yes.**
Q. Thank you much. Let's just look at the last paragraph of the executive summary. It's very short. It reads, "We conclude that the Geomatrix methodology and the results of the Geomatrix report are appropriate for the application to the design of the TWRS-P Facility at the Hanford site." Is that correct?
A. (Dr. Ostadan) **That's correct.**
Q. And insofar as you contributed to that report, this reflects your view?
A. (Dr. Ostadan) **That's correct.**
MR. TRAVIESO-DIAZ: This might be a good time to take a break.
(Recess from 10:14 to 10:26 a.m.)
MR. TRAVIESO-DIAZ: Back on the record.

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Q. (By Mr. Travieso-Diaz) I'm going to switch gears and ask a couple of questions of Dr. Bartlett.
Dr. Bartlett, will you turn your attention to Exhibit 10. That is the list of the State of Utah's Response to the Second Set of Discovery Requests. Look to page 51 to response -- to item A.
A. (Dr. Bartlett) Uh-huh.
Q. Which is entitled "Undrained Shear Strength May Have Been Overestimated Due to Consolidation During Triaxial Testing." You have that?
A. (Dr. Bartlett) Yes.
Q. I believe you testified that this was one that you were the main author for?
A. (Dr. Bartlett) That's correct.
Q. All right. Now, as I read this response, it appears to say that the applicant may have overestimated the undrained shear strength of the soils because they used one set of ASTM standards instead of the others, and the result of using that set of standards is that you ended up with a more or greater amount of undrained shear strength than you should have had. Is that essentially what you're saying?
A. (Dr. Bartlett) Let me just reread it.
Q. Maybe you can explain it better than I can.
A. (Dr. Bartlett) I'll characterize the issue,

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maybe, and it may no longer be one.
Q. All right.
A. (Dr. Bartlett) What I was doing at this point was looking at the testing program and the depths from which the samples were taken versus the depths of which in the device they were consolidated to. And I noticed that the depth, the pressure which was applied in the apparatus was higher than which the depth from which the sample was taken. And because this is a partially saturated soil, then it would consolidate and obviously the strengths would increase. That was for just the overburden stresses.
The applicant has now come back and said, well, it's fine to do this type of testing and loading as long as we keep that loading in the range at which we anticipate the loadings of the foundations, which they've done in subsequent calculations. So I'm not sure right now if this particular interrogatory is really that important to discuss.
Q. So you take it that because of the fact that the design pressure when the building is sitting on top of the soil will be --
A. (Dr. Bartlett) Yes, that will effectively consolidate the soils, so one should then do the test program according to what those anticipated loadings

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are. So I was just checking what the depth of overburden was versus what the sample was tested. But the proper design would be to consolidate the sample to the stresses underneath the foundation.
Q. I'm going to introduce a document because I think it may be good for the record to show what we're talking about. This is going to be now Exhibit 62.
(Exhibit-62 marked.)
Let me just identify for the record what this document is. I have marked as Exhibit 62 a Stone & Webster calculation with a number of G(B)05. The name is Document Bases for Geotechnical Parameters Provided in Geotechnical Design Criteria. The pages are not numbered, but it is a document that is probably at least a half an inch thick. And we are dealing here with what appears to be Revision 2.
A. (Dr. Bartlett) Correct.
Q. (By Mr. Travieso-Diaz) I'm going to ask you only one question. Would you turn, if you can find it, because it's in the middle of the document and the pages are not numbered, but I am going to ask you to try to find page 36 on top right-hand corner. Page 36 has something that's called Figure 11 that looks like this.
A. (Dr. Bartlett) Correct.
Q. Okay. Find it?

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A. (Dr. Bartlett) Yes, I've found it.
Q. I have only one question. Is this figure a graphical representation of what we have discussed?
A. (Dr. Bartlett) Not necessarily. It includes test data, and the point is, as I was just making, is that if one was to devise a test program to get the undrained shear strength using the consolidated undrained test that the proper confining stress -- or the proper stress to apply to consolidate it prior to shearing it undrained would be the foundation loads underneath the building.
Q. Okay. I don't want to belabor the point, but just for labeling purposes, there are a number of data points marked with sigmas.
A. (Dr. Bartlett) Yes, I see that.
Q. And there is a sigma of 0 at 10 feet?
A. (Dr. Bartlett) Right.
Q. And a sigma of 0 at 16 feet?
A. (Dr. Bartlett) Right.
Q. And then at the end is a sigma sub V?
A. (Dr. Bartlett) At the end?
Q. At the end of the curve on the top right-hand side.
A. (Dr. Bartlett) Yes, I see that.
Q. The discussion that we had referred, if I

understand it, that your view -- that the sigma sub V zero at 10 feet is lower than the sigma sub V zero at 16 feet?

A. **(Dr. Bartlett) The sigma sub V at 10 feet -- yeah, that's trivial. Yes, the overburden stresses at 10 feet will be less than at 16 feet.**

Q. Obviously. And your contention or your concern was that what data that you were using was the sigmas -- or getting what the sigmas sub V zero at 16 feet instead of 10?

A. **(Dr. Bartlett) Something to that effect, yes.**

Q. And whereas the actual sigma V with at same pressure on the right is higher than either of the two?

A. **(Dr. Bartlett) Yes. They've put those in and represented those by arrows on the chart.**

Q. Okay, that's all I have. Okay, let's just move on to -- I believe it's item B on top of page 53, which I think you also identified as your contribution.

A. **(Dr. Bartlett) Yes.**

Q. Rather than my trying to paraphrase what you say, would you explain what the concern here is?

A. **(Dr. Bartlett) We discussed this somewhat yesterday. In my experience with the Bonneville clays, because they're lake bed deposits, they are deposited in**

fairly thin layers, if you will, the sequence is of fairly thin layers. And because of that layering that's there, the fabric of the soil has an inherent anisotropy to it. In this case, this is dealing with shear strength anisotropy, and the simple idea is the shear strength is dependent upon which direction you shear. And I think this B here that we're looking at on page 53 is addressing that in the initial calculations that we reviewed there was really no consideration for anisotropy in the testing program.

Q. Is this still a concern of yours?

A. **(Dr. Bartlett) What the applicant has done since this is they've gone to the direct shear device, which could give you part of the anisotropy envelope, if you want to call it that. One concern with possibly the direct shear test is, in cemented soils we may be -- with the direct shear test the failure plane is predetermined by the testing device. It's a shear box, and we fail it essentially along the gap between the upper and lower gap of the shear box. So we're predetermining the failure in the sample.**

In cemented soils there can be a fair amount of even differences even within the sample, and so one might perchance get a high estimate or a low estimate of the direct shear device because you're allowing the

sample, you're forcing the sample to fall in a predetermined manner. And the direct simple shear device was an attempt that's been devised to overcome that stress concentration, and just pointing out that perhaps the direct simple shear would give a better estimate on these maybe slightly cemented soils that were seeing. They have not addressed potential of triaxial extension along the buried surface, and I have not seen any testing done in triaxial extension.

Q. But you would not use this type of test to test the extension, for extension, or --

A. **(Dr. Bartlett) No, when you do the triaxial extension it's a different apparatus.**

Q. Okay. That's what I thought you meant.

A. **(Dr. Bartlett) The same device that's used for triaxial compression.**

Q. Let me ask you a couple questions about the direct simple shear test.

A. **(Dr. Bartlett) Sure.**

Q. Do you know whether the NRC includes that as among the types of tests it either requires or recommends to be used during testing for nuclear facilities?

A. **(Dr. Bartlett) That level of detail I don't know. I'd have to look at the Reg Guide.**

Q. Let's do that.

A. **(Dr. Bartlett) Sure.**

MR. TRAVIESO-DIAZ: I'm going to mark now Exhibit 63.

(Exhibit-63 marked.)

Q. Exhibit 63, for the record, is a copy of NRC Regulatory Guide 1.138 dated April 1978, and entitled "Laboratory Investigation of Soils for Engineering Analysis and Design of Nuclear Power Plants." Are you familiar with this document?

A. **(Dr. Bartlett) Yes, I've seen it before.**

Q. Let me ask you to turn to two areas in this document. First take a look at page 1.138.5, and this document, the pages have two columns. Look at the top of the right-hand column on top of page 5. Do you see that? Are you there?

A. **(Dr. Bartlett) Yeah.**

Q. There appears to be a listing of laboratory tests to measure shear modulus, at least in that page and that column. Do you find the direct -- the direct simple shear test among them?

A. **(Dr. Bartlett) These are tests to measure shear modulus, not shear strength.**

Q. And let's see. Let us look at then -- at something that may be a little bit more general. Let's

look at a table that appears in Appendix B on page 138-11. Actually it goes on for quite some distance. Starts on 11 and goes on through 13.
A. (Dr. Bartlett) Fair enough.
Q. Now, what is the test that you referred to a moment ago?
A. (Dr. Bartlett) The direct simple shear test.
Q. I understand; but for what parameter?
A. (Dr. Bartlett) It's for shear strength.
Q. All right.
A. (Dr. Bartlett) Well, it's for undrained shear strength.
Q. All right. Let's see if we can find that. That would be -- I guess the parameters are listed on this table not on the left-hand column but on the fourth column starting from the left. Is that right? Where it says "properties or parameters determined"?
A. (Dr. Bartlett) Yeah, I see that column.
Q. All right. Let's take a look at the second, if you will, page of this table, which is 1.138-12, and the type of soils, shear strength and deformability. Would that be where we should be looking?
A. (Dr. Bartlett) Yes, under that column.
Q. Take a look at the tests that are listed

there, and I believe it goes through beginning of page 13.
A. (Dr. Bartlett) Uh-huh.
Q. Do you see direct simple shear tests as one of them?
A. (Dr. Bartlett) No, not specifically. I see direct shear, but I do not see direct simple shear listed.
Q. All right, let me ask another question. Who does this type of test commercially?
A. (Dr. Ostadan) May I add to the response?
Q. Sure.
A. (Dr. Ostadan) Just before we change the subject. I would like to read from Exhibit 63, the cover page, the column on the right.
Q. Right.
A. (Dr. Ostadan) Second paragraph.
Q. Yes.
A. (Dr. Ostadan) Unfortunately the stamp has gone over some of the words here, but I'll do my best. "The course of" -- I don't know what the next word is.
Q. I believe it says "site." Some copies are probably better than others.
A. (Dr. Ostadan) "The course of site and laboratory investigations will depend on actual site

conditions, the nature of the problem encountered or suspected at the site, and desired requirement for foundations and earthworks."
A. (Dr. Bartlett) May I also point out that this document is dated April 1978. We're now in the year 2000. The geotechnical practice has progressed since this document's been written.
Q. And do you know whether this document has been updated or reissued?
A. (Dr. Bartlett) Not to my awareness, but it's dated April 1978.
Q. All right. But as far as NRC guidance is concerned, are you aware of anything that supersedes 1.138?
A. (Dr. Bartlett) I do not.
Q. Let me go back to the question that I had a moment ago.
A. (Dr. Bartlett) Sure.
Q. Do you know whether -- who commercially does this type of test that you're suggesting, the simple shear test?
A. (Dr. Bartlett) I believe Woodward-Clyde's laboratory in New Jersey does it.
Q. Okay. Who else?
A. (Dr. Bartlett) Well, that's mostly my

experience with Woodward-Clyde. Here locally in the valley you're saying, or nationally?
Q. Whoever you know. I'm trying to understand how widespread is the availability of this type of test.
A. (Dr. Bartlett) That I can't answer. I just have experience with a few labs.
Q. How about you, Dr. Ostadan? Do you know?
A. (Dr. Ostadan) Oh, in the Bay area we use the laboratory facilities at the University of California at Berkeley. I believe Woodward-Clyde has some laboratory facilities in the East Bay. I specifically don't know if they have direct shear tests or not. Hardin Lawson Associates, they have laboratory tests in that area.
Q. Do you know whether either Woodward-Clyde in the Bay Area or Hardin Lawson have facilities and conduct direct simple shear tests?
A. (Dr. Ostadan) I cannot be certain.
A. (Dr. Bartlett) I also believe, at least for some of the testing along the I-15 corridor, it's not a commercial lab, but MIT.
Q. This is only to the extent you know. Is this type of device more commonly found in academic institutions like MIT or University of California, Berkeley?

A. (Dr. Bartlett) I can't state that. I don't know the number of commercial labs versus university labs. But it's recognized as a test and it's in the geotechnical literature. It's discussed in the EPRI manual.

Q. Let's go to paragraph C on the same page of Exhibit 10. Again, that's one that you told us that you were main contributor to; is that correct? It's Exhibit 10, page 53.

A. (Dr. Bartlett) Okay.

Q. If you will first again explain to me what the concern raised in that particular item was.

A. (Dr. Bartlett) This is item C, correct?

Q. Correct, item C on page 53.

A. (Dr. Bartlett) As I was reviewing I guess calculations relating to something using the subgrade reaction, it seems like I saw a value used for cohesionless soils in that I felt at least the shallow surficial soils were more cohesive and one should use a modulus of subgrade reaction that was more appropriate for cohesive soils.

I cannot say whether this has been changed, the subject calculations. It may have been. I'm not sure -- I can't state, because this is somewhat of a historic calculation that may have been revised, and I

didn't really review, readdress this issue. It's not a major concern of mine. It's just a fine point.

Q. Just so that we get the record clear on this: do you recall when Mr. Trudeau and Dr. Chang testified a couple days ago that they made reference I think more than once to the fact that this calculation has been superseded?

A. (Dr. Bartlett) Sure, and it may. The design has been superseded by the intent to use soil cement, too. So I think this is a historic issue.

Q. All right, then. It's not a current concern?

A. (Dr. Bartlett) No.

Q. All right. Let's go to paragraph D. Paragraph D starts on the same page. It addresses "No Consideration in Foundation Design of Potential Ground Rupture of Faulting." Again, would you briefly explain to us what your concern here is?

A. (Dr. Bartlett) Well, in the Geomatrix report when I reviewed this looking for potential for faulting underneath the facility, which I thought from a geotechnical perspective would be prudent to look for, there is indications of shear zones and small displacements of the soils that could be indicative of faulting.

Now let me read what I said.

Q. That always helps.

A. (Dr. Bartlett) As I recall, I think Geomatrix has done a subsequent report talking about the probability of displacements and gave a number assigned that I can't remember, it's a very small number. Given that that number is a good number -- and again, I'm not going to comment on the validity of that number other than, as I recall, it's a fairly small number and it was a probabilistic displacement number, as I recall. Those are relatively small, I think, for the foundation design.

Q. Since this is not a memory exercise --

A. (Dr. Bartlett) Let's look at it.

Q. Yes.

MR. TRAVIESO-DIAZ: Mark it Exhibit 64.

(Exhibit-64 marked.)

Q. (By Mr. Travieso-Diaz) Exhibit 64, even though the pages are out of order, includes the cover page of the final report prepared by Geomatrix entitled "Fault Evaluation Study and Seismic Hazard Assessment," February '99. It is a very voluminous report.

A. (Dr. Bartlett) Yes, I recall it from yesterday.

Q. And the second page of the exhibit is

Section 7.4 called "Summary of Results."

A. (Dr. Bartlett) Right.

Q. And it appears to indicate that the displace -- the small number displacement that you referred to a moment ago was less than .1 centimeter. Is that the way you read it?

A. (Dr. Bartlett) Yes. This is a probabilistic number. And so it's not the displacement during an actual event, but it essentially says that probably the mean annual frequency of the number is .1 centimeters. So it's a probabilistic displacement, sure.

Q. This is the number that you were referring to?

A. (Dr. Bartlett) That's the small number I was referring to.

Q. No, do you know what the tolerance for settlement is in the canister transfer building?

A. (Dr. Bartlett) The tolerances for settlement?

Q. Yes.

A. (Dr. Bartlett) Are you talking differential settlement? What type of settlement?

Q. Well, the type of settlement that you would experience as a result of exposure to hazard during an

earthquake that is mentioned here.
A. (Dr. Bartlett) I don't, but I'm sure it's well above these tolerances.
Q. But let me again, since this is not a test of memory, go to Exhibit 62 for a second.
A. (Dr. Bartlett) Sure. I think.
Q. I think this document has an answer on page 13.
MS. CHANCELLOR: Exhibit 62?
MR. TRAVIESO-DIAZ: Yes.
Q. We're on Exhibit 62, which again is Calculation G(B)05. Number 13 on the top.
A. (Dr. Bartlett) Okay.
Q. And you take a look at the very end, this is a handwritten calculation, or portion of --
A. (Dr. Bartlett) I see it, okay. I see what I'm looking for.
Q. And the last -- I think the answer is the last number in the page, the very last line. And the number is, as I read it, 1.73 inches?
A. (Dr. Bartlett) Correct.
Q. And that's greater than .1 centimeter?
A. (Dr. Bartlett) Yeah, sure.
Q. I think I'm going to move now to one that both of you identified as having contributed to, which

is Item E, and Item E is on page 54. Is that right?
A. (Dr. Bartlett) Yes. I think this is more coming from Dr. Ostadan's experience, not mine.
Q. All right. Dr. Ostadan, would you again summarize for the record what your concern was that you sought to express in Item E?
A. (Dr. Ostadan) Yeah. I think this has to do with previous work that Geomatrix did to develop the deterministic ground motion. And the comment or the question is whether the basin effect has been included in the calculation of deterministic ground motion. However, subsequent calculations and position that the applicant has taken, you have moved from deterministic to probabilistic ground motion. And whether or not this comment still applies in the probabilistic ground motion, I must say I have not reviewed the Geomatrix report, I cannot assess that at this time.
Q. Fine. Just so that we understand for the record: this concern referred to a calculation that was performed based on the deterministic ground motion earthquake.
A. (Dr. Ostadan) That's correct.
Q. And that calculation is no longer applicable because we have moved from a deterministic to some sort of probabilistic ground motion earthquake, right?

MS. CHANCELLOR: Could I just put on the record, the State considers that the deterministic earthquake is still the standard. Until PFS's exemption required before the Atomic Safety and Licensing Board, the regulation requires a deterministic. I'd just like to note that on the record.
MR. TRAVIESO-DIAZ: And I would like to note that my intent is not to debate that here but only to figure out whether Dr. Ostadan has reviewed the same concern based on the probabilistic ground motion to see if it's still a concern, assuming that that applies.
MS. CHANCELLOR: I have no problems with Dr. Ostadan answering any questions with respect to updated and current calculations.
MR. TRAVIESO-DIAZ: And that's all that I'm going to do. I believe he testified that he hasn't looked at it so, he doesn't know.
A. (Dr. Ostadan) That's correct.
Q. (By Mr. Travieso-Diaz) Now, would the answer be the same with respect to paragraph F, which I also believe refers to a deterministic ground motion earthquake? Paragraph F on page 54.
A. (Dr. Ostadan) We are talking about now somewhat of a historic calculation. At the time that the deterministic ground motion was reviewed, the

concern was whether the attenuation relationship used were adjusted to reflect the site conditions for PFS facility.
If I have to comment whether this concern has been addressed or not, I will say it's been aggravated ever since, because applicant has conducted seismic cone data and identified a very soft layer in the upper ten feet. And I do not think that even in the current ground motion calculation, probabilistic calculation, the recent geotechnical data has been used.
Q. Have you reviewed the, as you call it, the current calculation to in fact assess the start of your concern?
A. (Dr. Ostadan) I have looked at the few pages of Appendix F, and I have discussed that with Dr. Bartlett. I do not have the report itself. And made certain that the shear wave velocity, the mean shear wave velocity that is now recognized to be 540 feet per second has not been used in Geomatrix's calculation.
Q. All right. I might have the document that you referred to or may not. What Geomatrix calculation are you talking about?
A. (Dr. Ostadan) Since I do not have the report, may I defer to Dr. Bartlett?

A. (Dr. Bartlett) I believe the issue is in Appendix F where it discusses the development of the probabilistic ground motions. And those are discussed and developed in the shear wave velocity profiles from which the -- we're calling them calculations -- but the analyses done by Geomatrix isn't discussed in Appendix F, or the fault evaluation and probabilistic -- or the hazard evaluation study. When we look both in the text of that Appendix F and also the figures from which we could conclude that the ground motion studies were done, both of those apparently had shear wave velocities around 750 feet per second. So our concern was that it didn't appear that the shallow layer that we've been talking about with the mean velocity of 540 feet per second had been included in the discussion analyses in Appendix F.

A. (Dr. Ostadan) I would like to add to that answer. Since we are discussing about whether this concern has been addressed or exists in the recent calculation, I think as was stated by Dr. Bartlett, we are certain that the upper soft layer was not represented in the ground motion analysis. I also would like to state that the properties of the deeper layers, 750 feet per second and increasing with depth were obtained from geophysical refraction tests that were

conducted by the applicant at the time, predating the seismic cone data, obviously.

And as far as I understand, and I'm not a geophysicist, but if in this analysis you measure some layers such as the upper ten feet soft layer, it could potentially impact the measurement -- not the measurement -- the properties developed for the deeper layers. So another way of saying this is that if the refraction data were to be analyzed again or conducted again and the upper ten feet is recognized, it's very likely that the velocities for deeper layers will change.

Q. Since both of you referred to Appendix F and I happen to have a copy of Appendix F here, let's mark it as an exhibit so rather than talking generally where your concern is expressed in the body, you can pinpoint it for the record.

MR. TRAVIESO-DIAZ: Let's make this Exhibit, what, 65?

(Exhibit-65 marked.)

MR. TRAVIESO-DIAZ: And while we're looking at that, can we go off the record for about two minutes?

(Discussion off the record.)

Q. (By Mr. Travieso-Diaz) Now, we were talking about Appendix F to the Geomatrix report, which is now

Exhibit 65. And I asked you to perhaps give us references as to where in the analysis do you find the problems that you just referred to. Have you been able to do that?

A. (Dr. Bartlett) Yes, we have.

Q. All right. And will you tell us where that is?

A. (Dr. Bartlett) It is on page F-8.

Q. All right.

A. (Dr. Bartlett) Okay. The last paragraph beginning "As indicated above."

Q. Correct.

A. (Dr. Bartlett) You see there that "the average velocity," and this would be shear wave velocity, I believe they're referring to, "for the Holocene and Pleistocene sediments are estimated to be," they're speaking of both, 750 feet per second, shear wave velocity; 2,000 feet per second, P-wave velocity, primary wave velocity.

Q. And your concern is that for the upper layer these numbers may be too low?

A. (Dr. Bartlett) That's correct.

A. (Dr. Ostadan) No, too high.

A. (Dr. Bartlett) Excuse me.

Q. I'm sorry. Too high.

A. (Dr. Bartlett) Too high.

A. (Dr. Ostadan) And the second concern is the new measured data could impact the numbers cited here?

A. (Dr. Bartlett) Let's also refer to Figure F-4 just to show that the apparent shear wave velocity profile used in the analysis, or at least the mean -- should probably say the mean shear wave velocity profile used in the analysis. I see a Skull Valley sediment with a solid line, a California deep soil with a dashed line. And to the best that we can tell from the scale of this drawing, it appears that in the upper 50 feet of the profile, going from 50 feet to the surface, that there's a shear wave velocity here of 750 feet per second. And we believe this to be incorrect now, at least in light of the new -- not the new, but the seismic cone penetrometer data that's been developed by the applicant.

Q. I didn't mean to cut you off; but to further define your concern, what is your understanding as to what the cone penetrometer data reflects or shows as to the shear wave velocity in the upper, what, layer 2?

A. (Dr. Bartlett) I believe we discussed this yesterday, but the mean value is approximately 540 feet per second with a lower bound somewhere around 400 feet per second and an upper bound maybe around 700 feet per

second --
Q. All right.
A. (Dr. Bartlett) -- in the upper 10 feet, at least in this layer 2 that we've been talking about, this clay layer near the surface.
Q. And I take it -- do you have a concern with the values of shear wave velocity that are plotted on Figure F-4 with respect to layers below I guess 50 feet?
A. (Dr. Ostadan) Yes, I do.
Q. And what is the concern?
A. (Dr. Ostadan) The concern was the development of these properties were based on refraction data at the time that the upper soft layers were not recognized to exist at the site. Now, with the new information from seismic cone data, I believe the refraction data needs to be reanalyzed and the properties for the deeper layers needs to be recalculated.
Q. Just explain for the record how the velocity on the layers say 50 feet or below would be affected by a variation in the velocity in the upper layer.
A. (Dr. Ostadan) Okay. This is -- I am speaking from experience. I'm not a geophysicist and I don't claim to have expertise there. They trigger a source and they measure vibration of the ground at the

surface, and then they collect a lot of raw data repeating this test. And then they assume certain layering at the site and they take the peak's time to travel a refraction. And they work from layers above to below. If they miss on a layer at the top, the properties that were subsequently calculated for layers below would be impacted.
Q. Would be impacted or might be impacted?
A. (Dr. Ostadan) Would be impacted.
Q. For a fact?
A. (Dr. Ostadan) Yes.
Q. If you assume, as this curve appears to assume, that there is a uniform velocity on the top 50 feet or so -- I believe that's what Figure 11 seems to show.
A. (Dr. Bartlett) Approximately 50 feet.
Q. Assuming for the moment that this figure is correct, would a shift in that curve, say, from 750 to 600, 500 change their response below?
A. (Dr. Ostadan) "Their response below," would you clarify?
Q. The velocity below. I'm sorry.
A. (Dr. Ostadan) Would you repeat the question?
Q. Yes. You express a concern that there may

have been an underestimation of the -- or overestimation of the shear wave velocity in the, say, layer 2, the first couple layers of soil. Is that it?
A. (Dr. Ostadan) I did not characterize it as over or under. I stated that the layers, soft layers were not recognized in the refraction test that was performed.
Q. What I'm trying to get to is two things. First, assuming that it was in fact as it is shown in the curve, uniform, the same shear wave velocity for the top 50 feet as opposed to perhaps being different from one layer to the other, would that result, assuming that this curve is correct, perhaps not as to what the number is but that the fact that it's uniform, would that affect the value of shear wave velocities at levels below, say 100 feet or below?
A. (Dr. Ostadan) You recognize this is a hypothetical question. You're assuming it's uniform.
Q. Yes.
A. (Dr. Ostadan) We know it is not uniform from seismic cone data. Therefore, I cannot really postulate that. As I said, I am not a geophysicist, but I do know the process sitting through these meetings and other projects that if you did not pick the upper layers properly, the layers below will be impacted.

Q. Let me ask you a variation of that question. Assume that the average velocity for the top 50 feet is as depicted in Figure F-4, average as opposed to, you know, point-by-point variation. How would that affect the validity of the shear wave velocity measurements of layers below 50 feet, if you know?
A. (Dr. Ostadan) I would suspect it would impact the velocities.
Q. Even if the average is as stated on Figure F-11? And what would be the basis for your suspicion?
A. (Dr. Ostadan) Simply based on the techniques and the methods the geophysicists use to come up with these properties, and they work out from layer to layer.
Q. I tell you, I think we should move to paragraph G. Paragraph G is on page now 55. Do you see that paragraph?
A. (Dr. Ostadan) Yes, I see.
Q. Can you again explain for us what your concern is in paragraph G?
A. (Dr. Ostadan) This is I believe again an old calculation to do with deterministic ground motion. The state suggests the P-wave velocity of 4,000 feet per second is applicable to the site. And the reason for the erroneous measurement of 2,500 feet per second

should be described.

It's been a long time. I think there was a mismatch in the package, as I recall. There was a measurement of 2,500 feet per second that was recognized to be an appropriate property, and they chose to use in this case I believe Geomatrix' 4,000 feet per second. However, the geophysicist did not provide any information why the property he or she picked was 2,500 feet per second rather than expected value of 4,000 feet per second. And what would be the impact of this erroneous assessment in the other layers, that was the comment.

Q. Is this still a valid comment?

A. **(Dr. Ostadan) Again, I have not reviewed appendix -- Geomatrix report that's reflected here. I cannot answer that.**

Q. Do you recall when Mr. Trudeau and Dr. Chang testified on Wednesday that they testified that this particular Calculation (P05)-1 had been superseded by what's now called (P018)-1?

A. **(Dr. Ostadan) I recall that.**

Q. Have you reviewed (P018)-1 for purposes to determine whether this is still true?

A. **(Dr. Ostadan) Can you give me the title to (P018)-1? I don't remember numbers.**

Q. I can do better than that. Let me just give you (P018)-1.

MR. TRAVIESO-DIAZ: Let's mark this as 66.

(Exhibit-66 marked.)

Q. I have marked as Exhibit 66 a Stone & Webster calculation entitled "Soil and Foundation Parameters for Dynamic Soil-Structure Interaction Analyses," Calculation Number G(P018)-1. The date appears to be August 26, 1999. And it says on the right that it supersedes calculation G(P05)-01, Rev. 1. Do you see that? On the front page.

A. **(Dr. Ostadan) Yes, I see it.**

Q. Okay. Would you turn your -- look at -- I believe it's page 9 of 26. And I believe also that there is a table on the top of page 9.

A. **(Dr. Ostadan) Two tables.**

Q. You're right. And then there is on the bottom of the page a section 4.0. Let's look at 4.0 first. And the section 4.0 indicates that the dynamic properties for the idealized layers as developed in support of this analysis are presented in Table 1. And then now I'll ask you to look at Table 1, which is on page 14 of 26. Do you have that?

A. **(Dr. Ostadan) I have that. Yes, I'm there.**

Q. By looking at this Table 1, and let's look

at the middle column, which is entitled "Best Estimate."

A. **(Dr. Ostadan) Yes.**

Q. Will you take a look at the best estimate entries for the shear wave velocities and the pressure velocities, which I believe are in the fifth and sixth columns.

A. **(Dr. Ostadan) Yes.**

Q. And look at the numbers that are reported for the various layers which correspond to various depths.

A. **(Dr. Ostadan) That's correct.**

Q. All right. Now, isn't it true that the shear wave velocity as reported now in this new calculation is 500 to 663 for the first -- well, let me not characterize myself what this shows.

Would you look at the shear wave velocities in the middle column for best estimates on this table, and tell me whether these are better estimates than the ones that you were referring to with respect to (P05)-1, and meaning better in the sense of being closer to measured values?

A. **(Dr. Ostadan) Yes, I think these properties, as I recall, reflect latest soil data, including seismic cone data.**

Q. Would the fact that these are the numbers

now used by Geomatrix in its calculation resolve the concern that you had on paragraph G with respect to the use of inconsistent figures?

A. **(Dr. Ostadan) I think there are two topics here mixed up.**

Q. All right. Please clear me up.

A. **(Dr. Ostadan) As far as the development of soil and foundation parameters are concerned, which is the mission of Calculation G(P05)-1 and Exhibit 66, I do believe the Exhibit 6, as I stated, reflected the latest geotechnical data.**

However, the premise of the comment G was that at the time Geomatrix performed a similar calculation using the deterministic motion, they recognized that the velocity of 2,500 feet per second was erroneous, and I believe that probably came from refraction data. And they chose to use 4,000 feet per second.

Therefore, part of the concern has been addressed, the part that relates to development of soil and foundation parameters in support of dynamic soil analysis. But part of the comment that it states that the impact of the cause and the velocities of the layers below should be explored has not been answered.

Q. So what you are referring to as being a

separate concern, even though it's part of the same paragraph, is that -- what is stated on the last clause, if you will, on this paragraph which reads, the impact of the cause on -- I'm sorry. The cause for what? The cause of what?

A. (Dr. Ostadan) I think -- I'm recalling from memory here on this. You handed me this calculation, the old calculation. I think Geomatrix states that the P-wave velocity of 2,500 feet per second in their opinion is erroneous, and they chose to use 4,000 feet per second. And part of the concern expressed here, if that is the case that 4,000 feet per second is appropriate, what would be the impact of this erroneous measurement or analysis on the other velocities of other layers.

Q. All right. Let me ask you to turn back to page 5 of the text of that exhibit.

A. (Dr. Ostadan) Which one?

Q. The one you have in front of you, Exhibit 66.

A. (Dr. Ostadan) Correct.

Q. I believe on page 5, middle of the page to the bottom of the page, there is a section called "Site Data."

A. (Dr. Ostadan) Yes.

Q. And I believe that that paragraph contains an explanation of how the values that are reported in Table 1 were contained.

A. (Dr. Ostadan) Yes, I read that.

Q. Okay. Does it help you understand how the numbers on the table were obtained, and does it alleviate the concern you just expressed in any way?

A. (Dr. Ostadan) I don't think that issue is really as important, because first of all, this calculation is really a historic calculation now on the account of change of ground motion and the philosophy here. I don't think I have a major concern with this.

Q. Why don't we move to H. I guess we're up to H on page 55. And H is entitled "Unknown Influence of the Sharp Contrast in Dynamic Soil Properties on Foundation Parameters and Soil Structure Interaction Analysis." Again, so that I don't misinterpret what your concern was, will you explain?

A. (Dr. Ostadan) Okay. At the time this calculation was performed, they used a very quick approach to estimate the stiffness and damping, and the effects of frequency dependency was not considered. I think in the revised calculation it has been considered. But I do not have a concern on this anymore.

Q. Let's then look at "I" on page 55. Again,

it's entitled "No Variation of Soil Parameters Has Been Considered in Performing Site Response Analysis." This goes up to page 56. And again, I think it refers to the same calculation that we have been discussing before, the 1997 calculation.

A. (Dr. Ostadan) Yes, sir.

Q. In light of the new calculation, (P018), is this still a current concern?

A. (Dr. Ostadan) You need to realize the chain of calculations that are using the information that are provided by Geomatrix calculation -- first of all, this is again an old calculation. At the time they did not recognize any variation of the properties. Now, the revised calculation does recognize the variation of soil properties. However, the way the new Geomatrix calculation is written out, they have chosen to vary the properties in the upper 30 feet or so by increasing and reducing shear modulus by a factor of one and a half. And I made a comment yesterday that no statistical analysis was shown to justify whether this variation is sufficient, or they should have used NRC SRP 371 to change the shear modulus by a factor of 2. However, for layers below 30 feet or so, Geomatrix calculation states that the properties are less known, and they choose to change the properties by a factor of two, which is, in

my opinion, sufficient.

And I mentioned this chain of calculation needs to be considered because then Stone & Webster performed a similar calculation using the shake results provided by Geomatrix, the strain compatible soil properties, in order to develop soil spring and damping for canister transfer building. In doing so, Stone & Webster chose to vary the shear modulus by a factor of one and a half for all layers, shallow and deep.

So the concern remains, how come Geomatrix, for reasons to be provided, limited the variation to one and a half in the upper 30 feet but recognized that more variation is needed for deeper layers, but Stone & Webster using Geomatrix data did not recognize this. I have not seen any discussion of data to suggest that would be appropriate.

Q. To paraphrase what you just said and to make sure I understand it, with respect to the Geomatrix calculation, your concern is that it has not been established a basis for using a variability factor, if you will, of 1.5 for the upper layers?

A. (Dr. Ostadan) That's correct.

Q. And you don't have other concerns with the Geomatrix calculation; is that right?

A. (Dr. Ostadan) I do not have any other

concerns.
Q. With respect to the Stone & Webster calculation that uses the Geomatrix calculation or may use it, your concern is that they had used 1.5 across the board for all layers. Is that it?
A. (Dr. Ostadan) Yes. I make a correction. They have used it.
Q. They have?
A. (Dr. Ostadan) Yes.
Q. So to the extent that the Geomatrix approach for using 1.5 in the upper layer is faulty, the Stone & Webster will be faulty as well; and to the extent that it is correct for the upper layers, the Stone & Webster's 1.5 would be correct?
A. (Dr. Ostadan) I think that's true.
Q. On the other hand, Stone & Webster will have to prove why they used 1.5 for the other layers, whereas Geomatrix used 2?
A. (Dr. Ostadan) That's correct.
Q. I think I understand. Now, what determines, based on your knowledge of industry practice and their standards, whether you can use a 1.5 factor of adjustment or not? What basis do you make that determination?
A. (Dr. Ostadan) Statistical analysis of the

data. One needs to collect enough data to be able to capture the variance to be able to establish the upper bound, lower bound, mean, so that a call can be made whether a limited variation should be considered or a larger variation should be considered.
Q. Now, let's consider for a second the upper layers of soil at the PFS site and the shear wave velocities that have been reported using the various tests that have been run. You remember we had some discussion of that the other day when Mr. Trudeau was testifying?
A. (Dr. Ostadan) Yes.
Q. Do you recall whether there is a wide variation on shear wave velocities in the upper layers?
A. (Dr. Ostadan) I think it is fair to state that I do not expect a wide variation of shear wave velocity based on seismic cone data. However, all I am asking is that statistical analysis needs to be presented to justify that.
Q. So you think that a confirming statistical analysis should be performed?
A. (Dr. Ostadan) That's correct.
Q. But your recollection of the data is that the velocities are fairly uniform for that?
A. (Dr. Ostadan) I expect them to be. That's

correct.
Q. And in fact, just -- again, this is not a test of memory. Do you recall, we introduced in the deposition of Mr. Trudeau Exhibit 38, and Exhibit 38, I'm only going to show it to you to refresh your memory. Includes as the last page Figure 2.628 of the SAR.
A. (Dr. Ostadan) Yes.
Q. And if I remember the discussion, Mr. Trudeau testified that it appeared that the shear wave velocities were reasonably uniform across. And that's what my understanding was of this graph.
A. (Dr. Ostadan) That's my understanding, yes.
Q. Thank you. All right. And again, your concern as to the upper layers would be that even though this may be the case, you'd like to see statistical verification?
A. (Dr. Ostadan) That's correct.
Q. And as to the lower layer, you'd like to know how come Stone & Webster used a factor of 1.5?
A. (Dr. Ostadan) That's correct.
Q. Thank you. By the way, when you say Stone & Webster, I think I know, but I don't want to put words in your mouth. What calculation did Stone & Webster use?
A. (Dr. Ostadan) I don't remember the number

even to touch it, but this is a calculation that calculates the soil spring and damping.
Q. Soil spring and damping for -- okay. If we come across that calculation, we'll come back to it.
A. (Dr. Ostadan) Sure.
Q. We were now talking about -- I lost my train of thought here. I think we just finished talking about "I" on page 55. And let's just move to J on page 56.
Now, this -- again, I'll let you explain what your concern is with respect to J.
A. (Dr. Ostadan) Okay. What I would like for the record to state, it is a very, very important decision in the course of the study of seismic design for any facility that once a design basis motion has been developed, and the engineers will take that motion and will have to apply it into their analysis at which location in the soil profile this motion should be introduced -- in technical terms, the control point, the location of the control point. SRP 371 specifically states, if you have soil profile that has a thin soft layer, the design motion should be specified as outcrop at the top of the competent material. In other words, they want applicants not to put the design motion on the top of a thin soft layer.
That issue is still very much of the

concern, and I must say has been even aggravated by the new seismic cone data.

Q. Let me ask first just to -- perhaps we can agree on the applicable standard. Are you familiar with Reg Guide 1.165?

A. (Dr. Ostadan) I believe I am. Is this the one that talks about damping?

Q. Again, we're not going to test your memory here. I'm not going to introduce it because it's already on the record as Exhibit 2. I'll give you a copy. Reg Guide 1.165 entitled "Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion," dated March 1977. I believe that testimony by all the witnesses earlier on has indicated that this is the currently controlling regulation from the NRC standpoint on the issue that we were discussing a moment ago.

MS. CHANCELLOR: Objection. It's not a regulation.

MR. TRAVIESO-DIAZ: Okay, guidelines from the NRC. I stand corrected.

A. (Dr. Ostadan) May I comment on that? I think that counsel has stated that their position on the probabilistic ground motion will be formulated. This guidance specifically talks about the probabilistic

method to be used for the development of ground motion.

Q. Well, let me ask you the following question. Looking just within the text of this regulation, and I'm going to refer you specifically to page 1.1657, 1.65-7. And as many NRC documents tend to be, this is has two columns. I'd ask you to look at the left column, paragraph No. 3, and let me ask you to read that paragraph first.

A. (Dr. Ostadan) Do you want me to read it?

Q. No, no. Read it to yourself. I can read it, but I just want you to study it.

A. (Dr. Ostadan) Yes, I read that.

MS. CHANCELLOR: For the record, I'm going to object that this document addresses probabilistic ground motions and addresses sites in the eastern United States, that this isn't relevant to the PFS site. He may answer if he can.

MR. TRAVIESO-DIAZ: Well, my question was -- in fact, as to the second part of your objection, I invite you to look at the middle of the paragraph.

MS. CHANCELLOR: I see it now.

MR. TRAVIESO-DIAZ: Right.

Okay, and your objection to the first part is noted.

MS. CHANCELLOR: Okay.

Q. (By Mr. Travieso-Diaz) My question to you is, first clarify for me, when it says in the second part of this paragraph that the ground motion estimates should be made for road conditions in the free field, is the free field that they referred to the same as competent materials you're testifying? I'm trying to understand what the distinction is, if any, between the two concepts.

A. (Dr. Ostadan) Well, I do know it is done both ways. Free field simply means ground free of presence of any structures or building.

Q. Would that mean on the surface?

A. (Dr. Ostadan) Yes. So -- and that's how the practice is. You develop ground motion for the ground first. And it's done for the rock and it's also done for competent soils, yes.

Q. Now let me ask you a different question. Is it your concern, one, that the top 30 feet of soil at the PFS site are not competent material as you define it?

A. (Dr. Ostadan) Yes.

Q. So your concern is that you feel that the top 30 feet of soil at PFS is not competent material; therefore, you should not place your earthquake source there?

A. (Dr. Ostadan) Not on top of that layer, that is correct. I'd like to make a clarification.

Q. Please.

A. (Dr. Ostadan) There are two ways to apply or use the analysis, in my opinion, to be proper. One is, the seismologist that developed the design basis motion recognize the soil profile and all the layers and the latest information in their calculation. This obviously was not the case. The upper layers with the low velocities were not reflected in the Geomatrix seismic hazard analysis. Short of doing that, recognize that the ground motions were developed for a soil profile that has a velocity of 750 feet per second in the upper layers, and therefore use a ground motion that has been developed but put it in the soil column where the shear wave velocity of 750 feet per second shows up to be consistent with the development of the ground motion.

Q. So your view is that the earthquake location should be at the place where you computed your shear wave velocity?

A. (Dr. Ostadan) Consistent with that assumption that you used in the development side, that's correct.

Q. Now, if it was determined by reference to

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industry standards or some other source that in fact the top 30 layers -- the top 30 feet of soil at PFS were competent material, as you defined it, would that resolve your problem?

A. (Dr. Ostadan) I certainly would like to see that documentation. I think to help you out, if I may, there is a documentation by NRC that defines thin, soft layers. And if I'm not mistaken, thin is defined to be anything less than 100 feet, and soft is defined to be -- and I have to be approximate here -- anything less than either six or seven hundred feet per second.

Q. And can you give me for the record that NRC standard?

A. (Dr. Ostadan) That's a NUREG publication. I don't recall the name.

Q. All right. Does that publication contain a definition of what competent soil is?

A. (Dr. Ostadan) It defines what thin soft layer is as stated in the Standard Review Plan 3.7.1.

Q. But it does not contain, and this is only if you remember because I don't have the document in front of me to give you, it does not specifically define what a competent layer is?

A. (Dr. Ostadan) I think it implies what a competent layer is by defining the properties of the

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soft layer.

Q. Do you know whether there are other industry publications that provide a definition of what a competent soil layer is?

A. (Dr. Ostadan) I don't recall any. I think the most relevant guide and standard would be NRC here.

Q. Well, the only reason I'm asking that is, in the absence, and we don't know if there's an absence, but assuming that there is an absence of definition by the NRC of what a competent layer is -- let me ask the question again.

Assuming, and again it's not established, that there is no NRC specific guidance as to what a competent layer of material is, would the practice in your profession be to refer to other industry sources that may contain a definition?

MS. CHANCELLOR: I'm going to object because he testified that soft thin layer was basically synonymous with competent layer, and the NUREG defines soft thin layer. And he gave you his best recollection of what soft thin layer, the definition of that. And so now you're asking him to speculate that that may not exist and that what would you do if this didn't exist, and I think he's told you that it's in the NUREG.

MR. TRAVIESO-DIAZ: Only for clarification.

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If I understand the witness, and please correct me if I'm wrong, he said that you can imply what a competent layer is from the definition of soft layer --

Q. -- but they are not the same thing, are they?

A. (Dr. Ostadan) Well, in the context of discussion we have as to where you place the design motion, the NUREG document talks about or clarifies what the soft layer is, and that would also clarify what thin soft layer is not.

Q. And how do you go from there to what a competent material is? That's my question.

A. (Dr. Ostadan) My assessment of that information is, if you have a layer that has velocities in excess of what is recognized to be a soft layer, you can treat it -- for the purpose of locating design motion, you can treat it as competent.

Q. Let me ask you the question differently. In determining whether you have competent material, what you look at is the velocity in that material?

A. (Dr. Ostadan) That is correct.

Q. And you're inferring that if you have a thin layer, a thin layer may not have a velocity high enough to be classified as a competent material?

A. (Dr. Ostadan) That is correct.

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Q. All right. I think that that clears what you're talking about.

Why don't we move on to I think paragraph K, which I believe starts on page 56. And again, rather than attempting to describe the concern, I would ask you to please summarize it.

A. (Dr. Ostadan) There are a number of points made under K. "The seed time used to generate each component of the design time history has not been described." Seismic design time history for private storage facility, etc.

All right. So at the time, again, this is a historic calculation, and the comment states that what recorded time history date is started with a seed time history. I think to that effect this has been resolved. The new Geomatrix calculation states which seed time history they have used.

Q. And which is that?

A. (Dr. Bartlett) I remember seeing it. It has been stated.

A. (Dr. Ostadan) Right. It is a record from Italy, I believe.

A. (Dr. Bartlett) It's an external site, rock site. We've seen the time history.

Q. Excellent memory.

A. (Dr. Ostadan) I think he lived through that motion, I believe.
A. (Dr. Bartlett) I have been in that earthquake.
Q. Then you have good reason for being intimately familiar with this. But anyway, let's just put this on the record so we know what we're talking about. Let's call this Exhibit 67.
(Exhibit-67 marked.)
Exhibit 67, and for the record, let me identify, this exhibit consists of excerpts. It's not a complete document.
A. (Dr. Ostadan) Yes.
Q. I believe it's the first ten pages of Stone & Webster Calculation G(PO18)-3 entitled "Development of Time Histories for 2,000-Year Return Period Design Spectra."
A. (Dr. Ostadan) That's correct.
Q. All right. Now, and this is only for purposes of clarifying the record, would you take a look at page 4 of 34 in Exhibit 67. I believe it identifies the earthquake that was used as the seed -- to provide a seed history, as you mentioned it. And I believe it says in the last paragraph of the page that it was the November 23, 1980 M 6.9 Irpinia, Italy earthquake. And

that's what we're talking about.
A. (Dr. Ostadan) That's correct.
Q. So the first portion of your concern was only historical, because now we have an identification of which was the seed history.
A. (Dr. Ostadan) That's correct.
Q. Do you have any concerns as to that selection itself, whether that was a proper selection for PFS?
A. (Dr. Bartlett) It seems to be a reasonable record. As I understand it, it comes from a normal faulting type of event which we have in the Basin and Range. I believe it was also used at Yucca Mountains.
A. (Dr. Ostadan) I would like to add to that. It is, in my opinion, appropriate but not adequate.
Q. Now you need to clarify what you mean by that. So it's necessary but not sufficient?
A. (Dr. Ostadan) Then again, we have to recognize what this calculation does to the entire design package. Geomatrix was asked to develop time histories to be compatible with the design response spectrum. And in the second round of calculations that they performed, I think they did a substantially much better job than the previous round. And they developed one set of time histories with three components, two

horizontal and one in vertical. And these time histories, in my opinion, are acceptable. They meet all the requirements in terms of energy and frequency characteristics.
However, they're not sufficient, and the reason is we need to now look at the entire design package. And there are two elements that come in. One is, the analysis of the casks on the pad that was conducted by Holtec is a nonlinear analysis. They have modeled the friction and the sliding behavior of the cask on a pad by nonlinear elements. It is a common practice in our field that whenever you do a nonlinear calculation you use at least three sets of time histories rather than one, because it is recognized that the nonlinear analysis is sensitive to the phasing of a time history, and in order to cover variation of the phasing in the design, a minimum of three time histories and sometimes four are used.
The other concern I have is that Geomatrix has appropriately recognized that we are near a major fault, the applicant is near a major fault here, and therefore the velocity cause, or quote-unquote, fling, should be included in the time history. They have done so. They have included that. However, no parametric study has been done in this design package to reveal

what is the impact of these pulses on the design. Therefore, the concern remains whether the pulse in terms of shape and period has been adequately characterized.
And I would like to cite an example, for example, in the Bay area, San Francisco Bay area. The same issues have been raised for construction of a bridge there, the San Francisco Bridge -- Bay Bridge, in which it's been recognized that these pulses could be symmetric, asymmetric, one-sided, two-sided. And as a result of that, several time histories were generated to make sure variation of these pulses are included in the design.
Q. Before we address the two concerns you just mentioned, I want to ask you about one more item that is mentioned in paragraph K, and that is in the last paragraph, just to make sure that we don't overlook it. It says, "Acceleration-compatible time histories are shown to match the design response spectra at only 5 percent damping." Is that a historical concern, or is it still correct?
A. (Dr. Ostadan) It's a historical concern.
Q. So it is no longer true?
A. (Dr. Ostadan) It's no longer true.
Q. Now, let's go back to the two you did

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address. If I understand the first, you don't have a problem with the time histories that Geomatrix developed, but you do have a problem with the ones that Holtec used. Is that correct?

A. (Dr. Ostadan) **I think my concern is the ones that were developed are fine but are not sufficient. More needs to be developed.**

Q. You mean they have to develop more than one time history?

A. (Dr. Ostadan) **That's correct.**

Q. So that all their designers, like Holtec, could have them available to use?

A. (Dr. Ostadan) **That's correct.**

Q. And your understanding is that in the design Holtec did not use three time histories?

A. (Dr. Ostadan) **My understanding, they used the one set that Geomatrix developed.**

Q. I understand it now. Now, the second concern is that even though Geomatrix has addressed fling in its calculations, they did not try to determine parametrically the potential variations or the potential differing effects assuming various levels of fling. Is that the concern?

A. (Dr. Ostadan) **Yes. I would restate that, as I stated earlier, that if the design calculation can**

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identify that the design parameters are not sensitive to the fling, perhaps there's no need to have additional time histories for the P. But if this effort has not been done, and it has not been done, therefore I think that has stuff that needs to be covered.

Q. And I was remiss in asking you earlier to identify for the people who read this transcript what "fling" means so that we can have a better idea of what we're talking about. In common parlance that means something else, I'm sure.

A. (Dr. Ostadan) **As you know, we learn from every earthquake, a fling is a phenomenon that was known for a number of years but was not appreciated until we had these two recent earthquakes in Kobe and North Ridge. But what is the best way to characterize fling is to look at the velocity time history of a record of a site which is near a major fault. And what you will observe is a huge pulse that contains a lot of energy in a short period of time. For example, in the case of North Ridge, the shaking was in the order of ten to fifteen seconds. If I'm not mistaken, 85 percent of energy was delivered in -- some of it in one to one and a half seconds. This is what make earthquake more of a blast.**

And of course as a result of that, there was

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major damage in the Los Angeles area and Kobe, and the subsequent research and studies identified that the fling was a major contributor to that damage.

Q. To put it perhaps in layman's terms, an earthquake that features fling is one in which there is an energy pulse delivered over a very short period of time?

A. (Dr. Ostadan) **I think that is one way of characterizing it, yes.**

Q. And that energy pulse can be characterized in terms of the velocity?

A. (Dr. Ostadan) **That would be the best way to observe it. You will not see it in a response spectrum. You will see it in time history -- in velocity time history.**

Q. And what you're suggesting is that what has not been done at PFS is in addition to use of recorded type -- recorded value or pattern of fling where they should have also done parametric studies to determine the extent to which variation in the size of the velocity would have an impact on the response?

A. (Dr. Ostadan) **As I stated, there are two ways to address my concern and my opinion. One is to go back and look at the dynamic analysis of the cask and the pads and the canister transfer building and show**

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whether those seismic responses are sensitive to the pulse or not. And these pulses usually take place at longer periods. If that can be established, I don't see there's a need to generate additional time histories with other pulses.

If applicant chose not to do that, then my concern is we should have enough time histories with variation in the pulses to ensure, in case the design parameters are sensitive, they are covered.

Q. So you're saying that a designer has a choice between two procedures; either you establish parametrically that you are not sensitive to fling -- to variations in the fling, and therefore you can use whatever best fit you can find, or if you don't do that or if your parametrics show that you are sensitive, then you have to use a range of those values?

A. (Dr. Ostadan) **That is correct. I think the record will be clear what you mean here.**

(Recess taken from 12 noon to 12:10 p.m.)

Q. Dr. Ostadan, before we broke, took a break, we were talking about paragraph L, I believe, on page 57. And I neglected to ask you a question about the parametric study that you were -- suggested that would be used. And typically in a parametric study, you take what you consider to be a significant parameter and you

vary it manually to how see how it affects the output of the result. Is that what you do?
A. **(Dr. Ostadan) Variation within reason, yes.**
Q. Now, in the parametric study that you're suggesting, what parameter would you suggest be varied and how?
A. **(Dr. Ostadan) You need to be specific. We talked about two issues. One had to do with the nonlinear analysis of Holtec. The other has to do with characterization of the pulse in the time history. Both of them.**
Q. Well, you can talk about both of them.
A. **(Dr. Ostadan) All right. For a nonlinear analysis, as I have stated, it is generally known that the response is sensitive to the phasing of the time history. And the only way that it can be, to my knowledge, can be properly recognized is to have more than one time history so that various phases are conducted in the design.**
With respect to the pulse, if the applicant chooses to have simply a number of time histories, it would be to look at other recorded time histories with the pulse and do the same calculation that Geomatrix did so that we have several time histories with various pulse confirmations.

Q. But I'm not understanding now where the parametric study would come in in the second scenario. I understand your testimony to be that for the first concern --
A. **(Dr. Ostadan) Okay.**
Q. -- there is no way around using different time histories. Is that it?
A. **(Dr. Ostadan) I don't know of any, no.**
Q. Okay. For the second concern as to whether --
A. **(Dr. Ostadan) Where the parametrics study comes in or how the variation -- it's very simple. There are a lot of recorded motion, the so-called seed time history that's stated here that are recorded that do have the fling in them. And you look at it you see the fling are different. You know, they have different energy, they have different periods, they're symmetric and asymmetric. So it's a matter of simply going after different recorded motion and introduce additional recorded motion into the similar calculation.**
Q. So the parametric study here would be not to take the one time history that you are using and varying the magnitude?
A. **(Dr. Ostadan) No, I would not do that.**
Q. It would be a parametric study in which you

tried to use three different earthquakes, if you will, with different fling and see what effect, if any, you have by using one or the other?
A. **(Dr. Ostadan) That's correct.**
Q. Now I think that that's pretty clear. Thank you.
I believe that there was an item being K that we didn't talk about. Take a look at page 57.
A. **(Dr. Ostadan) Yes.**
Q. And these may be historic, but I just want to make sure I have a confirmation. On top of page 57, the second full paragraph says, "Acceleration-compatible time histories are shown to match the design response spectra at only 5 percent damping." Is that still a valid concern?
A. **(Dr. Ostadan) No, it's not a concern.**
MS. CHANCELLOR: He already testified to that.
MR. TRAVIESO-DIAZ: He did? Well, to prove how much I understand what people tell me. I apologize.
Q. (By Mr. Travieso-Diaz) Well, now let's move to paragraph L. I believe -- well, again, will you summarize for me what your concern with L is.
A. **(Dr. Ostadan) I think this first paragraph is historical. The seed time history has been defined**

now.
Q. How about the second paragraph?
A. **(Dr. Ostadan) Yes. I think this is historical. At the time the designer used -- for each package they used their own time histories. There are a number of them. It is now consistent but not sufficient.**
Q. I understand. That was your concern with respect to the previous one.
A. **(Dr. Ostadan) Right.**
Q. Looking at M on top of page 58.
A. **(Dr. Ostadan) Yes. That -- for the one set of time history that has been developed by Geomatrix, this is no longer a concern.**
Q. How about -- move to N on the bottom of page 58.
A. **(Dr. Ostadan) This, again, for the one set of time history that will apply, Geomatrix is no longer a concern.**
Q. Would the concern that you expressed on M and N remain a concern if only one time history was used? I'm referring you back to your discussion earlier.
A. **(Dr. Ostadan) Well, at the time I was very concerned, because at that time also everybody used one**

time history. But they didn't do the check and balances as requested here. They need a revised calculation, they go to the check and balances required.

Q. Now, on N, and this is only because I'm not sure the terminology will be able to stand up to it, either, they talk about checking for drift.

A. (Dr. Ostadan) Yes.

Q. Will you just explain for the record again what drift means in connection with this concern?

A. (Dr. Ostadan) I think drift essentially has to do really to make sure the time history of earthquake is properly and adequately characterized. And what drift is, you would calculate the displacement time history, because designers often use acceleration time histories. You want to make sure you look at the displacement time history and you don't see any peculiar behavior, especially in the drift, which is the build-up of displacement over time. That was a concern at the time.

Q. And there has been addressed now?

A. (Dr. Ostadan) For the one time history Geomatrix has developed, it has been addressed.

Q. Let's look at O, which starts on page 58. We talked about this I believe before, but let's make sure that there is nothing there that we haven't

addressed. Paragraph O refers to fling.

A. (Dr. Ostadan) I think, as I stated before, the only concern that remains is that to show that the design is either not sensitive to the fling and therefore no more fling characterization is needed, or have enough fling in the various time histories to color variation in the fling.

Q. So this paragraph O will be, if you will, incorporated into what we discussed on K?

A. (Dr. Ostadan) I think so. We can blend that.

Q. All right. Let's go to P. That's on page 59.

A. (Dr. Ostadan) Okay.

Q. (By Mr. Travieso-Diaz) "Soil Structure interaction Issues in Modeling Cask Seismic Response." This goes for a number of pages, 59 through 61.

A. (Dr. Ostadan) Okay.

Q. Let me ask you, so that the record is clear: you are talking about a very specific document, which is a report that is cited on the first paragraph, Holtec report?

A. (Dr. Ostadan) Yes. That is true, yes.

Q. So that again we know we're talking about something that is valid, is this report the current

Holtec calculation that you're concerned with, or is there a newer version of it?

A. (Dr. Ostadan) Well, of course the comment was made at the time I reviewed that. This is in '97. But I did review the latest version of it, too. And I think the only difference within these two versions are, they chose to use the time history that was developed by Geomatrix consistently with other things. I don't believe there was any difference in the modeling of the cask or the nonlinear elements. That part remained the same.

Q. And this is a report that deals with what? It is a report with --

A. (Dr. Ostadan) Well, it is an important calculation for the pad. This is really -- is the calculation that generates the seismic loads that would be acting on the pads.

Q. Is this part of the same package that Holtec developed for the pad?

A. (Dr. Ostadan) Yes.

Q. Now, will you briefly summarize -- I know this is long but just to get a sense, what the concerns are -- the current concerns that you have with respect to that calculation?

A. (Dr. Ostadan) Okay. Let's start with (1),

input motion. I think we discussed that in length on one of the previous items here, on K or J. It effectively has to do with presence of thin soft soil layer at the site. Holtec in their dynamic analysis of the cask and the pad placed design motion at the top of the soft soil layer in the profile.

I'm going to page 60 now, first paragraph. I think it's stated in the SAR that this site is located near a major -- a major fault, and in fact the fault is dipping under the site a distance of four to six miles. I don't remember exactly. It is known when a site is near a major fault, the seismic wave arriving to the foundation of structure are not necessarily vertically propagating waves. The analysis performed by Holtec assumes that the waves are vertically propagating. There has been no concentration whatsoever to the possibility that the waves may come at an angle. And the concern there is, a wave coming in an angle tend to introduce additional rocking and torsion above and beyond what is captured by assumption of vertically propagated waves.

Q. Can I interrupt for a second?

A. (Dr. Bartlett) Sure.

Q. Because I have a question of what you just said. Have you studied the earthquake analysis

performed by Geomatrix to characterize the earthquake that would be usefully designed?

A. (Dr. Ostadan) I think, if I'm understanding you correctly, you're referring whether Geomatrix has specified what type of wave should be considered.

Q. That's exactly my question.

A. (Dr. Ostadan) Right. To the extent I know, and again, I have not reviewed the Geomatrix seismic hazard in detail, I don't expect that they would have specified the wave would be of one type or the other. It is appropriate to assume the waves are vertically propagated, and I think applicant has done that, although it's not sufficient because of the proximity of the site to a major fault. I think parametric studies should be performed with concentration to the fact that the wave may arrive in an angle.

Q. And so that I understand the concern better: is that characterization or that parametric study one that would be done by Geomatrix as the generator of the earthquake information or by the designer using that information to figure out what difference it makes at what angle the earthquake arrives?

A. (Dr. Ostadan) I think the answer is both. Geomatrix can provide input as to what would be a reasonable angle of incidence, and then the designer can

assess the analysis.

Q. And you don't know whether Geomatrix has provided that input?

A. (Dr. Ostadan) I do not know that.

Q. All right. But you know that the designer, in this case, Holtec, did not use --

A. (Dr. Ostadan) I do know that for a fact, yes.

Q. Okay. I understand you now. Please go on.

A. (Dr. Ostadan) Okay. The second paragraph on page 60, "The Holtec calculation is based on nonlinear formulation of the system." I think we discussed that. Nonlinear is sensitive to the phasing of the input motion, and therefore, multiple time histories should be used.

Q. Now we're to item 2.

A. (Dr. Ostadan) Item 2, okay. This remains to be a concern even in the latest calculation Holtec submitted: how do you calculate soil spring and damping for a foundation, and whether you recognize the site is a layered site here, and whether you recognize the spring and damping are function of frequency of vibration.

I think in the calculation performed for the spring and dash parts for the pad as well as the spring

and dash parts for the canister transfer building, it's been recognized that these properties, the stiffness and damping, are all a function of frequencies. As a matter of fact, it's shown to be a strong function of frequencies for these sites. However, in the calculation by Holtec, that aspect disappears. They have simply calculated A as spring and A damping without consideration to the frequency dependency of these parameters.

Q. All right.

A. (Dr. Ostadan) Let me move to the second paragraph, bottom of page 60. I think the fact that I state here -- I'm going to page 61 now, top -- at the time they did not consider the variation. Now they consider the variation, so that's not an issue.

Okay. Well, moving down to the first part of page 61, that is still a concern. The pad -- in calculating the spring and damping, Holtec apparently did not consider frequency dependency. They also assume this pad is rigid. And again, if you look at the chain of calculation for design, the results generated by Holtec was given to ICEC, International Civil Engineering Consultants, for subsequent stress analysis of the pads. And I reviewed that calculation. And I noted that when they applied the loading coming from

cask to the pad -- and they used computer program SASSI to do that -- they clearly show that the pad is not rigid. In fact, if you look at the displacement that they summarize in a table in that calculation, that is, ICEC calculation, you see quite a bit of variation.

So therefore, that brings up the concern that the Holtec assumption of pad being rigid is most likely not valid, and perhaps adjustment should be made to those soil springs and dampings they have used assuming pad is rigid.

Q. Again, on this question I'm going to display my ignorance that goes back to my first year of college training in statics and dynamics, and that's all I know. I find it hard to understand how a pad that is 30 by 60 feet has a thickness of several feet can be anything but rigid. Could you explain, I mean, conceptually?

A. (Dr. Ostadan) The thickness is two feet, by the way. "Rigid" is a relative term. It depends what you put on it and what loads comes to it. As I indicated, ICEC using the loads coming from Holtec have shown that once these loads are applied to the pad, the displacements vary, and I recall, more than a factor of two and a half from one corner of the pad to the other. It's clearly an indication that this is not acting in a rigid manner.

Q. So your concern that the pad may not be rigid is based on the results of that CEC calculation?
A. (Dr. Ostadan) That's correct.
A. (Dr. Bartlett) Maybe we should continue the impact, then, down to the soils, because that's ultimately where we need to discuss about how those subsequent calculations affected showing the stability of the soils due to sliding.
Q. Would you like to take off on there?
A. (Dr. Bartlett) We saw then because the pad is not rigid, it has a frequency vibration, and as I recall, it was five to eight hertz, somewhere in that order, which means then peak ground acceleration, which it would be applicable for an infinitely rigid system, that were used in the sliding dynamic bearing capacity calculations is not appropriate for the pad system. That one should go to the response spectrum for the particular frequency vibration of this pad and pick off the appropriate accelerations, which will be higher than those which were used by the applicant.
Q. To see if I have a greater understanding of what you said, is it correct to rephrase it very simplistically as saying that the current soil analysis assumes that there's a single peak ground acceleration and you are requesting or suggesting that if you don't

have a rigid pad, the effect of the lost -- the loss of rigidity or the lack of rigidity would introduce vibrations that need to be accounted for?
A. (Dr. Bartlett) Would introduce higher accelerations and peak ground accelerations. Everything has a natural frequency at which it resonates, and for this case it appears to be five to eight hertz. When you go to what's called a response spectrum, it shows the acceleration versus frequency of resonance, and for this case those would be higher values than peak ground accelerations.
Q. Thank you much. It's a good clarification. Could you -- I'm sorry. I keep interrupting you. You were on item 3, I believe.
A. (Dr. Ostadan) Okay, item three.
Q. (By Mr. Travieso-Diaz) On page 61.
A. (Dr. Ostadan) 61. "The Holtec calculation assumes a range in the coefficient of sliding." Okay, the comment here is, and is still valid, that over time cold bonding may develop within the cask and the pad, and it has not -- cold bonding has not been considered in the design. It has been assumed that when and if a major earthquake takes place, casks will slide on impact.
I think -- let me elaborate a bit on this.

Every design has a philosophy, and this design has its own philosophy. And I think the main feature when it comes to the cask and the pads is the philosophy here that the casks would have to slide on the pads. And then they have to slide in a controlled manner so that they will not fall down and they will not impact each other. It's a very bold philosophy to say this, in my opinion, and unprecedented, to be close to such a major fault with such a high level of ground motion to rely on a philosophy without any redundancy in the design.
Q. What do you mean by philosophy? Do you mean design assumptions as to the fact that the pads are going to act in the manner that you described?
A. (Dr. Ostadan) That is what is expected of the design.
Q. And your concern is that that, you're making that assumption without testing it somehow is not sufficient? Testing, by testing I mean trying to determine whether this is a good assumption to use.
A. (Dr. Ostadan) Every design in engineering has a redundancy. There is a possibility for anything to fail. There has to be a backup measure to help with design. Here the casks have to slide, and they have to slide in a controlled manner. And there is no other redundancy in the design. And the point raised here,

for example, what about cold bonding over time? What if one or two or eight casks do not slide?
Q. What redundancy would you expect to see introduced into the design to account for this possibility?
A. (Dr. Ostadan) Well, I really talked about what would be other philosophies here, you know. I think the designer has chosen not to anchor the casks to the pads. They have relied on the casks to slide. That will be something to look at. At a minimum, I would say if they do not slide, what will be the seismic loads coming to the pads.
Q. Again, I was remiss in not asking you to define for the record cold bonding so that either of us reading the transcript can understand what you're talking about. Can you go back and tell us that?
A. (Dr. Ostadan) When two bodies are in contact, in this case the cask and the pad, and the casks are in the order of, if I'm not mistaken, 350, 360 kips, over time at the point of contact some local deformation and redistribution of stresses may take place that, in terms of engineering characteristic, would create a bonding. And that also in turn negates the assumption of being ready to slide when the earthquake comes.

Q. Now, will you clarify what the consequence would be if the cask because of cold bonding does not slide if you have an earthquake?
A. (Dr. Ostadan) In my opinion, the seismic loads will be larger.
A. (Dr. Bartlett) To the foundation and soil system. And that's what we were -- when we investigated this issue was our concern is that if perchance they did not slide, the assumption that they -- the assumption was that they did slide and the forces were reduced because they did slide. If they did not slide, would the soils underneath the pads be able to take that additional force that would be imparted to them due to the fact that they did not slide.
Q. So your concern is, again, to see if I understand you properly, that in the event that there is no sliding, some of the forces or stresses that will be absorbed by the sliding motion won't be absorbed and instead will be transported to the soil?
A. (Dr. Bartlett) Transported to the soil system.
Q. And would these be vertical forces?
A. (Dr. Bartlett) These would be horizontal.
Q. Horizontal forces.
A. (Dr. Bartlett) Primarily.

Q. How would the horizontal forces be transmitted to the soil?
A. (Dr. Ostadan) I can clarify that. I think the forces would be impacted in all directions.
A. (Dr. Bartlett) In all the directions, okay.
A. (Dr. Ostadan) Yes. The seismic load and horizontal direction on the pad would increase. Of course, the load has to go somewhere. Therefore, it comes to the pad first. It would aggravate the stability condition of the pad first, and then it would go to the soil underneath. And then the question is if there's enough capacity to absorb that load. It also threatens the overturning stability of the pad because your loads have gone up.
Q. Would the fact that there is a plan to use soil cement on the foundations of the pads assist in the concern with having further or greater loads transmitted down to the soil?
A. (Dr. Ostadan) I don't see any relation with the soil cement and the fact that the casks may not slide on the pad. So the loads on the pad will -- if the casks do not slide, the load would go off. But as to what happens with the soil, I defer that to Dr. Bartlett.
Q. Actually, that was my question. What

happens to the soil assuming that you have a layer of soil cement within the pad?
A. (Dr. Bartlett) I think we're talking in this case now, sliding on top of this layer 2. That would be maybe then -- we went through a long discussion. We're not confident yet that this soil cement mat will behave as an integral unit as we've discussed; but also one additional force is, even if it did, it would be transferred then to the soil.
Q. So that the entire discussion we have been having is clarified -- I didn't quite follow what you just said. I mean -- no, no, wait. I did understand it, but I didn't quite get the grasp of this report. The sliding concern that you are relating to is not one in which the top layer of soil, if you will, slides, but it's the layer beneath -- some feet beneath the surface?
A. (Dr. Bartlett) Well, again, we'd look at the chain from the pad downward. We have to look at the different interfaces. The first interface would be the bottom of the pad, top of the soil cement. One would have to check that. We've raised issues about that behaving as an integral unit and resisting some of that. But then even if that did, one would have to look further down and look at the interface between the bottom of the soil cement mat and top of layer 2. And

that's -- you'd just have to check those loads and how they're transferred, and whether you have adequate factors of safety through the full system if the cask did not slide.
Q. I see what you're saying now. Let me ask you another clarification that I overlooked to ask before. And this relates for a moment back to the concern that you were talking about rigidity before. When you're talking about the CEC calculation showing that the system isn't rigid, the mat is not rigid, are you talking about rigid in which direction, vertical or horizontal?
A. (Dr. Ostadan) You're talking about the pad. Essentially my comment was on the vertical. The horizontal, the pad itself I expect to be rigid.
Q. That gets me some sort of relief, because I found it hard to understand. Okay.
I'm sorry. You were still talking about paragraph 3 on page 61.
A. (Dr. Ostadan) Cold bonding, we discussed that.
Then we go to the next paragraph. I think perhaps some of your experts are familiar with friction pendulum system. And this is another mechanism that relies on a sliding to cut back on seismic loads.

Q. May I ask you what friction pendulum system is?
A. (Dr. Ostadan) Well, it's oscillations. And if you are willing to accept displacement and dislocation, it gives you a mechanism to reduce the seismic loads on the foundation. And that's what's happening here if the casks are sliding on the pad.
But the question remains at what level of earthquake these sliding triggers. Of course at very low levels it will not trigger, it will be together.
And then you can carry on this discussion. Of course, Holtec calculation was done using the design basis motion and relying on the assumption that it would -- the casks would slide to cut back on the seismic loads. But they never look at the condition that some smaller earthquake, there may not be enough driving force to make the cask slide. And that condition may deliver larger seismic loads to the pad because the casks are not sliding.
Q. (By Mr. Travieso-Diaz) But if the earthquake is smaller, the load will be correspondingly smaller?
A. (Dr. Ostadan) That is correct. The load will be smaller in general term, but the fact that the casks are not sliding under that earthquake doesn't mean

that the loads that come to the pad are going to be smaller. That needs to be said.
Okay, let me move to the next paragraph, if I may.
Q. We're now looking at the last paragraph on page 61?
A. (Dr. Ostadan) That's correct. I think this is a discussion that I already talked about, the general philosophy, and I stated this is really a bold feature of this design. What I mean by "bold," it makes reviewers very uncomfortable, like me. And I like to see really adequate studies, parametric studies done to ensure the sliding in a controlled manner takes place in the event of major earthquake.
On page 62-Q --
Q. Before you start talking about Q, this is a different subject. Let me ask you one question on P, which is the items of Holtec that you have been referring to before.
A. (Dr. Ostadan) Yes.
Q. Is it fair to say that the various concerns that you have expressed you are raising as concerns of things that need to be addressed to determine whether in fact the problem exists? Is that a good way of putting it, or not?

A. (Dr. Bartlett) Well, what we're charged to do mainly under Contention L, as we see it, is to look at the soil system and how it will respond to these dynamic forces that are being imparted to it. And in doing so I guess we have to follow the chain of forces and where they're coming from. We cannot -- when evaluating whether the soil has a sufficient capacity to resist the seismic motions in those loads, we have to understand the nature of the loads and where they're coming from. And that's I guess why we're pursuing even looking at these issues, you know, of sliding at the top of the pads, because it impacts the loads ultimately imparted to the soils.
Q. Well, my question was intended to illicit from you the clarification as to whether these concerns that you expressed are at the current moment based on the study you have done, concerns that you feel need to be addressed as opposed to being --
A. (Dr. Bartlett) Historical?
Q. No. As opposed to being problems that you know exist.
A. (Dr. Ostadan) The answer is both. I think if you go back, look at the mat being rigid, as I indicated, applicant's another set of calculation clearly shows not rigid. So it is a problem.

Q. So that is a problem?
A. (Dr. Ostadan) Right. Then we talk about cold bonding. I would characterize it as a genuine concern, a serious issue. We talk about incline waves is a genuine concern. There may be a problem or not. I think the applicant needs to show that.
Q. Now, you were starting to talk about the items on page 62.
A. (Dr. Ostadan) Yes.
Q. Before you do that, because I believe that -- and tell me if this is right or not -- items that start with paragraph O -- sorry, Q on page 62 and go down to W on page 63, they all relate to the same calculation
A. (Dr. Ostadan) Yes, that's true.
Q. And the calculation is storage pad analysis and design?
A. (Dr. Ostadan) That's right.
Q. By CEC?
A. (Dr. Ostadan) That's correct.
Q. And this is the calculation of, as the title implies, for the design and analysis of the storage pads?
A. (Dr. Ostadan) Yes, that is.
Q. And the calculation that you cite is dated

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June of 1997?
A. (Dr. Ostadan) Yes.
Q. Is there a more recent version of that calculation?
A. (Dr. Ostadan) I believe there is, yes.
Q. And have you looked at the new calculation --
A. (Dr. Ostadan) Yes, I have.
Q. -- against these various concerns to determine if there is any one that has been cured by the geotechnical calculation?
A. (Dr. Ostadan) Let me go over every one, then.
Q. That's what I would like you to do.
MS. CHANCELLOR: Do you need a break for lunch?
DR. OSTADAN: Maybe we'll finish that and --
MR. TRAVIESO-DIAZ: That was my plan.
A. (Dr. Ostadan) I think the first one, what dynamic loading has been considered for foundation stability and design of the pad. I think that has been clarified. I think the latter part of Q says, "It is not clear why a friction value larger than .8 (due to potential cold bonding) was not considered." We already discussed that, why the condition of cold bonding has not been considered.
And moving to R, "Variation of Soil Properties Not Considered." I think this has been considered now.
Moving to S, I must say I have not looked at this specific item to see whether the revised calculation addresses that or not. I cannot express opinion now. I think same applies to T. I haven't -- or I don't recall whether it's been addressed or not.
We're to U now, and I think there is a twist now in the latest revision of this calculation. This is also an important issue. I think Stone & Webster has taken up this design feature to look at the stability of the pads. And I think specifically we discussed a number of details, issues when applicant's experts were deposed with respect to what seismic parameters should have been considered in estimating the foundation loading for stability analysis. I think, in my opinion, a wrong parameter was used. PGA is not appropriate. If one goes back to Civil Engineering Consultant calculation and look at the results they present, it's clear that this foundation is flexible. And as I recall, the site frequency is anywhere from 5 to 8 hertz, depending on the soil case -- lower bound, mean, and upper bound, to be a natural frequency of the

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foundation in a vertical direction.
And if one goes to the design response spectrum with those frequencies, you would have to use values close to or in excess of 1G rather than PGA in the stability evaluation. So that remains to be a genuine concern.
We -- again, the scenario and the concept for the pad has changed. Now, the applicant is discussing or has presented a conceptual design using soil cement. They have not submitted a final design. When and if they do that, we'll have to revisit this comment, whether separation takes place between the soil cement and the pad or not. It depends on their final design.
Q. So whether this remains a concern will depend on the characteristics of the design of the soil cement?
A. (Dr. Ostadan) That's correct.
Q. All right.
A. (Dr. Ostadan) This, again, has changed in the chain of events. I'm looking at W. Again, the soil cement is here. It was not there at the time. And I think once applicant's final design for soil cement is submitted, this item will be revisited.
Q. I'm sorry. I forgot to bring up paragraph X on the next page. Does paragraph X also refer to the same design document?
A. (Dr. Ostadan) Which page are you on?
Q. I'm sorry. On page 64, X.
A. (Dr. Ostadan) You're ahead of me.
Q. I'm sorry. At least we went through W.
A. (Dr. Bartlett) That's my comment.
MR. TRAVIESO-DIAZ: In that case, why don't we break for lunch now.
MS. CHANCELLOR: Did you finish with W, Dr. Ostadan?
DR. OSTADAN: I am finished.
MR. TRAVIESO-DIAZ: I was trying to go through what we need to talk about and reduce it somewhat. Okay.
(Lunch Recess from 12:54 to 2:06 p.m.)
Q. (By Mr. Travieso-Diaz) Before we broke for lunch, Dr. Ostadan, we went over a series of concerns that went from Item Q on page 62 of Exhibit 10 and went all the way through Item W on page 63. And we went through those, and you told me which were still valid concerns or current concerns. And based on your answers, I would like to ask you to talk a little bit more about Item U, which I believe is the first one that you mentioned that was definitely your concern. Tell me

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a little more about Item U. Why is it that you are concerned?

A. (Dr. Ostadan) When stability analysis is performed, one has to calculate the demand and capacity, and the demand consists of a number of components, one of the components being seismic loads: how do you calculate the seismic loads, and what parameters do you use.

The stability analysis of the pad, I think in this case, applicant has chosen to use one point in the design response spectrum curve without checking whether that point on that curve is applicable here or not. And when I look at the Civil Engineering Consultant cited here, I noted that the natural frequency of this foundation is such that that point chosen by applicant is not correct and that other points on the curve should have been used.

This is with respect to the pad. However, I must say, when it came to the canister transfer building, and it is not part of U here, perhaps the same team recognized the fact that the ground motion amplifies in the foundation and in the structure, and they appropriately chose to use the amplified accelerations for stability analysis. That concept was not carried on when it came to the pad.

Q. Let me ask you two questions, first one general. So I take it with respect to this concern, you don't see that something's looking too good as a real problem?

A. (Dr. Ostadan) I see that as a real problem.

Q. And the problem is that you believe that with respect to the design of the pad emplacement area to the pad, they did use a wrong volume?

A. (Dr. Ostadan) That's correct.

Q. Okay. Now, you said that they should have used a different point in the curve. What point should they have used?

A. (Dr. Ostadan) Well, I cannot be very precise. One has to obtain the natural frequency of the cask/pad system, and that would tell you which point on the response spectrum curve should have been used. Just a quick review of Civil Engineering Consultant, I think in the course of what they were asked to do, they have some plots that indicate what is the natural frequency of the foundation for the three soil cases they studied -- the lower bound, best estimate, and upper bound. If I recall correctly, that showed that the frequencies are within 5 to 8 Hz.

Q. And your concern is that they didn't used that information to --

A. (Dr. Ostadan) Yes. If you then accept that you're not sure of frequencies within 5 to 8 Hz. and you go to the design response spectrum, you would not read in the vertical direction .533 G. You would read a much higher number.

Q. So what you're saying is that the value they used in the design spectrum does not match the actual natural frequency of the structure?

A. (Dr. Ostadan) That's correct.

Q. All right. Is there any damping factor that could affect the value that you need to use?

A. (Dr. Ostadan) Yes. There is radiation damping in the soil that if it's quantified and established what value it is, it can be also considered in selecting the appropriate acceleration value.

Q. This also has not been done?

A. (Dr. Ostadan) No, they have not.

Q. Let's move now to Item V. And I believe you talked about -- a little about this before, but could you elaborate?

A. (Dr. Ostadan) I think what we discussed earlier was the applicant has submitted a conceptual design for soil cement around the pad, and that they have indicated they are working on the final design of the -- or they will be working on the final design.

Therefore, this point needs to be revisited when the final design is submitted.

Q. So this point is sort of on hold awaiting the final design?

A. (Dr. Ostadan) That's correct.

Q. Let's go to W.

A. (Dr. Ostadan) The same comment applies. When the final design for soil cement is submitted, this comment will be revisited.

Q. This Item W talks about passive pressure. Would you explain what that term means as you use it here?

A. (Dr. Ostadan) This pressure is a component of a resistance that is available to resist lateral loads, in this case, seismic loads, when and if it's needed. And I think that in that historic calculation here it was used and the comment was raised, but I think this comment really doesn't apply to that original concept because soil cement is being considered now. And after the final design is submitted, we'll have to revisit how is the passive pressure calculated.

Q. Let me be sure I understand. The passive pressure is a property of the soil, if you will?

A. (Dr. Ostadan) If the soil -- well, it's a behavior of the soil.

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Q. Behavior. And it's a behavior that tends to oppose or resist the forces that would act on it during an earthquake?
A. (Dr. Ostadan) Act on the structure during an earthquake, that's correct.
Q. And that force -- that property is available. And you say here sometimes it's taken credit for, but often it's not?
A. (Dr. Ostadan) Yes. If you're referring to the specific comment, and I assume you're not thinking of soil cement now, when there was soil around the foundation. Because the soil at shallow depth does not have any overburden, it's not confined, the design tend to not rely on the passive pressure in the shallow embedment area, because one cannot be certain that in the shallow area it is available.
Q. The reason I'm asking is, there's a sentence here that reads, "The basis for using the full passive pressure for entire depth of embedment should be clearly stated," and that implies to me that they took credit for that passive pressure.
A. (Dr. Ostadan) At the time they did, yes.
Q. And your belief is they shouldn't have taken credit for the passive pressure?
A. (Dr. Ostadan) I think they should have

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considered that at shallow depths the confinement necessary to develop passive does not exist.
Q. Are you saying that there should have been -- that there probably was no passive pressure at all, or there was a number that was less than full?
A. (Dr. Ostadan) I think it's a common practice to ignore it unless a designer can demonstrate that it exists.
Q. And there would have been some, but you have to demonstrate what that some is?
A. (Dr. Ostadan) Yes, it should be considered.
Q. Do you know as a matter of practice when this passive pressure is taken credit for, what its use? If you know. I mean, I don't know. I'm just curious.
A. (Dr. Bartlett) I was going to speak to the case that we have bridges and bridge foundations, and one of the issues is deep pile foundation also has a pile cap, and it has, you know, thickness is roughly three feet or so also. And a design issue is how much of that passive pressure again can I mobilize, and how much is it going to play in the resistance of the seismic forces in a deep foundation system. And to resolve that issue, UDOT has done some testing where they have -- essentially they use compacted fill on the passive side and did lateral loading and testing to try

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to measure and take count, or try to quantify the amount of passive pressure that was developed.
Now, those tests may not be particularly useful for this case because it's a different type of structure, different type of foundations. But there are somewhat tests that you can do on prototype structures with prototype soils, or in this case maybe even in the future soil cement to establish what those values might be, how are they mobilized and what deformations, and so on and so forth. So there are ways of determining how much of this passive pressure you can take credit for.
Q. Do you recall what UDOT came up with?
A. (Dr. Bartlett) I don't. I think the studies in fact are actually ongoing. I think most of the testing was completed I believe early summer. I do not recall that I've seen any published literature on it yet.
Q. Let's move to item --
A. (Dr. Ostadan) May I add to that answer? I came up with sort of another reason why the upper 3 to 5 feet is typically not considered in calculation of passive pressure. The other reason is the seismic loading is an oscillatory loading and the foundation moves back and forth. Soil does not have tensile strength, and so therefore a gap develops. That's in

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the foundation and the soil, where this back-and-forth movement takes place. The separation is typically limited to the upper depth of the soil. That's another reason that passive one is needed, and that is during the seismic loading. It would not be available in the full depth.
Q. Some would be available?
A. (Dr. Ostadan) Some would be, certainly, yeah.
Q. Let's move to X.
A. (Dr. Bartlett) I had one.
Q. Okay.
A. (Dr. Bartlett) Also in relation to gapping, I do believe, and I'm just going from memory, that maybe the study that has been done does look at that gapping issue, too. I know it does for the piles. Whether it does for the pile cap, I'm not sure. But I guess there are beginning to be studies to kind of develop ideas about how one deals with the issues.
Q. Thank you much. I think I know now about passive loading.
Let's move to item X, which I believe both of you talked about knowing about this. Does anyone want to take a lead in explaining Item X?
A. (Dr. Bartlett) I think this is mostly mine.

Q. Could you explain to us what X is?
A. (Dr. Bartlett) When we reviewed the calculations initially, it appeared to us that for the stability analysis or seismic stability sliding analysis of the pads that we could see shear strengths determined from two tests that were done. And we were concerned about, first, were those representative of this entire pad area, and also whether designers have considered if there was any potential variation in that value. It was hard to understand what this value meant. When we calculate factors of safety we like to know whether it's kind of a lower bound value that was being used, a medium or mean or upper bound. And we just really could not ascertain that.
Q. Now, there is a new calculation as we discussed earlier.
A. (Dr. Bartlett) Correct.
Q. Does the new calculation address this concern?
A. (Dr. Bartlett) Additional data have been gathered. We still have concerns about their adequacy. And yesterday when we started discussing the cone penetrometer data, that was the beginnings of discussing potential variation across this site. I don't know if you want to go into that or if we just want to defer

that to after --
Q. In the interest of getting Dr. Ostadan out of town early --
A. (Dr. Bartlett) Yeah, let's defer that, because I think we're going to go back to that.
Q. Definitely.
A. (Dr. Bartlett) Okay. So we can readdress the shear strength value for design when we start that discussion.
We had some initial concerns. Let's see if it's in here, too. Yes, there's a statement here that the Naval Facility Design Manual 7.2 provides an adhesion value of 950 to 1300 PSF. What the issue here was is when we reviewed the calculation, the applicant was using the full what we call cohesion of the clay. Some designers, instead of using full cohesion or cohesive strength of the clay, recommend that you should be using what's called an adhesion factor. In this case, it would have been between the concrete and the clay at that time. So we were concerned about using full cohesive strength and suggested that perhaps that adhesion would be more appropriate since we had concrete resting on top of clay.
That may be somewhat resolved with the addition of soil cement. We would still like to know

what, if any, issues of sliding with that bonding is between the concrete pad and soil cement interface. We assume that the lower interface, where the soil cement interfases with the clay, that that would probably be a fairly rough interface and that it might be appropriate then to use full cohesion. But we just don't really know much about that interface at this time until you submit a design.
Q. Would it be fair to say -- and I don't want to put words in your mouth, but would it be fair to say that the concerns that you have on Item X are -- whether they remain concerns or not depends on the review of the design of the soil cement foundation?
A. (Dr. Bartlett) Correct.
Q. Go to item Y. And this is back to you, Dr. Ostadan, I believe.
A. (Dr. Ostadan) Yes, thank you. This is -- actually, we've seen this comment before. At the time, every team has its own time history. So none of this comment's repeated here. I think the Stone & Webster develop their own time history, and this comment no longer applies. It's historic.
Q. And how about Item Z, checks for drift? This sounds very much like item N that we discussed before.

A. (Dr. Ostadan) That's correct. I think this is also taken carry of, because everybody's using Geomatrix's calculation.
Q. Okay. Now we go into double figures. Let's go to Item AA, which is on page 65 of Exhibit 10. Could you give us a brief summary of what this concern is?
A. (Dr. Ostadan) Okay. Again, this is -- previous calculation wasn't clear whether the time histories used in order to develop strain-compatible soil properties for canister transfer building were the same time histories that in fact were used for analysis of the building. So I think the first part of this paragraph is no longer a concern.
Q. And by first half, you mean the sentence that starts "it is not clear" and goes through "dynamic analysis of the building"?
A. (Dr. Ostadan) That is correct. I think in the second part, in light of the discussion we had with respect to ground motion and control point, if those are taken care of, I don't see a point pursuing this, the remainder of the paragraph here.
Q. Let's move to Item AB, then. AB is on the bottom of page 65.
A. (Dr. Ostadan) Yeah. This remains to be a concern still. I indicated that earlier. Stone &

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Webster in the calculation for development of soil impedance functions for canister transfer building chose to use a variation of one and a half for shear modulus, whereas Geomatrix for calculation of soil impedance for pads stated that properties of the soil are less known at deeper layers and chose to use a variation by a factor of two. And I think the latest calculation still have the same inconsistency.

Q. I'm trying to relate this discussion back to the one we had a little while ago. I'm trying to find out what item that was for. Can you help me locate?

A. (Dr. Ostadan) I will try.

Q. Item "I," maybe, on page 55.

A. (Dr. Ostadan) I think so.

Q. Do me a favor so we can short circuit this discussion. Will you compare Item "I" with Item AB to see if there is anything on AB that is not part of "I" that we need to discuss beyond what we already discussed with respect to "I." Do you understand my question?

A. (Dr. Ostadan) Yes, I understand.

I don't think so.

A. (Dr. Bartlett) One moment. Do you think it would be appropriate -- I think it talks here about major soil properties, and we have seen the applicant go in and do resonant column testing for it appears one

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particular layer in the system to develop these Gmax curves. But I'm not sure we've seen how those have really been applied at all in the analyses.

A. (Dr. Ostadan) Yeah, I guess at the point you're thinking of --

A. (Dr. Bartlett) We can cover that later.

A. (Dr. Ostadan) It may come up later. It's up you.

Q. But in any event, the concern will be that there is information available from the resonant column testing that you don't know whether --

A. (Dr. Bartlett) -- they have been applied or not.

Q. Okay.

A. (Dr. Bartlett) That's the only thing. It talks a little bit about -- there has been some work done to develop some of those soil properties for the apparently upper soil column. We're still wondering if they've been applied and how they have been applied in the analysis, the response analysis.

Q. Can we move to Item AC on page 66?

A. (Dr. Ostadan) Yes.

Q. Please.

A. (Dr. Ostadan) This calculation that developed the soil spring and damping for canister

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transfer building assumed the foundation mat to be rigid. It was a fairly large mat of 265 by 165, and the assumption was never verified and is still not verified, even though Stone & Webster performed a follow-up stress analysis of the Canister Transfer Building, finite element analysis of the building, where one could readily verify from the results if the mat behaved as a rigid mat or not.

Q. Again, I'm having the same freshman college concern or lack of understanding as we talk about it here. Tell me more on this mat. You said it is --

A. (Dr. Ostadan) I'm talking about vertical direction.

Q. Okay.

A. (Dr. Ostadan) And it was assumed to be rigid for the purpose of developing soil strength and mapping, or so-called soil impedance functions.

Q. And the rigidity in the vertical direction would have -- would it be affected in any way by how thick this mat was?

A. (Dr. Ostadan) Yeah. It has a function of how thick the mat is and how much load is coming to t.

Q. How thick is the mat?

A. (Dr. Ostadan) I don't remember. It's either five or seven. Somewhere around there.

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Q. So your concern that this mat, even though it's 5 feet thick, might still be flexible under the loads that it's going to see?

A. (Dr. Ostadan) Yes. And I -- what I'm also saying, that the information is available in the applicant's package to verify that. It has not been done.

Q. But let me just try to compare -- remember when we talked about the mat for the pad emplacement area, you felt there was a concern there.

A. (Dr. Ostadan) That's right.

Q. Because the analysis that CC had done showed that that mat was flexible in the vertical direction.

A. (Dr. Ostadan) That's correct.

Q. As to this mat on the canister transfer building, there is no similar information that turns a potential concern to a problem, is it?

A. (Dr. Ostadan) I have not seen any results presented in the documents otherwise.

Q. So in fact the concern is that there is no information that would elucidate the issue as to whether you have a rigid or a flexible mat for the canister transfer building. Is that a good way of putting it?

A. (Dr. Ostadan) I think the information is available but not presented in the documents I've seen.

As I indicated, Stone & Webster performed a finite analysis of the building and of probably all the loads. It's just a matter of looking up on the displacement for the mat.

Q. So again, to see if I can figure it out, how would this information be displayed? Separate calculation or --

A. (Dr. Ostadan) No. Just go to the finite element analysis of the building and obtain the displacement response of the mat, you know, several number of nodes in the vertical direction, and see if they are uniform or they show local deformation.

Q. And not to beat a horse to death, but you have not seen any information that leads you to believe that that effort has taken place?

A. (Dr. Ostadan) No, I have not seen any.

Q. All right. Let's move to the next one, which I believe we're now up to AD.

A. (Dr. Ostadan) Yes.

Q. We're on page 66.

A. (Dr. Ostadan) I think that's a historic comment. The graphs that were present at the time, they were not explaining what is vertical axis. And this comment no longer applies.

Q. Then we can go to AE, which begins on page

66 and moves to the top of page 67.

A. (Dr. Ostadan) Okay. I think this comment has to do with the fact that at the time the building members' dimensions were not known, and they simply assumed certain numbers for the purpose of dynamic analysis.

Q. Is that the case now?

A. (Dr. Ostadan) I have not reviewed the new calculation to be able to comment.

MR. TRAVIESO-DIAZ: Let's take one second, please.

(Exhibit-68 marked.)

Q. (By Mr. Travieso-Diaz) Let's look for a moment at what I have identified as Exhibit 68. It is a Stone & Webster calculation entitled "Seismic Analysis of Canister Transfer Building." It's Revision 1. The calculation number is SC-5, and the date of Revision 1 is 8/31/99. Is that correct?

A. (Dr. Ostadan) That's correct.

Q. I believe that if we go to this document and go to page 4, which is at the very beginning, and that page 4 has -- and the bottom half of the page, at least, are assumptions. Do you see that?

A. (Dr. Ostadan) Yes.

Q. Let's look together at assumption No. 1.

Can you read that to yourself?

A. (Dr. Ostadan) Okay. Yes, I've read that.

Q. That assumption seems to say to me that now there is a set of concrete drawings.

A. (Dr. Ostadan) Yes.

Q. And I take it those are design drawings for the building?

A. (Dr. Ostadan) I would assume so.

Q. And you would expect that those drawings would have the kind of information that was not available when Item AE was created?

A. (Dr. Ostadan) I think that's probably the case, yes.

Q. And it says at the end that there may be changes, "minor changes made to the building," "to the building configuration in the future. However, it is anticipated that any changes would be minor and will have little effect on results." Is that right?

A. (Dr. Ostadan) That's correct.

Q. And that's common engineering practice?

A. (Dr. Ostadan) That is common engineering practice.

Q. So if you wanted to find out information about dimensions and so on, you would just have to look at concrete drawings that are listed there?

A. (Dr. Ostadan) Yes. If I want to know the basis for development of the model, that's where I would go, yes.

Q. Understanding that you have not reviewed these concrete drawings, I presume --

A. (Dr. Ostadan) I did not.

Q. But subject to what the content of the concrete drawings may be, their existence would resolve your concern as to what was expressed in Item E?

A. (Dr. Ostadan) Item A --

Q. E.

MS. CHANCELLOR: Point of clarification. Do you know if you produced these drawings to the state?

MR. TRAVIESO-DIAZ: I have no idea.

MS. CHANCELLOR: Okay, then he can't review them if you haven't produced them.

MR. TRAVIESO-DIAZ: I know. And since you brought it, I have not reviewed them. If we haven't given them to you, obviously he hasen't.

Q. (By Mr. Travieso-Diaz) And subject to the review for the content, would their existence address your concern?

MS. CHANCELLOR: It's a little speculative.

MR. TRAVIESO-DIAZ: Why don't we ask the question a different way.

MS. CHANCELLOR: That's better.

Q. (By Mr. Travieso-Diaz) Would you anticipate, based on your extensive engineering experience, that a set of concrete drawings for a building like the canister transfer building would contain the type of information that you noted in Item AE that was missing, things such as thickness of walls and the slabs and the beams?

A. (Dr. Ostadan) Yes, I would expect that.

Q. In the normal of course of events, those drawings will have that information?

A. (Dr. Ostadan) That is true, yes.

Q. Unless the drawings are in some matter defective, they will have dimensions of beams and walls; is that correct?

A. (Dr. Ostadan) That's correct.

Q. Now, understanding that you haven't reviewed these drawings to determine whether they're defective or not, and I assume they are not, they would have information that you were calling for in AE. Is that correct?

A. (Dr. Ostadan) Yeah. There's one part to be added. They would have the information, and the information should have been properly transferred into the building model, the so-called stick model.

Q. And the stick model that we're talking about would be the one that was presented in Exhibit 68?

A. (Dr. Ostadan) Okay. Do you have a question? I'm sorry.

Q. Yes. The stick model that you referred to would be the one that is the subject of the document you have in front of you?

A. (Dr. Ostadan) I think so, yes.

Q. Look let's back again at this assumption 1e. We're now to the first part. It says, "The structural model developed in Revision 0," which I take it is the previous revision, "of this calculation was reviewed for conformance with ... concrete drawings" such-and-such, and minor changes to the model were made.

Assuming that that's a true statement, would it tell you that in fact level one includes a model that incorporates the information on the concrete drawings?

MS. CHANCELLOR: Before Dr. Ostadan answers that, I'd request that this is -- if you have a line on the structural concrete drawings, then I request that if you haven't already produced a copy, if you could produce a copy.

A. (Dr. Ostadan) Yes, I would expect that the model is based on these drawings, and I would expect that dimensions, beams and slabs, etc., are properly

calculated and represented by the stick model.

Q. Let's move, then, to Item AF, "Proper Location of Control Point for the Rock Motion Used in the Site Response Analysis."

A. (Dr. Ostadan) I think we discussed that in length with respect to the pads before.

Q. So it is the same concern as to the proper location of the control point where we talked about having competent soil?

A. (Dr. Ostadan) That's correct.

Q. So the discussion that we had with respect to the pads equally applies?

A. (Dr. Ostadan) Equally applies. It does.

Q. All right. Let's go to Item A sub G on page 67.

A. (Dr. Ostadan) Yes. Well, it certainly was a concern at the time that there was a cut-off frequency of 15 Hz. And it was not shown that it is appropriate to cut off the frequency at 15 Hz.

Q. What's the current status of this concern?

A. (Dr. Ostadan) Okay. I'm looking at Exhibit 68 to see whether --

Q. Can I give you a hint?

A. (Dr. Ostadan) Sure. In the interest of time.

Q. May I?

A. (Dr. Ostadan) Sure.

Q. Can I refer you back to the same page 4 we were looking at before, and I ask you to look at Assumption No. 5 on that first page.

A. (Dr. Ostadan) I need to ask for a clarification to put this concern to rest, whether this analysis is done for a horizontal direction or vertical, or both.

Q. You're clearly asking the wrong person.

A. (Dr. Ostadan) So I have not -- I don't know on this. The results here specifically show -- it's a statement here that says that. It's not obviously complete. It doesn't say whether it's horizontal or vertical. But I don't know if there are results presented that show the results were 15 Hz. and 19 and a half Hz. or not. I would think not, just judging from the nature of this statement here.

Q. Can we defer, since I don't think anybody at this table is able to answer that right now, but perhaps after the break we can see if it is something that we can pose in the form of a question that will help you?

A. (Dr. Ostadan) Sure.

MR. TRAVIESO-DIAZ: Can we take a break right now?

(Recess taken from 2:44 to 2;52 p.m.)

Q. (By Mr. Travieso-Diaz) Before we took a short break, I asked a question to Dr. Ostadan and he gave me a reply that seemed to indicate that the answer would depend on whether we are dealing with horizontal or vertical elements. Can I ask him to again repeat the answer that he gave, and if he can't, since we don't have at this moment the information that he needs, tell us what the result will be or the resolution depending on whether we're talking horizontal or vertical.

A. (Dr. Ostadan) I think I -- we'll check the vertical response and make sure the statement made here does indeed include the vertical analysis.

Q. So for you, it will be satisfactory if the vertical response was the subject of the analysis -- if the vertical response was the subject of the analysis that is discussed in Assumption 5?

A. (Dr. Ostadan) Yes. Basically that's true, yes.

Q. All right. Now, tell me about paragraph AH, which is now on page 68. It's entitled "Basis for Ignoring Translation Motion Caused by the Rotation."

A. (Dr. Ostadan) I don't even remember this one. This -- again, the original calculation or the earlier versions of these calculations. I'm afraid I

can't even remember the context in which this concern was raised.

Q. I have a question that maybe we can get out of the way, in any case. You are making reference here to ASCE Standard 4-98?

A. (Dr. Ostadan) Not in AH.

Q. I'm sorry. I'm looking at the -- strike that question. We'll forget it. I got ahead of myself. Okay.

So you say that you can't address the concern that you have on AH because you don't recall this particular concern in detail now?

A. (Dr. Ostadan) I do not recall right now, yes.

Q. Do you recall what it was about?

A. (Dr. Ostadan) My mind is just blank on this right now. I'd have to revisit the whole version to remember.

Q. Not to pursue and put thoughts into your head, but would that indicate to you that it's not a really big concern on your list?

A. (Dr. Ostadan) It would include that I'm a very busy person.

Q. That's probably true. Good answer. Let's move to item AI.

A. (Dr. Ostadan) Yes.

Q. "Consideration of Concrete Cracking."

A. (Dr. Ostadan) Yes.

Q. Is this a current concern?

A. (Dr. Ostadan) If you're going to follow up with another question, I would appreciate that. But I will look.

Q. Well, I can tell you that the next question will be -- is totally independent of the former one, so maybe you should --

A. (Dr. Ostadan) I do not see a discussion here. Obviously I don't recall this being addressed or not, but I'm looking at Exhibit 68 to see whether concrete cracking has been considered. On page 4 I'm looking at the assumptions. No. 1, "structural model developed," it does not indicate cracking. No. 2 is a bridge crane. No. 3, "not used." No. 4, again, no discussion of cracking. No. 7, don't see anything about concrete cracking. All right. To the extent I can look now, I don't see this being address.

Q. Okay. Let me ask you the first of the two questions, which is, if concrete cracking was taken into account in your calculations such as this one, and by "this one" I mean Exhibit 68, how would it be taken into account?

A. (Dr. Ostadan) The way it's been taken into account is that, depending on the stresses developed in the structural members, the stiffness of the structural member will be reduced, and then the subsequent dynamic analysis would be performed using the reduced stiffness properties.

Q. And the stiffness properties would be input values to the model?

A. (Dr. Ostadan) It would be revised input values to the model, yes.

Q. So it is conceivable, I'm not saying this is or is not the case, that the model could have accounted for concrete cracking by using lower values for the parameters even though you may not have listed them in the assumptions. Is that a possibility?

A. (Dr. Ostadan) I'd like to make a clarification. Concrete cracking is not a replacement of condition of concrete not being cracked. Both analyses are needed on the uncracked and cracked conditions.

Q. So you would like to see or expect to see a different computer drawing that would take -- analyze the same structure again but assuming now that the concrete is cracking?

A. (Dr. Ostadan) Correct. That's the

practice.
Q. And you have not seen that before?
A. (Dr. Ostadan) I have not seen that.
Q. My second question is, you start your discussion on this item AI by saying that "ASCE 4-98 requires consideration" -- "requires consideration to the effect of concrete cracking." Do you see that?
A. (Dr. Ostadan) That's correct.
Q. Now, is this project committed to following 4-98?
A. (Dr. Ostadan) I do not know. I think this is a document that -- what standards and rules are adopted by design, I expect that to be documented. I have seen references cited to ASCE 4-98 in a number of other calculations, for example, with respect to variation of soil properties that the designer has opted to adopt ASCE 4-98.
Q. Is there another ASCE Standard numbered 4-86?
A. (Dr. Ostadan) That's correct. That's the previous version of 4-98.
Q. So 4-86 was the standard that was in effect prior to the promulgation of 4-98?
A. (Dr. Ostadan) That's correct.
Q. Now, do you recall when 4-98 came to be

promulgated?
A. (Dr. Ostadan) Actually, you know, the draft version was available in '99, and perhaps a true name for this should be ASCE 4-2000, I think it was officially published. But as far as the cracking is concerned, the previous standard I believe also has guidelines for concrete cracking.
Q. Could you -- maybe we should look together at page 6 of this document.
A. (Dr. Ostadan) Which document?
Q. I'm sorry. "This document" being Exhibit 68. I believe you have it handy.
A. (Dr. Ostadan) Okay.
Q. And page 6 is the references?
A. (Dr. Ostadan) Yes.
Q. Will you look at reference 4?
A. (Dr. Ostadan) Yes.
Q. Would that be -- I don't know if it is the same, but asking for "Standard for Seismic Analysis of Safety-Related Nuclear Structures," 1986. Is that what it's also called, 4-86?
A. (Dr. Ostadan) I believe you're referring to reference No. 3.
Q. That's correct.
A. (Dr. Ostadan) I think it is, yes.

Q. So would that tell you that the designers were following at the time what's said in shorthand is 4-86?
A. (Dr. Ostadan) It would tell me that, yes.
Q. And if you look at the later calculations, which appears to have been done in the first instance, at least -- well, Rev. 1 is from 8/99.
A. (Dr. Ostadan) Yes.
Q. That calculation may have been issued at a time where 4-98 had not yet been published.
MS. CHANCELLOR: Objection. Calls for speculation. He doesn't know when the calculation was done.
MR. TRAVIESO-DIAZ: I'm only bringing it up because he says it may have come out, it may have been called 4/2000 because it come out this year.
MS. CHANCELLOR: The discovery is June 28, '99, and so it would have to be sometime -- the calculation would have to be at some time before June of '99 for that to be applicable. So I think it calls for speculation.
A. (Dr. Ostadan) Well, if you want my technical opinion, if you go to ASCE 4-1986, Reference 3, I trust that the concrete cracking issue has been addressed as well. However, I'm not certain. I need to

look it up.
Q. Is it -- do you recall whether 4-86 and 4-98 have different standards as to how and to what extent on whether concrete cracking should be considered?
A. (Dr. Ostadan) I think definitely 4-98 states that it should be considered. As I said, 4-86 I expect to have it, but I cannot be certain unless I look it up.
MR. TRAVIESO-DIAZ: Can we take a very short break? And I promise it's very short.
(Brief Recess.)
MR. TRAVIESO-DIAZ:
Q Just let's go back on the record.
Before we took a short break, we were discussing whether and to what extent ASCE Standard 4-86 contained any guidance information on how to deal with concrete cracking. And during the break Dr. Ostadan reviewed a copy of the standard ASCE 4-86. And could you tell me based on your review of 4-86 how that standard addresses concrete cracking?
MS. CHANCELLOR: I would like to note for the record that Dr. Ostadan took a couple of minutes to review this.
A. (Dr. Ostadan) Well, I'm reading from page 11 of ASCE 4-86 3.1.3, "Modeling of Stiffness." Under

"Stiffness of Reinforced Concrete Elements," okay. I'm going to read paragraph A. "Best-estimate stiffness properties for elements shall be used, except that reinforced concrete elements may be modeled as uncracked sections, provided that the elements do not crack significantly due to the critical load combination."

Q. What does that mean to you?

A. (Dr. Ostadan) Let me read paragraph B, and I will respond. "For generation of input motion for subsystems, consideration shall be given to the uncertainties in the stiffness properties of the concrete elements."

Q. Now, could you tell me what information you draw or guidance from those two sections?

A. (Dr. Ostadan) Okay. Under paragraph A it's saying, the best estimate stiffness properties can be used provided that the elements do not crack significantly due to the critical load combination. So you're allowed -- in my interpretation of this, you can use uncracked properties if you can show cracking does not development.

Q. To a significant degree?

A. (Dr. Ostadan) To a significant degree.

Q. Tell you what I'd like to do. Let's mark this as Exhibit 69, and we will make copies and put it

in the record, the cover page and the page we were reading from.

Let me identify for the record. We have marked as Exhibit 69 a document that is comprised of two pages. The first one is the cover page of ASCE Standard ASCE 4-86 dated September 1986. And the second page of the exhibit is page 11 of the standard that contains section 3.1.3 entitled "Modeling of Stiffness."

A. (Dr. Ostadan) I'd like to add for the record that it is a common practice in the industry for nuclear-type structures that condition of concrete cracking be recognized in dynamic analysis.

Q. We are I believe about to discuss Item AJ, "Consideration of Accidental Torsion," on page 68. Could you tell us about Item AJ?

A. (Dr. Ostadan) Yes. At the time I reviewed that older version of this calculation for canister transfer building, I did not see any consideration to accidental torsion in developing seismic loads.

Q. Have you reviewed the updated calculation, which I believe is Exhibit 68, to see if this concern is addressed?

A. (Dr. Ostadan) I have not reviewed it in detail. I am looking at it, Exhibit 68, and looking at the assumptions. I am looking at page 37 of Exhibit 68

where seismic response of the building in terms of acceleration and seismic loads for the upper-bound soil case are presented, and I do not see here any discussion or any adjustment to these loads on the account of accidental torsion.

Q. Again, I was remiss in asking you before to define what you mean by accidental torsion.

A. (Dr. Ostadan) Oh, this is again a requirement that is typically observed for nuclear structures, and it is in recognition of the fact that when the buildings are built and equipment are placed on the floors, they don't necessarily will be located exactly where the drawings at the time of development of the model show that they will be located, and therefore the mass may be offset. So this measure is to guard against any adjustment that may be made later on either due to construction or operation that the mass of the building or equipment may be located slightly from where it was. Therefore the shear loads are increased, and that is taken into account in the design of the building.

Q. I take it that you really won't know whether you have this sort of a problem until the building is built and the masses are placed on it, the equipment itself. Is that correct?

A. (Dr. Ostadan) That is exactly for the same reason that this guidance has been provided and exercised, because you do not know and you're likely -- you're likely never to know.

Q. But that was what I was about to ask. Is it perhaps a more appropriate time to make this adjustment once you know the extent to which you may have offset in the location of the masses of the structures and components in the building?

A. (Dr. Ostadan) I would say it would be very unusual if applicant proposed an approach or a calibration that this can be measured during the operation or after the construction. Based on my experience, it is addressed and guarded against during the design time.

Q. Well, help me understand, because I'm missing something here, which is, if before you actually physically located masses in the building, when you are to the point when this Exhibit 68 was prepared, if you don't know where the masses are to be located, how can you perform a calculation to determine the effect of offsetting their location? How would you determine how much to offset them by?

A. (Dr. Ostadan) Well, when the drawings are drawn and the final design done, you are more or less

certain as to what the structural members are and what sizes they are and where the mass is. However, when you build this, it's recognized that there may be deviations. The beam may be thicker or heavier, and it could have been that could have been on a spot A, maybe now a few feet away on a spot B. And these are the necessities that come about after a building is built, for operational reasons. And as I said, to guard against that, in the early part of the design this impact is included in the design.

Q. Are you familiar with what I have seen at a number of nuclear plants which is called the preparation of as-built drawings?

A. (Dr. Ostadan) Yes.

Q. And is it a process whereby after the construction is finished, you go back with the design drawings to compare the location and characteristics of your components against what the design called for? Have you seen that?

A. (Dr. Ostadan) Yes.

Q. And if you find discrepancies, you try to reconcile them by re-running your calculations?

A. (Dr. Ostadan) No, I have not seen discrepancies for the purpose of going back and whether or not to include accidental torsion in the design. As

I said, my experience at least has been that during the design this is taken care of in the early part of the design to guard against this measure.

Q. Are you aware of whether applicant in this instance intends to do that in the future?

A. (Dr. Ostadan) If the applicant makes the commitment that the model that they have at this time would present the building after it is being built and during the operation and can be verified, I suppose that means the model is adequate.

(Exhibit-69 marked.)

Q. (By Mr. Travieso-Diaz) The next item on page 68 is AK, "Combination of Coupling Effects." Would you summarize this item for us?

A. (Dr. Ostadan) Okay. At the time -- again, it's a historic calculation -- the question was, or the concern was, how the coupling within two horizontal directions were considered in developing the seismic loads as realized in the structure responses.

Q. Can you tell by looking at Exhibit 68 whether the coupling effects have been taken into account in the calculations?

A. (Dr. Ostadan) Okay, I'm looking at Exhibit 68 now. Looking at the assumptions again.

I cannot see anywhere in this exhibit a

discussion about coupling effects. However, I haven't looked carefully to make sure it's not anywhere here.

Q. Where would you expect to see the coupling effects to be taken into account?

A. (Dr. Ostadan) In the very same calculation in Exhibit 68.

Q. I understand. But within the calculation, where would you see them if they -- where would you detect that these effects have been taken into account in the calculation?

A. (Dr. Ostadan) Okay. It would be on page -- like page 37 here where the seismic loads are present in the X and Z. And as you can see here, I don't see any discussion on the coupling on this page. It should direct the designer what to do with these numbers. Should we use them directly? Should we add them up? And I don't see anything here.

Q. And I take it that, looking at the handwritten attachments to the calculation, would they help you determine where they are incorporated?

A. (Dr. Ostadan) I think these are the calculations that how this stick model was developed. So it goes through or back and forth between the drawings and a bunch of hand calculations. I would expect the discussion of coupling to be on a page like

38 where you see the results as where you apply when you have seismic responses.

Q. So your testimony is that you would like to -- you will expect to see a specific reference in the text of the calculation to how these coupling effects were accounted for?

A. (Dr. Ostadan) That is correct.

Q. And you haven't seen that?

A. (Dr. Ostadan) I haven't seen it.

Q. Let's turn to item AL on page 69, the title being "Percentage of Live Load Used in Calculation of Lumped Mass Values." Can you tell us what the concern was?

A. (Dr. Ostadan) Well, at the time it was not clear -- while it was clear that how much of a dead weight was included, it was not clear how much of a live load was included in calculating the mass points.

I'm now looking at Exhibit 68 to see whether that information has been provided or not. I'm looking at assumptions on page 4. Okay. This is definitely not here. I will go to the back of the calculation. I think there's a section for mass calculation on page A-1, Attachment A.

It states in the first paragraph, "The attributed masses to each mass point location from

walls, roofs and mat are shown on the attached sketches." Again, it does not talk about live load, talks about the mass due to walls, roofs, and mat.

Q. By live loads, you would mean things like equipment?

A. **(Dr. Ostadan) Equipment, yes.**

Q. And what would be the biggest equipment pieces, if you will, that would be placed in the canister transfer building?

A. **(Dr. Ostadan) I don't think it's referred to or characterized in terms of biggest equipment.**

Q. More massive, I meant.

A. **(Dr. Ostadan) Well, it really depends where the equipment is. If there's small equipment on a small slab, could be important. And I do not see, as I indicated, a discussion about mass, masses.**

Q. Again, let me just, so if you know, and for the record, do you know what the most massive piece of equipment --

A. **(Dr. Ostadan) I think the crane is probably your massive equipment. I would expect that to be included.**

Q. And will you happen to know the relative masses of the crane vis-a-vis, say, the mat or the building?

A. **(Dr. Ostadan) I do not know. I must say, there is a percentage of the live load simply due to operation. You may have personnel, traffic or equipment traffic, or a number of other reasons. That is typical to include percentage of a live load and permanent equipment loads in the dynamic model.**

Q. And you have seen no specific accounting being made that you can detect of live loads in this calculation?

A. **(Dr. Ostadan) Yes. As I mentioned, I am in Attachment A where the discussion of building masses is presented, and it specifically talks about the mass of the wall, roof and beam. No mention of operating weights or equipment.**

Q. And this may not be a help at all, but would you turn to page 7 of the exhibit that talks about the model development and read through it to see if it tells you anything about how masses have been accounted for in the model. Take a look at the first paragraph.

A. **(Dr. Ostadan) Yes. Okay, I think the first paragraph states that, again, the mass of the beam, walls, etc., partition walls are included. And it goes on to say, "an allowance of 5 percent will be" -- "will be made for miscellaneous equipment."**

Q. Does that imply to you that they are

accounting for live loads by having a 5 percent allowance on the other masses?

A. **(Dr. Ostadan) I would think that is what they intend to do, yes.**

Q. And if that was what they intended to do, would that be properly accounting for the live loads?

A. **(Dr. Ostadan) That, now, I cannot answer, because I do not know enough about the building and its mission at this time.**

Q. But you -- at least based on that paragraph, you know that they have done some accounting or tried to do some accounting.

A. **(Dr. Ostadan) As indicated here, yes.**

Q. Let's look at now AM, "Amount of Peak Broadening Considered."

A. **(Dr. Ostadan) Yes.**

Q. Describe this for me, if you would, please.

A. **(Dr. Ostadan) Okay. At the time it was not clear when the response of the building, in terms of in-structure oscillation responses were generated, how much broadening of the peak were considered. And looking at figures presented in Exhibit 68, I think now it has been indicated. Therefore, this is not a concern.**

Q. Thank you. Item AN that begins on page 69

and goes to page 70, will you describe this one for me?

A. **(Dr. Ostadan) Okay. Refers to the previous version of the calculation for canister transfer building. It was information regarding the center of rigidity and center of mass was not available at the time.**

Q. Have you reviewed Exhibit 68 to determine whether it is available now?

A. **(Dr. Ostadan) I think we are talking about the first paragraph in AN. I will expect that is taken care of.**

Q. I'm sorry. The first paragraph of AN?

A. **(Dr. Ostadan) That's correct.**

Q. It goes from -- on page 69.

A. **(Dr. Ostadan) Page 69.**

Q. How about the second paragraph, the one that starts with the words "the center of rigidity"?

A. **(Dr. Ostadan) Okay. That is a comment that at the time was when the soil spring and dampings were calculated, springs and damping values were attached to the beam stick model of the building. By virtue of the attachment, it implies that the center of the rigidity at the lower level of the building is at the center of the mat. And that was the point of discussion, whether or not the center of rigidity is indeed at the center of

the mat.

Q. I don't want to assume, but may I offer you another hint?

A. (Dr. Ostadan) Sure.

Q. Would you turn to page B-1 of Attachment B. It's like two-thirds through the calculation.

A. (Dr. Ostadan) Yes, I'm there.

Q. Will you look at the first full paragraph. And to be exact, to the middle of the first paragraph.

A. (Dr. Ostadan) Yes.

Q. To a sentence that says, "To account for eccentric of the center of the rigidity from the mass centroid, the stiffness matrix is calculated using SWEC program RIG3 and RIG4."

A. (Dr. Ostadan) Yes.

Q. The results are given in the attachment. Does the text that I read to you indicate that some effort has been made in this calculation to account for the eccentricity of the center of the building?

A. (Dr. Ostadan) I am not familiar with this program RIG3, RIG4 and the statement is vague. And it could be quite unrelated to what we are talking about.

Q. So you cannot tell in fact from this text whether indeed it takes care of or seeks to address the concern you raised?

A. (Dr. Ostadan) That's correct.

Q. Well, that was my hint.

A. (Dr. Ostadan) I appreciate it.

Q. Now we're in paragraph AO on page 70 of Exhibit 10 entitled "Consideration of Both Translation and Rotational Mass Properties." Could you explain to us what the concern here is?

A. (Dr. Ostadan) Well, again it refers to the previous version of the calculation. It was not clear at the time whether translation and rotational mass properties are properly included in the dynamic model of the building. And that the design of the canister building has gone through some changes, one of the elements being shear key is being added to the mat, and that point was discussed the day before yesterday in the context of passive soil pressure.

And a number of other issues was raised. I think your expert stated that the design is such that the passive pressure will be developed beyond the face of the shear key and not within the inner side of the shear key. And it was stated that the soil under the mat will be moving with the shear piece, however, not participate in the development of passive pressure. If that is the philosophy for the design, I would expect not only the shear key but also the mass of the soil

under the mat within the circle of shear key to be included in the dynamic model.

Q. I'm glad that you mentioned the words, because I don't believe that two days ago an explanation was given on the record of what a shear key is. Could you just help us here?

A. (Dr. Ostadan) Shear key is the, as I understand it, for canister building is the extension of the mat in the form of a ring. It's one foot high, and I forget how thick it is, around the periphery of the mat.

Q. For what purpose is it intended to serve?

A. (Dr. Ostadan) It is intended to provide additional passive resistance for -- to help improve sliding stability of the building.

Q. And with specific reference to item AO, you are concerned, I take it, that the mass properties of the shear key -- the shear key and the other elements of the mat are not properly accounted for in the model, or at least there is no evidence that they are?

A. (Dr. Ostadan) There is certainly no evidence, and as I indicated, if the philosophy is that the passive soil pressure does not develop under the mat and the soil and the mat would act in an integrated manner, the mass of the soil should be included in the

model.

Q. Can you ascertain by looking at this calculation what the design philosophy in that regard is?

A. (Dr. Ostadan) I don't think Exhibit 68 gets into passive calculation or engages in the philosophy of developing passive resistance.

Q. Where do you expect that you'll be able to find that information?

A. (Dr. Ostadan) The passive calculation for passive pressure is in the Stone & Webster calculation for slope -- for stability analysis of canister transfer building. This is another mismatch of the process and concept between various groups.

Q. In which respect?

A. (Dr. Ostadan) Well, as I said, at the time the state raised the concern that if passive develops under the mat, the passive wedge would also put vertical load acting on the mat, and the question was whether this effect of vertical load is considered or not.

Again, the witness stated that they don't expect such passive pressure develops under the mat because they expect the soil under the mat within the area of the shear key moves with the mat and the passive pressure develops beyond the shear key.

Now, that's fine, but that also means the mass of the soil under the mat within the depths of shear key would participate in the dynamic vibration of the building.
Q. Based on your review of the calculation you alluded to, stability analysis of the canister transfer building, do you have an opinion or can you tell what design philosophy was used in -- with respect to what you just mentioned? If you can tell.
A. (Dr. Ostadan) Yes. I think the calculation of -- when I reviewed the calculation, the impression I got, the design philosophy was for passive soil pressure to develop beyond the face of the mat and the shear key. And then the state raised a question that, why is the assumption valid, because under the mat you have the effect of overburden of the building, the soil is confined, and it's likely that the passive will develop under the building rather than outside the building. And the expert stated that will not happen because, as I said, the soil and the mat will act as an integrated unit.
Q. Let's move on, then, to Item AP, entitled "soil-structure interaction (SSI) Effects on Building Response."
A. (Dr. Ostadan) Okay. AP, as a general

concern that is even valid now, is very typical in our practice that when you perform soil-structure interaction analysis, you also show the results or responses from the building to see how significant the effect of interaction is. This was not presented at the time. Frankly, I don't see it is presented now. I do know it's included because they used the soil spring and damping, but I cannot judge how much of this amplified response is due simply to structural vibration, how much of it is due to soil-structure interaction.
Q. Can you, for the record, identify where in the calculation you're looking?
A. (Dr. Ostadan) Oh, I'm specifically looking at the response spectra plots in Exhibit 68. For example -- let's see, the beginning is back here. Page 15, and the series of plots go all the way to 36.
Q. And these plots are, so that the record is clear, plots of what?
A. (Dr. Ostadan) These are plots of acceleration response of the building at various elevations.
Q. Versus?
A. (Dr. Ostadan) Well, if you're talking about the vertical and horizontal axis --
Q. Yes.

A. (Dr. Ostadan) -- the way these responses are expressed is in terms of acceleration response spectra, and --
Q. As a function of frequency?
A. (Dr. Ostadan) As a function of frequency, yes.
Q. You said, then, that you don't know, you cannot tell from these various acceleration versus frequency plots whether the accelerations that are shown incorporate the -- well, I'm sorry. I'll let you describe it rather than me.
A. (Dr. Ostadan) Well, I did not say it. I think the effect of soil-structure interaction is included. The calculation is clear, and it discusses soil springs and damping. But what I am saying is, it is typical in our practice to delineate these various effects, specifically to show how much is the effect of soil-structure interaction on building response.
Q. So what you're lacking here is a separate tabulation or a graph or a plot that will tell you how the soil-structure interaction is factored into the plots that you see starting on page 15?
A. (Dr. Ostadan) I would like to see how much is the effect of soil-structure interaction, and I think some results can be extracted easily to demonstrate

that.
Q. So you would like to see those things separately identified and -- so that you can look at them?
A. (Dr. Ostadan) That's correct. Because -- that also is important, because you would right away know how much is the effect of soil and how much variation of the soil properties impacts your building response.
Q. Let's move to item AQ. It's on page 70 of Exhibit 10, and it refers to "Modeling of Secondary Systems in Dynamic Analysis."
A. (Dr. Ostadan) Yes.
Q. Could you explain AQ?
A. (Dr. Ostadan) Yeah. I think that when you have heavy equipment in the building, it is recognized that there will be equipment-structure interaction. And the acceleration, floor acceleration response spectra, such as those shown in Exhibit 68, would not be sufficient for the qualification of the equipment if these equipments are heavy with respect to the supporting structural members.
What I would like to see is that -- and a statement here that perhaps this condition does not exist in this building, or, if it exists, how it has

been addressed.

Q. You mentioned earlier that as far as you remembered, the most massive piece of equipment in the canister transfer building would be the bridge crane --

A. (Dr. Ostadan) That's correct.

Q. -- that is used for moving the canisters?

A. (Dr. Ostadan) Right.

Q. Do you know whether a separate analysis has been performed for the bridge crane?

A. (Dr. Ostadan) With respect to comment AQ, I don't think Exhibit 68 addresses whether equipment and structure interaction should be considered or not. It simply uses the mass of the crane in the model.

MR. TRAVIESO-DIAZ: Let me mark this document as Exhibit No. 70.

(Exhibit-70 marked.)

Q. I have identified as Exhibit No. 70 Stone & Webster calculation entitled "Crane Decoupling Evaluation -- Canister Transfer Building." The calculation number is SC-8, it's Revision 0, and it's dated 12/14/98.

Q. (By Mr. Travieso-Diaz) Are you familiar with Exhibit 70?

A. (Dr. Ostadan) No. It's the first time I see this.

Q. Can I ask you to look at page 4 of Exhibit 70?

A. (Dr. Ostadan) Yes.

Q. It's only one paragraph in the text of the page, and the paragraph reads, "Purpose. The purpose of this calculation is to verify that it is not necessary to consider coupling between the Canister Transfer Building (CTB) and the 200 ton bridge crane when performing the seismic analysis of the crane. The seismic analysis of the building (Ref. 1) and the analysis of the crane (Ref. 4) were performed independently, and do not include dynamic coupling between them."

A. (Dr. Ostadan) Yes, I saw that.

Q. Based on what you read, will you understand the purpose of this calculation to be to determine whether in fact there is a coupling between the crane and the building?

A. (Dr. Ostadan) Yes. As I said, I have not seen this document before. I see now it has been addressed.

MS. CHANCELLOR: Could I ask, is this the full document? Are there more calculations or anything?

MR. TRAVIESO-DIAZ: I believe this is the entirety of the document.

MS. CHANCELLOR: It's got references.

MR. TRAVIESO-DIAZ: Oh. There is only one thing missing from the exhibit is something called STRUDL Analysis.

Q. (By Mr. Travieso-Diaz) And I will let either Dr. Ostadan or Dr. Bartlett tell me what a STRUDL analysis looks like .

A. (Dr. Ostadan) STRUDL is the name of a computer program for a structure analysis.

Q. And STRUDL analysis, what would it look like, the result of the analysis. Would it be a few pages or --

A. (Dr. Ostadan) Well, it depends on how extensive is the model. Could be small, could be very big. You know these programs.

MR. TRAVIESO-DIAZ: So to answer Counsel's observation, the document that has been identified as Exhibit 70 includes a document that is not attached to it, and which is the actual calculation of which I don't have the copy.

Q. (By Mr. Travieso-Diaz) Now, understanding that you have not reviewed this document, and moreover, the calculation is not attached to it, will you turn to page 7.

A. (Dr. Ostadan) Yes.

Q. The conclusion reads, "It is concluded that the analyses of the CTB and the bridge crane can be performed independently without considering dynamic coupling." Is that what that says?

A. (Dr. Ostadan) That's right.

MS. CHANCELLOR: I'm going to object to this line of questioning, because these are just mere conclusions. He hasn't seen the supporting calculation.

MR. TRAVIESO-DIAZ: You anticipated my next question, which is, understanding that without seeing the calculation, you cannot agree with the conclusion.

Q. (By Mr. Travieso-Diaz) Assuming that the calculation supported the conclusion, would this calculation, Exhibit 70, address the concern you raised?

A. (Dr. Ostadan) Yes, it would.

Q. Now, you cannot tell that because you don't have the calculation, do you?

A. (Dr. Ostadan) That's correct.

Q. Moving to item AR on page 70, which reads, "Load Combinations for Bearing Capacity Calculations for Transfer Building." Will you describe for me what the concern here is? This has a familiar ring to it.

A. (Dr. Ostadan) Yes. I think, and I'm not sure whether this is in collaboration with Dr. Bartlett or entirely by Dr. Bartlett, I don't recall now, but

from what I read here, the question was raised at the time in the previous version of this calculation that how the bearing pressure when the building was calculated, and whether or not live load was included in compilation of bearing pressure.

Q. And the calculation that would have to be examined to determine that would be the one cited here, G(C)13?

A. (Dr. Ostadan) I would think so, yes.

Q. Do you have a view today as to whether this is still a concern?

A. (Dr. Ostadan) I need to look at the calc.

MR. TRAVIESO-DIAZ: Go off the record for a second.

(Discussion off the record.)

Q. (By Mr. Travieso-Diaz) Let me ask a couple of leading questions. Dr. Ostadan, we have been discussing a calculation which I believe Dr. Bartlett presented to you, and it is entitled "Stone & Webster Calculation G(B)13, Stability Analysis of the Canister Transfer Building Supported on the Mat Foundation." If my recollection serves me right, at the deposition of Mr. Trudeau and Dr. Chang this calculation was discussed at some extent.

A. (Dr. Ostadan) That's correct.

Q. and some concerns were raised.

A. (Dr. Ostadan) That's correct.

Q. Now, your concern, I understand, is not of the same nature of those that were raised during Mr. Trudeau's deposition. Is that correct?

A. (Dr. Ostadan) That's correct.

Q. But the concern if it were addressed, to the extent it is not addressed now, will be embodied by a revision to the calculation that I believe Dr. Bartlett gave you, G(B)13?

A. (Dr. Ostadan) It would be in the revision?

Q. No. I mean, if there was such an adjustment, you would expect to see it in the revision?

A. (Dr. Ostadan) Yes.

Q. And what would the nature of that adjustment be?

A. (Dr. Ostadan) I would expect loads on the foundation to be somewhat higher to include the live load.

Q. Do you expect that this would result in a significant increase on the foundation loads?

A. (Dr. Ostadan) I do not.

MR. TRAVIESO-DIAZ: Off the record for a second.

(Discussion off the record.)

Q. (By Mr. Travieso-Diaz) Then let's move on to Item AS, described as "Use of Full Undrained Shear Strength Overstates Sliding Factor of Safety of the Mat Foundation of the Canister Transfer Building." Could you explain to us what Item AS refers to? I believe this was one that was identified as being the result of joint input or input from both you and Dr. Bartlett, so either of you can address it.

A. (Dr. Bartlett) I think what's going on here in this AS is that in the calculation for the allowable bearing capacity of the Canister Transfer Building supported on a mat, the -- I think that title's probably -- is that the correct title of the current calculation? Maybe --

The current calculation is G(B)13, Rev. 3. In addressing seismic sliding of the mat atop the soils, it's our position that when one does that, that adhesion should be used in analyzing the soil's resistance to that sliding instead of full cohesion.

Q. Now, understanding that we have now a revised calculation or a different calculation than the one you cited in Item AS, are you still of the view that this remains a concern?

A. (Dr. Bartlett) It's my understanding the current calculation still uses the full undrained shear

strength, not adhesion between the soil and the mat.

Q. Do you have anything to add?

A. (Dr. Ostadan) No, I don't.

Q. Is adhesion now an applicable concept in light of the fact that you have a shear key as we have been discussing a little bit earlier?

A. (Dr. Bartlett) Maybe we'd better go back and revisit what the assumptions are for the mat/clay interface.

I'm not seeing any statement to this. I'll have to look for numbers. I guess the basic assumption I'm looking for is whether it was used in the clay's cohesion on the bottom of the mat. I recall it was coming from the passive resistance.

Q. Can I direct your attention to page 15 of the calculation?

A. (Dr. Bartlett) Yes.

A. (Dr. Ostadan) I think -- we're looking at page 16 of the calculation. It does not seem that adhesion has been used. It relies on the passive pressure. However, I think, as was noted, it takes advantage of passive pressure for the full height of the foundation embedment. I think we discussed whether or not the passive pressure in the upper few feet would be available or not.

A. (Dr. Bartlett) So I guess to summarize our concern about using adhesion now, since the design has been revised with the shear key now does not seem applicable. We still have issues regarding the passive pressures that are developing.
Q. And we discussed those. Do you have anything else to add?
A. (Dr. Bartlett) No, not now.
Q. Dr. Ostadan, let me ask you to return now to Exhibit 12 that we talked about some time ago today. According to my notes, you indicated that you had some input with respect to a few of the matters raised in Exhibit 12.
A. (Dr. Ostadan) Yes.
Q. And I am going to identify this for you, and please tell me if I am missing any.
On page 28 of Exhibit 12, you indicated that you have some input in the discussion of strain rate of soil. It starts on page 28 and goes into page 30.
A. (Dr. Ostadan) I indicated I have discussed this most likely with Dr. Bartlett. I don't think I should get credit for ownerhip of this.
A. (Dr. Bartlett) Sure.
Q. Let me ask both of you, which of you will be in the best position to address the item that starts on

page 28 and goes to page 30?
A. (Dr. Bartlett) I would be.
Q. So it would be okay for you to pass on this one, Dr. Ostadan?
A. (Dr. Ostadan) I think I will do that, yes.
MS. CHANCELLOR: When we went through this before, I thought Dr. Ostadan had identified on page 32 "Factor of Safety Against Bearing Capacity."
MR. TRAVIESO-DIAZ: We are still on page 28. We'll get there.
MS. CHANCELLOR: Oh, I'm sorry.
Q. (By Mr. Travieso-Diaz) I'm now on page 30 on the item identified as "Factor of Safety Against Sliding" that starts on page 30 --
A. (Dr. Ostadan) Yes.
Q. -- and goes through page 32. You identified again that you have provided some input into the discussion on these pages?
A. (Dr. Ostadan) Yes.
Q. What -- again, would this be one in which your input -- well, let me don't put words in your mouth. Describe for me what your input would have been and the extent to which you feel that Dr. Bartlett would be a better person to ask.
A. (Dr. Ostadan) I think I have discussed that

with Dr. Bartlett, but I think he gets -- he deserves more credit on this than I.
Q. Dr. Bartlett, do you believe that you will be able to explain this -- what this concern is that starts on page 30 to 32?
A. (Dr. Bartlett) I hope so. It appears to be my writing.
Q. Okay. You don't mean to say that you are actually the author?
A. (Dr. Bartlett) Well, no, I'm not the actual author, but I provided the major technical content.
Q. All right. How about the item on page 32 entitled "Factor of Safety Against Bearing Capacity"? Again, that's one that you mentioned, Dr. Ostadan, that you may have provided input on.
A. (Dr. Bartlett) I think this is addressing a phi angle using -- of 30 degrees. I believe the applicant's probably justified the use of that phi for cohesionless soils.
Q. So your view is that this is no longer an item that we need to address?
A. (Dr. Bartlett) For bearing capacity.
A. (Dr. Ostadan) Let's make sure, which topic are we addressing?
A. (Dr. Bartlett) I think we're on bearing

capacity.
Q. We're on bearing capacity.
A. (Dr. Ostadan) All right.
A. (Dr. Bartlett) And I think the issue was at the time I reviewed this I couldn't see any basis for the phi used. I think that subsequent investigations have clarified that.
Q. Do you have anything to add Dr. Ostadan?
A. (Dr. Ostadan) No, I don't have anything.
Q. How about the next item, starts on page 32 and goes on top of page 33, entitled "Factor of Safety Against Sliding of the Pads." Again, if I recall, you identified this one as one in which you provided input.
A. (Dr. Ostadan) Yes, I did, and I think it was a mixed response between Dr. Bartlett and I. To the extent that it discusses -- however, this claimed factor of safety against sliding is potentially incorrect because, A, 1, no soil-structure interaction was considered in determining the foundation loading for the sliding analysis.
I think I can address that. That remains there needs to be a concern. It was discussed extensively, whether the use of PGA, the ground acceleration, is appropriate or other spectral values on the design response spectrum. And we expressed a

concern that the natural frequency of the foundation should be evaluated and appropriate spectral evaluation used.

Q. Are you saying that this concern is the same one that we talked about a few minutes ago in which you expressed -- made the observation that you just related to us?

A. (Dr. Ostadan) That's correct.

Q. So there's nothing here different from what you said earlier?

A. (Dr. Ostadan) There's nothing different.

Q. Any other part of the discussion that goes from page 32 to top of page 33 that you, Dr. Ostadan, contributed to?

A. (Dr. Ostadan) No, I think the latter part probably goes to Dr. Bartlett.

Q. All right. I don't believe that my notes showed that there was any other portion of Exhibit 12 that you contributed to. Will you take a quick look to see if there's anything else there that I may have overlooked.

A. (Dr. Ostadan) No, I don't seem to notice any other points.

MR. TRAVIESO-DIAZ: I don't believe I'm going to have any more questions for Dr. Ostadan at this

time. I'd like to ask counsel for the state whether she has any.

MS. CHANCELLOR: Could we take just a couple minute break before we decide if I need to ask him any questions?

MR. TRAVIESO-DIAZ: Sure.

(Brief Recess.)

MS. CHANCELLOR: I've just got a couple of things.

EXAMINATION

BY MS. CHANCELLOR:

I wanted to thank counsel for PFS for allowing Dr. Ostadan to catch his plane this evening and for allowing me to ask him questions out of turn. I have just a few brief questions.

Q. Dr. Ostadan, could you put in front of you the original Contention L, which is Exhibit 3, I believe.

A. (Dr. Ostadan) Yes, I have it here.

Q. The contention reads, "The applicant has not demonstrated the suitability of the proposed ISFSI site because the license application and SAR do not adequately address size and subsurface investigation necessary to determine geologic conditions, potential seismicity, ground motions, soil stability, and

foundation loading." In that general statement in the contention, the issues that you have been retained for, what issues are in the general statement of the contention?

A. (Dr. Ostadan) I think, going back to all the issues raised in the past few days, my concern remains in the area of ground motion, soil stability, and foundation loading.

Q. And then turning to the basis, is there anything in Basis 1 that you will be testifying on? Surface faulting?

A. (Dr. Ostadan) No, I don't see anything in this.

Q. In Basis 2, does any of your expertise fit into Basis 2?

A. (Dr. Ostadan) Very much so. I think a lot of the issues we discussed with respect to adequacy of ground motion characterization, number of time histories, fling, location of the control point, and so on and so forth, does right fall under Basis 2.

Q. And Basis 3, "Characterization of subsurface soils," the first -- is there anything in the first general statement in subsurface soils under which your issues would fit?

A. (Dr. Ostadan) I don't recognize anything in

the general statement.

Q. And Item A, "subsurface investigations"?

A. (Dr. Ostadan) No, nothing in A.

Q. B, "Sampling and analysis"?

A. (Dr. Ostadan) Yes. To the extent that relates to the statement here, foundation loading, my concerns remain.

Q. So that's the first sentence that says, "Site specific investigations and laboratory analyses must show that soil conditions are adequate for the proposed foundation loading"? Cites 10CFR 72.102(d).

A. (Dr. Ostadan) That's correct.

Q. Okay. Anything else?

A. (Dr. Ostadan) Okay. I think following up on 3b, the sentence that starts under "subsurface condition."

Q. Okay. This is on page 85, okay.

A. (Dr. Ostadan) Towards the end of that sentence, again, the concern has been raised with respect to foundation under static and dynamic loading.

Q. So the part of the sentence that reads, "analyses are inadequate to accurately model the expected behavior of the soil foundation under static and dynamic loading"?

A. (Dr. Ostadan) That's correct.

Okay. Following up, next paragraph towards the end. It starts with "These data are essential in order to correlate with the field seismic profiling."
Q. This is on the first full paragraph on page 86?
A. (Dr. Ostadan) Yes. And it goes on. I will not read the whole paragraph.
Q. Is it the paragraph or the sentence? "These data are essential in order to correlate with field seismic profiling" --
A. (Dr. Ostadan) That's correct.
Q. -- "(shear wave determination) for use in the analysis of the seismic response of the buildings and their contents, and to determine the potential for soil collapse"?
A. (Dr. Ostadan) Yes. To the extent that the relates to the seismic response of the buildings, we have a number of open items.
Q. Anything in the next paragraph?
A. (Dr. Ostadan) Nothing in the next paragraph, no. Okay, I'm following the paragraph after that.
Q. The paragraph that says "the collected field data"?
A. (Dr. Ostadan) No, I don't see anything

there.
Q. The license application?
A. (Dr. Ostadan) That's correct.
Q. It's in the middle of page 87?
A. (Dr. Ostadan) Yes. Middle of the paragraph, "The basis for the selection of samples and the type of test to be made is a function of the structure, anticipated loading, duration of loading (seismic), and the need to modify the soil's physical characteristics." And again as it relates to anticipated loading.
Q. Anything in the next paragraph at the bottom of page 87?
A. (Dr. Ostadan) Let me make a correction in the previous paragraph that starts with "the collected field data."
Q. On the top of page 87?
A. (Dr. Ostadan) Right. There is I think the second sentence, "The Applicant must obtain representative undisturbed samples of each of the site soils and determine the dynamic properties." I think we discussed the soil degradation curves. That remains to be the concern.
I don't see anything in the paragraph after that.

Okay. Now I'm going to the long paragraph that starts, "a major failing in the application."
Q. That's on page 88?
A. (Dr. Ostadan) Yes. Towards the end of this paragraph is a sentence that starts, "The Applicant must also show that the static and dynamic engineering properties of the soils." I will not read the whole thing, but I think we discussed dynamic properties concerns remain.
Q. That's on page 89 towards the middle.
A. (Dr. Ostadan) Okay. I think following up on that paragraph, towards the end there's a sentence that starts "This demonstration should explain how the developed data were used in design analysis, how the test data were enveloped for design, and why the design envelope is conservative." We had long discussions and a number of issues open.
Moving to 3c. Okay, the early part of the paragraph there's a sentence that says, "This is especially a complex site from the standpoint of assessing potential earthquakes and resulting ground motion."
Q. This is the carry-over sentence that starts on page 89 and it carries over to page 90?
A. (Dr. Ostadan) Yes. And the sentence goes

on, "that may affect plant operation." I think we talked about flings, incline waves, so on. Those issues remain open.
Okay. Following up, I think -- going down a few sentences, there is a sentence that states, the dynamic analyses presented instead use published information from 1973, reference 3, which is extrapolated to decide without any basis for such extrapolation.
Q. Where are you?
A. (Dr. Ostadan) I am in 3c.
MR. TRUDEAU: Page 90.
A. (Dr. Ostadan) And there is a sentence that says, "the dynamic analysis presented instead used." Do you see that?
Q. Yes. The footnote should be 21. Footnote is to Seed and --
A. (Dr. Ostadan) That's correct. The footnote is Seed and Idress.
I think that was discussed; and a concern was expressed that even though a resonant column test were performed, applicant did not make any attempt to compare site specific data with the published data.
Towards the end of the paragraph there is a sentence that says, "In addition, strain controlled

dynamic triaxial tests should be conducted." That remains to be a concern, especially that applicants attributed the shear strain of Bonneville clay to cementation.

Q. So this is the last sentence on page 91, the carry-over paragraph?

A. (Dr. Ostadan) That's correct.

MR. TRAVIESO-DIAZ: Counsel, I'm concerned that we may not be dealing from the same document.

MS. CHANCELLOR: What document do you have? Do you have Exhibit 3?

DR. OSTADAN: It's -- I have a printout of Contention L.

MS. CHANCELLOR: You should have Exhibit 3, the actual document that should be on the table.

A. (Dr. Ostadan) Okay. I believe they're identical. This printout may have -- may show different page numbers. Exhibit 3.

Where were we?

Q. We're on page 91. And the last reference was "In addition, strain controlled dynamic triaxial tests should be conducted to reference one or more strain intervals to support the basis of the curves."

A. (Dr. Ostadan) Okay. We move to Basis 4. On page 92 right before Basis 4, the statement that

"Such additional tests will allow a reviewer to make a reasonable judgment about how the soil will perform under the anticipated static and dynamic loading of the short and long term conditions." Then Basis 4 has a specific title of "foundation loading," and to that extent we have a number of open issues.

I don't recognize any other item, the remainder of the document.

MS. CHANCELLOR: That's all. I have no further questions.

MR. TRAVIESO-DIAZ: I regret to say that, based on your counsel's examination, I have a few more questions.

FURTHER EXAMINATION

BY MR. TRAVIESO-DIAZ:

Q. First, starting from the back, you referred to Issue 4, "Soil stability and foundation loading."

A. (Dr. Ostadan) Which page are you?

Q. I'm sorry. Page 92 of Exhibit 3.

A. (Dr. Ostadan) Yes.

Q. You recall -- do you recall earlier in the testimony that you indicated that you were not the author of any part of what is known now as Contention L?

A. (Dr. Ostadan) That's correct.

Q. So you didn't write Contention 4?

A. (Dr. Ostadan) I did not write any part of this.

Q. Do you know who the author of Contention 4 was?

MS. CHANCELLOR: Excuse me. Do you mean Basis 4?

MR. TRAVIESO-DIAZ: Exactly.

A. (Dr. Ostadan) I was told Mr. Larry White, or perhaps Barry Solomon as well.

Q. Are you aware that Dr. Solomon testified in his deposition a few days ago that he was the author of Basis 4?

A. (Dr. Ostadan) I did not know that.

Q. Are you aware that Dr. Solomon testified in his deposition that the concern that he expressed on Basis 4 had been resolved?

A. (Dr. Ostadan) I'm not aware of that, either.

Q. Do you disagree with Dr. Solomon's assessment of the status of the Basis 4?

A. (Dr. Ostadan) I can only speak to the extent that it relates to my expertise and extent of the review I have performed and the interpretation I make on Basis 4.

Q. Would you please, starting on page 92 and

going through the end of Basis 4 on page 95, go line by line and tell me which element on Basis 4 do you have -- as reading on those four pages you have a concern about? I can ask you sentence by sentence, but I'd rather have you give me one single answer.

A. (Dr. Ostadan) I cannot specifically single out a statement here. However, I do recognize the topic of Basis 4 specifically outlines foundation loading, so I don't know what the intent of the author was. All I can say is that, based on the reviews I have done, the concerns raised, a number of them fall under foundation loading.

Q. Let me ask you specifically. Putting aside the type of Item 4, have you started or do you have any -- expect that you're going to provide any testimony with respect to any of the items that are disclosed starting on page 92?

A. (Dr. Ostadan) Not on 92.

Q. How about 93?

A. (Dr. Ostadan) I don't recognize here, either.

Q. How about 94?

A. (Dr. Ostadan) No.

Q. How about 95?

A. (Dr. Ostadan) Again, I see a statement that

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states "foundation loading" on 95 towards the end under 10 CFR 72. So I think a number of issues.

Q. Can I read entire sentence to you? It starts on page 94, and in my copy it reads, "Thus, the Applicant did not consider the presence of such soluble materials during the evaluation of adequate soil conditions for the proposed foundation loading as required under 10 CFR, Section 10 72.102(d)." Reading the sentence in its entirety apart from the use of the words "foundation loading," is this an area that you have investigated? The presence of soluble materials --

A. (Dr. Ostadan) No, I certainly did not do that, but if my opinion is as to what is the foundation loading, I do have a input there.

Q. Let me ask the question this way. Other than the fact that if Basis 4 uses the word "foundation loading" in two places, is it your testimony you had nothing to contribute to the matters specifically mentioned on Basis 4?

A. (Dr. Ostadan) I could not find anything but the foundation loading.

Q. Just the words "foundation loading." And those words "foundation loading" might refer to all other items that are raised throughout Contention L?

A. (Dr. Ostadan) Would you clarify the question?

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Q. Strike that question. Let's move to -- let's now move to what is presented on page 82, bottom, the paragraph called "Ground motion."

A. (Dr. Ostadan) Yes.

Q. Okay. Let's take a look at the sentence after the title "Ground motion" that reads, "The site may also be subject to ground motions greater than those anticipated by the Applicant due to spatial variations in ground motion amplitude and duration because of near surface traces of potentially capable faults (the Stansbury and Cedar Mountain faults)." Is the area that is identified or described on the center paragraph one that you are addressing?

A. (Dr. Ostadan) Very much so. I think we discussed extensively about characterization of ground motion, amplitude, inclined wave, flings, etc.

Q. I believe that this sentence refers to -- of spatial variations because of the near surface traces of potentially capable faults, the Stansbury and Cedar Mountain faults. Have you studied the effects of near surface traces of potentially capable faults, Stansbury and Cedar Mountain faults, on the ground motions?

A. (Dr. Ostadan) As I indicated, I have not read the Geomatrix report in its entirety, but I do know that there is a major fault near the site; the fault is dipping under the site. I have expressed concern about wave being inclined, which other way of saying that there is a spatial variation in ground motion.

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Q. Have you studied the characteristics of either the Stansbury or Cedar Mountain faults?

A. (Dr. Ostadan) To the extent I see the application for the engineering design, I did not see a need to study that.

Q. Are you aware of whether there's any other witness propounded by the state who will address or who has addressed the matters referred to in this paragraph?

A. (Dr. Ostadan) I do not know.

MR. TRAVIESO-DIAZ: I'm going to ask counsel. Counsel, do you intend Dr. Ostadan to be a witness with respect to the matters set forth in the first paragraph of Basis 2?

MS. CHANCELLOR: Dr. Ostadan will be one of the witnesses for Basis 2. Dr. Arabasz, who you have already deposed, will be the other witness for Basis 2.

MR. TRAVIESO-DIAZ: Since we deposed Dr. Arabasz without the notice that Dr. Ostadan was going to take part in the discussion of Basis 2, could you clarify for the record what the respective roles of the two will be?

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MS. CHANCELLOR: Dr. Arabasz -- let me see if I can get this straight. Dr. Arabasz will deal with the issues of the deterministic seismic hazard analysis and the ground motions that were developed for the deterministic seismic hazard analysis. Dr. Ostadan will testify with respect to the effects of the ground motion, such as the amplitude and duration, and whether the ground motions affect SSE's. In other words, whether it would affect safety. So I think that there's two different components in Basis 2.

MR. TRAVIESO-DIAZ: I will state for the record that when the deposition of the first group of Contention L witnesses was noticed, I don't believe that PFS was made aware that there was going to be Dr. Ostadan providing testimony as to any part of Basis 2. And I have to express surprise at the fact that we are now, with Mr. Ostadan about to leave and with no preparation, being told that he's going to be addressing an area that we did not know of before.

MS. CHANCELLOR: I think that is because we have a distinct difference of opinion as to what is contained in Contention L. And we had an exchange earlier in the day where you didn't think that anything that Dr. Ostadan was testifying to was contained in the Contention L, and that's why I specifically went back

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with Dr. Ostadan to establish where his issues fit within Contention L. You certainly had the opportunity at the beginning of the deposition to go through the contention with Dr. Ostadan to find out where his issues fit into Contention L. And I'm sorry if you're surprised, but we have this fundamental disagreement about the interpretation of Contention L and how it fits into his area of expertise.

Q. (By Mr. Travieso-Diaz) Let me ask Dr. Ostadan again, what studies have you done today that relate to the subjects raised or disclosed in the first paragraph on Contention L?

MS. CHANCELLOR: If could I just add, if I may, Basis 2 refers to the Stansbury and Cedar Mountain faults, and I'd just like to clarify for the record I understand that Mr. Solomon testified that -- his testimony was that these were examples of potentially capable faults and that at the time the contention was written, the other identified -- PFS had not identified other faults.

Oh, I beg your pardon. The example was the reference to Sommerville, et al.

Q. (By Mr. Travieso-Diaz) The subject of this deposition today, as I understood it when it was arranged, was soils. So I don't want to get into the

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details of Issue 2, which I believe were already explored in other depositions. But I will ask again of Dr. Ostadan to what extent to date he has done any studies or valuations with respect to the subject of the effects of the spatial variations in ground motion amplitude and duration because of near surface traces of potentially capable faults, the Stansbury and Cedar Mountain faults. Is this a subject you have studied to date?

A. (Dr. Ostadan) Yes, to the extent that ground motion has been characterized for application or design.

Q. Have you studied the characterization of the Stansbury and Cedar Mountain faults?

A. (Dr. Ostadan) I think I know enough about them.

Q. What do you know?

A. (Dr. Ostadan) That they are a nearby fault, that they are capable fault, they are capable of generating large magnitude earthquake. And as a result of that, as I indicated earlier, the ground motion used for design need to look at other variations in the ground motion, such as the possibility of incline waves, different types of flings, number of different time histories involved above and beyond one set considered,

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so on and so forth.

Q. Have you studied, are you aware of the spatial variations in ground motion amplitude and duration because of the faults in the vicinity of the site? Can you disclose that for me?

A. (Dr. Ostadan) Yes. I think another way of explaining spatial variation, what it means to me as an engineer is that if you assume vertically propagating wave, the motion in the ground at all points are the same. There's no spatial variation. Whereas if the wave come in an angle, and that will happen only if you're near a major fault, then the motion in the ground will not be identical. It will be other phase. It depends on the angle of incidence.

Q. Have you studied the characteristics of the ground motion that is provided or assumed to be provided by earthquakes cited as the Stansbury and Cedar Mountain faults to determine their potential impact on ground motion amplitude and duration?

A. (Dr. Ostadan) I have studied the engineering design calculations where these results have been used.

Q. Of what?

A. (Dr. Ostadan) Where ground motion characterization has been used.

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Q. And how have you studied them? For what purpose?

A. (Dr. Ostadan) Well, I have looked at, as I mentioned, Holtec calculation that specifically uses the assumption of vertically propagating waves. I have reviewed Geomatrix' calculation for degradation of soil properties. They also used vertically propagating waves. The canister transfer building dynamic analysis is based on vertically propagating. So no special variation of ground motion is considered in any of these design calculations.

Q. Other than the fact that there have been no -- let me just rephrase the question. Have you studied the earthquake analysis report by Geomatrix?

A. (Dr. Ostadan) I have not studied that, no.

Q. Are you aware of the characterization of the ground motion that is the result of the output of that study?

A. (Dr. Bartlett) Yes, we have. We looked at the response spectrum.

Q. Are you aware of the extent to which there will be spatial variations in ground motion amplitude and duration as a result of the specific spectrum that is the result of Geomatrix study?

A. (Dr. Bartlett) Yeah, that's part of the

probabilistic process to take care of that.

Q. So you wouldn't agree with that?

A. (Dr. Ostadan) No. I think once you have the motion, there is another piece of information that the designer needs to consider during the design calculation: What type of wave would comprise that design motion? Is it vertically propagating, or is it inclined that would create a spatial variation?

Q. Can you testify today as to the first sentence of Basis 2 that says, "The site may be subject to ground motions greater than those anticipated by the Applicant"?

A. (Dr. Ostadan) Yes.

Q. How can you enlighten us?

A. (Dr. Ostadan) Well, again, I will not comment on the issue of deterministic and probabilistic and the level of the motion anticipated. That is a position the state will take. It's beyond my expertise. Having said that, given one of these motions, whether it's deterministic or probabilistic, I express concern that the motion should have been placed on top of a competent layer, and if it's done so, it would amplify by propagating through the upper 10 feet.

Q. But just to clarify the areas as to which -- as of today you will be competent to provide testimony:

it would be in the first sentence that says, "The site may be also subject to ground motions greater than those anticipated by the Applicant"; is that correct?

A. (Dr. Ostadan) Are you saying I would or will not?

Q. Well, will you?

A. (Dr. Ostadan) I think to the extent, as I indicated, that the upper 10 feet and the new velocity data has been ignored in the development of ground motion, I would testify to that.

Q. Could you testify to -- answer questions today for me as to what the extent of the nature of the ground motion will be?

A. (Dr. Ostadan) Would you clarify the question, please?

Q. Yes. My question is, I want to know whether you know about, first, what -- where are the ground motions that were anticipated by the applicant. Are you aware of those?

A. (Dr. Ostadan) I still don't understand your question. I'm sorry.

Q. I'm referring you to the first part of the first sentence at the bottom of page 82, and I'm referring to "ground motions greater than those anticipated by the Applicant."

A. (Dr. Ostadan) Yes.

Q. Can you explain to me now or talk about what are the ground motions that applicant expects or anticipates, the ones that are referenced to here? Do you know what those are?

A. (Dr. Ostadan) I think I -- again, I can only speak on the area that I -- my expertise is.

Q. That's what I'm trying to -- is this not your area of expertise?

A. (Dr. Ostadan) I think to the extent that in the development of the ground motion the latest information from seismic cone data has not been considered, and therefore the amplification in the upper 10 feet is not reflected. I could testify to that.

Q. Are you aware of the ground motions that, as of today's analysis by applicant, applicant expects to be found -- to be experienced at the site? Is this an area that you're aware of today?

A. (Dr. Ostadan) Please clarify the question.

Q. My question is very clear. I'm sorry, may not be clear. I'll go again.

This contention speaks about "ground motions greater than those anticipated by the Applicant."

A. (Dr. Ostadan) Yes.

Q. What are the ground motions that the

applicant anticipates?

MS. CHANCELLOR: That's a little unfair to not read the qualification to the sentence.

MR. TRAVIESO-DIAZ: Well, I think it's fair, because I need to know what he knows about it. Since you're telling that me he's going to be testifying on Basis 2, I want to know what part of it he is aware of today and what part of it he expects he'll be talking about. One part of it is what is the ground motion that the applicant expects to see, and I want to know what he knows about that.

MS. CHANCELLOR: I already stipulated that Dr. Arabasz will be our expert with respect to the development of deterministic and probabilistic seismic hazard analysis and ground motions that are a function of that analysis.

MR. TRAVIESO-DIAZ: Okay. Are you stipulating to the fact that this witness will not be involved in what is discussed in the first sentence of paragraph 2?

MS. CHANCELLOR: I cannot stipulate whether he's going to be involved in this first sentence. I just don't understand it well enough. I have to rely on Dr. Arabasz and Dr. Ostadan to tell me what part of this they can support.

MR. TRAVIESO-DIAZ: That's what I'm trying to get to, because I need to decide whether I need to bring him back to answer questions on this or what we need to do about it.

MS. CHANCELLOR: Okay.

A. (Dr. Ostadan) Well, all I can say is, as it says after that "anticipated by the Applicant due to spatial variations in ground motion." And I emphasize spatial variations. Yes, I think that is an area that I have raised a number of questions.

MS. CHANCELLOR: Could we go off the record for a minute?

(Discussion off the record.)

MS. CHANCELLOR: We had a discussion off the record as to what Dr. Ostadan will be testifying to. We have agreed that we'll go back on the record and describe what Dr. Ostadan will be testifying to.

He will not be testifying as to Basis 2. He will not be testifying about foundation loadings -- strike that. We have agreed -- the state has agreed that Basis 2 ground motion does not address or challenge foundation loading, that foundation loading is contained in Basis 3, and Dr. Ostadan will be an expert witness with respect to Basis 3 in which it addresses foundation loading.

The applicant disagrees with the state with respect to whether foundation loading is contained in Basis 3, and we have agreed to disagree.

Is that a correct statement?

MR. TRAVIESO-DIAZ: That's a fair, correct statement. However, I would like you to add also that you do not anticipate that Dr. Ostadan will be testifying with respect to Basis 4.

MS. CHANCELLOR: Oh, that's correct. I'm sorry. I thought that I did that. No, Dr. Ostadan will not be testifying with respect to the -- the caption to Basis 4 is "Soil stability and foundation loading." Dr. Ostadan will be testifying with respect to foundation loading, but the text of Basis 4 does not address foundation loading.

MR. TRAVIESO-DIAZ: Will you stipulate that he will not present testimony on Basis 4?

MS. CHANCELLOR: Provided that foundation loading, you don't say that foundation loading is precluded because it's in the caption of Basis 4.

MR. TRAVIESO-DIAZ: I will stipulate that to the extent there is any foundation loading issue admitted into this, the litigation of this contention will be part of Basis 3.

MS. CHANCELLOR: So stipulated.

MR. TRAVIESO-DIAZ: I have no further questions for Dr. Ostadan.

MS. CHANCELLOR: I have no further questions.

MR. TRAVIESO-DIAZ: I want to thank you very much for your cooperation.

DR. OSTADAN: Thank you very much.

(Recess from 5:28 to 5:38 p.m., during which Dr. Ostadan left the deposition.)

EXAMINATION OF DR. BARTLETT, Continued

MR. TRAVIESO-DIAZ: Back on the record.

Q. (By Mr. Travieso-Diaz) Dr. Bartlett, good evening.

A. Good evening.

Q. If I recall when we --

MS. CHANCELLOR: Could we just establish that Dr. Ostadan has left?

MR. TRAVIESO-DIAZ: Yes, I was going to say that.

MS. CHANCELLOR: Oh, beg your pardon.

Q. (By Mr. Travieso-Diaz) When we broke for the night last night and through most of the day today, you were testifying as a panel with Dr. Ostadan; is that correct?

A. That's correct.

Q. And he has now left the deposition and you're testifying by yourself; is that correct?

A. Yes, that's correct.

Q. Again, when we broke for the night last night, you were in the middle or started to disclose what has been identified as Exhibit 59; is that correct?

A. Correct.

Q. Now, I know we went through this to some degree last night, but just to provide continuity, will you briefly describe for the record again how Exhibit 59 was prepared and what the purpose of the exhibit is?

A. I'll explain the preparation first and then what I was trying to accomplish through the preparation.

The applicant has done a grid of cone penetrometer testing throughout the pad emplacement area, and also not a grid but, however, some cone penetrometer testing in the area of the canister transfer building.

One of the issues that we're trying to -- let me stop before I get into -- one of the issues that we're trying to understand is what is the potential for variation of undrained shear strength across this site to see if the applicants used reasonable and representative values for that -- for the analysis that pertains to dynamic sliding and dynamic bearing

capacity.

The cone penetrometer I think when we looked at that data did reveal to us a layering system that was slightly more -- well, more complex than we saw from the first phases of investigation, and revealed that the shallow surface soils have an Eolian silt approximately three feet thick underlain by approximately seven feet of upper Bonneville predominantly clays that are probably best characterized as silty clays/clayey silts with low to some high plasticity to them. We understand that the applicant plans to treat the Eolian silts, and so we also then wanted to look to see what would be the resistance that the underlying clayey silts/silty clays could provide to these dynamic analyses.

The laboratory data really did not help us greatly in understanding the variability, because based on our understanding of the way the data were used for the dynamic -- the dynamic sliding and bearing capacity analyses, that they were based on laboratory testing, and the number of data for the laboratory testing are probably not large enough to really make a statistical sampling of the area.

For example, it's our understanding that the canister transfer building relied for the dynamic bearing capacity analyses on UU testing. I believe the

value that was used in the design is approximately 2.2 kips per square foot. And as I recall, those were coming from I believe Borehole C-2 and No. 4, but I could be wrong. And we had concerns about the proximity of some of those boreholes to the canister transfer building.

Also, for dynamic sliding, my recollection is that the results were coming from the direct shear test. For the pad emplacement area, I believe the borehole was C-2. The design value was approximately 2.1 kips per square foot. And for the canister transfer building, I can't exactly recall where the direct shear test came from, probably a couple borings within that area. And the design value, best I can recall for the loads due to the mat foundation was about 1.75, 1.8 ksf.

So we wanted to know whether those values represented low-bound values, mean values, upper-bound strengths for the design; and I believe in our discussions Wednesday when we discussed these, they were characterized as mean, though we may be using "mean" maybe not in a statistical sense. I'm not sure what the mean meant in that context.

We realize then because of that sparse sampling that it may not give us an idea of variation across the site. However, the cone penetrometer data

were pushed in I would say a nonbiased fashion. It was pushed as a grid, so it did not appear to be any bias in where those cone penetrometer data were pushed. Also, because the cone penetrometer gives you a continuous vertical profile, it allows you to understand the variation in the vertical direction quite well so one can see subtle but insignificant changes in the tip resistance.

Likewise, if one would compare cone to cone to cone laterally across the site, one could begin to understand if there were significant variations in the strength of the soils by just doing comparisons from one cone to another for the particular layer of interest. And again, most of our interest has been focused really on layer -- what we've been terming layer 2.

When I went to try to do that analysis, I couldn't really find any composite plots to try to understand that. I was in haste to prepare for this deposition, did not have the digital data available to me to plot it up. So I got some overhead transparencies and began with my pen to just trace down the traces of the tip resistances from the cone penetrometer. In preparing to do that I enlarged them on the photocopy machine and then traced them in different colors according to groups of five. I did not really bias the

way I was grouping them. I just went through them numerically 1 through 5 and then 6 through 10. I didn't want to get too many traces on one plot, or I couldn't really make any sense of it.

Also, if you notice on the sheets that have been provided in Exhibit 59, there's the -- one of the heads, for example, the first one says CPT 1 through 5, and the dash by it which is brown just means that I used brown for that. And as I went through the zone of interest, which would be layer 2, I tried to make a mental note when I went through a group of five which one out of the group of five potentially had the lowest tip resistances in layer 2. So that's what it means by "(CPT lowest)" underneath it.

The reason for doing this is, I think that I had in my mind that undrained shear strength is correlated with tip resistance. We discussed it being linearly correlated. There are published correlations that establish that there's a linear correlation between tip resistance and undrained shear strength.

So maybe we cannot really use these in quantitative manner to do design, and the I think applicant has also said they have not used the cone penetrometer in a quantitative way to do design; however, they have used it in a qualitative way to

adjust their undrained shear strengths according to corresponding and relative changes in the tip stress.

So I was hoping to just discover by the variation in tip stress the potential range of undrained shear strength. For example, a variation in tip stress by a factor of 2 would suggest that the undrained shear strength in this layer could also vary by approximately a factor of 2.

And I think we were starting to look at the variation on some of these. I believe we started on the first plot, CPT 1 through 5, and saw something. We were discussing values and ranges as we last left. And I don't know if you want to continue doing that, or --

Q. Well, I do, but before we look at results, let me try to get some better understanding of the record as to what the parameters of interest are here. I take it that you are using the cone tip resistance as a proxy to try to estimate the changes in the parameter that you really care about, which is undrained shear strengths.

A. That's correct. They are correlated.

Q. And your belief is that there's a correlation that's linear, so it's that. If for a given value of cone penetration resistance there is a corresponding value of unstrained shear strength --

A. Correct.

Q. -- and if we move, say, horizontally, laterally across a layer of soil --

A. Right.

Q. -- that parameter that relates to the two of them remains a constant.

A. If the soil was homogeneous.

Q. Exactly. Well, try this again. In order to determine, assuming that in fact that correlation factor is a constant, if you move from point A to point B horizontally --

A. Correct.

Q. -- you get the same tip resistance or a small variation in it --

A. Correct.

Q. -- you are entitled to assume that the corresponding undrained shear strength is essentially the same according to points. Is that the reasoning?

A. Correct.

Q. In order to do that, it requires for you that the correlation be indeed linear, that the constant be -- that the number that relates to two, whatever that may be, be a constant.

A. Be nonchanging, yes. And the assumption then would be, the soils are relatively homogeneous.

Q. Now, with that background, let's go back to your previous, the calculation that you gave me, the Exhibit 49. Remember it was --

A. Oh, yes, I remember that.

Q. I believe that one identified the parameters.

A. It does. It's one of the correlations, yes.

Q. That's what I'm trying to use. Identified the parameters of interest.

A. It's entitled N sub K.

Q. Now -- I'm looking now at Exhibit 49, and I'm looking at the -- there are a number of equations on the exhibit, but the one that I'll ask you to look at is the last one that reads as follows. And I don't know if this may be captured by our able reporter, but I'll try. Su = (Qc - sigmav)/Nk. Did I read that right?

A. Uh-huh.

Q. Now, please identify for the record what each of these four parameters are.

A. Okay. Su is the undrained shear strength. Let's see if it mentions what units it's in. I think for this example we haven't probably plugged any values of Nk in, but it looks like it would give you values in ksf.

Q. And that would be?

A. Kips per square foot.

Q. Thousand pounds per square foot?

A. Thousand pounds per square foot. Qc would be the tip resistance or tip stress that would have to be in the same units which the undrained shear strength was in.

Minus sigma-V would be the overburden stress. It doesn't say whether it's effective or total. However, that would be fairly minor for this -- differences would be fairly minor for this case.

And then divided by a coefficient that relates the two determined by regression analysis or some other method is called Nk.

Q. All right. So that again the record is very clear: in this equation what we want to do is get a better understanding of Su, and the variable, if you will, that we're using to understand Su is Qc?

A. Qc.

Q. Now, tell me a little bit more about sigma-V, since that's another factor that is involved.

A. Sigma-V is essentially the weight of the materials overlying where the particular reading was taken. The readings are taken somewhat continuously as you push down through the profile, so as you get deeper and deeper in the subsurface, sigma-V is changing. It's

a function of the unit weight of the soil above and the thickness of the material above.

Q. Right. Now, based on the results of the tests the applicant has conducted and samples taken from the site, is the unit weight for a given layer of soil a constant, or does it exhibit variability?

A. The unit weight for a given layer?

Q. Yes.

A. I'm not sure I've seen a breakdown according to layer by layer in the system. That was one of things that --

Q. Let me show you, and we can make this an exhibit --

A. Sure.

Q. But the SAR has a Figure 2.6-31, which I will turn into an exhibit, which I'd like to show you. Do you have a copy of the SAR?

A. I do.

Q. Can you take a second and find your copy, and we can look at it at the same time?

A. Sure. The figure was --

Q. I'm sorry. Figure 2.6-31. It's entitled "Dry Densities of Subsurface Soils at the Site."

MR. TRAVIESO-DIAZ: We have -- we can turn this into an exhibit now because we have a sufficient

number of copies, I believe. This will be Exhibit 71, and I will provide more copies tomorrow, but we have at least one for the court reporter. And the witness has his own copy.

A. I do. I do remember seeing this.

Q. This plot appears to be one of dry unit weight in pounds per square foot versus depth for locations both of the pad emplacement area --

A. Yes.

Q. -- and the canister transfer building.

A. Yes, it does.

Q. And they're identified differently. The ones in the pad emplacement area are circles, and the ones in the canister transfer building are little diamonds; is that correct?

A. That's correct.

Q. Now, will you take a look across -- let's take a look at the layers that we're interested in that we believe is from three to ten feet. Take a look for me at the data points that are shown in this figure for the pad emplacement area, which I believe are the circles.

A. Yes.

Q. Go across for me -- the values are recorded, and if I read this graph properly, you are recording dry

weights anywhere between 40 and 70?

A. Correct. But I would wonder if the two data points between 60 and 70 may be of a higher unit there. They're quite a bit out of range from the other data. So I think one would have to verify that those are actually part of the data set.

Q. All right. Well, how about in that same layer, the value for the canister transfer building? I see that those vary in terms of unit weights anywhere between like 45 and as high as almost 80.

A. Yes, but I see again two points that are quite out of the data set. There may be something abnormal about those two data points. They may be in the right zone. Maybe there's something different about them.

Q. But would you agree with me that aside from the potential fact that some of this may be outliers, that you believe the data as plotted could be almost a factor of 2 variation in the unit weights?

A. That I can't testify to.

Q. Well, okay. What it would be -- take just the values across on the -- for the pad emplacement area going --

A. Sure.

Q. Do they go anywhere from 40 to 70, assuming

that you give credit to all the data points?

A. For the pad emplacement area?

Q. Yes. The circles, don't they go from 40 to 68 or something?

A. They do, but the depth to the Eolian silt which may be denser is not always exact, and I still don't know if 60 and 70 are in or out of that data set. But for the moment for the argument, let's go ahead and discuss what they are.

Q. But as an engineer, would you tend to at least have a question in your mind as to whether you can assume -- based on the data as presented in this exhibit, that it is correct to assume that the sigma sub V, the dry unit weight, is uniform across the layer?

A. I'm sorry. I missed question.

Q. I don't know if I said this right. Let me try again. Without trying to reach a conclusion, as an engineer wouldn't at least you have a question raised in your mind by looking at this plot --

A. Correct.

Q. -- as to whether it is a correct assumption to assume that the dry unit weights are uniform across a layer of soil?

A. What I would do as an engineer with this data set is I would come in and say I have potentially

two ranges now, particularly where I see a couple data points that are somewhat out of the rest of the data range, and first try to verify where those particular samples were stratigraphically. Then if I can determine that, then I would feel more comfortable where I place them. So I guess I could be looking now with potential two ranges, something between 40 and roughly 55, or something between 40 and possibly as high as 70.

Q. All right. But let me put the question this other way. Without further investigation, would you feel that it would be prudent to assume looking just at this data as you have it and looking further into it that the dry unit weights are constant across a layer horizontally?

A. Well, "constant" defines one point or line. There's variability to any data.

Q. Right. Would it have low variability across a given layer of soil without reaching conclusions without -- I'm sorry. Strike that question.

My question is, can you assume based on this data as reported without looking more into it that in fact sigma sub V --

A. Correct.

Q. -- is a constant across a given layer?

A. We talked about differences in approach and

philosophies of how investigations are done, and if I were going to use data that have been attained to determine unit weights -- that's why I preferred when we talked about these to have paired CPT and boring data together. Then there would be no question to where potential outliers fall. I would be hesitant to assign a range -- I think the data tend to support more between the 40 and 60 range than the 40 to 70 range.

I would also then get all the unit weights of the overlying Eolian soil, which are not plotted here, and see where they lie in relation to the data that I'm looking at. I'm only looking at the -- from five feet down. And I assume this was done on five-foot sampling, so it's kind of a hit-and-miss proposition what layer we're in.

Q. Dr. Bartlett, I guess it should be no secret to you where I'm going with this question.

A. I know where you're going.

Q. And my question is only -- and I'm going to ask you the question just based only for the moment on this particular parameter, sigma sub V. I understand what you have done with Exhibit 59 --

A. Correct.

Q. -- and I understand that you're trying to derive some feel for whether you have variation or not.

A. Right.

Q. But before you could print an opinion or have a conclusion based on Exhibit 59, wouldn't you with respect to unit weights have to look more into it?

A. Well, I think before we worry about whether we have a unit weight that could be somewhat variable, I guess the next approach would be is to go back in and look at the effect of sigma-V on the parameter that we're trying to calculate. Even if we looked at variations between 40 and 70, if the component of sigma-V which is contributing to the shear strength is not large, then this may be somewhat of a trivial thing we're doing here.

Q. Are you saying that perhaps if Qc is so much larger, that --

A. Yes, that it may override the variation that we see in sigma-V.

Q. Okay. That's a fair consideration. But then you'd have to do that analysis?

A. I would just have to plug in the values. It's not a very difficult thing to do if we know the weights of the materials.

Q. Before we do that, let's talk now on Nk. I take it that you are assuming, as you said, Nk is a constant?

A. Well, Nk would vary according to different types of soils. That's reasonably known. In fact, it's unfortunately a very variable parameter, and that's what makes this correlation hard to apply to soils without some prior experience of calculating it. What I'm saying is Nk should be locally correlated and used not trying to apply an Nk for soils here versus soils somewhat quite a distance away.

Q. Let me ask the question this other way. In order for the relationship between the cone penetration tip resistance --

A. Correct.

Q. -- and the undrained shear strength to be able to draw up the conclusions, you testified earlier that you would need to have Nk be a constant across a layer?

A. It would have to be assumed if you're going to use it to predict a certain layer that it is constant, yes.

Q. All right. And what is your basis for assuming that Nk is constant across a layer of soil?

A. Just from the cone penetrometer data, it seems to be that the upper Bonneville clay seems to be relatively homogeneous, at least in the interval from about somewhere around five feet. It's hard, you know,

that five-foot boundary gets a little blurred. Sometimes it's as high as three feet. Down to about eight to ten feet we seem to get a monotonous, if you will, tip stress signature, and my prior experience with the upper Bonneville clay is it's somewhat of a monotonous clay. It can vary from a silty clay to clayey silt.

Q. Even within a monotonous layer, as you describe it, would Nk be a function of factors such as plasticity?

A. **It could, yes.**

Q. Let me show you -- let's mark this as an exhibit. Let's call that Exhibit 72.

(Exhibit-72 marked.)

Q. (By Mr. Travieso-Diaz) Now, what I have provided you as Exhibit 72 I believe is a portion of a treatise called -- or it's not a treatise, at least -- a monograph perhaps is the word, called "Cone Penetration Testing in Geotechnical Practice" by Tom Lunne, L-u-n-n-e, Peter Robertson, and John Powell.

A. **Yes, I see.**

Q. Are you familiar with this treatise or this monograph?

A. **I haven't seen it in this form, but I may have seen parts of the equation. So it's -- there's**

been several people investigating Nk.

Q. I know. Let's look at page 64, the bottom of the page in an equation that is identified as 5.16. Is that equation the same as the one that you have at the bottom of the front page of Exhibit 49?

A. **Yes.**

Q. So the parameters are the same?

A. **Yes.**

Q. Let's turn, then, to the next page, which is page 65. And I'm not going to, but I invite you if you wish to, review the discussion on that page, which I believe talks about how you go about predicting or estimating Nk.

MS. CHANCELLOR: Do we know the date of this document? Do you know if it's recent or if it's --

MR. TRUDEAU: It's in the SAR reference list. I can find that for you.

MR. TRAVIESO-DIAZ: I can tell you there is a list -- more -- no older than 1985, because if you look at the last page, 106, it references a 1985 study by Greig, and he says "recent data." So without attempting to testify, I will guess that this document is of approximately 1985 vintage.

THE WITNESS: In fact, I could probably find it. If I may pull out the EPRI manual, it may be

referenced in here. The EPRI manual does reference these authors. We could get the exact date.

MS. CHANCELLOR: I was just trying to establish whether this was recent.

THE WITNESS: It may not be. Well, it has a 1986 reference, so it's -- wait. Excuse me. There is a 1996 here, so it's within the last four years.

Q. (By Mr. Travieso-Diaz) Well, I am shown a page 2.8-6 of the SAR that has a list of references.

A. **Okay.**

Q. And it lists this work as being a 1997 date.

A. **Okay, fair enough. That's fine. So it's relatively recent.**

Q. Again, I'm not requiring or asking you to read it in detail, but I'm inviting you to look at how they go about estimating Nk. And what I want to draw your attention is to two figures. First figure is on top of the page on the left, in which there is a plot of Nk versus something known as the rigidity index, and it is described in -- within a rectangle by what appears to be a logarithmic relationship.

A. **That's correct.**

Q. And I'm not technically competent to render a judgment, but that would tend to indicate to me --

A. **Tremendous scattering.**

Q. -- that this is a logarithmic scale that is not a straight line.

A. **No. And there could be potential large scattering of these data, too.**

Q. And now I invite your attention to look at two plots of Nk again versus plasticity index.

A. **I see it.**

Q. And they are in fact I believe identified for particular types of soil. They have a series of plots for onshore Norwegian clays and a series of plots for North Sea clays.

A. **Yes, I see that.**

Q. Without attempting to imply that these are the same soils as at the PFS site --

A. **I understand that.**

Q. -- the published data appears to indicate that there is a wide range of values for Nk depending on what plasticity index you have.

A. **I disagree.**

Q. Oh. Well, help me here. Maybe I'm misreading it.

A. **The lines that are plotted on this figure, you can see they plotted an upper and lower bound based on it looks like ranges of data that they plotted to either horizontal or vertical bars with the two lines on**

the end.
Q. Right.
A. **And the authors here have chosen to draw a relationship based on no statistical analysis. When you do statistical analysis, you should show all data points and fit with regression line. And you'll notice there on the plasticity index between about 5 and 10 several significant points of their data above their upper bound line. I might argue that if one would use the correlation of the whole data, there might be essentially a flat line across there.**
Q. If you circumscribe yourself just to looking at what you describe as being the extreme bounds of the set of data points.
A. **Sure.**
Q. For example, in the first of the two figures, I see that for a variational plasticity index going from, say, what is shown here as 5 percent to maybe 45 percent, you have values of Nk that go anywhere between 15 and -- I don't know. Can you read the graph?
A. **I can't.**
Q. Well, let me just ask you a question. Again, presented with data of this sort, and without asking you to draw any conclusions, would it be prudent to look more into the extent to which it is fair to

assume that Nk is a variable or is a constant?
A. **That's a fair question because, you know, when we look at the borehole data we do see CIML materials in this range, and we also see indications of some CH and MH materials. And given all things constant, I still think there is a relationship between plasticity index and Nk. I'm not sure if this document doesn't slightly overstate it in its presentation.**
So yes, the assumption that Nk is constant through this layer may not be valid because we do see indications from for the borehole data that the plasticity is changing, and my experience with the Bonneville clays elsewhere have suggested there's some high plastic zones in it. For whatever reason, they show up.
Now, I think again all I was doing, this was in a relative sense, trying to understand, and yes, the assumption was that Nk in this monotonous zone was somewhat constant.
Q. I'm not trying to denigrate what you did, I'm just trying to explore the bounds of what you can --
A. **Explored the assumptions that we're going through, yes.**
Q. And would it be fair to say that, while useful to try to figure out the extent to which you may

have a variation on undrained shear strength across a layer using cone penetration tip resistance, you couldn't just do a single plot by this and draw a definitive conclusion. Is that correct?
A. **No, I think it's just a possible approach. And that's all it was for me was a possible approach to try to understand potential variability. Because we have discussed differences in plasticity, void ratio, water content, and potential -- now slight cementation in this zone, it is reasonable to assume that the undrained shear strengths in this layer is variable.**
Q. On the other hand, you could also assume that the undrained shear strength is fairly constant and the other things have changed. Is that right?
A. **I have a hard time assuming that.**
Q. Well, you cannot rule it out. You cannot rule it out because you --
A. **Well, I can say definitively if the void ratios are changing, if the moisture contents are changing, and if the plasticity is changing, the undrained shear strength is changing. And I'll say that definitively.**
Q. All right.
A. **If those are true.**
Q. Right. And you can do that even without

referring to --
A. **I can pull you a standard textbook and show you those statements.**
Q. And you can do that even without doing --
A. **I do not have to do analyses to make those assumptions.**
Q. One more question that I have on this Exhibit 59. And just keep looking just between five and ten feet, if you will, which is I think the layer that you are interested in.
A. **Yeah.**
Q. Even though they are in your plots, and assuming for purposes of this discussion that in fact there's a linear relationship in these two parameters, that there is some variability. To my very untrained eye, they appear fairly homogeneous throughout all layers in terms of you're going to assume that there is a band, the band as such is pretty uniform throughout.
A. **Out of all that we see in this system, it is the most monotonous, yes.**
Q. In fact, the layer that relates most uniformly as compared to --
A. **Is layer 2. That's fine. That's why we can pinpoint it so well from these data.**
Q. All right. Do you think there's anything

else that we can draw from this Exhibit 59?

A. No, other than it's just a potential approach to look at the variability. Do with it what you may. It was just something I was trying to understand.

MR. TRAVIESO-DIAZ: All right. Off the record for a second.

(Discussion off the record.)

MR. TRAVIESO-DIAZ: Let's go back on the record.

Q. (By Mr. Travieso-Diaz) And before we talked about Exhibit 59, we were beginning to go over Basis 3b as it is described on Exhibit 3, page 85.

A. Exhibit 3?

Q. Exhibit 3 is the statement of the contention.

A. Got it.

Q. If I recall, yesterday we did go through Basis 3.

A. Yes. This is the copy I had yesterday, because I recall my markings on it.

Q. Right. And we were on b on page 85.

A. Okay.

Q. And I am embarrassed to tell you that I don't recall exactly where on page 85 we were, but at

the risk of repeating what has been covered already, and if I have, I apologize, I believe we have not talked about the statement that starts in the middle of paragraph b on page 85 that says, "For example, only five undisturbed samples were collected." Do you recall our discussing that before?

A. I'm not sure.

Q. Am I in the right place? Thank you much.

Now, tell me first as to the numbers that are outside there. Are those correct numbers as of today?

A. Well, no, not of today, because there has been additional sampling, yes.

Q. So you will say that even though your opinion may be that the sampling, even though maybe it's not enough, the sampling certainly is significantly bigger than what's shown in that sentence?

A. There is more basis for undrained shear strength than there was when this was initially written.

Q. Okay. Now, if I remember, I asked you yesterday how many more you think would be sufficient, and you were not able to tell me how many more.

A. It's a difficult question, because it does again go back to our understanding of the potential variability within the layer. If it's perfectly

homogeneous, we need one sample. If there's variability, then our challenge is try to understand whether we've captured somewhat that variability in our sampling program. So that's why determining the number of samples is not always an objective process. But we try to keep it as objective as possible.

Q. Now, I am going to show you -- I'll mark as an exhibit, which is I guess now 73.

(Exhibit-73 marked.)

MR. TRAVIESO-DIAZ: For the record, Exhibit 73 consists of a two-page drawing identified as Figure 2.6-20 of the SAR, and it's entitled "Soil Properties Vs. Depth in Storage Pad Area." And again, has two sheets. It doesn't show a revision number. If it does have it, it's not on my copy.

Q. (By Mr. Travieso-Diaz) Are you familiar with this figure?

A. Yes, I've seen this before.

Q. As I understand, the intent of this figure was to try to group and present as a function of depth various properties of samples taken in various borings in the pad emplacement area. Is that a fair characterization of what this appears to be?

A. Yes. It's trying to summarize data versus depth for these borings.

Q. All right. And now looking at the first of the data sets, if you will, which is a plot of N blows per foot versus depth.

A. Correct.

Q. I take it N, as we discussed earlier, is the number of --

A. Blows to drive the split spoon sampler one foot with a 140 found hammer falling 30 inches.

Q. Now, it has as a key -- it's trying to do something similar to what did you in Exhibit 59, I guess, in that it's trying to superimpose the results of borings --

A. Correct. Data approximately taken every five feet, yes.

Q. And from four different borings, A-1, B-1, C-1, D-1?

A. Yes.

Q. Okay. Now, if you look at that data set and you try to look across again, we're interested in the layer between I guess zero and ten feet -- three and ten feet?

A. Yes.

Q. Okay. For that figure on top, I see that at least three of the data points, the N value is essentially the same. I don't know where the fourth one

lies. There may not even be a fourth one, or --
A. They may have done an undisturbed sample, so you're missing a blow count in that interval.
Q. Will you read that figure for me on that layer?
A. At five feet?
Q. Yes.
A. The blow counts -- do you want the blow count values?
Q. Well, yes, if you can do it.
A. Looks like approximately 8, probably 12 and then maybe 13.
Q. So the range is from 8 to 13 or so?
A. Correct.
Q. And if you look at -- the same figure looks at -- I'm sorry. The same type of information is presented in the graph immediately below?
A. Correct.
Q. Which is N versus depth. But now we're talking about Borings A-2, B-2, C-2, and D-2?
A. Correct.
Q. And if you look at -- again at 5, I think that you have here only two data points.
A. Yeah.
Q. Two data points are pretty close, correct?

A. Yes.
Q. And they are in the order of what, say, five or six, five and six? Six and seven?
A. Yeah, approximately.
Q. Continuing, let's just try to look at these parameters throughout. The second page of the exhibit has N versus depth for another set of data points corresponding to Borings A-3, B-3, C-3 and D-3. And here you have three data points that go from like -- I'd say maybe 5 to 15?
A. Yeah, 6 to 15.
Q. All right. And the last one again is for four data points, A-4, B-4, C-4 and D-4, for those four borings?
A. Correct.
Q. And the values -- actually, there are very few values. There are no values that corresponds to the ones we talked about before. We're a little below. They range from, what, 5 through 15? That's the number of blows?
A. On the last one?
Q. Yeah, I'm on the last one.
A. I'd say more from about 4 to 17 or 18.
Q. Four to seventeen, okay. Now, if you were going to look at N count alone versus depth, and you

were going to look only at the depth that we are talking about, which appears to be the one of interest which is layer 2, would you conclude based only on this data, and there may be limitations to using just this data, that the blow counts are going to be uniform for the 16 samples that we looked at?
A. No, you wouldn't conclude that. But we do get into the same issue again that we see some fairly high blow counts. For example, I'll point out the last diagram we looked at, the one approximately 17 or 18. Again, I would make sure that that didn't capture some of the bottom of the Eolian silts, because it certainly is inconsistent with the other data and it seems to be inconsistent with the monotonous layer that we've seen in the cone penetrometer.
And might I add that really I personally believe, and I think others would substantiate this, that the cone penetrometer data are better for trying to do just this, because there is -- the standard penetration test is, due to many, many different errors, the cone penetrometer test is a much more standardized test.
Q. Well, what I'm trying to gather is an understanding from you and taking into account the limitations of the data that you just mentioned -- and

by the way, if you have a higher blow count, it means that your soil is stronger?
A. It can mean two things. In sands, it means it's usually denser and stronger. In clays, we use the term "stiffer."
Q. And if you throw that data point out as being an outlier, you're being conservative in a way?
A. If you're trying to predict strength, that's correct.
Q. All right. But my question is, can you draw any inferences, or would it appear to you that understanding the limitations of using N --
A. Right.
Q. -- to predict uniformity, but at least as far as the N values that you agreed, they are reasonably uniform for layer 2?
A. I don't like that 17. Something just bothers me about it. I'm not going to include it in the data set. I just can't. Not in these units.
Q. Okay. You take the 17 out?
A. Yeah, I'll take the 17 out. Then we're looking at something between 8 and 12, 6 and 13, 5. So somewhere between 5 and maybe 12 to 13 blows would be a representative. That's a reasonable amount of differences in this unit. A factor of two, two and a

half.

Q. And what conclusion would you draw -- be able to draw, if any, based on that observation as to the possible uniformity of the soil in layer 2 using N only as a reference point?

A. But there's suggestion that there are stiffer or denser layers in here, if that's what we're truly measuring when we pound that thing in the ground.

Q. Let's go to -- let's go back to Exhibit 3.

A. Sure.

Q. I think you did testify that with respect to the next sentence that reads, "Unless subsurface conditions are predictably uniform across the site, the number of tests and analyses are inadequate to accurately model the expected behavior of the soil foundation under static and dynamic loading."

A. That I cannot remember what I've said.

Q. Well, if I recall, your testimony was that you consider this still to be a valid concern and that the reason it was a valid concern is that in fact you had some doubts as to where -- whether the soils on layer 2 were uniform horizontally across the site.

A. Yeah, that was I think the reason why I went to the cone penetrometer data to try to discover that variability, and it looked like the tip stresses varied

roughly by a factor of two. And maybe that's not a bad estimate, because we now see the standard penetration values varying by roughly a factor of two to two and a half. But I'm not inferring that the undrained shear strengths vary that largely, but we do see penetration values from both sets of data suggesting a variation by a factor of two, possibly two and a half.

Q. Going to -- I'm sorry.

A. I'm not sure if I said this yesterday, but I guess the reason why we're focusing in so closely on this issue is because we discussed Wednesday that the applicant has used the peak strength to estimate foundation loadings. And we've pointed out a couple things that concern us with using peak strength if indeed the values that they have picked are peak strengths.

First, the free field ground motion that comes up through the soil column mobilizes some of the shear strength. There has to be something to resist the free flow motions, and we do not know how much of that peak strengths is being mobilized, or, in other words, how much of the capacity is left of peak to resist for foundation loading. And we can't really determine that yet from the applicant's data.

And then secondly, we were concerned that

potential degradation -- I'm going to use degrading, degrading of peak due to cycling. The applicant has done stress controlled triaxlic cyclic shear, and we believe that it would be prudent to revisit the strains that are developed in this key layer from the 1-D shake analyses and run strain controlled tests at that level to see if there's any potential for degradation. And our concern for potential degradation really is not so much that the clays will degrade, because my experience with the Bonneville clay is it doesn't degrade significantly, but we have heard suggestions that some of the strength is derived from cementation. If there is cementation going on, we need to know at what strain level, not what stress level, but what strain level might that degradation occur.

And those I guess are our concerns under static and dynamics. So that's why this 2.2 kips per square foot or approximately there that's used in a lot of the analyses became -- become important to us. Fair enough?

Q. Yes. Let me ask you a question about cementation, though, because we really have not addressed that totally before.

A. Yes.

Q. And we'll talk more.

A. Sure.

Q. Now, to have the record be clear: the applicant has never taken any credit for the potential strengthening of the soil due to cementation?

A. Maybe we misunderstood, but Wednesday we thought we heard that there was some credit taken to these soils being potentially stiffer due to cementation, and we don't preclude that because these are calcarious sediments. They have calcium carbonate in them. So we just don't know the degree to which cementation is affecting the undrained shear strength.

Q. Apart from what may have been said at the deposition two days ago, have you seen any calculation or analysis by applicant in which expressed credit is taken for cementation of soil?

A. I believe the applicant suggests in the calculations that there's cementation going on and it could be contributing to some of the undrained shear strength.

Q. Well, but is that just a qualitative statement, or is there a value assigned to it for which they take credit?

A. Well, the issue is if cementation does exist and it is making these layers stiffer, if it is existing there, there's a potential for the soil to behave more

brittlely. In other words, it will reach a peak and then the peak will drop off with more strain. And that's our concern is if that could occur, then we could see some degrading. If the undrained shear strength is not derived any from cementation, my experience with this clay is that the drop-off and peak will not be marked.
Q. I understand. But what I'm trying to clarify is --
A. Sure.
Q. -- whether you are aware of any particular analysis in which a number has been developed.
A. You can't break it out. You can't say that 30 more percent is due to cementation. I don't see any place where undrained shear strengths have been increased due to cementation. We are taking the tests at face value.
Q. And to the extent that cementation was mentioned in documents where applicant would be perhaps along the lines of saying that the result that we are showing is conservative because we're not taking credit for cementation?
A. Well, my issue is --
MS. CHANCELLOR: Object to the form of the question.

Q. How can I make the question better? Okay. Strike that question. We don't need to go into that.
A. We are taking the 2.2 ksf at face value. I have not seen anything that the applicant has said that there is no cementation in that value, so we have to assume that there could be some even of that 2.2 ksf that could be potentially cementation. We're just looking at the data at face value. We do not I think fully understand the mechanism that's going on with cementation and what role it is or is not playing to these shear strengths.
Q. Fair enough. You have raised a variety of issues which I think we may better take one by one at an appropriate point rather than trying to deal with them all at once. Let's just follow on, because they're going to come up, I believe, as we go through Exhibit 3.
Could you turn to the top of page 86. And the first sentence says, "The investigations (sampling and analysis) to determine the properties of the various materials underlying the site are not sufficient." And what I would like to understand is, because there is a discussion that follows through several sentences in the rest of the paragraph, and my question, see if you can follow what I'm asking you. --
A. Fair enough.

Q. -- whether the first sentence says anything different from what the totality of the others do say. We need to examine the first sentence separate from the rest.
A. Yes, this first sentence seems to be a general statement.
Q. So it is like a summary or a general --
A. Of what should follow, yes.
Q. All right. So let's keep that sentence and go to the others. Second sentence says, "The scope of investigations should match the design requirements of the facility and complexities of the site." Again, would you characterize this as a general statement as to what should happen?
A. It may imply that because we're dealing with a nuclear safety facility that we should pay prudent attention to the requirements for design at such a facility. That's what I would interpret maybe in the design requirements. And then complexity of the sites I guess is inferring that somebody's already got some idea about -- that this may be a very complex site.
Q. Okay. But in itself, is there any assertion that is made in that sentence with respect to the investigations that were conducted at the site?
A. Well, I think it also implies that when one goes through a design that one should consider the appropriate tests to resolve design issues.

Q. Okay. Fair. But let's move now to the third sentence, which says, "For example, the analysis of soil is not based on the results of dynamic testing of insitu samples either in a stress or strain controlled manner."
A. Correct.
Q. Now, as I read that sentence, that one is making an assertion --
A. That is correct. It says that --
Q. -- of a problem.
MS. CHANCELLOR: It's got "for example," so I want to make sure that you're not limiting it to just this.
MR. TRAVIESO-DIAZ: Well, I think when you say "for example," it's hard to limit it to what follows grammatically.
A. So for example, it's saying at this point in time when this was reviewed that there were no dynamic testing in either a strain or stress controlled manner.
Q. And my question would -- just with respect to this, for example, is it -- has the concern raised with respect to this particular sentence remained viable based on the additional testing that has been conducted

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by applicant?
A. I think we discussed Wednesday about, again, looking at the amount of strain developed particularly in layer 2 and doing cyclic triaxial strain tests to look at degradation. The applicant has done stress controlled testing, but it appears that the stress level at which those tests were done may not be applicable in light of some of Dr. Ostadan's comments about the foundation loadings. They may have been underestimated. And generally when we want to look at degrading of strength, a strain controlled manner would be preferable.
Q. I know it's hard to try to correlate a sentence I was reading three years ago with current concerns.
A. Correct.
Q. Now, what I'm trying to do throughout this examination is to figure out what your current concern is with respect to the issue that is addressed in the sentence that we're talking about; and if I hear you correctly, you have a concern with that the testing was done as of today only in a stress controlled manner and that no strain control tests have been conducted?
A. For cyclic triaxial.
Q. For cyclic triaxial. All right.

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Now, take a look at -- well, the last sentence on that paragraph, if I remember your testimony and Dr. Ostadan's, is trying to correlate the fact that these tests have not been run with the ability or lack thereof to create a seismic profiling of the site. I'm trying to follow the text.
A. I'm trying to understand what this -- we did raise issues of, you know, potential adjustments that need to be made to the refraction data as a result of the seismic cone penetrometer. I remember those discussions with Dr. Ostadan. This sentence, though, I don't think is alluding to that. It's alluding again to the use, and I think it's -- when it says "these data," it's talking again about stress controlled or strain controlled manner. And I assume when it says "field seismic profiling," again that's out of my area of expertise, but in some way maybe these data from these laboratory tests help in determining shear wave velocities because one can also determine a modulus or stiffness from it.
Q. Okay.
A. So I think that, frankly, the seismic cone penetrometer data and how we suggested that looking at that and at the refraction data, because of -- in light of the seismic cone penetrometer data need to be

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adjusted is a better way to go. And I do not see really any advantage in using stress or strain controlled triaxial data -- cyclic triaxial data and the appropriate -- and the moduli to go back and help with the field seismic profiling.
Now, let me see what the rest of this is.
Q. Let me try to help you in the rest of the sentence.
A. Okay.
Q. The last clause I think we already talked about earlier, "determine the potential for soil collapse." That's not really a concern?
A. No. We've seen cyclic triaxial testing done for that, and I think that's why some of the stress controlled tests were done initially is to try to determine the potential collapse of these soils. I'm not so concerned about collapse, and I think we've already talked about that in Basis 4 and dismissed that.
Q. Let me ask you something that I think I understood you to say.
A. Sure.
Q. And if I didn't get you right, just correct me. Did you say a moment ago that your recommended approach would be perhaps to enhance or increase your cone penetration data?

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A. No. What I was saying is, Dr. Ostadan suggested that when the geophysicists develop their refraction profile that part of the assumption that they have to do in developing their model is make an assumed shear wave velocity profile. And that model is kind of, I think they call it an inversion process. You kind of guess and then take the data, and you keep going through this process until what you're gathering back and what you assume have some convergence, and then you think you have a realistic seismic model with depth. Again, I'm not a geophysicist.
But the initial survey was done with an assumed velocity model in the shallow layer. And we now see the seismic cone penetrometer showing that layer 2 perhaps had lower shear wave velocities than what was anticipated when the refraction survey was done. And I think he suggested that one should revisit that and see if the seismic cone penetrometer data would help in adjusting that deeper refraction data.
We do see some -- even some inconsistencies with the deeper data. Well, no, I'm not going to -- that may not be correct. I'm going to not go into that area.
Q. Okay.
A. And this sentence seems to suggest to me

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that one could use the strain controlled or stress controlled cyclic triaxial data to help calibrate your geophysical model, but I think that the seismic cone penetrometer data is more valuable in doing that.

Q. It's a better tool?

A. Yes. Leave it at that.

Q. Let's go to the first sentence on the second paragraph on page 86. And the sentence indicates that -- I'm going to paraphrase it slightly -- that there is not enough test data to determine that the strength tests have been performed on undisturbed samples and that there is sufficient relevant test data to support the selection of the design parameters.

Now, I understand this to be saying two different things, and correct me if I'm wrong in my interpretation. But the first half is saying, you don't have enough test data to determine that you indeed have run your test on undisturbed samples. Is that how you read the first half?

A. Let me really focus on it.

Q. Yes. I'm sorry. It's difficult.

A. Yes, I think I read that the same way, that here is somebody trying to understand whether there has been disturbance on the tests, and there's not enough data to support that. Again, we've seen examples of

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minor disturbance, but I don't think that that's a large issue here.

The second part of the sentence then again says that there are sufficient relevant tests to support the selection of design parameters. We still, as we've discussed, feel uncomfortable about the design with the few number of tests we've seen.

Q. So again, I thought that that's what you said earlier. But just concentrating on this particular sentence here, the first half isn't really your concern; what you're concerned about is that we haven't done testing to feel comfortable that we --

A. About the undrained shear strengths, right.

Q. It's ten minutes to seven. Do you want to take a break?

A. I'm fine.

May I offer a suggestion?

Q. Yes. Always open to suggestions.

A. Since it is such a key parameter and we do have I think some idea from the cone penetrometer where potentially weak zones may be, one could easily go through the data and select, like I did, looking for a fairly low value that's consistent through a reasonably thick interval, thick meaning two to three, four feet, and do somewhat targeted sampling around that. The

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applicant tended to do that.

I'm not sure in the canister transfer building quite the strategy, but maybe continuous sampling. I'm worried about doing continuous sampling down one borehole because of the effects of disturbance and things that we could do. But in the area where we see very low tip resistances, maybe two boreholes where we alternate depth so that we get essentially a roughly ten-foot continuous sampling of these layers and do just a little bit more testing to be sure.

Q. I will be glad to convey the suggestions.

A. Will you? Thank you.

Q. It's not within my purview to --

A. Because I really -- I think we're going to see maybe this insufficient sampling to determine design parameters throughout this. And maybe we could just say this is our position right now, that we're still a little uncomfortable again, and go on.

Q. Is it in fact -- I don't want to characterize it in any particular way, but is it in fact your main concern with respect to the testing that has been done that you don't feel that enough testing has been done to feel comfortable that you have selected properly the design parameters?

A. Repeat the question.

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Q. Let me try it again. Would it be fair to -- just to have a big picture description of your concern in the testing area --

A. Right.

Q. -- that enough sufficient testing has been done to be comfortable that you have selected values for the same parameters that are appropriate?

A. Yes, That's correct.

Q. Okay. And then the rest of the detail as to what kind of test you do and how you do them and how much --

A. Yes, and how much -- you know, we've talked about other issues, that even once we get the proper representative values, there are still issues about, again, how much peak is available and all of those things. But at least whether this roughly 2 to 2.2 ksf that we've been designing with could probably be relatively substantiated now that we have such a good sampling of cones across the area.

Q. I'll ask to have you clarify your recommendation as to whether you mean two borings in one specific area, targeted area, or multiple pairs of borings.

A. Well, maybe -- I think there was a better strategy for the canister transfer building in the

investigations. That's obvious.
Q. Okay.
A. But I'm not sure continuous sampling was done there. So I'm going to reserve my judgments on that, but suggest that it may be considering two borings in the pad emplacement area where the -- after one goes through -- carefully through the cone penetrometer data. And if this assumption that tip resistance equals low strength is true, then target a cone that seems to be -- have a fairly low tip stress throughout a fairly thick unit, six, five, six feet, and try to continuously sample that. And to do that you'll have to do two borings right adjacent to that cone so that you can alternate the borings. You'd sample one, and then in the adjacent one you would go down to the interval just below that sample, and you just kind of piggyback down. I think that's not unreasonable.
Then you get continuous samples, but you essentially avoid the impacts of disturbance trying to sample that one borehole. And the canister transfer building, perhaps something can be considered the same approach. But then we can feel very comfortable that we did indeed capture some of the apparently lowest strength zones in the cone penetrometer. We did sample very closely to that and discovered what those undrained

shear strengths are.
Q. I want to say for the record that I hope that this transcript does justice to the description you gave so people can follow and can understand.
A. I believe key people on the applicant's side understood what I said.
Q. I would be presumptuous if I said that I understood half of it.
A. Now, there may have to be a little bit of additional sampling, perhaps, to support cyclic strain controlled testing. That may involve another boring. I don't know. We may not be able to get everything we need.
Q. Now, we did talk as to the next sentence on the second paragraph of Exhibit 86 that reads, "For example, the soil test data did not include samples taken from each of the soil strata, did not include each foundation of buildings or structures, did not include the PMF diversion dike foundation, and did not evaluate compacted soils."
I don't want to repeat what we talked about the other day, but if I understand your interpretation of what this sentence means today, it's essentially not too different from what you have been saying, because as to whether samples were taken from each soil strata,

that has happened, perhaps not as much as you would like. And dealing with the foundations, again it has also happened.
So would it be fair to say that again the concern that is expressed in that particular sentence is still your concern with respect to the number of the samples that have been taken as to -- as it appears to say here as to whether samples are taken at all?
Is that an understandable sentence? No? I didn't think so. I tried. It sounded good to me.
A. I think we talked about this yesterday, and we now have information that we didn't have when this was written, a much better idea of the soil stratigraphy, at least in the upper 30, 35 feet where the cone penetrometer data are. We can now do more focused studies and resolve issues in key layers. I'm not implying that in this five layer system that we're looking at in the upper 30 feet, 30, 35 feet that we need to worry about fully -- worry about certain layers. There seems to be certain layers to me that are not of particular interest now. The Eolian silt is no longer a real particular interest to us. It may have some interest when you design your soil cement and some of the issues associated with it, but those are different types of testing we're talking about here.

Layer 2 we've discussed extensively.
Layer 3 appears to be siltier, denser, probably from a standpoint that I can see is not as great a concern.
Layer 4 is again a Bonneville clay sequence. At least it seems to be more plastic, but again stiffer because it's deeper. I'll leave it up to -- I haven't really gone through and seen the data in that layer. I again defer to Dr. Ostadan in maybe if there are some things that are unresolved in layer 4. But from a strength perspective, I don't see a lot there, because it's deeper and stiffer. And if Nk is somewhat constant between these two layers, I think you can figure out, and you've already done, that how to increase the strength in that layer. Fair enough.
Layer 5 is extremely dense.
Q. Layer 5 is where?
A. It's that dense -- I can't -- is it a sandy silt/silty sand that we start getting quite high blow counts.
Q. Just so that we on the record --
A. Let's look at that.
Q. We're talking about where potential depth. Let's see if we can get that. You know what I'm looking for. Here it is.

A. Let's use -- let's do the first one, because that's probably the best.
Q. And we are looking at Exhibit 53, which was the 14-sheet set of foundation profiles. And --
A. Correct.
Q. -- those foundation profiles have various soil layers identified, and we're just trying to figure out where layer 5 starts.
A. Layer 5 in this profile on the left-hand side where there's a labeling CPT-36 begins at approximately 433, 34 feet.
MS. CHANCELLOR: Four hundred?
A. Let's try 4,433 feet elevation. And you can see a marked increase in the penetration resistance as it's going up to about 36 there. Likewise we can see the cone trace going up to near refusal just below that depth.
Q. In terms of depth below surface, how many feet is that?
A. Oh, let's see. The ground surface is approximately 4,463. So it would be about 33 feet below ground surface, and is also labeled silty sand/sandy silt.
Q. Again, could you repeat the depth?
A. I believe I said 33 feet.

Q. So it's below 30 feet?
A. Yeah. I think it's characterized in the SAR somewhere between 30 and 35 feet. It has a little bit of variability in its depth.
Q. Would it be fair to summarize that from your standpoint, the layer of concern, using the classification that is on that exhibit, would be layer 2?
A. Layer 2 primarily, though I haven't really strongly focused on layer 4, but I don't see how it would affect sliding or perhaps bearing capacity calculations. But I will defer a little bit on dynamic response analyses if there's any issues remaining with it in its characterization.
Q. And not trying to short change, if you will, what has been said here. What I'm trying to -- if there is a way that we can summarize the concern to translate what is in this exhibit into things that the state is fairly worried about now in this area. And with that in mind, could you look at the last two sentences in this second paragraph of page 86 to tell me if there is anything in the discussion there that is different from what we have already discussed with respect to essentially we haven't seen enough data to feel comfortable that we have picked the design parameters

properly?
A. I'm a little bit hesitant to get into rock characteristics. But soil characteristics, again, other than maybe characterization for shake or dynamic response analyses, I'll defer to Dr. Ostadan's characterization. And what he said, I can't remember all of what's been said today about that, but from my perspective, the soils are fine -- well, not fine, but I'll defer to what I said the last ten minutes or so.
MR. TRAVIESO-DIAZ: Can we go off the record for a second?
(Discussion off the record.)
Q. (By Mr. Travieso-Diaz) Let me rephrase the question. My understanding of the current perception of the state of the concern expressed in the last two sentences of page 86 has to do that there is insufficient information in your perception with respect to the characteristics of the soil of layer 2 to make you feel confident that the design parameters for this facility have been selected appropriately based on the results of tests performed today.
A. That is correct.
Q. Would you like to elaborate on that?
A. Yes. The engineering analyses that deal with seismic dynamic sliding and dynamic bearing

capacity really rely upon soils that are in the shallow profile, namely layer 2, though for the canister transfer building are fairly wide foundations. I imagine that issues come up with even layers 3 and 4 because of the width of the foundation. I don't know how deep the bearing capacity, the bearing capacity circle goes. But it seems to me the key layer is layer 2. We understand from this data that apparently layer 3 is denser. It appears to be perhaps more granular, though it may have some plasticity to it.
Layer 4 is a much thinner layer. It has apparently higher tip resistances. I'll defer whether it's cohesive or cohesionless. It appears to be cohesive, and the applicant's already come up with, once they have determined the appropriate undrained shear strengths in layer 2, a way to ratio that layer 4 up, and they've used that already. We have no I think major objections to that.
So from my perspective, layer 2 seems to be the one that we just had outstanding issues with. I will defer for dynamic response to any additional data that maybe Dr. Ostadan may have suggested.
Q. Now, I take it that your response does not include, because he's not here to expand on it, concerns that Dr. Ostadan may have as to the dynamic performance

of some of the layers?
A. Correct. The dynamic characterization and the properties you get there are a little bit different than the shear strength properties that we've been talking about. And I believe he talked a little bit about some of the assumptions in the modulus and damping curves that were used in the shake analyses. And I'll defer to his testimony about those type of properties and how he derived those.
Q. Now, can we turn to the top of page 87? The first sentence on page top of 87 says that "The collected field data must be compared with the soil information found in the literature, and correlated with other data for similar soils when comparing the shear modulus values."
I have difficulty asking questions on this particular sentence because there's so much that I don't understand what I'm talking about. Can you help me? Do you -- can you try to actualize what the concern is, if any, with respect to this first sentence?
A. I think it's trying to state when we predict shear modulus values that one should compare the collected field data and the appropriate parameters. Again, for shear modulus I'm not an expert on, but for granular soils it's most likely a function of density or

something to that effect for clayey soils, plasticity, and make sure that one's using appropriate curves when you do -- when you assign shear modulus values from the literature.
I think Dr. Ostadan is a better -- his testimony is better on this issue, but I'll defer to -- he I think suggested that we had seen for this soil profile some resonant column testing data to develop shear modulus curves. I'm not sure exactly how they were applied and also whether they -- well, since they came from these soils, they would have to be considered more representative of textbook values.
Q. In fact, that's what my concern is. The concern that Dr. Ostadan expressed is exactly the opposite of what it says here, that we haven't given enough credence or haven't done enough with site specific data and would rely on the literature too much. So I don't know what to make of this concern based on his testimony.
A. Yes, I see what you're saying. I will just say I confer with Dr. Ostadan's recommendation. If we do have site specific data and curves developed, it seems to me always a more -- a better, better set of data because it is representative of the site. When one applies textbook values, then you have to be careful to

make sure that you can say that they are representative of this site.
I don't know exactly. Obviously there are not resonant column data for all of these layers in the system, and I'll defer to Dr. Ostadan's testimony where he believes that those site specific modulus curves should be applied. I believe they'll be predominantly in the shallow surface. For the deeper layers maybe textbook values may be appropriate. I'll defer to him. That's I think somewhat consistent with what's been said today.
Q. Isn't it a fact that general engineering principles, which I suspect apply to soils as much as is where, that to the extent you're able -- reasonably able to collect site specific data, you prefer to use that --
A. Correct.
Q. -- as opposed to resorting to literature?
A. That is correct.
Q. And the literature's a fallback when you have nothing better to resort to?
A. Or when maybe your analyses are not too sensitive to the assumed values. And I think that's what Dr. Ostadan was trying to say, and we're not -- we couldn't tell whether we saw that site specific data really being applied. So the question is why was it

not.
Q. Yeah, I believe that both you and Dr. Ostadan mentioned that before.
A. Sure.
Q. Now, look with me at the second sentence in that paragraph that says "Applicant must obtain representative undisturbed samples of each of the site soils and determine their dynamic properties." Again, this sentence is really not -- not what we're talking about anymore, is it? I mean, in terms of that you like to see more samples for the layers of interest, which in this case is layer 2, and perhaps --
A. Dynamic properties infers a couple different types of testing, perhaps. We just finished discussing the resonant column type testing. I'll defer to his testimony about what he thought about that resonant column data, how it should be applied. I think we've already discussed in layer 2 cyclic triaxial strain controlled testing that can also be inferred as a dynamic test. And we discussed our feelings about that. So I think we kind of already covered what this is saying.
(Recess from 7:17 to 7:35 p.m.)
Q. (By Mr. Travieso-Diaz) When when we took our break we were about to discuss the last sentence,

the next to the last sentence of the first paragraph of page 87, which starts with "The apparent differences in Poisson's ratio as cited in SWECO calculations should be evaluated, not assumed to be an appropriate value, and then used for safety related calculations." Is this an issue that has already been addressed?
A. Trying to decide what the SWECO calculation refers to.
Q. I believe that SWECO is Stone & Webster.
A. Okay. Poisson's ratio, from my perspective, is not usually used. However, in dynamic analyses it is an input. I don't recall any testimony by Dr. Ostadan that raised significant issues with this, but I guess all we can say at this point is go back and look at those assumptions of Poisson's ratio. If there are newer data that could help -- help in determining Poisson's ratio, fine, look at that.
Q. Do you personally have any concerns that you would like to discuss with respect to this sentence?
A. I do not in my review, no.
Q. Moving to the next paragraph, the first sentence that starts with "The license application does not provide a detailed and quantitative discussion." I won't read the rest of this paragraph into the record. Is there any concerns that are expressed in that

paragraph that have not been addressed in your prior testimony?
A. Did you say the paragraph or first sentence?
Q. I'm sorry. I do that all the time. The first sentence that runs for five lines on the second paragraph on page 87.
A. Thank you. I think most of the issues related with the sentence have been discussed. I have seen in my review citings of applicable ASTM standards. In some cases it may be well to look at those standards, but consider potential deviations from them. We have discussed some key issues, at least in resolving strength characteristics, and when explained why one's deviating from an ASTM standard, and the purpose for deviation is perfectly acceptable as long as it fits in with the -- within the framework of what we're trying to determine. For example, I was initially concerned about allowing a sample to sit for 90 minutes or more before we shear it because of potential moisture content changes. Perhaps ASTM standards suggest that you do that, but that didn't make sense for this particular program. So all I'm saying is that the appropriate standards appear to have been followed for the most part, but deviation from standards are allowable if there is reason to do it.

I think also we discussed one sample that was left two and a half years before testing. My preference is that that type of data would not really be used. Again, I think there's a little bit of a chance, a significant chance still of drying just due to the age of that sample, and perhaps not all seals are airtight. So just encourage relatively rapid testing after the sampling event has occurred. Those I think are the only issues that we've seen regarding ASTM standards.
So I guess what we like to see is good discussion of a test program, what standards are used and what procedures, and if you vary from them, why, and why did you vary from them. And sometimes you do vary from the ASTM standard because it doesn't make sense in light of what you're trying to accomplish for design input.
Q. Are you aware whether such standards are in place now for how the applicant conducts his test program?
A. Oh, yes, there are ASTM standards for these tests. Is that what you're --
Q. No, no. Are there also project specific standards that you have had the opportunity to review?
A. Project specific standards, the ones that I think that were most complete that I have been involved

with were developed at Savannah River. Those testing methods and sampling methods, some of them are applicable here, some may not be. I have seen, yes, the development of site specific standards, if you will, or procedures to meet the goals of an investigation.
Q. Actually, what I meant is, have you seen any specific standards developed for the PFS site with respect to how samples are taken and tested?
A. They seem to -- I saw a document that Stone & Webster provided us that it seems to be their manual for testing, field testing. And I can't recall if it included also laboratory testing, but I have seen, yes, their procedures, if you will. I didn't review them thoroughly.
MR. TRAVIESO-DIAZ: Let's put it on the record. Will you mark this as Exhibit 74.
(Exhibit-74 marked.)
Q. (By Mr. Travieso-Diaz) Describing this document is going to take a little while because the actual document starts, the pages of this document, there's a set of numbers on the bottom right-hand side, starting with 00857 and going through No. 911.
Now, the document itself, as I understand it, consists of or starts in the page that's marked 00868, which is like ten pages from the first page, and

is entitled "Engineering Service Scope of Work for Test Borings and Laboratory Testing." And that is dated October 14, 1996. Well, then the other ten pages that precede the one that I just identified appear to be addenda to that -- Addendum 1, Addendum 2, and Addendum 3 to the document, and that's why the first page of Exhibit 74 is labeled "Addendum 3."

A. Okay.

Q. Now, I believe that in the testimony that Mr. Trudeau and Dr. Chang gave a few days ago, they refer to this document as the ESSOW or Engineering Service Scope of Work. And what I would like you to do is just review with me the table of contents that appears on pages Roman Numeral i, ii, and iii at the start of the document, and the page numbers at the bottom are 869, 870, and 871, just for the purpose of telling me whether the document appears to include standards for taking samples and performing laboratory tests.

A. It does, yes.

Q. And it has also a section of quality assurance requirements that apply to these programs?

A. Yes.

Q. To the programs we're talking samples and performing tests. And I take it you have not reviewed

this document recently?

A. No, not recently. I recall seeing it. I think we requested this in discovery, or it was provided to us. So I think I have a copy of this, but it's reasonably lengthy, and probably most firms that do this type of work have such similar documents. I've seen them before.

Q. Okay. The next sentence on the second paragraph on page 87 indicates that "The basis for the selection of samples and the type of tests to be made is a function of the structure, anticipated loading, duration of loading (seismic) and the need to modify the soil's physical characteristics." Do you find anything in this sentence that has not been discussed before?

A. No. We've discussed reviewing the dynamic loading of Dr. Ostadan and making sure that the sampling program, whether it be strain control, cyclic triaxial testing, reflect those anticipated loadings. We've also discussed degradation and making sure that that program to investigate potential degradation considers the strains.

I see a sentence here talking about the need to modify the soil's physical characteristics. I believe we talked about -- I think that refers to some type of modification of the soil so that it becomes more

of an engineering structure or feature. The applicant has suggested to use soil cement. I think we've talked about the need to consider tensile strengths in the design and some way of understanding tensile strength.

We may have discussed some other items, but for the most part I think everything's fine.

Q. Okay, let's look at then the next sentence, because it indicates, "The boring location plan appears to be merely a grid across the site and not structure specific."

A. This has changed. This is a historical comment. When this review was done, it was done with a simple grid across the site. That was the plan of the first investigation, and perhaps that's not a bad plan. I assume at the time maybe the location of major facilities hadn't been identified. And there has been subsequent testing in at least the safety-related areas.

Again, we discussed our concerns about -- a little bit about some of the sparsity of the sampling and the number of borings, but those are already on the record.

Q. Let's move on, then, to the first sentence of the last paragraph on page 87, which says, "The descriptions of the test results for field and laboratory tests are generally insufficient to allow

detailed analysis." Let me ask you, is your understanding of this sentence that the complaint appears to be that the report that talks about the test doesn't provide enough information?

A. Which page?

Q. I'm sorry. Look at the first sentence at the bottom of page 87.

A. This seems to be addressing the issue to me about how the data are tabulated from those test results.

Q. Do you have a current concern as to the presentation as opposed to the content or the scope of the tests?

A. For a reviewer, since the layering system has somewhat changed, it would be nice to see the data now put into that layering framework and described according to that layering framework.

We earlier expressed concerns about averaging properties over a 30- to 35-foot interval. That seems kind of not useful to us anymore. So maybe putting the test results in a framework according to the stratigraphy we discussed.

Q. Is this a nice-to-have or a must-have kind of a --

A. I consider it not a nice-to-have. I think

it's a must-have, because one can be misled if the data are not put in their proper layering by simply just using -- the chance of using values that may not be appropriate for that layer. And we've seen a little bit of that today where we've been trying to compare standard penetration values very near a layer boundary. So if the parameter is being used for design, I think it should be just the best possible put in its proper layering context.

And I would also add that the CPT data, yes, this -- the cross-sections we've seen show this layering across the pad emplacement area and the canister transfer building, but at least I found it useful to do some composite plots similar to what I did. And I think one would have to do that to try to decide where is the actual lower strength zones if we do agree that tip resistance is somewhat correlated with undrained shear strength. It helped me do these exploratory plots that I did as a reviewer just to try to understand the variability laterally across the site. So composite plots might be considered at just the cone penetrometer data. Those are easily done. And that's not a very difficult effort if one has the data to do it.

The tabulation of the data, and I think even in the RAI's, I think there was some request to kind of

tabulate the data and present the data in type of the forms. I think those have improved over when this comment was made.

Q. Now, the next sentence goes from page 87 to the page top of page 88. It says, "While the conditions of the testing were explained to be in accordance with accepted testing procedure, any deviations from the normal procedure recommended in the standard test should be documented." Have we talked about this?

A. I think we have when we talked about ASTM standards. Again, ASTM standards are standard practice in the industry, but once in a while one is asking a specific question from a test program. So it's perfectly acceptable to deviate from ASTM standards if that deviation makes sense from what we're trying, as long as it's documented and explained what was being done.

Q. Are you aware that as the SAR is organized today, the attachments to Appendix 2-A reporting the results --

A. Right.

Q. -- of tests, at the front of each attachment there is a description --

A. Right.

Q. -- of the extent to which there are any

deviation from the standards?

A. And I've read them, yes. So I just encourage that to continue. I haven't found that markedly deficient. Once in a while if there are additional questions about a testing program, certainly maybe we'll request further explanation.

Q. But the concern would be whether the tests show as to whether do I understand how they did the tests. Is that a good way of saying it?

A. Yes. The concern is what do the tests show, and also was the test procedure set up specifically to resolve design issues that we have.

Q. But it no longer is, have you told me how you did it? Is that --

A. What's that?

Q. But there is no longer a concern as to whether the applicant explained how they did it and to the extent that there were exceptions?

A. Not what I reviewed in the most recent testing programs.

Q. Okay. Now, look with me at the rest of the paragraph that starts on page top of page 88 to the bottom, because I believe, according to my notes, that all of that was described to be historical and being now resolved. That's what I wrote when we talked about this

yesterday.

A. I think so. I recall talking about unit weights, and we felt that there was really no issues with unit weights. We've already gone on the record discussing our issues with strength and its characterization.

Consolidation, no, I don't see major issues with consolidation. Dynamic response, I think we've gone on the record our concerns about dynamic response and the testing that needs to support that.

Q. Why don't you go through the rest of the paragraph, you might as well do it, and if there is anything you want to add to either -- I understood you to say that these things were historical concerns, but to the extent that you have a current concern, just either state for the record that you already discussed it and identified, or else let's talk about it.

A. Okay. Well, also it says here with assumed values, so it appears that some of the values in the earlier calculations were assumed. There's now a body of data that assumed values do not have to be used. And in my review, at least for the most part, assumed values are not being used in response to strength. I think Dr. Ostadan had some talk about assumed values in his dynamic issues, and I'll defer to that testimony.

And the sentence, "The justification of the values should be provided before their use is permitted in the static and dynamic analyses, particularly when determining the dynamic strain response of the soils under cyclic testing." I think we've already gone on the record quite frequently about our beliefs on cyclic triaxial testing. Not our beliefs but our position about triaxial testing.

We've already gone on the record about stating that one should use site specific data when possible and obtainable in lieu of using, quote, textbook values.

The last part of this talks about a calculation involving bearing capacity reports. My review at least for the static bearing capacity suggests that that's not a large issue. I think this must be a bearing capacity on top of a structural fill. So this must be somewhat historical.

Q. Yes. I believe this predates the possible use of soil cement.

A. Okay. So I think that is historical, and the issues raised throughout the rest of the paragraph are historical and not an issue anymore.

Q. Then let's move to the first sentence in the last paragraph of page 88. Let's talk about the first

sentence on the last paragraph of page 88, which talks about "A major failing in the application is the lack of a detailed discussion of field and laboratory sample preparation for testing, the omission of which prevents independent review and assessment of the quality of data collected." That sentence appears to indicate to me that the concern of the writer at the time was that not enough was said on how the samples were collected and prepared for testing.

A. Correct.

Q. Is that your concern now? Or is that concern resolved?

A. In subsequent investigations that have gone on since this statement, I haven't noted that to be a major inadequacy. We've got a few points I think we've brought up through the last few days. It would be good to see maybe in the laboratory reports, specifically now if we're going into more refined issues of how the program was set up to resolve those design issues, specifically what the issues were and what was the test program set up to resolve specific design issues.

Q. In other words, you'd like to see for future tests not only a description of how the test was set up but what was it intended to accomplish and what issue it was trying to resolve?

A. Right. For example, we discussed maybe targeting certain CPT data according to the load tip stresses, how those were identified, how the samples adjacent to those CPT data were gathered, how the sampling was done, how the data -- how the samples were transported and preserved, and how the test program went through to resolve the specific issues at hand, whether they be changes in moisture content and how that affects the undrained shear strength. We discussed other issues, too. Now we need to be very targeted and specific about what we sample and what we -- how we do our testing. Not more just the generic get tests, take samples, report results. Not the more general initial type of sampling that one does of just going out and sampling blindly, testing, and reporting results.

Q. You wouldn't expect at this stage to be doing that anymore; is that correct?

A. No. We're focusing in and honing on specific issues. So our sampling is not generalized, but it's targeted specific to resolve specific issues. And one should go through and be very thoughtful and careful about those issues, and set up a program to make sure that when we get done those issues are no longer there.

Q. Fair enough. Could you move to the next

sentence, which is the last complete sentence on page 88 that indicates, "How samples are prepared and tests performed can significantly impact test results and their interpretation, potentially making the test results and interpretations meaningless." I take this sentence just to be caution as to what may happen if you don't do --

A. The right type of testing to solve the type of issues that are at hand, or if your type of testing program does not consider the type of loading that's going to be imparted to the soils. You can perform a test, but if it is outside the bounds of the loading that's anticipated, then the test results are meaningless. Well, I won't say meaningless to you, but they're not as valuable.

Q. Would it be fair to say that this sentence is a general description of why it's important to do the sample testing the right way as opposed to bringing up particular problems? In other words, is this a general sentence without any specific issues being raised by it?

A. Right. I think it's a general sentence, and I think through the last three days of testimony we've already discussed specific issues and how to make the testing more meaningful.

MS. CHANDLER: Could we just go off the

record for a second?
(Discussion off the record.)
(Recess from 8:06 to 8:27 p.m.)
Q. (By Mr. Travieso-Diaz) We were, if I recall, on the bottom of page 88. And we were discussing the sentence that starts at the end of page 88 and goes over to page 89. Starts with the word "Additionally, the test results may not reflect those conditions to be modeled in the field and therefore either underestimate or overestimate the response of the foundation system to actual field loading conditions." And I want to ask you to comment as to what your understanding is of the concern that is expressed here.
A. I think what is being said here is that when one sets up the test program, it's important to go through and look at the demand side. What I mean by the demand side would be the loads imposed on the soil by either the foundation system or, in this case also, since this is seismic, the earthquake loadings, and make sure that once one understands the demand side that what is being done in setting up the field test program, or now also laboratory test program, that you bound those conditions which the demand side may give you. It makes no sense to not have a program thought out that could potentially leave you still in an unsafe envelope when

you consider the dynamic loadings on -- just a moment.
I can just maybe give a couple examples from previous discussion of maybe what I'm interpreting this as saying. I know the state's had reservations about the soil cement mat particularly in tense -- tension, and it seems like that was never really considered. And certainly a large soil cement mat like that will not behave rigidly, and one must now consider not only compressive strength but tensile strength of this and also consider whether cracking is going to affect its tensile strength and how it's going to perform.
Q. Can I ask you a question for a second? Given that this sentence is worded kind of broadly, would it be fair to say that the specific concerns that you had that relate to this sentence have already been put on the record?
A. I think so. I just want to go on the record as stating that we feel it imperative to consider what we would call the demand side, i.e., the loadings, whether they be static or dynamic loadings, and to fully understand them prior to setting up a program, a laboratory program. And also making sure then that the test results and the analyses reflect those actual conditions. I guess we've gone on the record already with our issues regarding that.

Q. I'm going to skip the next sentence, because I believe you told earlier that this is a historical concern. Is that right?
A. That's correct. Let me -- I want to make one point, maybe, that I'm not sure has gone on the record quite as emphatically maybe as we could. It's the state's -- I do not want to use the word "concern," but we still have some uncertainty about how layer 2 seems to gain its apparently high undrained shear strength. And we have postulated that possibly it may be sensitive to changes in the moisture content. Perhaps the applicant can think of a reasonable test program to vary the moisture content somewhat within reasonable ranges -- we do believe that some drying and wetting do occur even when mats or foundations are placed upon these soils due to capillary action and unsaturated flow, which are documented phenomenon -- and see if within reasonable ranges that, all else equal, that these soils are not sensitive to dramatic losses in strength due to moisture content.
I don't believe the sample has to absolutely saturate it. That may be an extreme. But maybe some controlled increases in moisture content could help us better understand whether this apparent stiffness is due to some cementation phenomenon, or if it also might be

partly controlled by changes in moisture content and partial saturation.
Q. Now, the next sentence that reads, "For sites that are underlaid by cohesionless soils." I won't read the next sentence in its entirety. I don't think we need to. Could you summarize your current position on the issues discussed there?
A. This I think -- the cohesionless soils I think implies that the applicant should check to see if that potential cohesionless soil could become unstable due to liquefaction. And I think we've gone on the record already saying that liquefaction is not an issue.
We have discussed I think extensively the potential for some strain softening due to earthquake loading. I'm not sure we're completely resolved on that issue. We've gone on the record on that, so I guess -- and I'm not so much concerned about collapse. Maybe marked settlements, but I think the issue is could we lose capacity that we thought we had because of the strain levels and how much we're straining this layer 2.
Q. Okay. Let's go to the next sentence. "The Applicant must also show that the static and dynamic engineering properties of the soils, such as unconfined compressive strength, shear strength parameters for strength parameters from cyclic triaxial tests, were

properly determined and that reasonable and conservative values were used in the design."

A. Dr. Ostadan talked about this. I don't think I have anything really more to add to this.

Q. Going to the next sentence. "This demonstration should explain how the developed data were used in design analyses, how the test data were enveloped for design, and why the design envelope is conservative."

A. I think this was a concern of Dr. Ostadan, particularly talking about the design envelope and the margins of safety or factors of safety. I don't think I have any more substantial to add to this.

Q. The last sentence in section b reads, "A table indicating the values of the parameter used in design should be provided and should be supported by field and laboratory test records." What do you make of this sentence?

A. I think some of this has been met by the engineering calculations that try to -- well, the engineering calculation, and I don't know its number, trying to tabulate how different data were used and input in the various geotechnical analyses. I guess I would encourage maybe some kind of tabulation like I discussed before according to the current layering

system as we understand it. And then certainly anytime any calculation uses design parameters, that should be referenced in where those values are coming from. And I sense that that's improved over when this was written.

Q. Let me just bring to your attention two items that you probably are aware of. First, you're aware that now the attachments to the appendices of the SAR have tables that summarize the results?

A. Correct. I've seen those.

Q. Are you aware also that the geotechnical design criteria calculation G(B)05, I'm not sure if I can remember the complete name, but it does have a number of complete tables that appear to be trying to do what you just said?

A. Yes.

Q. Shall we look to Item c on page 89.

A. Uh-huh.

Q. Okay. Let's just go to the first sentence of Item c, the one that starts with the words "The static and dynamic properties of materials." Do you see that sentence?

A. Yes.

Q. Could you describe for me the current -- your current understanding of what the concern for this sentence is?

A. I don't think we have any really substantive things to add to this.

Q. This is things that should be -- how things should be done?

A. Yes. And we've discussed I think our issues and how we believe things -- how we -- the concerns we've had and how we believe things should progress.

Q. Can we go to the next sentence, then. "This is especially a complex site from the standpoint of assessing potential earthquakes and resulting ground motion that may affect plant operation." Again, is there any concern, either explicit or implicit, in that sentence that we haven't discussed?

A. Dr. Ostadan I believe had discussed his issues and what he felt about this particular sentence. I agree with his testimony. I don't have anything to add.

Q. All right. Let's go to the next sentence on top of page 90. "However, it is not possible to ascertain if the Applicant's field and laboratory test data have been conservatively interpreted to determine the design parameters recommended for the various materials at the site."

A. Correct. I think we've discussed that considerably. We've suggested some potential

unconservatisms, both in the capacity side, as I'll refer to it, which would be the soil strength and capacities to resist earthquake motions; and I think we've also suggested some potential unconservatisms on the demand site where loadings may not have been considered properly. And I will defer to our previous testimony.

Q. So that means that we're now looking at the sentence that starts, "The SAR relies heavily on the published values for static and dynamic strength and the performance of compacted materials, not the physical characteristics and specific site soils." Could you address the status of that concern?

A. I believe we've already discussed this also. I don't know if there's anything substantive to add to this over our last three days of discussion.

Q. The next sentence, "Because of the limited number of tests and generalizations made with respect to the soil profile and use of general uncorroborated published soil data, a reasonable judgment cannot be made regarding the applicability of the averaging conditions as assumptions used in the design calculations." You need to help me with this one. Can you rephrase it in a way that expresses your current concern?

A. We've already discussed the issues with the limited numbers of tests.
Q. Yes.
A. I don't see any issues of that. We've discussed some generalizations. One obvious generalization that we felt was potentially nonconservative was rigidity. I remember that.
I'm not sure if there's much to add here with respect to the soil profile. We've discussed some -- the soil profile quite extensively over the last few days where we think some maybe potential uncertainties are in the shallow zone of this profile. I think we have also suggested maybe some deeper data, at least one borehole down to rock might be useful.
I'm not going to try to summarize it all, because it's been quite extensive. So I think we said enough about the soil profile. Our opinions are that the -- from when this statement is written, we're learning more about the soil profile.
Q. I -- sorry, go ahead.
A. We discourage averaging whenever possible unless averaging can be justified by the data, i.e., there's not a large variability or doesn't appear to be any significant zones where low strength zones can control the failure.

We've already discussed our uncertainties about the published data at this site.
Q. Can I ask you a question or two about something you just said, to clarify the record, which is, you said that you would like to see at least one boring down to rock. I take it that you mean down to the bedrock?
A. Yeah, I'll defer -- we've discussed that, I believe. And my experience at other sites has been that that's been typically done. Not being -- generally when we've done a deeper borehole site was to identify the exact depth to rock and log shear wave velocities in the deeper profile. I am going to suggest that if there's still uncertainties about the deeper profile, that that could be considered.
I can't remember in the last few days if we discussed large uncertainties other than -- we have discussed the refraction data. Whether that data would be -- a deep hole would be useful in resolving that, I don't know. And perhaps when we review the Geomatrix report it may say something about that issue and whether there's sensitivity to the analysis to that assumed depth, whether it makes a difference whether it's 800 feet or 500 feet.
Q. Can I put the question this way to you.

First from the geotechnical standpoint, do you care in any way --
A. From a geotechnical standpoint, I do not care. I am giving a lukewarm recommendation here about a deeper hole, not quite knowing whether there are issues with the dynamic profile and response, which really is somewhat out of my area of expertise.
Q. What you're saying, if I understand you, is that to the extent that there is a use or a need for such a big boring would be for issues such as surface -- as wave velocities in the deep layers and so on?
A. Yes, it would help maybe understand or clarify the design basis ground motion and its variability as it comes to the site. I -- from a geotechnical perspective relating to the stability of the pad emplacement area and the canister transfer building, and that hole doesn't really help with those. It's not needed because these are shallow profile issues.
Q. One question that maybe I need to ask. You are aware, of course, that there have been at least two borings that have come down below 200 feet. I don't believe they have reached the assumed layer of where bedrock is understood to be.
A. Okay.

Q. But they have gone fairly deep. Are you aware of that?
A. Yes. It's fairly distant in my memory.
Q. I don't want to examine you on this, but there is -- let me say this to refresh your memory. Are you aware that Borings CTB-1 and CTB-5 were drilled deeply, and CTB-5 in fact was used to install a monitoring well?
A. Yes, I do recall the discussion that a monitoring well was installed, that there was one on the site. I remember. That was one of our recommendations. I guess my -- I'm -- not knowing what data was collected in those two deep borings, I'm not sure what the purpose was.
MS. CHANCELLOR: I'd like to make a request. If there's any data that you get from a monitoring well, we'd like a copy of it.
MR. TRAVIESO-DIAZ: Well, in fact, I think it has been -- it's already included in the attachments to the SAR.
MS. CHANCELLOR: I see. Okay.
MR. TRAVIESO-DIAZ: Because those are -- those borings were part of the boring program. They served multiple purposes, as I understand it.
Q. And maybe you can confirm this. One purpose

was to get to the point where you could try to find where the ground water was and monitor the levels, but also you were taking samples as you were going down. Is that your understanding of what was done?
A. I don't know if sampling was done or not, because I obviously -- these holes, I haven't reviewed the data that was collected in them.
Q. Fair enough.
A. I think when I'm talking about a deep hole was if a deep hole was useful in helping resolve any of the shear wave velocities and any uncertainty in the geophysical or ground response modeling that was done for the site. But maybe others that reviewed this more thoroughly than I may feel maybe this may not be necessary or necessary. I'm not sure.
Q. Fair enough. I think this is very clear.
Okay. The next sentence that we haven't gone over yet I believe starts in the middle of the page with the words "Because of the limited number of tests and generalizations made with respect to the soil profile," etc. I'm only trying to identify the sentence to the record.
Could you address that sentence and tell us what the current state of your understanding is as to what the issue is and whether it has been addressed in

previous testimony?
A. I do not see anything in this that we have not discussed fairly extensively.
Q. Let's go to the next one, that simply states, "There is too much uncertainty regarding the applicability of published data to the site." Can you comment on that sentence?
A. I think we discussed our concerns about uncertainty, about certain key soil parameters and how they may impact mainly the seismic design.
Q. The next sentence starts, "For example, the dynamic analyses presented instead use published information from 1970 which is extrapolated to the site without any basis for such extrapolation." Do you see that sentence?
A. I think that sentence and also the following sentence Dr. Ostadan commented on, and I'll just defer to his testimony.
Q. How about the next sentence, which is the last one on the page and goes to the next page. It says, "This data is not applicable for characterizing dynamic properties of slightly cemented silts found at the site based on SW-AJA (1972) at 39 of SWECO calculation.
A. I think the concern here is that the

properties using that particular calculation, which I assume is somewhat historic, may not be applicable to slightly cemented soils. And we've discussed issues regarding the slightly cemented soils and particularly where -- in the shallow profile where they may affect ground response, that the applicability of standard, quote, textbook curves and relationships should be considered by the applicant. And we have seen the applicant gather some resonant column data for these that perhaps are more applicable than what was used in this calculation.
Q. Let me ask perhaps as a way to shorten the discussion with the next two or three sentences. Would it be fair to say that the sentence that you described and the sentence that follows it that talks about "please note the variation in shear modulus," etc. --
A. Right.
Q. -- is either historical to the extent that it addresses something that has been superseded --
A. Correct.
Q. -- or has been addressed by Dr. Ostadan and you in your testimony?
A. That statement would be correct.
Q. Okay. And then I take it that's also true with respect to the next sentence, that reads, "The

Applicant should explain why the data extrapolated from this curve is appropriate considering the various shear strain levels"?
A. Yes. And I think Dr. Ostadan discussed that and also the following sentence, so I'll just defer to his testimony.
Q. So that we are finished, then, with the first paragraph on page 91?
A. Yes.
Q. Let's go to the second paragraph. The first sentence of the second paragraph indicates that "some of the data do not fit together, and it appears data presented from different sources have been combined without assessing their applicability to the site."
A. I think there was concern as I see here regarding void ratio and consistency amongst void ratio and blow counts which had some inconsistencies. I think a lot of this was addressed in a subsequent RAI, as I understand it. The void ratios in some of these upper soils are reasonably high.
Q. If I recall, there's an extensive discussion --
A. There is.
Q. -- in the SAR now that addresses this issue. Is that correct?

A. Yes. And I'm not remembering quite fully. I guess I'm not sure what's been said in the SAR about this right now, about the high void ratio. But I believe it's been -- the reasons for it have been explained by the applicant.

Q. Okay. And then the next sentence that says, "the void ratio for soils indicate very loose soil conditions yet blow counts from standard penetration tests are indicative of dense soils." Would it be fair to say with respect to this particular sentence that there is a much better understanding today of the layering of the site?

A. Yes. This suggests there is potential for cross-layering where maybe void ratios were coming from one layer and standard penetrations from another. And I have seen this before. What happens when one is undergoing a test solely with a drilling program, you can change into different layers and essentially cross-layer or cross-stratify things and misclassify things. And I think with the cone penetrometer data, our chances of doing that are much, much less now.

Q. So I take it this in fact is sort of a historical concern as of today based on the information that we now have?

A. Yes. I guess the only thing I would add is,

we discussed about trying to put the data now in our new layering framework which will help probably clear some of these issues.

Q. Now, could you please maybe with respect to the next few sentences, you can deal with them together, because, if I understand it, the discussion on the sentence that starts with the words "the void ratio equation," and the sentence that starts -- that follows it and says -- well, "See laboratory data results," and then the sentence that says, "This soil structure may be typical of cemented sands," are all these sentences addressing the same concern as to what the meaning of the high void ratio was?

A. Yes, I think it's trying to explore why the large void ratio existed, and --

Q. In fact, that discussion goes all the way up to the end of this sentence -- this paragraph on top of page 92?

A. Yes. Again it's a concern about the high void ratio. And the last sentence, "The Applicant should verify if this abnormally high void ratio is typical of cemented soils." Again, the part in the SAR where this is discussed is not fresh in my memory, but I would encourage, if the applicant has not done so, go back and see if there are similar cemented soils

somewhere to verify that these high void ratios do fall in the ranges of similar calcarious or cemented soils elsewhere.

Q. And you have explained for the record what your concerns are with the potential cementation of layer 2; is that correct?

A. We have. We've discussed that extensively.

Q. So we don't need to go over that again.

A. Correct.

Q. Now, moving to the last paragraph on issue 3. It starts with the words "Further, the Applicant performed only limited soil engineering tests ... omitting a number of additional widely accepted index and engineering property tests." Rather than putting words in your mouth, can I ask you to update the discussion that appears in this sentence?

A. Well, we've already discussed our concerns with the limited engineering testing.

Q. So this paragraph doesn't add anything to what you already have said?

A. The first sentence certainly doesn't.

Q. How about -- I'm sorry. When you say the first sentence, where are you? Where --

A. I think it ends after "Annual Publication (1997)." Oh, excuse me. No. First sentence ends after

"layer 1 and 2 soils."

Q. And then the rest is citation?

A. That's correct, it is a citation.

Q. All right.

A. So those sentences, I did not see anything really to add to them.

Q. Okay. Now, going to the last sentence now on this paragraph under Contention 3, "Such additional tests will allow the reviewer," etc. Is there anything on that -- anything on that paragraph that has not been addressed before?

A. This seems to be somewhat of a summary sentence. So we've discussed these issues quite extensively. We still at this point in time have uncertainties about the performance of the soil and foundation system under seismic loading.

Q. Yes.

A. And we believe calculations should be revised. Additional mechanisms and loadings that were not considered should be considered. The soil mat -- at this point, the soil cement mat seems to be very conceptual, and we discussed our concerns about that philosophy and encouraged the applicant to consider those. And we cannot really comment further on the soil cement mat until further is known about its actual

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design.

And we've discussed today a little bit about passive resistance that will be developed by the soil mat. We encourage the applicant maybe to think of maybe a field testing program. We could do that. And when I mean field testing, I mean not a sampling and submitting to the lab but perhaps some type of in-place prototype or full-scale test that could help us understand how much of the soil mat passive resistance can be mobilized.

However, there are still significant issues again with tensile and torsional stresses to such a large area of mat and how that will perform.

Q. Finished?
A. I'm just looking at a couple of other scratches that I have here.
Q. Okay. I'm not rushing you, just -- you paused.
A. Yes, at this point I guess we cannot say that the adequate margins of safety or factors of safety have been demonstrated according to our concerns.
Q. For the reasons you have been testifying about the last couple of days?
A. Right. I cannot think of anything I want to add. I know this is my last chance to say something,

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and nothing new is coming. We believe there's still additional work and analyses that have to be done.

MR. TRAVIESO-DIAZ: We can go off the record a second.

(Discussion off the record.)

Q. (By Mr. Travieso-Diaz) I tell you what I would like to do. Would you go back to Exhibit 10 and identify on the record first, again, each of the interrogatory responses by the state that are contained in Exhibit 10 that you have provided information for, and as to each of those, would you please go down through that and tell us what your current -- well, tell us either whether it is a current concern or a historical one or one that has been resolved, and to the extent there is a current concern, whether you have already addressed it in prior testimony.
A. Do you want me to identify them first?
Q. Yes. No, go --
A. Identify them as I go?
Q. As you go along. I think it will be faster.
A. Okay. On page 28, Response to Interrogatory No. 3, subsection A, I remember having discussions with the review team on this issue. However, I believe Dr. Arabasz has already testified and addressed this, so I'm going to not saying anything further on it.

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Q. Could you, just so the record is very clear, give the title of the response?
A. Sure. It's the "Inadequate justification for qualifying for the Frequency-Category-1 design basis ground motion (1,000-year return period)."

The next one is found on page 40, Interrogatory No. 5. The first few sentences of this interrogatory just refer to other interrogatories for other types of data and deficiencies that are discussed in those interrogatories, so I don't see any need to go into that. So I guess I'll go to the general response part.

Q. That's part A?
A. That's part A.
Q. Page 40?
A. Correct. The first sentence just acknowledges that there was additional analysis still going on. And it's somewhat of a disclaimer that these statements may not have considered that additional data that was ongoing at the time that this was written.
Q. Is it your understanding that the test program that at least the applicant envisioned coming out is now completed?
A. Yes. That was the ConeTec report and the data gathered by ConeTec. I do not see anything in the

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paragraph beginning "In addition Section 2.6 of the SAR is poorly written." I think this was expressing concerns about how to understand key design assumptions and put some parameters, tabulation of data, where the data actually came from, and difficulties in referencing. I believe subsequent revisions of the SAR improved and clarified much of that.

I believe part B, which begins "Geotechnical Design Profile Has Not Been Adequately Defined," refers to the old two-layer system. So there's really not much to discuss about this. We felt initially that that two-layer system was inadequate for the design.

Q. But that has been superseded by --
A. That has been superseded by Figure 2.6-5 and all of its various sheets.
Q. Yes.
A. We've already discussed the spacing of geotechnical borings. I think we referred to the Reg Guide 1.132, I believe, regarding spacings of borings in investigations. We've also discussed ways of removing uncertainties in key layers. We've discussed critical layers that we feel that were still undersampled.

At this time when this was written it appears that there were still no borings on the canister transfer building and other non safety related

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buildings. Those have been -- subsequent borings have been done since this was written, and I think we've already gone on the record discussing those.

Q. In connection with Item B, do you remember having a discussion a few minutes ago about borings that you might not remember having done at different layers than 100 feet? Do you recall that discussion?

A. About the two borings that went down to 200 feet?

Q. Right.

A. Correct. I remember.

MR. TRAVIESO-DIAZ: Let me, just so that the record has a reference point of what we talked about, mark this as Exhibit 75.

(Exhibit-75 marked.)

Q. (By Mr. Travieso-Diaz) For the record, I will identify Exhibit 75 as being a copy of the boring logs for Boring CTB-1, and that goes for seven pages, and CTB-5 that immediately follows, and that goes for five more pages.

MR. TRAVIESO-DIAZ: Can we go off the record for a second?

(Discussion off the record.)

MR. TRAVIESO-DIAZ: Going back on the record.

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Q. (By Mr. Travieso-Diaz) Will you just confirm for me that these two boring logs correspond to the items of which we had a brief discussion before we took the last break?

A. Yes. I remember discussing two deeper borings down to approximately 200 feet which I could not recall reviewing when I looked at the SAR. They have just been provided to me.

Q. Okay. I'm sorry. Would you please go on. I believe you were on Item E on page 42 of Exhibit 10. Oh, I apologize. I'm attributing you a -- I'm sorry. I presume to direct which way you're going.

A. Yes. Still on item D. I think the data that I see in front of me from a geotechnical perspective seemed to be adequate. I don't believe there are major geotechnical issues in this deeper profile, and now we have a little bit better understanding about some of the deeper sediments down to 200 feet. I still think I have gone on the record discussing maybe the potential of logging shear wave velocities deeper, but not being in my area of expertise, cannot say if that data -- I'll defer to other testimony whether that data is needed or not to complete the analysis.

Q. Could you help me make a correction in the

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record. Go back to Exhibit 75 for the second and look at the very last page of the exhibit. The very last page of the exhibit shows where Boring CTB-5 ends.

A. Yes. I see it's 158 feet.

Q. So when I said 200 feet respecting this particular boring, I misspoke. Is that correct?

A. Yes.

Q. Thank you.

A. Item No. E discusses no variability in the shear wave velocity profile. I believe Dr. Ostadan has commented extensively about this. And his concern again about thin layers near the surface and what the effects of that thin layer on the geophysical model, and how the deeper velocity may be adjusted because of the newer data that we saw from the seismic penetrometer. I don't believe there's anything really new to add to this.

Seems to express a concern that the seismic refraction data may not be able to resolve a thin layer, but the cone penetrometer certainly identified it.

Q. Do you have anything to add yourself to the statement?

A. No. The cone penetrometer data I think at least identified a lower velocity zone. It is now characterized. So the issue of the refraction survey missing a thin layer seems to be irrelevant now. It's

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already been identified by other data.

Item No. F again points out that the depth to bedrock and the nature of bedrock has not been established by physical sampling. We've made recommendations to consider doing that. But again, not having read other testimony -- not having read the -- I don't want to use the term "read." Not having reviewed the conclusions about Geomatrix and whether they feel this data is valuable and other testimony, I'm just going to point out that it still has not been done. Fair enough?

Q. Only a clarification. When you mean -- when you say "the depth and nature of bedrock has not been established in the SAR," from the viewpoint of stiffness of soil or strength of the soil, there comes a point -- I don't know -- whatever number of feet below the surface, where from the geotechnical standpoint it doesn't make any difference whether you call it bedrock or something else, right?

A. Yeah, this issue does not have really to do with the geotechnical investigations. There's no need to go that deep with the geotechnical investigations. What I'm pointing out here is that there's uncertainty to the depth of the bedrock, and I'm not sure how that affects the characterization of the ground motion. And

if characterization of the depth of the bedrock and nature of the bedrock would remove uncertainties, it would be prudent to do that. But again, I'm not sure Geomatrix's conclusions on whether they would really need that data. Obviously it hasn't been drilled, so it seems like that they haven't needed that data.

I think we discussed some discrepancies a little bit between the shallow refraction data and the cone penetrometer data, but I'm not certain right now at this point whether a deep hole is beneficial or not. I guess at the time when one was reviewing initial investigation, my experience at other facilities is, we had done this. But I will defer to the experts who do this type of modeling, whether they need that data or not.

MS. CHANCELLOR: Can we go off the record for a second?

(Discussion off the record.)

MR. TRAVIESO-DIAZ: Back on the record. We were on Item G on page 43.

A. Item G addresses hydraulic gradient, seasonal variations. When this was written I was trying to anticipate perhaps the need for doing any ground water hydrological modeling. I understand the applicant has now installed a ground water well within the site,

thus seasonal variations in the height of the ground water will be able to be documented. One cannot establish a gradient from one well, but from my viewpoint from a geotechnical perspective, there is no need to establish a seasonal gradient for modeling of ground water. If others within the state have testified they would like to see gradients, i.e., you need multiple wells to establish a gradient, I'll defer to that testimony. But from my perspective, it's been resolved from a geotechnical standpoint.

Q. The next one, Item H on page 44.

A. Item H discusses a potential for confined aquifer conditions. Most likely the well that has been installed will indicate whether there are confined conditions in the aquifer. How that confinement varies spatially across the site right now, again, unless one is doing ground water modeling, is not that particularly useful from a geotechnical perspective. So I'll just say, from my perspective, one well will define whether we have a confined or unconfined condition in that aquifer.

Q. Item I, "Potential Variations of the Preconsolidation Stress Have Not Been Considered."

A. I think the first paragraph is kind of a picky point. The uppermost clayey layer has an apparent

overconsolidation to it, and the SAR maybe at this point mentions something about -- well, I'll read what it says here. "It is assumed that this maximum pressure was caused by approximately of an additional [such is the case] 80 feet of soils above the current ground surface." I do not know, but I believe that statement should have been removed from the SAR because that is not the cause of the preconsolidation stresses. There were never 80 feet of materials, soils above the current ground surface at this site.

Q. I should have asked you before you began addressing this paragraph whether it is your recollection that this calculation has been superseded.

A. It's probably been superseded, and I said it was the SAR and I didn't look at that to realize that this was a calculation. I apologize. I would assume that that statement has been struck from any calculation.

Then the next paragraph elaborates about potential mechanisms of overconsolidation and specifically mentions dessication, cementation, and aging. We have discussed these processes considerably.

Q. Cementation in particular?

A. Cementation and dessication. I want to get my dessication issue in. And there's still a little bit

of uncertainty of which of these mechanisms are playing a dominant role, if not both.

Q. And you have already testified about this?

A. We've already discussed about this. And then also aging is to remind the applicant that these sediments are anywhere from 30,000 to 10,000 years old, and apparent overconsolidation due to aging is a known phenomenon also.

I believe the applicant's assessment of the preconsolidation stresses seem to be reasonable. Just warn of averaging them in the upper 30 feet. Look at it layer by layer in our current layering system.

Q. Item J, "Uncertainty in Estimates of Poisson's Ratio."

A. I believe we talked about this when we went through Contention L, so let's just defer to that and go on.

Q. And Item K, "Dynamic Soil Properties Are Poorly Defined."

A. I think we've discussed extensively the dynamic properties and the uncertainties that we have with them, and also Dr. Ostadan has discussed the frequency dependency of these parameters. So I believe there's not much to add to this statement. There still are some issues.

Q. And we've discussed this?
A. Yes, we discussed this.
Q. Let's look at response to Interrogatory No. 6, Item A, "Split Spoon Sampling Procedures and Documentation of Sampling Methods." I don't believe we have discussed this before.
A. We haven't, but I don't know if there's any really significant issues left here. When I was reviewing the applicant's documents, it appears that I did not find documentation of the types of hammers that were being used, types of procedures to do a standard penetration testing, whether there were liners included or not, what type of drill rod was going to be used. Those factors affect the SPT sampling, need to be documented, and there are correction factors for them. So when these data are used for analyses, these adjustments should be accounted for and documented. However, I think we've already gone on the record discussing dynamic settlement, and it's not -- from our evaluation, it's not a major issue here.
Q. Item B, "Type of Sampling Used in the Upper 35 Feet of the Soil Profile is Inappropriate for Soil Conditions."
A. This was written before the CPT data were available, and the first paragraph -- and as is commonly

done sometimes in geotechnical investigations, that you do the wrong sampling for the type of layer that you're in because you're what I call drilling blind, blindly. And you do not know what you're going to encounter below you, so you sample with a split spoon when you should have Shelby Tube sampled, and vice versa. Obviously the CPT data that are now collected makes it so that we do not have to, quote, drill blindly. And we will have no really great uncertainties in what type of sampling we should be doing in key layers.

The second paragraph, first sentence beginning with "also" -- just a moment -- addresses the issue that there appears to be an undersampling of the shallow profile using undisturbed sampling. It appears that the initial sampling used split spoon sampling in an apparently -- split spoon or disturbed sampling in an apparent cohesive layer, and the number of undisturbed samples recovered in this layer were few. And the table tabulates that the number of undisturbed samples were in the upper 35 feet only nine, whereas 177 split spoon samples were taken.

This would not be a major concern for future investigations here because, again, we do not have to worry about uncertainty of layering, and we know which type of sampling to do when we do it. We've already

expressed our concerns about the under-representation of undisturbed samples in layer 2.
Q. Item C, "Type of Undisturbed Sampling Used by Applicant May Still Cause Significant Disturbance."
A. Yes, I recognize this. In the first paragraph, and I think we discussed this -- I can't remember if it was yesterday or this morning, frankly. But it was the idea that our experience in saturated Bonneville deposits, that even with reasonably good quality Shelby Tube sampling, a significant portion of the Shelby Tubes indicate disturbance. This was surprising to us and actually something that was given to us by Chuck Ladd in his review of our data. And currently UDOT has a research topic looking into this issue, because we extensively use Shelby Tube sampling in general practice here in the valley. Probably not as great of an issue at the PFS site because of the stiffness of these soils.
Q. And in fact, if you recall, I showed you two or three curves of --
A. Oh, yes, the test you gave me yesterday.
Q. It wasn't a test.
A. The quiz. I hope I passed.
Q. Well, I think that you said that two of them appeared to be undisturbed or reasonably undisturbed and

one wasn't.
A. Right. And by the way, the reason why disturbance is not as large an issue here is because these are stiffer soils, and any disturbance would tend to most likely cause a conservative estimation on your part. So we're not going to make a big issue about disturbance.

And the sampling seems to be, at least the recent events of sampling, there has been some indication of minor disturbance, but I leave it up to the judgment of the evaluators to look that. And if they feel disturbance has occurred, potentially remove some of those sample on their program.
Q. Can we turn to Interrogatory No. 7 on page 49, which I believe has only two parts, and look to part A that talks about "RAI No. 1, Question 2.8 is Not Applicable to Addressing the Potential for Collapsible Soils." Did I understand your testimony before that the collapsibility, potentially collapsible soils has been a concern?
A. Yes. Our initial issue with this was potential collapse in the Eolian deposits. Those have had problems with collapse. The applicant intends to treat them with soil cement.
Q. How about Item B, which says "The Applicant

May Have Mistaken Collapsed During Consolidation Testing as Secondary Consolidation." Is that --
A. I think when I researched this further I was confused by what was being said in a particular laboratory report, and the subsequent RAI's have addressed this.
Q. So will you say that this is no longer a concern?
A. I don't believe there's any concern here.
Q. Let's move to No. 8 on page 51. Item A, "Undrained Shear Strength May Have Been Overestimated Due To Consolidation During Triaxial Testing." I believe we covered this yesterday morning. Is that correct?
A. I did. It was just pointing out that soils -- saturated soils consolidate, and one has to be careful to make sure that effective stresses represent the anticipated vertical loads.
Q. And you have nothing to add to what we discussed yesterday?
A. I do not.
Q. Paragraph B on page 53, "Applicant Did Not Consider Soil Anisotropy During Shear Strength Test Program and Subsequent Calculations."
A. Yes, we've discussed anisotropy extensively.

Q. I believe we did. And you have nothing to add to the previous discussion?
A. I do not.
Q. Item C, "Applicant May Have Used An Improper Modulus of Subgrade Reaction for Foundation Calculations."
A. I believe we've already discussed this also. I have nothing else to say about it.
Q. Item D, "No Consideration in Foundation Design of Potential Ground Rupture of Faulting."
A. We discussed the Geomatrix report and its assessment of potential magnitude of displacements at the site. I have nothing else to add to this.
Q. Item E, "No Consideration of Potential Basin Effects in Developing Ground." Probably a word missing there.
MS. CHANCELLOR: It should be "motion."
A. Yeah, motion. This appears to be Dr. Ostadan's.
Q. In fact, if I recall --
A. It's got a red tab by it. I was about ready to answer that.
MR. TRAVIESO-DIAZ: Let's go off the record for a second.
(Discussion off the record.)

Q. (By Mr. Travieso-Diaz) Which is the next item that you --
A. X.
Q. And Item X is on what page?
A. Page 64.
Q. "Use of Full Undrained Shear Strength Overstates Sliding Factor of Safety of the Pad."
A. Yes. This is historical. The initial design considered sliding on -- of the concrete pad on top of a clay, clay layer, and we were pointing out that adhesion should be used. But this has been changed now.
Q. And that's the last one that you have that you provided input on Exhibit 10?
A. Yes, I believe so.
Q. Would you like to take a break?
A. Oh, wait. There was another one hidden here. Maybe there's a dual one. It's on page 71.
MS. CHANCELLOR: I'd just like to make a comment. I think on some of these dual ones we discussed it together with Dr. Ostadan.
THE WITNESS: Yes. We've discussed the -- I believe we've discussed this already.
Q. (By Mr. Travieso-Diaz) This is Item AS on page 71?
A. Yes.

Q. My recollection is both you and Dr. Ostadan talked about it.
A. Yes.
MR. TRAVIESO-DIAZ: Would you like to go off the record for a minute?
(Discussion off the record.)
Q. (By Mr. Travieso-Diaz) Could we turn now to Exhibit 12, which is the State of Utah's Objections and Responses to Applicant's Fourth Set of Discovery Requests to Intervenor State of Utah and Confederated Tribes, and what I would like to ask you to do is to repeat the procedure that we went through with respect to Exhibit 10 and go over those element or those responses to discovery requests that you were involved with, stating as to each what your current position of that discovery response is.
MS. CHANCELLOR: Can we go off the record for a moment?
MR. TRAVIESO-DIAZ: Sure.
(Discussion off the record.)
Q. (By Mr. Travieso-Diaz) Modify my last question. The question that I intended to ask was, going -- I'd like to ask you to go through Exhibit 12. --
A. Correct.

Q. -- which is the State of Utah's responses to the fourth set of discovery requests; and limiting yourself to those discovery requests in which you provided substantive commentary, could you go through those and tell me what your current position with respect to that commentary is?
A. I'm on page 27, Response to Admission Request No. 4. That was denied, and the reason was that we didn't see any really geostatistical or statistical analysis to discuss the extent of variation.
Q. And your current view on this response?
A. I think we've discussed our ideas about still uncertainty, particularly in layer 2.
Q. In terms of horizontal --
A. Variation of the potential shear strength and some potential ways of looking at that.
Q. So this has been amply discussed?
A. We've discussed this. No. 5, we've discussed also the depth and nature of bedrock at the site.
Q. You are talking about the response to Item 5 on page 27?
A. Right.
Q. And this is one that we have discussed?
A. Right. The idea of the deep hole and

establishing properties to bedrock.
Q. Okay.
A. We've also discussed Response to Admission Request No. 6 about depth of ground water, hydraulic gradient, and seasonal variations. We just did that a few moments ago.
Q. No. 7 on page 28?
A. We do not see there's any outstanding issues with collapsibility of soil.
Q. And No. 8, with respect to the determination of soils and undrained shear strength, I take it you're not providing any additional information?
A. No. We've already discussed undrained shear strength probably too much.
Response to Interrogatory No. 1, strain rate of soils at the bottom of page 28 is where this discussion starts. I don't think I need to go through this, because I know the issues. And I do not want to read several pages. It's our position that the strain rate effects are used, and our current understanding is they haven't been. They've been alluded to but have not been used in the calculations. They may not be as high as some of the other literature suggests. We've given a few quotations of where some literature suggests that there's only a 10 percent rise in peak strength per each

one log cycle increase in strain rate.
If this is going to be used, we suggest that using site specific testing and data would put this to rest. And if the applicant intends not to use this effect or needs not use this effect to demonstrate adequate margins, then let's not discuss it.
Q. And your comment at the end of this question and this particular response that, "hence, without site specific testing, it appears more appropriate to consider a possible 25 to 30 percent increase"?
A. I think we'd accept that. That is supported by a textbook that we've cited here, but also we got into this quite extensively on the I-15 project. Our senior advisors were Chuck Ladd and also a person named Yoshi Moriwaki from Woodward-Clyde. I was a party to the conversations, and ultimately we used a 10 percent increase for each log cycle as stated. And in that case the rate of our strains and testing yielded a 30 percent increase in peak strength due to strain rate effects. And I guess we would accept that value without site specific testing. But if we consider it a conservative value, yes; but if one's going to use less conservative values, i.e., higher multipliers for strain rate effects, then they should be justified by site specific testing.

Q. In other words, if they're going to take credit for anything over 30 percent, they should prove it by testing?
A. Well, let's not characterize it as 30 percent. At least 10 percent for each log cycles of increase in strain rate over the laboratory. So carefully compare the rate of strains induced by the earthquake motion and the strain rate done in the laboratory, and adjust it 10 percent for each log cycle increase. Just use the rule of thumb by Kramer.
Q. Okay. That's simple enough.
A. We will accept that.
Q. Undrained shear strength on page 30.
A. We've discussed the potential reduction in peak strength due to degradation. I don't see anything more to add to this. We also discussed the percent of peak that may be mobilized due to free field motion and action.
I don't recall how much we've said about Newmark sliding block analyses.
Q. We have not talked about that.
A. So maybe we need to make a comment about that, because the next pages -- on 31 I see some discussion on Newmark analysis.
Q. As I recall the discussion today,

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Dr. Ostadan deferred to you on this one.

A. Yes. For shallow sliding we feel very reluctant to accept any factors of safety less than 1.1, and justify sliding -- justify factors of safety of less than 1.1 based on the use of sliding Newmark analysis.

I think these studies were done to cover somewhat uncertainties in characterization and understanding of the soils beneath certain facilities, so I hope that they're somewhat historical. But it seems that we could potentially move into an area that NRC may not allow us to go to a factor of safety of less than 1.1. So I guess we would like to see that factor of safety demonstrated for all case, not rely on deformation analysis.

Q. Can I ask only one clarification, which is, when you said "shallow sliding," where are you assuming the sliding?

A. Shallow sliding to me would be anything from the foundation system down through to the bottom of layer 2.

Q. In your last answer, do you combine your comments of factor of safety against sliding and the next factor of safety against bearing capacity, or are these two different issues?

A. Discussed factor of safety against bearing

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capacity. This was dealing with an issue of maybe a fee that had not been justified.

MS. CHANCELLOR: I'd just like to make a comment. I think we already have testimony on --

THE WITNESS: I think we have.

MR. TRAVIESO-DIAZ: I believe we have.

MS. CHANCELLOR: -- this, and also on the next one.

THE WITNESS: We've covered this, as I recall. Yes, I think I also recall much testimony on factors of safety against sliding on the pads and the subsequent issues in this section.

Q. I don't believe that we have discussed settlement. That is on page 33. Would you summarize your current position on settlement?

A. As I recall, the design has built in some margins for a potential 3.5 inches of settlement with time. I consider settlement somewhat of an operational issue. I hope you're right in your guesses, but I think you can cover -- this settlement I would expect to be -- and when I'm referring to settlement, I'm talking about consolidation settlement or creep settlement also. It will be fairly uniform, so it really becomes to me an operational issue of how much of a nuisance it is, but not a real concern.

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Q. The next one, soil cement. May I suggest that we have discussed this?

A. Yes. This is a -- still we consider this soil cement idea conceptual. We've discussed it considerably.

Q. Will you turn to the next set of questions, which I believe is a response to Interrogatory 2.

A. Yes, I see.

Q. That's on page 34. What is the first item that you care to address?

MS. CHANCELLOR: I could stipulate --

A. I believe that there's -- if I have any part to this, it's probably in the first part of this. So let me just see if I can identify where I may have said some things.

Q. May I help you refresh your recollection, perhaps?

A. Sure.

Q. My recollection is that with respect to the response to Interrogatory 2, there were two parts to what is in that paragraph. The first part is, you indicated that you provided input to others that were discussing the various issues that are raised in that portion?

A. Correct. And as I think -- I'm looking at

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the sentence here -- see if I can find the beginning of it. I believe it's "notwithstanding."

Q. Can we stipulate that a lawyer wrote that?

A. I believe so.

MS. CHANCELLOR: It's all right if you don't stipulate it was me. I can stipulate that the primary author to this was not Dr. Bartlett.

THE WITNESS: Right. And I may have had some input into a couple key words that I saw here.

MS. CHANCELLOR: I believe Dr. Allison was responsible for this interrogatory response.

A. Identifying faults would not be mine. Ground motions. Perhaps ground displacements I assume would refer back to any potential offsets across the site due to the seismic event.

I did have input to the depth of the nature of the bedrock. This is the deep hole again that we've talked about.

Obviously the analysis of collapsible soils, we discussed that. That's not an issue.

Perhaps now the overestimation of undrained shear strength is a little strong, but the verification of undrained shear strength values in key layers.

I'm not sure I see anything else that I would have contributed to in here.

Q. Anything else on this document, in this set of discovery responses?
A. No. It appears to be mostly Dr. Allison's.
Q. Could I ask you to turn now to Exhibit 13, which is the State of Utah's Objections and Response to Applicant's Fifth Set.
A. Yes.
MS. CHANCELLOR: Off the record a minute.
(Recess from 10:22 to 10:28 p.m.)
Q. (By Mr. Travieso-Diaz) Again, let me just -- would you please go through Exhibit 13, State of Utah's Objections and Responses to Applicant's Fifth Set of Discovery Requests, and go through the same process that we went through with respect to Exhibit 12, please?
A. Sure. I think earlier I identified some part in Response to Admission No. 2 on page 6. I recall having some phone call discussions. This appears to be discussing the use of probabilistic seismic hazard analyses and talking about their use when the state has used them before.
Q. Is it fair to say --
A. This is mostly I think Dr. Arabasz's writing. I think my conversations were just to point out to Dr. Arabasz that the deterministic approaches are still used, too, and pointed out that the dam safety

group within the State of Utah still uses deterministic events for dam design. So that's why I think -- I think that was my input to this was just that dam safety -- that dam safety evaluations are still done with deterministic events and maximum credible earthquakes.
Q. But you have nothing to add to what's here?
A. No. I don't have anything to add to 3, either. I recognize my participation by citing a reference here that deals with I-15, and a probabilistic seismic hazard analysis.
Nothing to add on response to request No. 6.
I think No. 7, there's nothing to add here. We've clarified and come up with a consistent nomenclature I think even for the upper five layers.
Q. I think we did.
A. I don't see anything on the next page that I can contribute beyond that. Is this the beginning -- I'm confused now.
MS. CHANCELLOR: Can we go off the record a minute?
MR. TRAVIESO-DIAZ: Sure.
(Discussion off the record.)
THE WITNESS: I have nothing to add to 8.
MS. CHANCELLOR: I'd like to make a comment. No. 9 refers back to another admission. I think it's

going to be difficult --
THE WITNESS: I'm wondering why we're hung up on competent soil layers.
MS. CHANCELLOR: Can we go off the record a minute?
MR. TRAVIESO-DIAZ: Yes.
(Discussion off the record.)
THE WITNESS: I have no additional comments on 9. I believe the issue has been discussed by Dr. Ostadan. Yes on 10. We still admit that the applicant has discussed soil cement mixtures with us.
Q. And would it be fair to say that on 11 we have discussed the potential concerns that exist to the use of --
A. Correct. And I think also 11's objecting to the term "stronger." It doesn't lend itself to a good engineering terminology.
Q. And again, No. 12 also addresses the properties of soil cement?
A. Yes. That still is conceptual and must be demonstrated.
Q. Did we discuss that today? Maybe yesterday?
A. Yes. On 13, it's still our understanding that that's what's intended, and we have nothing to comment on that yet. We have nothing further to comment

on. I'm so jumbled, I can't speak. We have nothing additional to comment about on this.
Q. Do you have any additional comments that you wish to make on No. 15?
A. We've discussed extensively our current concerns still of layer 2 being able to be a bearing capacity layer. So I have nothing more to add to that.
Q. According to my notes, the next item which you provided input was No. 37 on page 22. Is that correct?
A. Correct.
Q. Will you address that item?
A. Depth of bedrock still remains an uncertainty. We talked about it, but I've deferred to others to determine whether that data is germane.
Q. We discussed that today.
A. Yes.
Q. 38 again addresses bedrock. We have talked about that. Is that --
A. Yes, that's the same issues -- or those two are together, linked together. The next I see is -- we didn't cover 39, correct?
Q. My notes don't show that you covered 39, but you can look at it.
A. Coring to bedrock is not necessary to

establish the competency of the overlaying soils from the geotechnical perspective.
Again, we've discussed I guess the use of the term "competency" and what it should mean. We admit that for shallow bearing capacity and consolidation that --
Q. With respect to items 41 -- I'm sorry, 40 and 41, are those items related to testing?
A. Yes, they are.
Q. Have we discussed those items?
A. Yes, we have. I see nothing else there.
Q. With respect to item 42, do you have anything to add with the conservatively -- the conservatisms or lack thereof on the soil parameters?
A. No, I don't.
Q. 43, the question is whether there have been additional cone penetration tests.
A. Yes, we admitted there was additional cone penetrometer tests.
Q. We have discussed those at length.
A. Yes.
Q. And 44, again, whether cone penetration tests are accepted industry methods. I believe we discussed those as well.
A. Yes. I think the objection here is a

clarification that soil properties are not determined from the cone penetration tests, that properties are derived from correlations to the base measurements you make from the cone through statistical correlations.
Q. Is that it for Exhibit 13?
A. That's it.
Q. Just confirm for the record that this, as far as you remember today, is your last -- the totality of contribution with respect to the issues related to Contention L?
A. Yes, to the best of my recollection.
Q. May I ask you for a second, just for completeness, will you look at page 27, item C on the page. And Item C, the title of that particular paragraph is "Soils and foundation loading."
A. Yes.
Q. Take a look at that paragraph and tell me whether this has been already discussed.
A. Yes, I believe collapsibilities have already been discussed.
MR. TRAVIESO-DIAZ: I have no more questions for Dr. Bartlett.
MS. CHANCELLOR: Can we go off the record for just one second?
(Discussion off the record.)

EXAMINATION
BY MS. CHANCELLOR:
Q. Dr. Bartlett, I would just like to ask you a question for point of clarification. During your testimony, I think it was yesterday, I heard you testify that Dr. Arabasz would be the state's expert supporting Basis 1 of Contention L, which is surface faulting and deals with seismic reflection, seismic refraction. Is that what you meant to say?
A. No. Dr. Lee Allison would have covered those. I must have just had the numbers mixed up.
Q. And Dr. Arabasz, is he the state's expert for ground motion, Basis 2?
A. Yes, that's my understanding.
MS. CHANCELLOR: I have no further questions. Thank you.
MR. TRAVIESO-DIAZ: I have nothing else to ask.
On the record, I would like to thank you very much for your testimony and your patience.
MS. CHANCELLOR: And I want to thank everybody for enduring, too.
MR. TRAVIESO-DIAZ: And I'd like to extend my compliments and my thanks to the court reporter.
(Deposition was concluded at 10:48 p.m.)

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CONDENSED TRANSCRIPT

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of:	)	Docket No. 72-22-ISFSI
	)	ASLBP No. 97-732-02-ISFSI
PRIVATE FUEL STORAGE, LLC	)	Deposition of:
(Independent Spent Fuel Storage Installation)	)	**PAUL TRUDEAU** and
	)	**THOMAS Y. CHANG**

Wednesday, November 15, 2000 - 9:14 a.m.

Location: Utah Attorney General's Office
160 E. 300 S.
Salt Lake City, Utah

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

mean, really mean, it's really have a high density. So we have to really be careful what we talk about for what type of soil and what condition.

Q. Do you consider that the undrained shear strength numbers from the Supercollider, because -- because of the higher ground water table, that those -- that that undrained shear strength is not applicable to the PFS site because of the difference in ground water?

A. (Mr. Trudeau) I consider it to be a different material geologically, because it's so much lower in the profile than our materials are, a hundred feet further away from the water table than they are. You know, again, I don't recall exactly what's in the Superconducting Supercollider reports, because it's been a long time since I looked at it. But my general recollection was that they were closer to the ground water table than we are, hence I felt that the material properties weren't applicable to our site. So we used our site properties.

Q. Dr. Chang, are you familiar with matrix suction and capillary stress, as a general matter?

A. (Dr. Chang) Yes, somewhat. As a geotechnical engineer, yeah.

Q. Does that have any effect on the undrained shear strength?

A. (Dr. Chang) Yes, it does have some effect of undrained shear strengths.

Q. And what effect does it have?

A. (Dr. Chang) Well, overall if you have a -- the water column water deficiency, and then you have a capillary tension in the pore water, that will come out, give a soil that have a little bit higher strengths, because effective stress will -- in the soil particle is higher.

Q. Do you know whether changes in moisture content can change the undrained shear strength?

A. (Dr. Chang) I think you have to qualify a little bit. Be specific.

Q. For fine grain, unsaturated soil.

A. (Dr. Chang) For fine grain, unsaturated soil, the normal one, yes. That's a -- the water content going to have some effect on the undrained strength.

Q. Is unit 2 on Figure 2.6-5, is that fine grain, unsaturated soil?

A. (Dr. Chang) Yeah, that's -- have a wide degree of saturation. It's a partially saturated, not fully saturated.

Q. Can changes in its undrained shear -- can changes in unit 2's moisture content affect undrained

shear strength?

A. (Dr. Chang) I really cannot make a very general here, because you have to know what contribute to the undrained shear strengths of the soil. Sometimes they may have some kind of a cementation there. If you have a cementation that's contributing more to your undrained strengths, even you change the water content, if that cementation still exists, you probably not going to change undrained shear strengths.

Q. Are the soils in layer 2 cemented?

A. (Dr. Chang) I suspect so, somewhat.

Q. What do you base that on?

A. (Dr. Chang) Basis on we -- I think we had -- some of the soil we tested may have some kind of a react to HCl, hydrochloric acid. So maybe there's some company there, and I don't know exactly what the company that play the role in the cementation. And also the soil has been dry. There may be some kind of chemical or something deposited during the drying process. So that may contribute another cementation.

Q. If you know, at what strain level do you expect cementation to break?

A. (Dr. Chang) I'm glad you asked.

Q. Good.

A. (Dr. Chang) All right. From the very

beginning, we know that soil has got a high water ratio. And that's why we suspect this is some -- this is some of soils there for that particular type of the soil with that kind of high water ratio and kind of strains we got. We said, well, maybe this is some problem; if it's cementation, maybe what destroy even in the weighting. And that's why when we doing our soil conservation test, we add the water -- one of them -- some of them add water, and we specific to check that cementation will break down by saturation on that. And it didn't show any change. Very, very slight change.

So based on that, because the soil is not really break down, and we continual load the test, we compare them. One is inundated and one is not inundated. And there is very, very little difference. So basic what we -- based on that, we said, well, this soil, at least that cementation cannot be break down, you know, just by changing the water content.

Q. At what shear strength level does the cementation break down?

A. (Dr. Chang) I object to the question.

A. (Mr. Trudeau) We don't know.

Q. If you know.

A. (Mr. Trudeau) We didn't measure a breakdown in cementation even with the -- well, with the stresses

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as high as eight tons per square foot in our consolidation test, we saw no behavior that looked like a breakdown in cementation.
Q. Is cementation likely to break down at large strain?
A. (Dr. Chang) Well, you want to define "large"? How large?
Q. One to two percent. One to two percent shear strength.
A. (Dr. Chang) I don't -- the strength, you talk about strength?
Q. Shear strength, yes.
A. (Dr. Chang) All right. Depends --
Q. Shear strain, beg your pardon. Shear strain. One to two percent shear strain.
MR. TRAVIESO-DIAZ: Can I have that question read back? I don't know what the question is.
Q. (By Ms. Chancellor) Let me try this. Is cementation broken down at one to two percent of shear strain?
A. (Dr. Chang) Well, from the test, the sample we test, I don't believe -- we have to calculate what the, you know, from the consolidation what the shear strain -- you probably see the shear strain going to be. At least we see that probably more relate to the no more

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load. We should have said it, how high is that going to, you know, even low, beyond that low, the cementation will break down. But so far from the consolidation test, we really haven't seen the cementation break down due to the load, because we -- the sample we run and partially saturate and was inundated basically is very similar. There's not much difference.
Q. Do you know whether there were any cyclic measurements for shear strain for suspended cemented soils -- suspected cemented soils?
A. (Dr. Chang) You mean in published literature, or --
Q. For the soils at the PFS site.
A. (Dr. Chang) Yes. We did some cyclic triaxial tests.
Q. And at what levels of strain were those cyclic measurements taken?
A. (Dr. Chang) We applied the stress level to the design earthquake, and the strain, we come out I think very, very small. It's probably about -- strain is 1 percent?
A. (Mr. Trudeau) I'm looking at Attachment 6 of Appendix 2A of the SAR. The results for sample CTB 4, U-13D showed double amplitude strain of 1.23 percent after 513 cycles.

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MS. NAKAHARA: Can you repeat that page again?
A. (Mr. Trudeau) It's close to the back of Appendix 2A, Attachment 6. It's Appendix C of that attachment. It's that page right there.
Q. Were these samples wetted in the cyclic trial test on Attachment -- Attachment 6 to Appendix 2A of the SAR?
A. (Dr. Chang) No, it's not saturated.
Q. Not saturated. Would you agree that these samples are taken at approximately 23 to 24 feet depth?
A. (Dr. Chang) I think we have a wide test. I think some of them may be shallower.
Q. Could you turn to the Appendix -- Attachment 6, Appendix C to Appendix 2A where it's got the cyclic triaxial tests? Do you see that?
A. (Mr. Trudeau) Yes.
Q. The first sheet shows depth of 24.9 feet?
A. (Mr. Trudeau) Correct.
Q. Second one, the same depth?
A. (Mr. Trudeau) 23 feet.
Q. Oh, 23 feet. The next one, 8 feet?
A. (Mr. Trudeau) Correct.
Q. 9.6 feet?
A. (Mr. Trudeau) Correct. 6.3 feet.

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Q. I guess I don't have a question.
You mentioned you used the design earthquake value. What value did you use?
A. (Dr. Chang) I think that's point --
A. (Mr. Trudeau) 67 G.
A. (Dr. Chang) -- .67? That's in --
A. (Mr. Trudeau) When we laid out these tests, it was --
A. (Dr. Chang) -- in here.
A. (Mr. Trudeau) -- prior to the PSHA study. So we hit these samples as hard as we could without putting them into tension.
A. (Dr. Chang) In the requesting form.
A. (Mr. Trudeau) It's not in this. This SAR is missing some pages. Can we look at yours?
MS. CHANCELLOR: Sure. We're glad to share.
A. (Mr. Trudeau) We have those in all of these, but not this here.
Q. Is that our book you're taking about?
A. (Mr. Trudeau) No, no. It was found about five pages ahead of where it belonged. So we found it. I'm sorry.
There's a page that's labeled page 18. We're in Appendix 2A of the SAR, Attachment 6. I'm sorry to say I can't refer by page number. We're

A. (Mr. Trudeau) Yes.
Q. I didn't copy this as part of this exhibit, but on page 73 -- let me read you this statement, then I'll give you page 73. Is it states, "Furthermore, the pads will be constructed on and within soil cement which will be strong enough to resist sliding of the pads using only the passive resistance of the soil cement. The soil cement will effectively lock the pads in their respective locations so that they cannot move relative to one another." That's at the very bottom --
A. (Mr. Trudeau) I see it.
Q. -- of page 73. Does the statement on page 73, does that imply that for the soil cement mat to be effective in resisting sliding, it must act as an integral unit with the pads and allow no differential movement between the pads?
A. (Mr. Trudeau) **It will effectively do that, because its strength will be higher than the strength necessary to resist movement of the pads.**
Q. If you would look at Exhibit 38, the excerpts from the SAR Figure 2.6-2.
A. (Mr. Trudeau) **Yes, I have it.**
Q. What are the approximate width and dimension of the integral pad soil cement based on, as shown in Figure 2.6-2?

A. (Mr. Trudeau) **What are the --**
Q. Approximate width and dimension of the integral pad soil cement based on.
A. (Mr. Trudeau) **We're planning to use soil cement between all of the rows of pads, so these pads are spaced 30 feet on centers so that whole area will be soil cement.**
Q. If you look at Figure 2.6-2, there are four grids or four --
A. (Mr. Trudeau) **Four quadrants.**
Q. Four quadrants. Would those four quadrants all act as a single mat?
A. (Mr. Trudeau) **That's the intent. The soil cement in those areas also provides a firm foundation for the transporter to travel, so you get added benefit out of supporting the transporter as well in those areas.**
Q. Do you know what the tensile strength is of the soil cement?
A. (Mr. Trudeau) **Not yet. Hasn't been designed yet.**
Q. When will it be designed?
A. (Mr. Trudeau) **We're -- well, we've -- we're in the process of preparing the ESSOW for the lab testing required for that right now, Engineering**

Services Scope of Work.
Q. In designing the soil cement mat, were the effects of surface waves and non-horizontally propagated waves considered?
A. (Mr. Trudeau) **We looked only at the strength required to resist the dynamic forces.**
Q. In which direction?
A. (Mr. Trudeau) **Horizontal direction.**
Q. But you didn't consider the vertical direction?
A. (Dr. Chang) **The vertical direction is not -- you have up and down, you're not going to slide.**
Q. Were the bending and torsional stresses imposed by the surface waves calculated over the four quadrants of the pad area?
A. (Mr. Trudeau) **No.**
Q. Would bending stresses place the pad mat in contention?
A. (Mr. Trudeau) **I don't know.**
Q. You stated that -- is the design complete for the cement pad?
A. (Mr. Trudeau) **For the --**
Q. For the cement --
A. (Mr. Trudeau) **For the concrete pad?**
Q. Concrete pad mat -- I mean, soil cement mat.

A. (Mr. Trudeau) **No.**
Q. Is it still in a conceptual stage?
A. (Mr. Trudeau) **That's correct.**
Q. When do you expect to reduce it from a conceptual stage to a design stage?
A. (Mr. Trudeau) **As I said, we're working on getting the lab program to test the soils to see what percentages cement are required to get the unconfined compressive strengths and the durability requirements done now.**
Q. Do you plan to measure tensile strength?
A. (Mr. Trudeau) **I had not planned to.**
Q. Can you preclude that there won't be any tensile stresses in the mat?
A. (Mr. Trudeau) **No.**
Q. Are you likely to change your mind about whether you're going to consider tensile strength?
A. (Mr. Trudeau) **We will look at that. Thank you very much.**
Q. Would you expect the soil cement and the mat to act as an integrated unit with forces in the vertical direction?
A. (Mr. Trudeau) **There will not be a shear connection on the edges of the pads, so whether they move as an integral unit or not will depend on the**

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magnitude of the stresses between them, whether the bond strength between soil cement and the concrete pad will be sufficient, and whether the pad underlying the -- I mean, the mat, the soil cement layer underlying the pads have sufficient shear strength to resist those forces.
Q. You testified that you're in the process of going from a conceptual to a design phase of the soil cement pad -- mat. When do you anticipate that you will have completed the design?
A. (Mr. Trudeau) First quarter next year, perhaps.
Q. In order to complete it, is there a lab test that you need to run? Do you need to do any field work?
A. (Mr. Trudeau) We need to obtain samples of the site soils for the lab testing program. So field work in that inasmuch as you have to go to the field to get the dirt.
Q. If you consider the pad and the soil cement an integral unit, should you consider the seismic -- seismic load from soil cement in the sliding analysis? Do you understand the question?
A. (Mr. Trudeau) The soil cement will have sufficient strength to exceed the Mononobe Okabe active pressures that would be applicable for that case, I believe.

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Q. If there are integral -- if the pad and the soil cement are an integral unit, wouldn't they move together?
A. (Mr. Trudeau) Yes.
Q. So where is the inertial load -- where is the inertial load of the soil cement going?
A. (Mr. Trudeau) Where is it going? It would be resisted by the bond between the soil cement mat and the underlying silty clay layer.
Q. So should this be included in the sliding analysis, the inertial load?
A. (Mr. Trudeau) I guess so.
Q. Has it been?
A. (Mr. Trudeau) No.
Q. Were potential weaknesses in the soil cement mat considered due to cracking upon drying or other environmental factors?
A. (Mr. Trudeau) Cracking would not impair the compressive strength of the soil cement.
Q. Would it affect its tensile strength?
A. (Mr. Trudeau) Yes.
Q. Did you consider that, and how much effect would it have?
A. (Mr. Trudeau) Can't tell you that. The nature of soil cement, the way it's constructed in

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layers, would tend to minimize the propagation of cracks throughout the whole mat of soil cement.
Q. Do you have data to support that, or is that your opinion?
A. (Mr. Trudeau) That's my opinion.
Q. Could you look at Exhibit 39 on the last page, page 84, and if you look at what's entitled Figure 3.
A. (Mr. Trudeau) I have it.
Q. Would you agree that Figure 3 shows a typical detail of a past soil cement interface?
A. (Mr. Trudeau) Correct.
Q. Do you agree that this typical detail indicates that the soil cement mat will be three feet thick outside the pad footprint and approximately one foot thick underneath the pad?
A. (Mr. Trudeau) The figure indicates it will be at least that, yes.
Q. Were calculations made to determine the effect of the non-uniformity and thickness at this point?
A. (Mr. Trudeau) Calculations of what?
Q. How this joint will respond to dynamic torsional and bending stresses.
A. (Mr. Trudeau) No.

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Q. Do you know either from other projects or review of literature whether soil cement has been used to reduce dynamic sliding?
A. (Mr. Trudeau) No.
Q. Do you agree that there is five feet longitudinal distance between the pads?
A. (Mr. Trudeau) Correct.
Q. Is passive resistance from one pad a driving force for the other pad?
A. (Mr. Trudeau) The whole unit acts -- I mean, the whole quadrant -- the whole pad emplacement area will act as an integral unit.
Q. So does this mean that the sliding analysis should be performed for the whole pad emplacement area?
A. (Mr. Trudeau) Correct.
Q. Are you familiar with Calculation G(B)13, which is called Stability Analyses for the canister transfer building Supported on a Mat Foundation?
A. (Mr. Trudeau) Yes.
Q. I'd like to have marked as Exhibit 46 --
(Exhibit 46 marked.)
Are you familiar with calculation G(B)13?
A. (Mr. Trudeau) Yes.
Q. If would you turn -- oh. If you would turn the -- Exhibit 46 is an excerpt from G(B)13. If you

need additional pages, let me know. I've got the entire package here. If you would turn to the last page, which is page 25. Were you responsible for this calculation package?
A. **(Mr. Trudeau) For Rev. 2 and 3, yes.**
Q. And Dr. Chang, did you independently review Rev. 2 and 3?
A. **(Dr. Chang) Yes.**
Q. And 1, too, I guess -- 1 also?
A. **(Dr. Chang) Yeah.**
Q. In the middle of the last paragraph on page 25, it states, "It is likely, that should slippage occur within the cohesionless soil underlying the building, it would minimize the level of accelerations that would be transmitted through the soil into the structure. In this manner, the cohesionless soils would act as a built-in base-shear isolation system. Any decrease in these accelerations as a result of this would increase the factor of safety against sliding, which would decrease the estimated displacements as well."
Do you see that --
A. **(Mr. Trudeau) Yes, I do.**
Q. -- that I just read? If slippage, that is, displacement, is required to reduce accelerations to the canister transfer building, then how can reduced

accelerations resulting from that slippage reduce the displacement that has already occurred?
A. **(Mr. Trudeau) This statement is saying that if the accelerations were so large that the soils could not transmit them to the building, the building would never see them.**
Q. But in reducing that acceleration, slippage has to occur, correct?
A. **(Mr. Trudeau) At the depth of the cohesionless layer.**
Q. Can you explain why this argument isn't circular?
MR. TRAVIESO-DIAZ: Object to the form of the question. Arguing with the witness.
Q. (By Ms. Chancellor) You state that displacements reduce slippage, yet slippage has already occurred, correct?
A. **(Mr. Trudeau) No. That's not the point I'm trying to make. The point I'm trying to make is that the earthquake coming up through the soil reaches a cohesionless layer. If the magnitude of those waves are so high that they exceed the strength of the soil to resist them, the soil will not transmit them through the soil into the upper overlying materials.**
Q. Does that define failure -- does that not

define failure of the soil?
A. **(Mr. Trudeau) I guess it does for slippage along that layer of the soil.**
Q. What is the magnitude of the slippage?
A. **(Mr. Trudeau) It would be less than what's shown here for Newmark's calculation, assuming that layer existed up at the base of the structure and assuming that that material had no cohesive strength associated with its cementation.**
Q. Does Newmark analysis consider fault fling and other near field earthquake effects?
A. **(Mr. Trudeau) Newmark analysis is based on the acceleration time histories. I'm not really familiar with fling and --**
Q. Do you know whether fling was considered?
A. **(Mr. Trudeau) For this analysis, no.**
Q. Did Newmark analysis consider the potential degradation of shear modular and shear strength?
A. **(Mr. Trudeau) No.**
Q. Did it consider the potential for asymmetrical sliding?
A. **(Mr. Trudeau) What do you mean by asymmetrical sliding?**
Q. Sliding in one direction.
A. **(Mr. Trudeau) This analysis looked at three**

different cases with the earthquake components in north/south and east/west and vertical directions.
Q. The charts from which you determined the displacement, were they for symmetrical or asymmetrical sliding?
A. **(Mr. Trudeau) May I see the rest of the calc? They were based on symmetrical resistance, as indicated by Figure 2.6-26 of the SAR.**
Q. 2.6 --
A. **(Mr. Trudeau) 2.6-26. It's Figure 6 of Calc G(B)13.**
Q. Do you know whether fault fling would produce asymmetrical sliding?
A. **(Mr. Trudeau) No.**
Q. You don't know?
A. **(Mr. Trudeau) Correct.**
MS. CHANCELLOR: Can we go off the record for a moment?
(Recess from 5:20 to 5:33 p.m.)
EXAMINATION
BY MS. NAKAHARA:
Q. Let's go back on the record. Good evening, gentlemen. For the record, my name is Connie Nakahara, and I'd like to continue asking you questions. And thank you for your endurance.

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Q. Are you familiar with the location of faults near the proposed PFS site?

A. (Mr. Trudeau) No. That -- at least on Geomatrix's scope on this project. I mean, I have a generic understanding that there are some faults nearby. The Cedar Mountain Fault I think is one of the ones that I've heard mentioned. But really the faulting study was under Geomatrix's scope.

Q. If there was a major fault capable of generating an alarming magnitude earthquake near the PFS site, do you believe there could be near fault impacts?

MR. TRAVIESO-DIAZ: I'm going to object to the question in that it calls for the witness to speak out of the areas beyond his area of expertise. But if he can answer the question, he can.

A. (Mr. Trudeau) I haven't really gotten into the Geomatrix faulting study, so I don't feel comfortable answering questions about that type of information. They were hired to do that kind of work. I understand they've done it. They developed the design ground motion. The design ground motion has been used in the soil structure interaction analyses, and the loads have been provided for the stability analyses that I needed to do.

Q. Are you familiar with the time histories

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that were prepared for PFS site?

A. (Mr. Trudeau) I know Geomatrix developed artificial time histories for the site in Calculation G(PO18)-3. But I haven't -- I have no real familiarity with characteristics of that time history one way or the other.

Q. Do you know who at Geomatrix was responsible for developing the time histories?

A. (Mr. Trudeau) I would look at G(PO18)-3. The cover page should indicate who prepared that calculation. I could guess, but I don't think you want guesses.

MR. TRAVIESO-DIAZ: No guesses, please.

Q. (By Ms. Nakahara) Do you have an opinion of whether large pulses in ground motion should be considered in time histories?

A. (Mr. Trudeau) It's outside my area of expertise.

Q. Dr. Chang, do you have an opinion?

A. (Dr. Chang) No.

MR. TRAVIESO-DIAZ: Before you ask the next question, I raised it this morning, but since we have a new team, let me restate my general objection on the record to having any questions on subjects such as time history which are outside the scope of Contention L, as

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I understand it. I had a standing objection this morning, but since we are having a new set of questions, I want to restate it for the record.

MS. NAKAHARA: And your objection is noted.

Q. (By Ms. Nakahara) Do you agree that major -- that a major fault dips under the proposed PFS site?

A. (Mr. Trudeau) I'm not familiar with the faulting study that Geomatrix did.

Q. I ask you to look at Exhibit 38, which is the Safety Analysis Report, page 2.6-3. Did you assist in -- did you draft this page? Were you responsible for drafting this page? In particular, the last paragraph on the page.

A. (Mr. Trudeau) No.

Q. Who would have drafted this page, if you know?

A. (Mr. Trudeau) My guess, I believe Richard Gillespie may have been the author of that paragraph, the geologist working for Stone & Webster back in 1996 when the SAR -- '97, when the SAR was originally filed. Looking at the text, however, it might have come from Geomatrix.

Q. Do you have an opinion if a major fault dips under the proposed PFS site, as stated in Exhibit 38,

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whether earthquake waves are likely to arrive at an angle?

MR. TRAVIESO-DIAZ: Same objection as before. It's outside his area of expertise. I'll let him answer if he can.

A. (Mr. Trudeau) The basis of my answer would be just my interpretation of reading this paragraph. I'm not familiar with this part of the license application.

Q. Just asking your opinion in general, if it was true that the fault dipped under the PFS site.

MR. TRAVIESO-DIAZ: Same objection.

A. (Mr. Trudeau) My opinion of what would --

Q. (By Ms. Nakahara) Whether earthquake waves are likely to arrive at an angle.

A. (Mr. Trudeau) That's not an area that I'm familiar with.

Q. Do you have an opinion? If earthquake waves arrived at an angle, could they cause additional rocking and torsional motion of the structures above and beyond the vibration caused by the vertically propagated waves of the earthquake?

A. (Mr. Trudeau) No.

Q. And why not? You don't have --

A. (Mr. Trudeau) It's outside my area of

expertise.
Q. I thought you meant no, it wouldn't.
A. (Mr. Trudeau) Oh. No, I don't have an opinion.
Q. This is a document entitled Multi-Cask Response at the PFS ISFSI from 2,000 Year Seismic Event, dated 8/20/99, approved. Are you familiar with that document?
A. (Mr. Trudeau) No.
Q. This document is Document 5996.02-SC-5, entitled Seismic Analysis of canister transfer building. Are you familiar with this document?
A. (Mr. Trudeau) I understand that that document was prepared by members of our structural mechanics department in our Cherry Hill office. I haven't looked -- I haven't reviewed that document. I have used some of the loads from I believe that document in Calc G(B)13.
Q. This is Document 5996.02-SC-4, entitled Development of Soil Impedence Functions for canister transfer buildinq. Are you familiar with this document?
A. (Mr. Trudeau) It's similar in that it was prepared by our structural mechanics people in Cherry Hill. I haven't reviewed those calculations, so I don't really know what's in there.

Q. Have you used anything from this document?
A. (Mr. Trudeau) I don't recall.
Q. Did you provide the soil properties for the calculations in that document, SC-4?
A. (Mr. Trudeau) I don't know what properties are used in that calculation. Perhaps I should take a look.
These properties that are shown here on -- let me rephrase. Page 9 of this calculation, which I'll refer to as SC-4, Rev. 1, indicates that the properties will be taken from Table 1 of Reference 5, see Attachment A. Attachment A presents -- page A-1 presents a table of dynamic soil properties that I recognize as coming from Geomatrix's Calculation G(PO18)-2, and it says right on the page that that's where those properties came from.
Q. This document is G(PO17)-2 from -- completed by the International Civil Engineering Consultants, Incorporated. Are you familiar with this document?
A. (Mr. Trudeau) This is what I would refer to as Calc G(PO17)-2 prepared by CEC. I have not reviewed this document either, although some of the loads from this document were provided to me for my stability analysis of the pads.
Q. Who provided you the loads?

A. (Mr. Trudeau) We could take a look at Calc UB-4. There may be correspondence in the attachment that indicates where the loads came from. I don't remember who it was that I got them from, but I suspect it may have been the project engineer on the job or the lead structural engineer on the job.
Q. Do you recall what form --
A. (Mr. Trudeau) G(B)4, the Pad Stability Analysis. G(B)4. We were looking at it earlier. We have an excerpt from it.
MR. TRAVIESO-DIAZ: It's Exhibit 39.
A. (Mr. Trudeau) But Exhibit 39 only has excerpts. It won't have what we're looking for.
Page B-1 of Calc G(B)4, Rev. 6 has a Post-it fax note near the center of the page that indicates to me that I received this data as a fax from Jerry Cooper, the assistant project manager, or project engineer at the time, likely.
Q. Is it correct that Attachment B was given to you in its entirety?
A. (Mr. Trudeau) That's my recollection. We can confirm that. Yes. The entire appendix is Attachment B of the calc.
Q. And what do those seismic loads represent?
A. (Mr. Trudeau) These are the dynamic

loadings from the casks to the top of the pads. It includes Table S-1, Maximum Vertical Displacements in Soil Bearing Pressures Dead Load; Table S-2, Maximum Vertical Displacements in Soil Bearing Pressures Live Load; dynamic horizontal and vertical soil pressures; total maximum horizontal soil reactions in the X direction dynamic loads; total maximum horizontal soil reactions in the Y direction dynamic load; summary of total maximum horizontal soil reactions dynamic load; maximum vertical soil bearing pressures dynamic load; vertical soil bearing pressures in horizontal soil shear stresses; and summary of vertical soil bearing pressures.
Q. Based on these results, do you have an opinion on whether the pad performs as a rigid mat or a flexible mat?
A. (Mr. Trudeau) I haven't looked at these results to determine whether or, you know, how to form that opinion as to whether there's information here to determine whether it's rigid or flexible.
Q. Did you use the pressure under the mat from that data to calculate bearing capacity for your bearing capacity analysis?
A. (Mr. Trudeau) I used the summary of vertical soil bearing pressures in determining the

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bearing capacity, yes, for the dynamic bearing capacity case for the two-cask, four-cask, and eight-cask loads shown in page B-10 of Attachment B of this calc.
Q. If you'll look at page 214.
(Exhibit 47 marked.)
Exhibit 47 is page 214, Table 5.2.5-1 out of the calculation package G(P017)-2. If you'll take a moment and familiarize yourself with this table. Let me ask that question: take a look at it.
Do you agree that this table shows the vertical displacement of the pad varies by a factor larger than 2.5 from one node to the other?
A. (Mr. Trudeau) That what varies by a magnitude of 2.5?
Q. The vertical displacement of the pad varies by a factor larger than 2.5 from one node to another.
MR. TRAVIESO-DIAZ: What column are you referring the witness to?
MS. NAKAHARA: On column A.
MR. TRAVIESO-DIAZ: Which column A?
MS. NAKAHARA: On the lower-bound properties.
A. (Mr. Trudeau) Is the question with respect to these nodes being adjacent to one another?
Q. No, any two points on the mat.

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A. (Mr. Trudeau) Any two points on the mat. Perhaps you can help me. Which nodes are we talking about?
Q. 274. For example, 274 versus 144.
A. (Mr. Trudeau) 274 versus 144?
Q. Yes.
A. (Mr. Trudeau) And the question is the difference between those?
Q. Do you agree the vertical displacement between those two nodes varies by a factor larger than 2.5?
A. (Mr. Trudeau) The vertical displacement at node 274 is listed as 0.046 feet, and the displacement at node 144 is listed as 0.017 feet.
Q. In your opinion, would this indicate, the difference between the two nodes indicate that the pad is not rigid?
MR. TRAVIESO-DIAZ: Object to the question. The witness may answer.
A. (Mr. Trudeau) I'm not familiar with this calculation, so I don't know exactly what it is I'm looking at. This is the displacements at the bottom of the pads from CEC's analysis?
Q. Yes.
A. (Mr. Trudeau) So what this is telling us is

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that at node 274, which is a point some almost 30 feet away from point node 144, the displacement is greater. So in the vertical direction, it appears the pad must be bending.
Q. Dr. Chang, do you have an opinion or do you agree?
A. (Dr. Chang) Based on the result, that means that they are not the same. So basically not -- you said still rigid, then everything should be the same. So the pad is elastic.
A. (Mr. Trudeau) I suppose it could be tilted, too.
Q. If the pad were bending, do you believe that in calculating soil spring and damping you should assume that the pads are rigid?
A. (Mr. Trudeau) That's, again, outside my scope on this project. Geomatrix is responsible for those soil springs and damping that were applied in the soil structure interaction analyses.
Q. Do you have an opinion?
A. (Mr. Trudeau) No.
Q. Dr. Chang?
A. (Dr. Chang) No.
Q. Earlier I believe you testified that the pads are only -- are five feet apart in longitudinal

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direction. Is that correct?
A. (Mr. Trudeau) Correct.
Q. Because the 64-foot pads are only five feet apart in longitudinal direction, did you consider the effect of pad-to-pad interaction?
MR. TRAVIESO-DIAZ: For what?
MS. NAKAHARA: For seismic loads.
MR. TRAVIESO-DIAZ: Do you understand the question?
A. (Mr. Trudeau) In the pad stability analyses G(B)4? Is that what we're talking about?
Q. Yes.
A. (Mr. Trudeau) The stability analysis in Calc G(B)4 took the dynamic loads on A single pad and used those in the analysis of the pad, so it did not combine pad after pad after pad in a row.
Q. Why not?
A. (Mr. Trudeau) Why?
Q. If the pads are only five feet apart, in your opinion you wouldn't expect A pad-to-pad interaction?
A. (Mr. Trudeau) I would expect that these are the maximum loads that any one pad would see at any one time. If you go far enough down the line, the loads are going to be less on adjacent pads. So if one pad can

stay in place for the maximum load that occurs at any particular time during the earthquake, the pad next to it will not see those same maximum loads. They'll be reduced somewhat.

Q. What's the basis of that opinion, your opinion?

A. **(Mr. Trudeau) Just the nature of the seismic loading. The seismic loading comes in waves, so that it's impossible for the pad at the beginning of the row to see and experience the same acceleration as the pad at the end of the row.**

Q. If the pads are all the same, would they create resonance that would increase the seismic loads?

A. **(Mr. Trudeau) I don't know.**

Q. Is it correct you did not consider it, the effect of resonance?

A. **(Mr. Trudeau) Correct.**

Q. If you'll look at, and I didn't make copies of this, SAR page 2.6-59. Are you familiar with PFS's analysis of overturning and sliding stability of the pads?

A. **(Mr. Trudeau) Correct, yes.**

Q. Do you agree that the analysis of overturning and sliding stability of the pads are based on the maximum peak ground acceleration?

A. **(Mr. Trudeau) It's not clear from this page what was done in sliding analysis, but what I can see for the overturning analysis is that the inertial force of the pad was used based on the peak ground acceleration.**

Q. Do you agree that using maximum peak ground acceleration -- strike that.

Do you agree that using maximum peak ground acceleration to attain inertial load to analyze overturning of the pads is only valid for rigid systems?

A. **(Mr. Trudeau) The pad is a rigid system in the horizontal direction. We're talking about horizontal loads to overturn this pad.**

Q. So you would agree that it is all developed for a rigid system?

A. **(Mr. Trudeau) Correct.**

Q. This is from calculation package G(P017)-2, page 177, which is a graph of amplitude and frequency. Are you familiar with this graph?

A. **(Mr. Trudeau) No.**

Q. Based on looking at the graph, do you agree that the vertical frequency of a cask/pad soil system varies from below 5 cycles per second to above 8 cycles per second depending on the soil properties considered?

A. **(Mr. Trudeau) I'm not familiar with this**

calc at all. Before I could answer that, I would need to know what the coordinate system is that's used in this. This is referring to a Z direction at node 261. I can only assume you have provided me with a vertical.

Q. Did you consider the natural frequency of the soil pad system in the overturning analysis?

A. **(Mr. Trudeau) No.**

Q. And why not?

A. **(Mr. Trudeau) I assumed the pad was rigid in the horizontal direction.**

Q. If you will look at the Safety Analysis Report on page 2.6-59, Revision 13. Is the maximum peak ground acceleration in the vertical direction in that calculation?

A. **(Mr. Trudeau) 0.533 G's.**

Q. What is your basis for using .33 G's in that calculation -- .533 G's?

A. **(Mr. Trudeau) I was calculating the inertia of the pad using the peak ground acceleration in a vertical direction.**

Q. Why did you use the peak ground acceleration?

A. **(Mr. Trudeau) Because I thought that was the right value to use.**

Q. Do you agree that the right acceleration is

the acceleration at the natural frequency of the soil pad?

A. **(Mr. Trudeau) I guess I would have to say no, because if I thought that was the right one, that's the one I would have used.**

Q. Are you familiar with the vertical design response spectrum?

MR. TRAVIESO-DIAZ: Sorry -- the vertical design response spectrum of what?

MS. NAKAHARA: The design basis motion.

MR. TRAVIESO-DIAZ: Of what?

MS. NAKAHARA: Of the PFS facility.

MR. TRAVIESO-DIAZ: Do you understand the question?

A. **(Mr. Trudeau) That's an area that our structural mechanics people would be involved with.**

MS. NAKAHARA: Can we take a five-minute break while we look for a document?

(Recess from 6:20 to 6:33 p.m.)

Q. (By Ms. Nakahara) Page 20 out of Calculation Package 05996.02-G(P018)-3, dated 8/24/99, Figure 7. Are you familiar with this document?

A. **(Mr. Trudeau) I know what it is, but I've never reviewed it. This is the generation of the artificial time history, I believe.**

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Q. Yes. On the right-hand graph is the vertical response spectrum design, design response spectrum. Based on this spectrum, would you -- in your opinion, would you agree that .533 G's applies to a foundation with natural periods at approximately .02 seconds?
MR. TRAVIESO-DIAZ: Excuse me, Counsel. Are you asking the witness to read a part of the graph, or what is it that you're asking him to do?
MS. NAKAHARA: He agreed that .33 G on this graph -- .533 G's on this graph applies to a foundation with natural periods at approximately 0.2 seconds.
A. (Mr. Trudeau) 0.02 seconds. That's what I believe this is saying, yes.
Q. (By Ms. Nakahara) If the natural period of the soil pad system in the vertical direction is in a range on this graph between .1 to .3 seconds, do you agree acceleration would be higher than 0.33 G's, 0.533 G's?
A. (Mr. Trudeau) Yes.
Q. Based on this response spectrum, would your calculations on SAR page 2.6-59 for overturning of the pads, were those calculations changed which used the 0.533 G's?
A. (Mr. Trudeau) I don't know.

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Q. You've already answered this, but is it correct that you did not consider the natural frequency of the soil pad system in your analysis of overturning of the pads?
A. (Mr. Trudeau) Yes.
Q. Did you consider the natural frequency of the soil pad system in your sliding analysis that you calculated in G(B)04?
A. (Mr. Trudeau) No.
Q. And why not?
A. (Mr. Trudeau) I assume that the pad was rigid in the horizontal direction because it is rigid in the horizontal direction.
Q. Is it correct that the pad was supported by 30 feet of medium stiff to stiff soil?
A. (Mr. Trudeau) As well as a thin layer of soil cement.
Q. Based on the fact that the pad is supported by 30 feet of medium stiff and stiff soil, wouldn't that indicate that the soil pad system is not rigid?
MR. TRAVIESO-DIAZ: I think he answered that question twice already. He's assumed it was rigid.
A. (Mr. Trudeau) In the horizontal direction.
MR. TRAVIESO-DIAZ: In the horizontal direction.

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A. (Mr. Trudeau) Which is the direction applicable for sliding.
Q. (By Ms. Nakahara) In your assumption that the pad is rigid in the horizontal direction, did you only consider the concrete pad, or the concrete pad and soil in combination?
A. (Mr. Trudeau) The concrete pad.
Q. Do you agree that the natural frequency in the horizontal direction for the soil is different -- is driven by soil dynamic, by dynamic soil properties -- strike that. Let me start over and try this again.
Would you agree that the natural -- just a minute. Let me try this again.
Would you agree that the natural frequency in the horizontal direction is driven by dynamic soil properties?
A. (Mr. Trudeau) I don't know.
Q. What information -- what type of information would allow you to assess whether the natural frequency in the horizontal direction is driven by dynamic soil properties?
A. (Mr. Trudeau) I don't know.
Q. This is Document G(PO18)-1. Did I ask you about this document before? This is Soil and Foundation Parameters for Dynamic Soil Structure Interaction

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Analysis, dated -- reviewed 8/26/99, Revision 1. Are you familiar with this document?
A. (Mr. Trudeau) Yes.
Q. What is your familiarity?
A. (Mr. Trudeau) I understand that this is a calculation that was prepared by Geomatrix to develop the strain compatible soil properties for use by our structural mechanics people in their soil structure interaction analyses for the 1,000-year return period earthquake.
Q. The one thousand?
A. (Mr. Trudeau) Yes, ma'am.
Q. Did you use any of the calculations from this document in any of your subsequent calculations?
A. (Mr. Trudeau) I don't think so. I mean, I've reported these results in the geotech design criteria. Geomatrix had the scope to produce those dynamic soil properties, and I added them to our geotech design criteria for use by our structural mechanics people and Holtec and CEC.
For the record, this calc is supplemented or superseded by G(PO18)-2, which is applicable for the 2,000-year return period earthquake. This calculation supplements (PO18)-2 inasmuch as the soil profile background information is developed in this calculation.

As opposed to reiterating it in (P018)-2, Geomatrix just referred back to this one in their subsequent calc.
Q. Do you know whether in this document it states that below 45 feet the soil properties are not well defined?
A. **(Mr. Trudeau) I don't recall.**
Q. Dr. Chang, are you familiar with this document?
A. **(Dr. Chang) No.**
Q. Are you familiar with the effects of concrete cracking under seismic loads?
A. **(Mr. Trudeau) No.**
MS. CHANCELLOR: I'd just like to say if the witnesses get tired, please let us know and we can continue this in the morning.
Q. (By Ms. Nakahara) Do you know if the foundation stability analysis from -- strike that.
Do you know if the seismic loads for foundation stability analysis were obtained from dynamic analysis of the building, for the canister transfer building?
A. **(Mr. Trudeau) The dynamic loads applied in the Calc G(B)13 did come from the soil structure interaction analysis.**
Q. Were the seismic loads obtained from the

soil structure interaction analysis?
A. **(Mr. Trudeau) Yes.**
Q. This is calculation package 5996.02-G(B)13, entitled Stability Analysis of the canister transfer building Supported on a Mat Foundation, Rev. 2. Are you familiar with this document?
A. **(Mr. Trudeau) Rev. 3.**
Q. Rev. 3.
A. **(Mr. Trudeau) Yes.**
Q. Is it correct that you are the preparer of this document?
A. **(Mr. Trudeau) Of Rev. 2 and 3, yes.**
Q. Is it correct that Dr. Chang is the independent reviewer and reviewer?
A. **(Dr. Chang) Yes.**
MR. TRAVIESO-DIAZ: I'd just like to state for the record that went through all this with respect to this document, which is Exhibit 46, in the prior examination by Ms. Chancellor.
MS. NAKAHARA: And I apologize. It's been a long day, which doesn't help you.
Q. (By Ms. Nakahara) Is it correct that the canister transfer building stability analysis in this document, that the seismic loads are obtained by multiplying the mass at each elevation by the

acceleration response from the dynamic analysis?
A. **(Mr. Trudeau) Yes.**
Q. Did the canister transfer building analysis consider the effect of rotational mass moment of inertia?
A. **(Mr. Trudeau) I don't know. I took the loads that were provided me in this Table 2. This Table 2 I believe was based on one of the SC calcs. I'd have to look there to find that answer, I think.**
Yes, page 41 of this calc says that "the dynamic bearing capacity was analyzed using dynamic loads for the building that were developed in Calculation 05996.02-SC-5."
Q. Did you use the loads from SC-5 or acceleration response?
A. **(Mr. Trudeau) I used the masses and the accelerations provided by SC-5.**
Q. Why didn't you include mass moment of inertia calculation in your calculation?
A. **(Mr. Trudeau) I didn't, you know -- I didn't think I needed to.**
Q. Based on --
A. **(Mr. Trudeau) Well, I thought that the correct way to calculate the dynamic load was to take the masses that were provided to me with the peak**

acceleration values that were provided me to come up with a force. Those are the forces I used.
Q. Do you agree that the mass moment of inertia creates additional overturning?
A. **(Mr. Trudeau) I don't know, nor do I know that those aren't already included in these accelerations that are shown here.**
Q. If the mass moment of inertia is not included in the Table 2 of Calculation SC-5, would you agree that estimating seismic load by multiplying mass times acceleration ignores the coupling from the two horizontal directions?
A. **(Mr. Trudeau) I don't know. This table included the two different horizontal directions by combining them in accordance with the 14040 Rule that comes from ASCE 4 now dash 98, but we're using 4-86, and also the SRP, I believe -- I don't remember the number. But it's an acceptable way of combining these horizontal components in this analysis. So I don't know if what you're suggesting results in different values, but the horizontal components were combined in this manner in this analysis.**
Q. Do you have an opinion, Dr. Chang?
A. **(Dr. Chang) No. I think what happened, it's whatever the structural mechanics give us a load,**

and we use their load in all our analysis.
Q. Same document I just took from you, G(B)13 on page 15, look at that. Do you agree that PFS used a shear key one foot deep around the canister transfer building to improve the shear resistance against sliding?
A. (Mr. Trudeau) Yes.
Q. Do you agree that this document -- this calculation document estimates a factor of safety as low as 1.1?
MR. TRAVIESO-DIAZ: Where in the exhibit are you asking the witness to look?
A. (Mr. Trudeau) Yes.
Q. (By Ms. Nakahara) Do you agree that this factor of safety calculation lies on the passive resistance behind the one-foot shear key to develop the resisting forces against sliding?
MR. TRAVIESO-DIAZ: I object to the question. You can answer if you can.
A. (Mr. Trudeau) I'm sorry. Could you repeat the question again, please?
MS. NAKAHARA: Would you read that back?
(The pending question was read.)
A. (Mr. Trudeau) Yes.
Q. This is calculation package G(P018)-2,

titled Soil and Foundation Parameters for Dynamic Soil Structure Interaction Analysis, 2,000-Year Return Period, Design Ground Motions, last reviewed 8/10/99. Are you familiar with this document?
A. (Mr. Trudeau) Yes.
Q. And what is your familiarity?
A. (Mr. Trudeau) This is the current strain compatible soil property development calculation that Geomatrix prepared for the 2,000-year return period earthquake, the current design ground motion.
Q. Did you use any of this data in any of your calculations?
A. (Mr. Trudeau) It's the same answer that I provided to the -- you know, I thought I was answering that question on this calc before. You know, I do not believe that I used any of these results in geotechnical calcs, but I understand that these were used in the soil structure interaction analysis. They do appear in geotech design criteria for that purpose.
Q. Do you know if in calculation package (P018)-2 if part of the shear strength has already been mobilized due to the free field wave propagation and the full soil shear strength is not available to resist the inertial load of the structure?
A. (Mr. Trudeau) I don't know.

Q. Are you aware of the shear strength value used in calculation package (P018)-2?
A. (Mr. Trudeau) The shear strength values used for (P018)-2?
Q. Strike that. Are you aware of the shear strength value used in calculation package G(B)13?
A. (Mr. Trudeau) For sliding?
Q. For stability analysis.
A. (Mr. Trudeau) I did the analysis. I don't remember the numbers. I'll find them.
Undrained strength used for dynamic bearing capacity analysis was 2.2 ksf, but it was modified based on the cone penetration test results to -- the 2.2 ksf was measured for what we were earlier calling layer 2. All of the boring data and the cone penetration data indicate that what we were calling layer 4 and layer 3 are stronger than the layer 2. And for bearing capacity analyses of the entire upper layer, it's appropriate to use an average strength to resist bearing failure. So we adjusted the 2.2 values in a relative increase as measured in the cone penetration test data. So the resulting average shear strength for the dynamic bearing capacity was 3.18 ksf.
Q. Did that shear strength value of 2.2 kips per square feet account for mobilized shear strength due

to free field wave propagation?
A. (Mr. Trudeau) No.
Q. Why not?
A. (Mr. Trudeau) I didn't think it needed to.
Q. Based on what assumption?
A. (Mr. Trudeau) No assumption necessary. I just didn't --
Q. Does free field propagation impose loading on the soil?
A. (Mr. Trudeau) I don't know.
Q. Is it correct this morning that you testified you estimated free field shear stresses to plan the triaxial -- cyclic triaxial tests?
A. (Mr. Trudeau) Yes.
Q. Would that imply there is free field propagation loading on the soil?
A. (Mr. Trudeau) I didn't understand the --
Q. Does that mean -- strike that last question. Does that mean that loading from free field -- from free field wave propagation would be imposed on the soil?
A. (Mr. Trudeau) I guess so, yes. I didn't understand the way the question was presented that that's the stresses that we're talking about.
Q. Okay. If those are the stresses we're talking about -- strike the last part of that. If you

use free field shear stresses to plan the triaxial, the cyclic triaxial tests, why didn't you consider the free field wave propagation in the stability analysis?
MR. TRAVIESO-DIAZ: The witness just testified he didn't think he needed to.
MS. NAKAHARA: But I thought he said he didn't understand the stresses that --
I guess maybe I don't understand. He didn't understand my question, and then I didn't understand his response.
A. (Mr. Trudeau) **It didn't occur to me that we needed to be including the free field shear stresses in the soil, in the sliding stability analysis.**
Q. Would you change your opinion now?
A. (Mr. Trudeau) **I don't know. I would want to think about it.**
Q. Dr. Chang, do you have an opinion?
A. (Dr. Chang) **I think that's two different things. One is the free field. That's typical, that's a normal seismic measure to calculate what the strain of the soil is going to be due to wave propagation. And during that one, if you have a soil -- you have a structure on the top, typical the low, the stress is still not going to change that much. The structure on the top have some effect, but overall you have to go**

with the soil structure interaction analysis, and that stress is based on a sealed beam analysis, one dimension. And when you have a structure on the top, typical the structure will have inertial force, and for this bearing capacity we only include that inertial force and apply on the soil. And the stress we apply through the propagation may not be the same time as the inertial force and also may not be in the same direction.
So when you do an analysis, if you pursue to that, you have to be really careful because we really don't know what we deal with. So basic for the bearing capacity analysis, we only consider inertial force of the structure.
Q. In your stability analysis, did you use passive soil pressure on one side of the key, on one side of the shear key?
MR. TRAVIESO-DIAZ: Which stability analysis?
MS. NAKAHARA: The canister transfer building.
A. (Mr. Trudeau) **I already indicated we did that on the analysis that follows the page 15 you pointed me to before. That, I'd like to add, is a hypothetical analysis of sliding on a potential deeper**

lying soil that maybe doesn't have cementation, and it used the passive resistance on the potentially sliding block to show that it would stay in place. Before that block could move, we need to exceed the passive resistance of that soil.
Q. (By Ms. Nakahara) Did you consider the static and seismic soil pressure on the other side of the shear key in your stability analysis?
A. (Mr. Trudeau) **This, again, is that deep-seated failure plane we're talking about, or the other analysis of the building?**
Q. In the calculation that you used passive pressure from the shear key.
A. (Mr. Trudeau) **I'm looking at page 13 of this calc that does the sliding stability analysis of the canister transfer building founded on the in situ silty clay soils. And I see that we used half of the passive resistance on the side of the building down to the bottom of the perimeter key, a six-foot height.**
Q. So is it correct you did not consider the static and seismic soil pressure on the other side of the key?
A. (Mr. Trudeau) **I haven't gotten that far yet.**
Q. I'm sorry.

A. (Mr. Trudeau) **We included half of the passive resistance.**
It appears we did not include it.
Q. Why not?
A. (Mr. Trudeau) **I don't see any mention of it in this calculation. I believe the fact that they're not included is just an oversight. The numbers that we're talking about are for very lightweight materials. They're going to be very small numbers that would be I suspect less than the half of the passive resistance that we didn't include.**
MS. NAKAHARA: Can you want to read back his answer?
(The last answer was read back.)
Q. (By Ms. Nakahara) Do you mean an oversight in not putting it in the document, or an oversight that you did not consider the static and seismic soil pressure on the other side of the shear key?
A. (Mr. Trudeau) **I don't understand the difference in the question.**
Q. Did you actually consider the static and seismic soil pressure on the other side of the shear key, or did you just not put in the fact that you considered it in this document?
A. (Mr. Trudeau) **It appears that we didn't**

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consider it.
Q. Okay, thank you. Do you agree -- do you need to look some more?
A. (Mr. Trudeau) Yes. Could I have just a couple minutes, please?
Q. Sure. Take as much time as you need.
A. (Mr. Trudeau) It's not like me to not include that kind of thing, so I want to make sure it's not here.
Q. Would you like to take a break so we're not all staring at you?
A. (Mr. Trudeau) That would be fine. I just need about five minutes.
(Recess from 7:29 to 7:40 p.m.)
A. (Mr. Trudeau) I can't see it in this calc. I'm afraid to say I think it was just an oversight that it wasn't included. I believe it's going to be a very small number. We have the same calc in the calc -- I mean, the pad stability analysis. We can see there that it's a very small number. It's going -- I would assume be less than the passive resistance. Looks like it was just an oversight.
Q. (By Ms. Nakahara) Do you agree that the soil behind the face of the mat has low overburden pressure; the passive resistance will actually develop

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behind the shear key on the inner side of the mat where the overburden of the building confines the soil?
A. (Mr. Trudeau) I believe the passive resistance will build on both places.
Q. Do you have an opinion on which location would have a higher passive resistance?
A. (Mr. Trudeau) The material behind the key will provide more of the resistance.
Q. Will the overburden of the building contribute to the passive resistance?
A. (Mr. Trudeau) Yes.
Q. Do you agree that the passive resistance under the mat mobilizes the passive zone and develops vertical loads acting locally under the mat?
A. (Mr. Trudeau) I don't think -- I don't understand the question. Could you say it again, please? Let me hear it again.
(The pending question was read.)
A. (Mr. Trudeau) There clearly are vertical loads under the mat. What effect the passive resistance behind the key has, I don't know.
Q. Would the passive soil on the inner side of the mat put a vertical load on the mat?
A. (Mr. Trudeau) The mat overlying the soil is holding it in place, so one acts against the other. I

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guess the answer would be yes.
Q. Did you consider the passive soil and its reaction under the mat in the stability analysis of the canister transfer building and design of the mat?
A. (Mr. Trudeau) The analysis assumes that the block of clay encompassed by the perimeter key is held in place by the perimeter key so that the resistance to motion is provided on the base of the plane defined by the bottom of the key.
Q. Would that imply there's no passive zone under the mat?
A. (Mr. Trudeau) It doesn't take credit to that passive resistance. It assumes that all of the strength is provided by shearing across the plain at the bottom of the key.
Q. The passive load, passive zone -- strike that. If a passive zone develops under the mat, would it put a vertical load on the mat?
A. (Mr. Trudeau) I'm not sure you would have a passive failure in that location. I think the soil is shearing below the plain defined by the perimeter key. And shearing at that point, it wouldn't get the vertical load that you're looking for, in my opinion.
Q. Dr. Chang, do you agree with Mr. Trudeau?
A. (Dr. Chang) There shouldn't be large amount

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of what they call load, because you have to consider the rigidity of the mat and the shear key. Basic they all move together, and the passive inside going to develop if the key moves against the soil, and the soil on the low core move up, and then you can develop the vertical load. But in this condition everything move together, you shouldn't have.
Q. Is the mass of the soil inside the shear key circle considered in calculating a load?
A. (Mr. Trudeau) I don't recall. I don't think it was.
Q. Why not?
A. (Mr. Trudeau) I don't know why not.
Q. Earlier we -- earlier I asked you questions with respect to your overturning analysis in G(B)13. Do you agree that in calculating the resisting moment for the overturning -- in the overturning analysis that you assume the mass center of the building is at the center of the mat?
A. (Mr. Trudeau) The resisting moment is calculated as the width of the building times the distance from one edge of the mat to the center of the mat.
Q. By making that assumption, did you account for the mass eccentricity at various elevations and

underestimating the overturning moment?
A. (Mr. Trudeau) **I don't know.**
Q. Did you consider that at each elevation the mass is not centered at the center of the mat?
A. (Mr. Trudeau) **No.**
Q. Why not?
A. (Mr. Trudeau) **I didn't know that they weren't centered.**
MS. NAKAHARA: Can you read my last question?
(The record was read: "Q. Did you consider that at each elevation the mass is not centered at the center of the mat?")
Q. (By Ms. Nakahara) If the mass is not centered at the center of the mat for each elevation, would that change your overturning analysis calculation?
A. (Mr. Trudeau) **It could.**
Q. In Calculation Package SC-5, which you already testified you weren't familiar with, it describes the -- in Attachment A, the building masses. And it gives the masses -- the masses, centroid and masses and mass moment of inertia at each elevation using the Stone & Webster computer program M-A-S-S. And although you're not familiar with that document specifically, have you seen any of the data in that

document?
MR. TRAVIESO-DIAZ: Objection. The witness testified that he's not familiar with the document.
MS. NAKAHARA: With the specific document, but I mean the data.
A. (Mr. Trudeau) **Well, I believe this is the document that the masses and accelerations that I show in my Table 2 of G(B)13 came from, but I don't know where in this calc it came from. And I'm not familiar with this page that you're referencing as Attachment A.**
Q. Can you clarify what processes are in place to ensure that you were provided with all applicable information for your calculation, for example, to ensure that you were given all applicable building mass information from this document, SC-5?
MR. TRAVIESO-DIAZ: Objection. The question was asked to this morning, and he testified at length how the design process and the sharing of information among disciplines and all the things that went on. We talked about that for at least 15 minutes. It's asked and answered.
Q. (By Ms. Nakahara) Doesn't that show there are gaps in the process if you're not sure what information from various calculation packages you've incorporated into subsequent calculation packages?

MR. TRAVIESO-DIAZ: Objection. That's not what he testified. He testified where he got information from.
A. (Mr. Trudeau) **I thought I had all the information I needed.**
Q. Is the information -- is it correct that -- strike that.
Who would identify what information from calculation package SC-5 goes into the design document that you obtained your information from?
A. (Mr. Trudeau) **Who would do what?**
Q. Who would identify what information in Calculation SC-5 would go into the overall design document that everyone else gets their information from?
A. (Mr. Trudeau) **I would guess the structural mechanics people that prepared that calc would provide that information.**
Q. And are they familiar with the type of information that you and other teams would need for the various different calculations?
A. (Mr. Trudeau) **I believe so, yes.**
Q. And how would they become familiar with the type of information necessary for other teams' calculations?
A. (Mr. Trudeau) **I would have requested the**

dynamic loads for use in an overturning and sliding analysis, and he would have provided them.
Now, the fact that I haven't included an eccentricity on the different elevations may mean that that's not significant. I don't know. I haven't seen that information. It needs to be checked, having brought up this issue. I thought that it was a symmetrically designed building and that it didn't need to be included in my analyses, because that information hadn't been provided when I asked for the loads.
Q. When you indicate the type of information that you need for various calculations, do you also provide the type of parameters such as identifying whether the mass centers are the same at each elevation?
A. (Mr. Trudeau) **I did not specifically ask for that information.**
Q. In general, would you identify various parameters for the type of information? Strike that.
If you thought that eccentricity was important, when you asked for information from other disciplines or from other teams, would you have specified that you wanted to know whether the mass centers were different at different elevations?
A. (Mr. Trudeau) **Obviously.**
Q. Okay. So for similar types of information

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that you requested, you would -- if you felt it was important, you would identify the type of parameters; you would define the parameters of information you wanted. Is that correct?
A. (Mr. Trudeau) **Correct.**
Q. Do you believe any oversight in considering eccentricity would underestimate the overturning moment?
A. (Mr. Trudeau) **I can agree that it might, but I suspect that the differences aren't that great. I will have to review the centers of gravity of these masses and see just how much it does affect these analyses.**
Q. Dr. Chang, do you agree?
A. (Dr. Chang) **I think what we have to know, exact what the structural mechanics provide to us. They provide to us the vertical load and also the moment, and some of the eccentricity probably already included in their analysis. So whatever the load, they give it to us, give it to the center of the foundation. Center of the foundation. And it include the moment. So those moment of shear force are probably already considered on the whole structure of eccentricity. So we really don't know. We have to check it out.**
Q. Did you obtain the seismic loads directly from the seismic -- or the structural group, or did you

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obtain the accelerations and calculate the loads?
A. (Mr. Trudeau) **We obtained the accelerations and the masses.**
MS. NAKAHARA: I think we're finally done, gentlemen. Thank you.
(Deposition was concluded at 8:06 p.m.)
* * *

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December 11, 2000

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GEOTECHNICAL CHARACTERIZATION OF PFSF SITE
DOCKET NO. 72-22/TAC NO. L22462
PRIVATE FUEL STORAGE FACILITY
PRIVATE FUEL STORAGE L.L.C.

Recent evaluations of test data previously collected for the Private Fuel Storage Facility (PFSF) site suggest that some of the data may not have been fully integrated into the geotechnical assessment of the site. We are currently assessing the implications that this might have with respect to design basis ground motion, soil/structure interactions, stability analyses, and other related issues. PFS anticipates completing this assessment by December 22, 2000. If we determine from this assessment that there is an impact on our licensing basis, we will provide at that time a timetable of the actions necessary to update our License Application. We do not believe that this assessment has any implications with respect to our analysis of the seismicity of the site or the choice of the appropriate return period used to select the seismic design response spectra.

If you have any questions please contact me at 608-787-1236 or Mr. J. L. Donnell, Project Director, at 303-741-7009.

Sincerely,

John D. Parkyn, Chairman
Private Fuel Storage L.L.C.

Mark Delligatti
John Donnell
Jay Silberg
Sherwin Turk
Asadul Chowdhury
Murray Wade
Scott Northard
Denise Chancellor
Richard E. Condit
John Paul Kennedy
Joro Walker

Private Fuel Storage, LLC

P.O. Box C4010, La Crosse, WI 54602-4010
John D. Parkyn, Chairman of the Board

December 22, 2000

Mr. Mark Delligatti
Senior Project Manager
Spent Fuel Project Office
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

GEOTECHNICAL CHARACTERIZATION OF PFSF SITE
DOCKET NO. 72-22 / TAC NO. L22462
PRIVATE FUEL STORAGE FACILITY
PRIVATE FUEL STORAGE L.L.C.

Reference: PFS Letter, Parkyn to Delligatti, Geotechnical Characterization of PFSF Site, dated December 11, 2000

PFS has completed the initial assessment of the implications of revisions to the geotechnical characterization of the PFSF site resulting from the inclusion of data not previously incorporated. We have determined that there will be an impact to the project licensing basis. An amendment to the License Application will be prepared to reflect the required changes in the PFSF design basis ground motion and dynamic stability analyses based on new shear and pressure wave velocity profiles being developed for the site. This amendment will update the following chapters/sections of the PFSF License Application:

1. Section 2.6.2.1 of the SAR, "Engineering Properties of Materials for Seismic Wave Propagation and Soil-Structure Interaction", will be revised to incorporate any changes that are made to the velocity profiles and resulting changes to the site response analyses and idealized soil profiles for use in soil-structure interaction analyses. Section 2.6.1.12 of the SAR, "Stability of Foundations for Structures and Embankments" will be updated, as necessary, to revise discussions of the results of dynamic stability analyses of the storage pads and the Canister Transfer Building resulting from changes to the PFSF site design basis ground motion. SAR Section 2.6.4.9, "Design Basis Ground Motion", will be updated, as necessary, to identify the

new design basis ground motions. Changes to maintain consistency will also be made to other subsections of Section 2.6 of the SAR.

2. Section 3.2.10.1.1 of the SAR, "Design Response Spectra", will be revised to reflect the site-specific horizontal and vertical response spectra curves associated with the new design basis ground motion. Changes to maintain consistency will also be made to other subsections of Section 3.2.10 of the SAR.

3. Section 4.2.1.5.1(H) of the SAR, which evaluates the structural design of the storage cask under seismic conditions, will be updated to reflect the results of the HI-STORM storage cask stability analyses based on the new seismic response spectra. SAR Section 4.2.3.5.1, "Storage Pad Analysis", will be revised to reflect the dynamic analyses of the storage pads for the new design basis ground motion. SAR Sections 4.7.1, "Canister Transfer Building", and 4.7.2, "Canister Transfer Cranes", will be updated as necessary to incorporate changes resulting from the new seismic loads.

4. SAR Section 8.2.1, "Earthquake", will be revised to reflect the new design basis ground motion and the results of the HI-STORM storage cask stability analyses based on the new seismic response spectra. In addition, the discussion of the stability of a loaded cask transporter under seismic conditions (Section 8.2.6.2) will be updated for the new design basis ground motion.

5. Section 2.6 of the PFSF Environmental Report, which includes a summary of the geotechnical and seismic information in Chapter 2 of the SAR, will also be updated so that it is consistent with the information presented in the SAR. Section 2.6.5 of the ER, "Engineering Characteristics of Site Materials", will be revised to incorporate any changes that are made to the velocity profiles and resulting changes to the site response analyses and idealized soil profiles that were used in the soil-structure interaction analyses. ER Section 2.6.8, "Design Basis Ground Motions", will be updated, as necessary, to identify the new design basis ground motions. Changes to maintain consistency will also be made to other subsections of Section 2.6 of the ER. PFS does not anticipate that changes will be needed in the NRC's Environmental Impact Statement (EIS), since Section 4.1 of the Draft EIS, "Geology and Soils", states that "The adequacy of the proposed PFSF design to withstand earthquakes will be addressed in the NRC's final SER and is not addressed in this DEIS."

Several calculations, analyses, and reports must be revised to support the license amendment and will also be submitted to the NRC. The current target date for submittal of Amendment #20 to the License Application is March 2, 2001. If you have any questions regarding this response, please contact me at 608-787-1236 or Mr. John Donnell, Project Director, at 303-741-7009.

Sincerely,

John D. Parkyn, Chairman
Private Fuel Storage L.L.C.

cc:
John Donnell
Jay Silberg
Sherwin Turk
Asadul Chowdhury
Scott Northard
Denise Chancellor
Richard E. Condit
John Paul Kennedy
Joro Walker

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

January 19, 2001

Mr. John D. Parkyn
Chairman of the Board
Private Fuel Storage, L.L.C.
P.O. Box C4010
La Crosse, WI 54602-4010

SUBJECT: YOUR DECEMBER 11, AND DECEMBER 22, 2000, LETTERS

Dear Mr. Parkyn:

I am responding to your December 11, and December 22, 2000, letters to Mr. Mark Delligatti. In those letters you inform the U.S. Nuclear Regulatory Commission (NRC) staff that Private Fuel Storage, LLC (PFS) plans to submit amendments to its Safety Analysis Report (SAR) and the Environmental Report (ER) for the license application for the proposed Private Fuel Storage Facility (PFSF), concerning certain geotechnical matters. Your second letter details the specific sections of the SAR and ER that you anticipate will be affected. I note that subsequent to your two letters, the NRC staff determined that new information concerning aircraft crash hazards was contained in the PFS motion to the Atomic Safety and Licensing Board for summary disposition of Utah Contention K and Confederated Tribes Contention B, "Inadequate Consideration of Credible Accidents." Mr. John Donnell, of your staff, has indicated that this new information will also be included in amendments to the SAR to be submitted in late January 2001.

As you know, the NRC staff completed its Safety Evaluation Report (SER) for the proposed PFSF on September 29, 2000. The NRC staff, the Department of Interior's Bureau of Land Management and Bureau of Indian Affairs, and the Surface Transportation Board [which are cooperating with the NRC staff in the development of the PFS Final Environmental Impact Statement (FEIS)] had planned to issue the FEIS (including responses to the extensive comments received on the Draft EIS) on February 28, 2001. To this end, many Federal employees and contractors have been diligently working during the preceding period to meet this schedule, and publication of the FEIS has remained on target for February 28, 2001.

You have now informed us of additional analyses being performed related to the geophysical characterization of the proposed PFSF site. You indicated that the resulting amendments to the SAR and ER will not be submitted to the NRC until early March 2001. PFS has indicated that the design basis ground motion and dynamic stability analyses could be affected, based on new shear and pressure wave velocity profiles being developed for the site; that structural design analyses could be affected; and that the SAR and ER will both be affected. You have also indicated that the new aircraft crash data and accident analysis revision, reflecting your motion for summary disposition, will be submitted as an amendment to the SAR later this month. This SAR amendment regarding credible accidents will account for new data that PFS received from the U.S. Air Force regarding F-16 aircraft, along with PFS analysis of this and other data, and reconsideration of previously submitted data and analyses.

In your letter of December 22, you state that "PFS does not anticipate that changes will be needed" in the staff's EIS, since section 4.1 of the Draft EIS states that "[t]he adequacy of the proposed PFSF design to withstand earthquakes will be addressed in the Staff's final SER and is not addressed in this DEIS." While you correctly cite this statement, we believe you overlook the fact that in the same section of the DEIS, the staff committed to provide a summary in the FEIS of its evaluation findings concerning geologic and seismic considerations (DEIS at 1-12); also, other DEIS conclusions concerning the impacts of the facility were reached on a preliminary basis, prior to completion of the SER (*see, e.g.*, DEIS at 4-48).

We anticipate that portions of the staff's SER published in September 2000, may need to be revised to reflect our review of your motion for summary disposition and your upcoming SAR amendment(s). If the staff determines that the bases for any safety conclusions reached in its SER have changed, a supplement to the SER will have to be developed; and even if the SER bases and conclusions remain unchanged, this would have to be documented.

With regard to the FEIS and the responses to comments on the DEIS, it cannot be determined with certainty, in advance of our receipt and review of your submittals, whether the conclusions which resulted from the staff's review of the currently docketed information are appropriate or require revision. Accordingly, in light of PFS' recent submittal of new information and its determination to amend its license application, we do not believe it would be appropriate or prudent to publish the FEIS until the staff has reviewed the new information and the upcoming license application amendments. When the staff has reviewed the new information and SAR and ER amendments, we will be able to determine the impact that the submittal of the new information and amendments may have on the schedule for completion and release of the FEIS.

Finally, PFS should consider that the Final SAR (FSAR) for the proposed PFSF must be submitted to the NRC staff under oath and affirmation. It is important, therefore, that PFS review the entire document and determine it to be complete and accurate at the time of its submittal, particularly after fully taking into consideration any impacts that may result from any new information and analyses. In addition, as Mr. Delligatti has previously indicated to Mr. Donnell, we expect all of the commitment letters associated with the safety evaluation to be included as an appendix to the FSAR.

If you have any questions regarding this letter, please contact Mr. Delligatti at (301) 415-8518.

Sincerely,

E. William Brach, Director
Spent Fuel Project Office
Office of Nuclear Material Safety
and Safeguards

Docket No.: 72-22
cc: Service Lists

CONDENSED TRANSCRIPT

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of PRIVATE FUEL STORAGE L.L.C. (Private Fuel Storage Facility)	) Docket No. 72-22) ASLPB No. 97-732-02-ISFSI))) DEPOSITION OF:)) WALTER J. ARABASZ)

CONFIDENTIAL AND PROPRIETARY

Wednesday, October 18, 2000 - 9:30 a.m.

Location: Parsons, Behle & Latimer

201 S. Main, #1800

Salt Lake City, Utah

Reporter: Vicky McDaniel

Notary Public in and for the State of Utah

study, being judged to be not directly significant.
Q. And you would agree with that judgment, that it's not directly significant, volcanic hazard?
A. I am not familiar with the history of volcanic activity in this general area, and I would be reluctant to offer an opinion.
Q. Just to clarify: apart from the volcanic activity, then, they did cover everything else in Appendix D?
A. Down to the next to the last bullet, the effects of human activities, I don't recall relevant investigations. I would infer a judgment that they were basically not material.
Q. And would you agree with that judgment or disagree?
A. I'm not familiar with any history of withdrawal of fluids in that basin. In general I would agree, but I don't have that direct familiarity.
Q. Then those are the only two potential exceptions that you see with respect to Appendix D?
A. In terms of acknowledging that appropriate studies were undertaken, yes.
MR. GAUKLER: I'd like to have marked as Exhibit 3 Utah Contention L.
(Exhibit 3 marked.)

Q. Dr. Arabasz, what I've handed to you is an excerpt from the State of Utah's original contentions filed with respect to the licensing of the Private Fuel Storage matter that contains Utah Contention L. Are you familiar with this document?
A. Yes, I am.
Q. And have you reviewed it previously?
A. I have read it, yes.
Q. The document, for the record, is dated November 23, 1997. Did you have a role in preparing this document?
A. No, I did not.
Q. When did you first read this document, approximately?
A. In early 1999 at about the time of the informal discovery.
Q. When you look at the document, on page 80 of the excerpt the top of the page it says "L, Geotechnical," and then it has the basic contention, and under that has basis. Basis 1 on page 80 is surface faulting; basis 2 on page 82 is ground motion. Do you see that?
A. Yes, I do.
Q. Basis 3 on page 83 is characterization of subsurface soils.

A. Yes.
Q. Then basis 4, soil stability and foundation loading. It's on page 92. Do you see that?
A. Yes, I do.
Q. Of those four bases, which ones do you have specific knowledge about in terms of your professional ability and expertise?
A. Primarily basis 2, ground motion. The surface faulting, I have expertise relevant to active faulting and surface faulting. In advising the state, I defer it to another state expert, notably Dr. Lee Allison.
Q. But you do have expertise in that area?
A. Correct, yes.
Q. And basis 3 and 4 would be beyond your areas of expertise, then?
A. Yes, they would be.
Q. What is your understanding of basis 1 as it's set forth in the contention?
A. In general, that -- excuse me. My general understanding is that there had been inadequate characterization. I would need to take time to read it in detail again, because I did not consider this an area that I would directly have to be involved in defending, that my familiarity is cursory.

Q. Do you understand it to be an adequate characterization of the site?
A. In general, yes.
Q. And what do you understand basis 2 to be?
A. Insofar as the seismic sources had not been completely characterized, then of course the ground motion characterization on which that rests would have been indeterminate, and that some features of ground motion relating to proximity to active faults, notably near surface -- excuse me, near source effects, had not been adequately accounted for.
Q. And in particular the basis refers to a particular approach or a journal article by a Dr. Somerville?
A. Correct.
Q. And what is that -- are you familiar with that journal article?
A. I'm familiar with a follow-up article that Dr. Somerville wrote in 1998 that I'm more familiar with. But it basically was I believe a restatement in another venue of the same methodology.
Q. And that's your understanding, then, of basis 2 of the contention, correct?
A. Correct.
Q. Now, the bases 1 and 2 of the contention --

So that now required -- or having identified the East and the West Faults at depth virtually beneath the site, that makes moot the need to import the random earthquake underneath the site.
Q. So in other words, if you have new information, your concern with respect to the random earthquake is no longer really a concern with respect to the PFS site. Am I understanding you correctly?
A. Correct, in terms of what the outcome would be from input in a hazard analysis.
Q. Because you really have an earthquake that you're -- concerning your analysis of the same size or bigger size?
A. Correct.
Q. Okay. Any other minor details that you looked at with respect to the Geomatrix report as referred to in Exhibit 4?
A. Under the subheading of "Hazard Characterization," no, I don't recall and carry with me any issues that I think are material.
Q. Outside of the area of hazard characterization, do you have any minor details you'd quibble with or other concerns?
A. Yes.
Q. And what are those?

A. These have become part of the record and entangled in the guidelines for a design-basis earthquake, notably the deterministic versus a probabilistic and what is relevant in this process for decision making.
Q. Could you explain -- I don't understand.
A. Okay, sure.
Q. Are you getting into stuff that might go to the probabilistic method? Are you talking about a return period or something like that? Explain so I understand. If it concerns probabilistic method, that isn't part of this contention; we won't continue. But if it doesn't, then we will continue. What do you mean?
A. Okay. Can we return to the original question?
MR. GAUKLER: Yeah. Could you restate the original question, please?
(The record was read.)
Q. Do you understand the question?
A. Yes. And in Exhibit 5, under the summary, the second paragraph here, in April 1999 we state that "One recurring point we comment on is the uncertain regulatory acceptability of the hybrid 'deterministic' approach, used both in the 1997 SAR and in an updated assessment provided to NRC in April 1999."

Q. Where are you reading from, again? I'm sorry.
A. The second -- Exhibit 5 summary, the second paragraph.
Q. Oh, I see it.
A. And given this concern, questions were put directly to NRC's staff. And I need help.
MS. CHANCELLOR: He'd like to look at a discovery document that we submitted to NRC.
Q. (BY MR. GAUKLER) To refresh your recollection?
A. Well, to call to your attention what NRC's staff admitted in response to a question asking whether the approach used by Geomatrix both in the 1997 SAR and in the updated PSHA as a deterministic analysis, whether the approach would meet the requirements of 10 CFR 100, Appendix A, and the staff ultimately responded.
MS. CHANCELLOR: Do you need to refresh your recollection -- it's the Staff's Objections and Responses to the State of Utah's Sixth Set of Discovery Requests Directed to NRC Staff, Utah Contention L, dated February 14, 2000. And it's both the staff's response to admission No. 1 and admission No. 2, and the response is the same.
A. Shall I read the request for admission and

response? The gist of it is that it asked both whether the DSHA, the deterministic seismic -- the deterministic seismic hazard analysis performed by Geomatrix in Appendix 2d of 1997 deviated from established precedent.
Well, I guess I'll read the whole thing. "Do you admit that the deterministic seismic hazard analysis (DSHA) performed by Geomatrix Consultants, Incorporated, and reported in Appendix 2d of the 1997 SAR deviated from established precedent in meeting requirements of 10 CFR 72.102(f)(1) and 10 CFR 100 Appendix A for assessing the maximum vibratory ground motion at the PFS site by incorporating uncertainty in the maximum magnitude, minimum source to site distance, and choice of ground motion attenuation relationship in establishing the 84 percentile ground motions?"
I should look at the bottom line and see if this was the right one.
Okay, this is correct. And the staff response, "The staff objects to this request on the grounds that it is vague and ambiguous. Notwithstanding this objection, the staff states that the Geomatrix DSHA did not meet the deterministic requirements in 10 CFR part 100, Appendix A." And similarly asked whether in the updated DSHA whether there was a deviation from established precedent. Similarly, the staff responds,