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~~April 1, 2002~~

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of)
)
PRIVATE FUEL STORAGE, L.L.C.) Docket No. 72-22-ISFSI
)
(Independent Spent)
Fuel Storage Installation))

NRC STAFF TESTIMONY OF GOODLUCK I. OFOEGBU
CONCERNING UNIFIED CONTENTION UTAH L/QQ, PART C

Q1. Please state your name, occupation, and by whom you are employed.

A1. My name is Goodluck I. Ofoegbu. I am employed as a Principal Engineer at the Center for Nuclear Waste Regulatory Analyses ("CNWRA"), which is a division of the Southwest Research Institute ("SwRI"), in San Antonio, Texas. I am providing this testimony under a technical assistance contract between the staff of the Nuclear Regulatory Commission ("NRC Staff" or "Staff") and the CNWRA at the SwRI. A statement of my professional qualifications is attached hereto.

Q2. Please describe your current responsibilities.

A2. In my position as Principal Engineer at the CNWRA, I have served as Principal Investigator for several projects involving geological engineering. My work includes mechanical analysis of underground excavations, foundations, earthworks, and natural geological processes, such as faulting and volcanism.

Q3. Please explain what your duties have been in connection with the NRC Staff's review of the application filed by Private Fuel Storage, L.L.C. ("PFS" or "Applicant") for a license to construct and operate an Independent Spent Fuel Storage Installation ("ISFSI") on the Reservation

of the Skull Valley Band of Goshute Indians, geographically located within Skull Valley, Utah (the "proposed PFS Facility").

A3. As part of my official responsibilities, I assisted the NRC Staff in its evaluation of the Applicant's site characterization and geotechnical evaluations for the proposed PFS Facility. Further, I assisted the Staff in the preparation of its "Safety Evaluation Report Concerning the Private Fuel Storage Facility," issued on September 29, 2000 ("SER"). I also assisted in the preparation of Supplement No. 2 to the SER, dated December 21, 2001 ("SSER Supplement No. 2"). Those two documents have been incorporated into the NRC Staff's "Consolidated Safety Evaluation Report Concerning the Private Fuel Storage Facility," issued in March 2002 ("Consolidated SER").

In addition, I assisted the NRC Staff in preparing its responses to several sets of discovery requests filed by the State of Utah ("State"), including the "NRC Staff's Objections and Responses to the 'State of Utah's Eleventh Set of Discovery Requests directed to the NRC Staff,'" dated December 11, 2000; "NRC Staff's Objections and Responses to the 'State of Utah's Eighteenth Set of Discovery Requests directed to the NRC Staff,'" dated February 1, 2002; and "NRC Staff's Objections and Responses to the 'State of Utah's Twentieth Set of Discovery Requests directed to the NRC Staff,'" dated February 27, 2002.

Q4. What is the purpose of this testimony?

A4. The purpose of this testimony is to provide the NRC Staff's views concerning the acceptability of the Applicant's characterization of subsurface soils, which is the subject of Unified Contention Utah L/QQ, Part C. I am also providing separate testimony on selected portions of Part D of this contention in the NRC Staff's testimony of Goodluck I. Ofoegbu and Daniel J. Pomerening, filed herewith.

Q5. Please identify the Commission's requirements related to the characterization of subsurface soils for the design of an ISFSI.

A5. The Commission's requirements governing the characterization of subsurface soils for an ISFSI are set forth in 10 C.F.R. Part 72. In general, 10 C.F.R. § 72.90 requires an evaluation of site characteristics that may directly affect the safety or environmental impact of the proposed facility. Specific requirements for the characterization of the subsurface soils are defined in 10 C.F.R. § 72.102. Specifically, 10 C.F.R. § 72.102(c) states: "Sites other than bedrock sites must be evaluated for their liquefaction potential or other soil instability due to vibratory ground motion." Additionally, 10 C.F.R. § 72.102(d) states: "Site-specific investigations and laboratory analyses must show that soil conditions are adequate for the proposed foundation loading."

Pursuant to 10 C.F.R. § 72.122(b)(1), structures, systems, and components important to safety ("SSCs") must be designed to accommodate the effects of, and be compatible with, site characteristics and environmental conditions associated with normal operation, maintenance and testing of the ISFSI, and to withstand postulated accidents. Further, 10 C.F.R. § 72.122(b)(2) requires that SSCs be designed to withstand the effects of natural phenomena, including earthquakes, without impairing their capability to perform safety functions.

Q6. Are you familiar with Unified Contention Utah L/QQ, Part C.?

A6. Yes. As admitted by the Licensing Board, Unified Contention Utah L/QQ, Part C., states as follows:

Unified Contention Utah L/QQ (Geotechnical)

C. Characterization of Subsurface Soils.

1. Subsurface Investigations

The Applicant has not performed the recommended spacing of borings for the pad emplacement area as outlined in NRC Reg. Guide 1.132, "Site Investigations for Foundations of Nuclear Power Plants, Appendix C."

2. Sampling & Analysis

The Applicant's sampling and analysis are inadequate to characterize the site and do not demonstrate that the soil conditions are adequate to resist the foundation loadings from the design basis earthquake in that:

- a. The Applicant has not performed continuous sampling of critical soil layers important to foundation stability for each major structure as recommended by Reg. Guide 1.132 Part C6, Sampling.
- b. The Applicant's design of the foundation systems is based on an insufficient number of tested samples, and on a laboratory shear strength testing program that does not include strain-controlled cyclic triaxial tests and triaxial extension tests.

3. Physical Property Testing for Engineering Analyses

- a. The Applicant has not adequately described the stress-strain behavior of the native foundation soils under the range of cyclic strains imposed by the design basis earthquake.
- b. The Applicant has not shown by case history precedent or by site-specific testing and dynamic analyses that the cement-treated soil will be able to resist earthquake loadings for the CTB and storage pad foundations as required by 10 CFR § 72.102(d).
- c. The Applicant has not considered the impact to the native soil caused by construction and placement of the cement-treated soil, nor has the Applicant analyzed the impact to settlement, strength and adhesion properties caused by placement of the cement-treated soil.
- d. The Applicant has not shown that its proposal to use cement-treated soil will perform as intended – *i.e.*, provide dynamic stability to the foundation system – and the Applicant has not adequately addressed the following possible mechanisms that may crack or degrade the function of the cement-treated soil over the life of the facility:

- (i) shrinkage and cracking that normally occurs from drying, curing and moisture content changes.
 - (ii) potential cracking due to vehicle loads.
 - (iii) potential cracking resulting from a significant number of freeze-thaw cycles at the Applicant's site.
 - (iv) potential interference with cement hydration resulting from the presence of salts and sulfates in the native soils.
 - (v) cracking and separation of the cement-treated soil from the foundations resulting from differential immediate and long-term settlement.
- e. The Applicant has unconservatively underestimated the dynamic Young's modulus of the cement-treated soil when subjected to impact during a cask drop or tipover accident scenario. This significantly underestimates the impact forces and may invalidate the conclusions of the Applicant's Cask Drop/Tipover analyses.

Q7. In Subpart C.1. of the contention, concerning subsurface investigations, the State asserts that the "Applicant has not performed the recommended spacing of borings for the pad emplacement area as outlined in NRC Reg. Guide 1.132, "Site Investigations for Foundations of Nuclear Power Plants, Appendix C." Do you agree with this assertion?

A7. No.

Q8. Please provide the bases for this conclusion.

A8. NRC regulatory guidance in Regulatory Guide 1.132 (and Draft Reg. Guide DG-1101) provides general guidelines concerning site investigations, including the spacing and depth of borings for safety-related structures. This guidance document appropriately recognizes that the spacing and depth of borings or other site-characterization activities depend on the

complexity of the site-specific subsurface conditions and the particular information needed for the engineering design of structure foundations. Indeed, Reg. Guide 1.132 states:

Because the details of the actual site investigations will be highly site dependent, the procedures described herein should only be used as guidance and be tempered with professional judgment. Alternative and special investigative procedures that have been derived in a professional manner will be considered equally applicable for conducting foundation investigations.

The specific regulatory requirement for the geotechnical site characterization for an ISFSI is contained in section 72.102(d), which provides that site-specific investigations and laboratory analyses must show that the soil conditions are adequate for the proposed foundation loading. The primary purpose of the site-specific investigation and associated laboratory analyses is to classify the site subsurface materials and to identify variations in important properties of these materials both laterally and with depth. As set forth in the Staff's Consolidated SER and discussed herein, the Staff has determined that the Applicant achieved this purpose through a combination of borings and other test methods, including cone penetrometer testing. Further, the geotechnical site characterization information provided by the Applicant in the PFS Safety Analysis Report ("SAR") satisfies the regulatory requirement of 10 C.F.R. § 72.102(d), by showing that soil conditions are adequate for the proposed foundation loading

The following considerations support these Staff findings:

First, standard penetration and cone-tip resistance data provided in the SAR (*see* Consolidated SER, page 2-55) support the Applicant's classification of the subsurface materials at the site as consisting of a relatively compressible top layer (layer 1) that is approximately 25–30 feet thick and underlain by much denser and stiffer material (layer 2), which is classified as dense sand and silt.

Second, the profiles of cone-tip resistance provided in the SAR Figures 2.6-5 (Sheets 1–14) and 2.6-21 through 2.6-23 illustrate the lateral and vertical variations of shear strength and

compressibility for layer-1 soil. As described in the Consolidated SER (page 2-56), the profiles support a subdivision of layer-1 soil into four sublayers, and show that the second sublayer from the top (a mixture of silty clay and clayey silt referred to as layer 1B soil in the Consolidated SER, page 2-56) is the weakest and most compressible sublayer.

Third, the bearing capacity of the storage pads was calculated using the undrained shear strength of layer-1B soil. See Consolidated SER, pages 2-58 and 2-61. The permissible value of undrained shear strength for evaluating the bearing capacity of the storage pads consists of the average undrained shear strength through a depth of 30 feet below the base of the pads. Cf. Terzaghi et al., 1996, page 406. Because layer-1B is the weakest sublayer, the value of undrained shear strength used by PFS is therefore a conservative lowerbound estimate of the permissible value.

Fourth, the bearing capacity of the canister transfer building ("CTB") foundation was calculated using an average undrained shear strength for layer-1 soil estimated using laboratory data for layer-1B and the cone penetrometer test data. See Consolidated SER, pages 2-63 and 2-65. The permissible value of undrained shear strength for evaluating the bearing capacity of the CTB foundation consists of the average undrained shear strength through a depth of 240 feet below the base of the foundation. Cf. Terzaghi et al., 1996, page 406. The value of the average undrained shear strength at the proposed PFS site would thus be determined mainly by layer-2 soil, which is much stronger than the layer-1 soil used by PFS to obtain an average undrained shear strength value for its CTB foundation bearing capacity calculations. The value of undrained shear strength used by PFS is therefore a conservative lowerbound estimate of the permissible value.

Fifth, the potential settlement of the storage pads and CTB was estimated using the laboratory compressibility data for layer-1B soil. Because layer-1B is the most compressible

sublayer, the estimated settlement values therefore represent the upperbound values. See Consolidated SER, pages 2-58 and 2-63.

In sum, the preceding considerations collectively support the Staff's findings that PFS, through its existing site-specific investigations and laboratory analyses, has satisfactorily classified the subsurface materials, identified lateral and vertical variations in the relevant properties of those materials, and demonstrated that the site-specific soil conditions are adequate for the proposed foundation loading. Therefore, because the Applicant has satisfied the regulatory requirement of 10 C.F.R. § 72.102(d), it is not necessary that the Applicant follow the particular spacing of borings recommended in Reg. Guide 1.132.

Q9. In Subpart C.2. of the contention, the State asserts that the "Applicant's sampling and analysis are inadequate to characterize the site and do not demonstrate that the soil conditions are adequate to resist the foundation loadings from the design basis earthquake." Do you agree with this assertion?

A9. No.

Q10. Please provide the bases for this conclusion.

A10. As discussed above, the Staff finds that the Applicant has satisfied the geotechnical site characterization requirement set forth in 10 C.F.R. § 72.102(d), including the sampling and analysis to characterize the site. The Applicant has provided sufficient geotechnical data in its SAR to demonstrate that the site-specific soil conditions are adequate for the proposed foundation loading.

Q11. More specifically, in Subpart C.2.a. of this contention, the State asserts that the "Applicant has not performed continuous sampling of critical soil layers important to foundation stability for each major structure as recommended by Reg. Guide 1.132 Part C6, Sampling." Do you believe that this presents a valid concern?

A11. No.

Q12. Please provide the bases for this conclusion.

A12. The purpose of "continuous sampling" is to determine the continuous variation of soil properties with depth. The continuous sampling of soil layers referred to in Reg. Guide 1.132 represents one method available for determining the continuous variation of soil properties with depth. PFS instead successfully determined the variation of soil properties with depth through the use of an alternative method, *i.e.*, *in situ* cone penetrometer testing. As discussed above, Reg. Guide 1.132 provides guidance [as opposed to establishing a regulatory requirement like 10 C.F.R. § 72.102(d)], and recognizes that alternative procedures which have been derived in a professional manner will be considered equally applicable for conducting foundation investigations. In the Staff's view, *in situ* cone penetrometer testing, as used by the Applicant, is one such alternative procedure for determining the continuous variation of soil properties with depth.

Q13. In Subpart C.2.b. of the contention, the State asserts that the "Applicant's design of the foundation systems is based on an insufficient number of tested samples." Do you agree with this assertion?

A13. No.

Q14. Please provide the bases for this conclusion.

A14. In the Staff's view, the relevant inquiry is whether the geotechnical site characterization data obtained by the Applicant is adequate to support the specific values or parameters used in the Applicant's foundation stability analyses, not how many samples *per se* the Applicant has taken. As set forth in the Staff's Consolidated SER and discussed herein, the Applicant has provided in the PFS SAR sufficient geotechnical data -- in the form of both cone penetrometer and laboratory test data -- to demonstrate that the site-specific soil conditions are

adequate for the proposed foundation loading in accordance with 10 C.F.R. § 72.102(d). This is further discussed in response to Questions 8 and 16, herein.

Q15. The State also asserts, in Subpart C.2.b. of this contention, that the Applicant's design of the foundation systems is based "on a laboratory shear strength testing program that does not include strain-controlled cyclic triaxial tests and triaxial extension tests." Do you believe that this presents a valid concern?

A15. No.

Q16. Please provide the bases for this conclusion.

A16. As indicated in response to Question 8, *supra*, the geotechnical information used for the PFS foundation system designs was obtained from laboratory test data for layer-1B soil (including laboratory compression test results) and the cone penetrometer test data. Information presented in a PFS calculation (Stone and Webster, 2001^g, Appendix C) supports the undrained shear strength value of 2,200 psf for layer-1B soil. This value, in turn, was combined with information determined from the cone-penetrometer test data to establish the basis for the soil-strength parameter values used for stability analyses of the storage pads and canister transfer building foundation. As stated in the Consolidated SER (page 2-57), the Staff reviewed the geotechnical information provided in the PFS SAR and concluded, *inter alia*, that (1) the index properties and strength and compressibility of the soil layers were determined by the Applicant using an appropriate combination of field and laboratory testing, and (2) the information presented is sufficient to support appropriate engineering analyses of the proposed structures. Thus, the specific combination of tests performed by the Applicant provided the data needed to obtain the soil-strength parameter values used in its stability analyses of the storage pads and canister transfer building foundation; strain-controlled cyclic triaxial tests or triaxial extension tests of site soils are therefore not necessary.

Q17. In Subpart C.3.a. of this contention, concerning physical property testing for engineering analyses, the State asserts that the "Applicant has not adequately described the stress-strain behavior of the native foundation soils under the range of cyclic strains imposed by the design basis earthquake." Do you agree with this assertion?

A17. No.

Q18. Please provide the bases for this conclusion.

A18. The information provided by the Applicant in the SAR regarding the stress-strain characteristics of the native foundation soils is sufficient to demonstrate that the soil conditions are adequate for the proposed foundation loading, as required by 10 C.F.R. § 72.102(d). Adequate information on the following aspects of stress-strain characteristics was provided by the Applicant: (1) undrained shear strength, based on laboratory triaxial-compression and direct-shear testing; (2) soil compressibility, based on laboratory oedometer testing; (3) the lateral and vertical variations of shear strength and compressibility at the site, based on in situ cone penetrometer testing data; (4) elastic parameters (Young's modulus, Poisson's ratio, and shear modulus), determined using shear and compressional wave velocities from field seismic reflection, refraction, and cross-hole velocity measurements and cone penetrometer testing; and (5) shear modulus and damping versus cyclic strain relationships, derived from a combination of laboratory data developed by PFS and information available in the literature.

One aspect of the stress-strain behavior of soils is the stiffness of the soils, which can be characterized through shear-wave velocity profiles obtained from field refraction data. Accordingly, the Applicant provided upper and lower bounds of shear-wave velocity profiles, in addition to the best estimate soil profile, to account for uncertainties in the average shear-wave velocity of the native foundation soils. The Applicant also performed sensitivity analyses to define the effects of the variability of the shear modulus and damping versus cyclic strain relationships on the calculated

seismic site-response factors. See Appendix F of Geomatrix Consultants, Inc., 2001a, *Fault evaluation study and seismic hazard assessment study—final report*. Revision 1. Oakland, CA: Geomatrix Consultants, Inc. (cited in Section 2.3 of the Consolidated SER). The modulus-reduction and damping versus strain curves provided by PFS were generated using accepted engineering practices and are consistent with other curves generated from comparable data.

In sum, the Applicant provided sufficient information on the behavior of the native foundation soils to demonstrate that: (1) the value of soil strength used for foundation-stability analyses is a lowerbound estimate of the applicable value; (2) the value of soil compressibility used for foundation-settlement analyses resulted in upperbound estimates of the potential foundation settlement; and (3) the values of shear-wave velocity used to determine the elastic-parameter values for the soils account for the variability of shear-wave velocity at the site. Based on the foregoing considerations, and as discussed in Section 2.1.6 of the Consolidated SER, the Staff therefore concludes that PFS has adequately described the stress-strain behavior of the native foundation soils, to support the various engineering analyses of the facility structures, systems, and components important to safety.

Q19. The State contends, in Subpart C.3.b. of this contention, that the "Applicant has not shown by case history precedent or by site-specific testing and dynamic analyses that the cement-treated soil will be able to resist earthquake loadings for the [] storage pad foundations as required by 10 CFR § 72.102(d)." Do you agree with this assertion?

A19. No.

Q20. Please provide the bases for this conclusion.

A20. My conclusion is based on several considerations. First and foremost, the soil cement around the storage pads and the cement-treated soil under the storage pads are not being

relied upon to support any safety function of the pads. This fact is reflected in the Staff's stability evaluation of the cask-storage-pad foundation in the Consolidated SER (pages 2-57 to 2-62).

Second, PFS has committed to demonstrate through testing that the stiffness of the cement-treated soil under the pads will not exceed the specified design value (*i.e.*, it will have a dynamic Young's modulus not exceeding 75,000 psi).

Third, with respect to the specific requirements of 10 C.F.R. § 72.102(d), the regulation states: "Site-specific investigations and laboratory analyses must show that soil conditions are adequate for the proposed foundation loading." The regulation by its terms does not require the use of "case history precedent" or "dynamic analyses," although the Staff does recognize the utility and value of such analytical tools (*see, e.g.*, references to prior uses of soil cement in discussion below concerning the proposed use of soil cement around the CTB foundation to provide additional lateral resistance). Therefore, to the extent that the State might be asserting that the use of these tools is explicitly required by 10 C.F.R. § 72.102(d), the Staff believes that the State's assertion is misplaced. As noted above, the Staff finds that the geotechnical site characterization information provided by the Applicant in the PFS Safety Analysis Report ("SAR") shows that the site-specific soil conditions are adequate for the proposed foundation loading, in compliance with 10 C.F.R. § 72.102(d).

Q21. The State similarly contends, again in Subpart C.3.b. of this contention, that the "Applicant has not shown by case history precedent or by site-specific testing and dynamic analyses that the cement-treated soil will be able to resist earthquake loadings for the CTB [] foundations as required by 10 CFR § 72.102(d)." Do you agree with this assertion?

A21. No.

Q22. Please provide the bases for this conclusion.

A22. My conclusion with respect to the CTB is also based on several considerations, which differ from those discussed in connection with the storage pads. This is due to the fact that the soil cement around the CTB is required to provide additional lateral resistance to increase the factor of safety against sliding of the CTB foundation.

First, to provide the necessary lateral resistance, the soil cement around the CTB foundation must have a minimum unconfined compressive strength of 250 psi, a value based on Staff-reviewed PFS calculations. Therefore, PFS is required (and has committed) to demonstrate through testing that the soil cement will meet this minimum strength requirement.

Second, in support of this proposed use of soil cement, PFS provided references to previous uses of soil cement within and outside of the United States (*see* SAR, Rev. 22, pages 2.6-113 to 114) as precedents for the use of cement stabilization to enhance the engineering characteristics of natural soils. The precedents cited by PFS are supported by other cases gleaned from the literature and reviewed by the Staff, which indicate that: (a) the soil-property changes that result from cement stabilization can be considered long-lasting (*see, e.g.,* Roberts, 1986); and (b) soil cement has been used as a buttress - *i.e.,* as a structure that provides lateral resistance to another structure - in several other engineering projects. *See, e.g.,* Van Riessen, 1992; Lambrechts, 1998.

Third, PFS has committed in the SAR (Rev. 22, pages 2.6-117 to 118) to follow the standards, procedures, and recommendations contained in the "State-of-the-Art Report on Soil Cement," developed by ACI Committee 230 [ACI 230-1R-90 (Reapproved 1997)]. This report describes the state-of-the-art procedures and identifies the applicable standards for mix proportioning, construction, quality-control, and testing of soil cement. The report, for example, lists ASTM D 559-82 ("Standard Methods for Wetting-and-Drying Tests of Compacted Soil-Cement

Mixtures") and ASTM D 560-82 ("Standard Methods for Freezing-and-Thawing Tests of Compacted Soil-Cement Mixtures"), which specify test procedures for evaluating the durability of soil cement. Adherence by PFS to these and the other standards contained in the ACI report provides further assurance that the proposed soil-cement layer around the CTB will provide the specified amount of lateral resistance for the proposed duration of the PFS ISFSI facility.

Q23. In Subpart C.3.c. of this contention, the State asserts that the "Applicant has not considered the impact to the native soil caused by construction and placement of the cement-treated soil, nor has the Applicant analyzed the impact to settlement, strength and adhesion properties caused by placement of the cement-treated soil." Do you believe that these represent valid concerns?

A.23 No.

Q24. Please provide the bases for this conclusion.

A24. As I understand Subpart C.3.c. of the contention, the State is raising two principal concerns associated with the construction and placement of the cement-treated soil: (1) that the cement-treated soil will form a relatively impermeable cap over the natural soil, resulting in an increase in the water content of the soil because of reduced evapotranspiration, and consequently, a decrease in shear strength and an increase in compressibility of the natural soil; and (2) that the use of heavy placement equipment for construction of the cement-treated soil may cause significant remolding of the underlying natural soil, which in turn could cause a significant decrease in the shear strength of the natural soil.

Based on this understanding, I do not believe that the State has presented any valid concerns in Subpart C.3.c. of the contention. In my professional opinion, both of the aforementioned concerns are based on phenomena that are either unlikely to occur or, if they were

to occur, would not have an adverse effect on the safety of the proposed facility, for the reasons discussed below.

First, the depth to the water table is approximately 120 feet below the base of the facility structures. Therefore, there is no supply of water close enough to feed the postulated water-content increase.

Second, data provided by PFS (see SAR, Rev. 22, pages 2.6-42 to 44 and Table 2.6-1) on the effects of inundation of five specimens of the natural soil indicate that an increase in water content is not likely to have any appreciable effect on the compressibility of the soil. Inundation of the specimens during consolidation testing caused an additional vertical strain of only about 0.001 (*i.e.*, an additional settlement of about 0.12 inch for a 10-foot thick soil layer).

Third, a small decrease in shear strength occurring over a large area (such as may result from the postulated water-content change) or a localized larger decrease (such as may result from the postulated remolding) would not have a significant effect on the bearing capacity of either the storage pads or the CTB foundation. It is important to note that the shear strength actually used by the Applicant to determine the bearing capacity of each of the foundations is much smaller than the permissible shear strength for the calculation of bearing capacity, given the foundation widths and depth profile of shear strength below the foundations. As such, it is unlikely that a sufficient decrease in shear strength can occur over an area large enough to significantly affect the average shear strength within the applicable depth for each foundation (30 feet for the pads and 240 feet for the CTB).

Q25. In Subpart C.3.d. of this contention, the State contends that the "Applicant has not shown that its proposal to use cement-treated soil will perform as intended — *i.e.*, provide dynamic stability to the foundation system," citing in support of this assertion the Applicant's alleged failure to adequately address five "possible mechanisms that may crack or degrade the function of the

cement-treated soil over the life of the facility." Do you believe that the State presents any valid concerns in this subpart of its contention, with respect to the Applicant's proposed use of cement-treated soil under the storage pads or soil cement around the pads?

A25. No.

Q26. Please provide the bases for this conclusion.

A26. As I noted earlier, the proposed cement-treated soil/soil cement under or around the storage pads is not being relied upon to support any safety function of the pads. As set forth in Section 2.1.6.4 of the Consolidated SER and discussed herein, the Staff's acceptance of the storage-pad design relative to the capability of the underlying soil to provide adequate support to the storage pads is based on the following considerations.

First, calculations provided by PFS demonstrate adequate safety margins against bearing capacity failure of the pads under combined static loads and potential dynamic loading from the design-basis earthquake. The calculations do not rely on any contribution of load-bearing resistance from the soil cement around the storage pads and the cement-treated soil under the storage pads.

Second, calculations provided by PFS demonstrate that the storage pads can be expected to undergo post-construction settlement of about 3 to 4 inches, taking into account both static loads and potential dynamic loading from the design-basis earthquake. The stiffness of the soil cement around the pads and the cement-treated soil under the pads was not relied upon to reduce the potential settlement of the pads. PFS has committed to perform maintenance repair of the pad-emplacement area as necessary to correct any changes caused by settlement. One such type of maintenance repair includes the scraping of aggregates from between the pads to maintain the top surface of the aggregate layer at the same elevation as the top surface of the pads.

Third, calculations provided by PFS demonstrate that potential sliding of the storage pads under seismic loading does not constitute a safety hazard, as there are no safety-related external connections to the pads or casks that may rupture or become misaligned as a result of pad sliding. Indeed, the Staff agrees with the Applicant that the storage casks are less likely to tip over if the pads are free to slide. The Staff's evaluation of the potential effects of sliding of the pads does not rely on any property of the soil cement or cement-treated soil.

For these reasons, even if cracking or other degradation of the soil cement/cement-treated soil in the vicinity of the storage pads were to occur -- and be of the type and occur by the various mechanisms specifically postulated by the State in Subpart C.3.d. of this contention -- it would not have any adverse effects on the safety functions of the storage pads.

Q27. Likewise, do you believe that the State presents any valid concerns in Subpart C.3.d. of this contention with respect to the Applicant's proposed use of soil cement around the canister transfer building foundation?

A27. No.

Q28. Please provide the bases for this conclusion.

A28. Notwithstanding the Applicant's proposal to use soil cement around the CTB to provide additional lateral resistance, the potential cracking or other soil-cement degradation mechanisms adduced by the State in Subparts C.3.d.(i)-(v) of this contention could not have an adverse effect on the safety functions of the CTB foundation, for the following reasons.

First, as I noted previously, PFS has committed (in the SAR, Rev. 22, pages 2.6-117 to 118) to follow the standards, procedures, and recommendations contained in the "State-of-the-Art Report on Soil Cement," developed by ACI Committee 230 [ACI 230-1R-90 (Reapproved 1997)], which describes the state-of-the-art procedures and identifies the applicable standards for mix proportioning, construction, quality-control, and testing of soil cement. These standards and

procedures were developed to reduce the likelihood and mitigate the effects of the type of soil-cement cracking/degradation cited by the State in Subpart C.3.d. of its contention. For example, the effects of any salts or sulfates in the native soil would necessarily be considered in the mix design. In this regard, the Applicant has committed to performing the appropriate tests to determine the proportions of natural soil and cement needed to achieve the soil-cement properties specified for the CTB foundation.

Second, even if vertical and/or near-vertical cracks were to form in the soil cement via the various mechanisms identified by the State in Subpart C.3.d. of this contention, the expected vertical/near-vertical orientation of the cracks would allow them to close up, and the small size of the cracks would be such that any resulting increase in the amount of lateral movement of the foundation necessary to close the cracks and mobilize the passive resistance of the soil cement would be small. Therefore, the Staff does not expect such cracking - assuming it occurs - to significantly affect the passive resistance of the soil cement, nor does it expect any associated small lateral movement of the CTB foundation to impact any safety function of the structure, as there are no external safety-related connections associated with the CTB.

Q29. In Subpart C.3.e. of this contention, the State asserts that the "Applicant has unconservatively underestimated the dynamic Young's modulus of the cement-treated soil when subjected to impact during a cask drop or tipover accident scenario." Do you agree with this assertion?

A29. No.

Q30. Please provide the bases for this conclusion.

A30. The State's assertion appears misplaced, insofar as the dynamic Young's modulus of the cement-treated soil underneath the pads is a design specification and not an estimated property. As stated earlier, PFS will be required to demonstrate through testing that the stiffness

of the cement-treated soil under the pads will not exceed the specified value -- *i.e.*, a dynamic Young's modulus of 75,000 psi.

Q31. What is your overall conclusion with respect to the various issues described by the State in Part C. of Unified Contention Utah L/QQ, concerning the Applicant's characterization of the subsurface soils underlying the proposed site of the PFS facility and its proposed use of soil cement/cement-treated soil?

A31. For the reasons discussed above and in the Consolidated SER, the Applicant has satisfied the Commission's requirements related to the characterization of subsurface soils for the design of an ISFSI, as set forth in 10 C.F.R. Part 72. The information obtained by the Applicant through its site characterization and geotechnical evaluations concerning the behavior of the native foundation soils is adequate to support the various engineering analyses of the facility structures, systems, and components important to safety. Further, with respect to the Applicant's proposed use of soil cement/cement-treated soil in the vicinity of the storage pads and CTB, the Applicant has committed to demonstrate through appropriate testing that any Staff-approved soil cement/cement-treated soil design specifications will be achieved.

Q32. Does this conclude your testimony?

A32. Yes.

REFERENCES

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GOODLUCK I. OFOEGBU
Principal Engineer
Center for Nuclear Waste Regulatory Analyses
Southwest Research Institute
San Antonio, Texas

Education:

B.Sc., Geology, University of Nigeria, Nsukka, 1977

M.A.Sc., Geological Engineering, University of Toronto, Canada, 1981

Ph.D., Geological Engineering, University of Toronto, Canada, 1985

Qualifications:

Dr. Ofoegbu is a geological engineer specializing in the mechanical analyses of geological processes, finite element modeling, and the constitutive modeling of geological materials. He has a background in geoscience, geomechanics and computer software development; and about 20 years of experience in teaching, research, and consulting.

Prior to assuming his current position as Principal Engineer in March 2002, Dr. Ofoegbu served as a senior research engineer at the Southwest Research Institute. In that position, Dr. Ofoegbu led several numerical modeling projects to investigate technical issues related to possible licensing of a geologic repository for high level nuclear waste at Yucca Mountain, such as: Evaluation of a finite element code, ABAQUS, for modeling thermal-mechanical-hydrological coupled processes; and investigations of ground motion patterns resulting from numerically simulated normal fault earthquakes, effects of perched water on thermally driven moisture flow, effects of spatial and time-dependent rock-mass property variations on the stability of underground openings and groundwater flow, and effects of regional crustal density variations on patterns of small-volume basaltic volcanism. Other numerical modeling investigations led by Dr. Ofoegbu include finite element analyses of geologic finite strain for fracture distribution predictions and numerical simulation of a deforming salt body. He has also participated in the development of review procedures for an anticipated license application for the proposed Yucca Mountain repository, technical review of uranium recovery site reclamation plans under the Uranium Mill Tailings Radiation Control Act, and a safety evaluation report for an Independent Spent Fuel Storage Installation.

Dr. Ofoegbu was a research engineer at the University of Toronto for five years, during which time he was the Principal Investigator for an industrial contract on the development and numerical implementation of a constitutive model for geological materials. He developed constitutive models for intact rock, non-lithified soils, and regularly jointed rock mass; implemented the models as user-defined code modules in ABAQUS (a commercially available finite element code); and conducted finite element modeling of the Atomic Energy of Canada Limited's mine-by experiment tunnel.

As an Assistant Professor at the Ahmadu Bello University, Nigeria, in the Department of Civil Engineering, Dr. Ofoegbu taught courses and supervised student research projects in the areas of soil mechanics, earthwork, and foundation engineering, and served as Principal Consultant on industrial site-investigation contracts.

Dr. Ofoegbu has published 25 articles in refereed journals and conference proceedings, as well as several technical reports. He is a member of the International Society for Rock Mechanics and the American Rock Mechanics Association. He is a registered professional engineer in Canada.

Professional Chronology:

Principal Engineer, Southwest Research Institute, March 2002-Present; Senior Research Engineer, Southwest Research Institute, 1993-2002; Consulting Engineer, GI-Johnson Engineering, 1991-93; Research Engineer, University of Toronto, 1987-92; Assistant Professor, Ahmadu-Bello University, 1985-87; Teaching/Research Assistant, University of Toronto, 1980-85; Hydrogeologist, Lower Benue Development Authority, 1978-79; Mathematics/Physics Teacher, Ogun State of Nigeria, 1977-78.

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1 CHAIRMAN FARRAR: Anything else, Mr.
2 O'Neill?

3 MR. O'NEILL: Yes, Your Honor. I'd note
4 that Dr. Ofoegbu's testimony covers both soil and soil
5 submit issues, but obviously you were limiting cross
6 today to soil submit issues.

7 CHAIRMAN FARRAR: All right. He's ready
8 for cross then?

9 MR. O'NEILL: Yes, he is.

10 CHAIRMAN FARRAR: Mr. Travieso-Diaz?

11 MR. TRAVIESO-DIAZ: I have no questions
12 for this witness at this time.

13 CHAIRMAN FARRAR: Thank you.

14 State, Ms. Nakahara?

15 MS. NAKAHARA: I have very few. You'd
16 like the same answer from us, but we do have very few.

17 (Laughter.)

18 CROSS EXAMINATION

19 BY MS. NAKAHARA:

20 Q Good afternoon, Dr. Ofoegbu. For the
21 record, my name is Connie Nakahara, and I represent
22 the State of Utah.

23 Dr. Ofoegbu, you yourself have not
24 designed or engineered an engineered foundation soil
25 using either soil cement or cement treated soils, have

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1 you?

2 A Using soil cement or cement treated soil,
3 no, I haven't.

4 Q And you have not developed a testing
5 program for either soil cement or cement treated soil,
6 correct?

7 A No, I haven't.

8 Q You have not used either cement treated
9 soil or soil cement in the construction of a facility,
10 correct?

11 A No, I have not, but we need to understand
12 that the soil cement and cement treated soil in the
13 proposed design are material that are assigned
14 material properties. I have reviewed designs that
15 cover a wide range of material properties.

16 Q Prior to the PFS application, in your
17 review of designs with material properties, have you
18 evaluated designs to implement cement treated soil or
19 soil cement?

20 A Not cement treated soil or soil cement,
21 but comparable materials with comparable properties,
22 yes.

23 Q And what are comparable materials with
24 comparable properties?

25 A Well, in this case, the properties that

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1 are at issue are the shear strength and the confined
2 compressive strength (phonetic), which is the semi-
3 such (phonetic), which is related to the shear
4 strength; the Young's modulus, stiffness of material.
5 Those are properties that compacted soil, concrete,
6 steel, or any other kind of material can have.

7 Q And have you designed a soil property
8 mixture to achieve a particular set of soil properties
9 in the past?

10 A Actually I don't understand that question.

11 Q Is it true you believe your experience
12 with other material property or other materials with
13 similar material properties relates to the application
14 of soil cement and cement treated soil in this case?

15 A Okay. What I said is I'm experienced with
16 the use of the properties of engineering materials.

17 Q And isn't it also true that you are
18 unaware of any prior application of cement treated
19 soil used to resist sliding?

20 A I'm aware of this one being proposed right
21 now, but I'm not aware of other applications.
22 Previous to this application, I wasn't aware of other
23 applications in which the similar materials are bonded
24 to resist sliding, but that doesn't mean they don't
25 exist. In fact, on review of literature, I found that

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1 there have been others that are.

2 Q You're aware that there are other
3 applications where cement treated soil was used to
4 resist sliding; is that --

5 A No, where the similar materials are bonded
6 together.

7 MR. O'NEILL: Just for clarification, when
8 you say "resist sliding," you're referring to sliding
9 of the pads or the CTB in this particular case?

10 MS. NAKAHARA: Of the foundation.

11 MR. O'NEILL: The foundation?

12 BY MS. NAKAHARA:

13 Q Dr. Ofoegbu, in response to Question 22,
14 at the last sentence of the second paragraph, you
15 state, "PFS is required (and has committed) to
16 demonstrate through testing that the soil cement will
17 meet this minimum strength requirement"; is that
18 correct?

19 A That is correct.

20 Q And this minimum strength requirement is
21 the 250 psi compressive strength, correct?

22 A That is correct.

23 Q PFS has not performed any tests to show
24 the compressive strength of its soil cement -- to show
25 that its soil cement is at least 250 psi, correct?

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1 A That's correct, to the best of my
2 knowledge.

3 Q And at this time, PFS has not shown that
4 the cement treated soil -- strike that.

5 Then at this time, PFS has not shown that
6 the soil cement is adequate for the proposed
7 foundation load, correct?

8 A They have shown that material with this
9 property would be adequate for the proposed foundation
10 loading, and they are reserving this in the literature
11 that this property can be achieved by mixing soil and
12 cement.

13 Q But there is no evidence in the literature
14 that demonstrates the particular soils at PFS could
15 achieve a 250 psi compressive strength, correct?

16 A There's evidence in the literature that
17 shows that soil with that kind of description and
18 looking at the particle size glass, whether it's
19 plastic or non-plastic. The soils with that range of
20 properties could be mixed with the cement to achieve
21 an increase in compressive strength similar to the
22 type that PFS is seeking.

23 The particular soil at discovery site, I'm
24 not aware that somebody has done these tests and
25 presented the results in publicly available format.

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1 Q Dr. Ofoegbu, do you agree that the cement
2 treated soil will be placed on a silty clay, clay silt
3 layer called the Bonneville clays?

4 A Yes, it will be played on that soil layer.

5 Q And you yourself have no prior experience
6 evaluating Bonneville clays; is that correct?

7 A I think I have prior experience in
8 evaluating that kind of soil. I have not specifically
9 worked with Bonneville clay.

10 Q In response to Question 24, is it true
11 that you essentially state that the water table is 120
12 feet below the surface, and thus you conclude there is
13 no water source to increase the water content in the
14 native soils? Is that essentially your --

15 A Yeah, what I said is that because the
16 water table is that far below the foundation, that I
17 don't see any source of water nearby to feed the post
18 related (phonetic) water content increase.

19 Q Notwithstanding the location of the water
20 source, the storage pad in the cement treated soil
21 will, in fact, essentially form a relatively
22 impermeable cap over the Bonneville clays; isn't that
23 right?

24 A It is believed that, yes, it will be
25 essentially to be relatively impermeable, yes.

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1 Q And I'm handing you State's Exhibit 2 --
2 THE REPORTER: You need to be at the
3 microphone.

4 CHAIRMAN FARRAR: By the way, was that
5 last work permeable or impermeable, about the cap?

6 THE WITNESS: Relatively impermeable.

7 MR. O'NEILL: Could you identify the
8 exhibit or --

9 MS. NAKAHARA: I've handed Dr. Ofoegbu
10 State's Exhibit 213.

11 BY MS. NAKAHARA:

12 Q Are you familiar with this document, which
13 is Applied Geotechnical Engineering Consultants, Inc.?
14 It's dated March 27th, 2001, and includes four pages
15 of Table 1, Summary of Laboratory Testing.

16 A I saw it when it was presented earlier
17 today.

18 Q You were present for the testimony earlier
19 today of Dr. Wissa and Mr. Trudeau, correct?

20 A Yes, I was.

21 Q Do you agree with either Dr. Wissa or Mr.
22 Trudeau that the depth at four to six feet essentially
23 represents the Bonneville clays at the PFS site?

24 A What I -- what I know is that the
25 Bonneville clay lies beneath the material described as

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1 eolian silt, and the thickness of the eolian silt
2 varies. In that range of five feet, four to six feet,
3 maybe you see Bonneville clay, but there is a
4 variation across the site.

5 Q Do I understand you correctly that the
6 eolian silts are approximately five feet deep at the
7 PFS site, but it varies across the site?

8 A The initial listing was five feet, but
9 after the trenches that were done at the last year,
10 PFS revised that estimated and said that they believed
11 now that it's less. The earlier silt may not be as
12 thick as five feet.

13 Q If the four to six foot layer represented
14 the Bonneville clays in Table 1 of State's Exhibit
15 213 --

16 MR. O'NEILL: Is this a hypothetical
17 question?

18 MS. NAKAHARA: Yes.

19 BY MS. NAKAHARA:

20 Q -- the moisture content at a depth of four
21 to six appears to range from 27 percent to 53 percent.
22 If you'll look at Test Pit 5 on page 4, which shows a
23 moisture content at a depth of four to six feet of 27
24 percent, ranging to Test Pit No. 12 on page 5, at a
25 depth of four to six feet, which shows a moisture

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1 content of 53 percent; is that correct?

2 A Those numbers are correct, yes.

3 Q Now with my hypothetical: assuming that
4 the depth of four to six feet represent the Bonneville
5 clays, with this range of moisture content between the
6 four to six foot samples, wouldn't the impermeable
7 cap, relatively impermeable cap presented by the
8 storage pad in the cement treated soil cause the
9 moisture content to change their equilibrium in the
10 four to six foot range?

11 A I don't see numbers that suggest that
12 they're not at equilibrium.

13 Q And the placement of an impermeable cap,
14 wouldn't that change the equilibrium?

15 A The placement of an impermeable cap will
16 prevent water from going in or from going out. There
17 would be some mandatory (phonetic) distribution, but
18 that would not lead to an increase in water content
19 that would cause an appreciable increase in -- I mean,
20 decrease in shear strength because the assumption here
21 is the water remains the same.

22 Now, if an influx of new water was
23 postulated and there was -- my feeling is that based
24 on the location of the water table, that the influx,
25 such influx of new water would be unlikely.

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1 Q In your opinion, what would the percentage
2 in water content -- strike that.

3 In your opinion, what would the percentage
4 of moisture content change would cause a decrease in
5 the shear strength?

6 A As a matter of fact, there are tests that
7 PFS has performed in which five soil specimens were
8 inundated, and this was compressibility test. This
9 wasn't a shear, but the change in compressibility was
10 insignificant for those.

11 Q How does shear strength relate to
12 compressibility?

13 A They are now related to something. There
14 might be relationships. There are empirical --
15 empirical data in the literature that may suggest that
16 shear strength -- well, not may suggest -- actually
17 shear strength would be expected to increase as
18 compressibility decreases for a given soil.

19 Q PFS has not performed any test to actually
20 analyze the effect of the cement treated soil layer on
21 the moisture content of the Bonneville clays; isn't
22 that correct?

23 A Could you specify which effect you think
24 they needed to test for?

25 Q That whether there would be an increase in

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1 the moisture content on the Bonneville clays for the
2 cement treated soil layer.

3 A To the best of my knowledge, we did not do
4 that test. Again, we did not think that that test
5 was needed, considering the factors that there --
6 there are two factors. One is the fact that the
7 relative wall (phonetic) is more than 100 feet below
8 the foundation.

9 But a more important one is the fact that
10 there will be a thermal gradient actually that will
11 drive -- would tend to drive moisture away from the
12 foundation.

13 Q Could you repeat that last part? I'm
14 sorry.

15 A It's that there will be a thermal gradient
16 that will tend to drive moisture away from the
17 foundation.

18 Q PFS is proposing to bond the cement
19 treated soil to the Bonneville clays, correct?

20 A That is correct underneath the pads.

21 Q And PFS has not demonstrated that this
22 bond can, in fact, be achieved, correct?

23 A No, that is part of the testing program.
24 That bond strength was in the calculation -- I mean,
25 was specified as a property in the calculation.

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1 Q And PFS is proposing to bond the cement
2 treated soil lifts with additional lifts, correct?

3 A That is correct.

4 Q And PFS has not demonstrated that that
5 bond can, in fact, be achieved; is that correct?

6 A They have not demonstrated that the bond
7 would exist for the material because they haven't
8 constructed it, but they have made reference in the
9 literature that shows that --

10 THE REPORTER: Dr. Ofoegbu, could you move
11 about six inches back from the mic?

12 THE WITNESS: Oh, I'm too loud?

13 THE REPORTER: Yes.

14 THE WITNESS: Okay.

15 (Laughter.)

16 THE WITNESS: Okay. They have made
17 reference to information in the literature that shows
18 that that kind of bonding can be achieved, and there
19 are tests available for determining whether they have
20 been achieved.

21 BY MS. NAKAHARA:

22 Q And that would be the same for the bond
23 between the concrete pad and the cement treated soil?

24 A That is the same, yeah.

25 Q Dr. Ofoegbu, in your prior oral testimony

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1 on May 3rd, in response to a question by Ms.
2 Chancellor, who asked -- and this is on page 6647 for
3 May 3rd -- "And NRC has not independently developed
4 that data, has it, concerning a bond between the
5 cement treated soil layer?" you responded not that you
6 know -- "Not that I know of."

7 And then Ms. Chancellor asked, "How many
8 other nuclear facilities have you signed off on where
9 there is data yet to be developed for the design of a
10 nuclear facility?"

11 And you testified, "Well, PFS is really
12 the first facility of that kind that I've been
13 involved in. And, again, where you say 'sign off,' we
14 issue findings, a document that in the safety
15 evaluation report I don't know whether that is
16 equivalent to signing off."

17 Dr. Ofoegbu, if PFS is the first facility
18 where you've allowed testing to occur post licensing,
19 what factors in this case gave you comfort to allowing
20 the testing to occur post licensing versus not having
21 done that in previous situations?

22 MR. O'NEILL: Your Honor, I have to state
23 an objection. I don't think Dr. Ofoegbu is solely
24 responsible for allowing or making the determination
25 that testing will be conducted post licensing. I

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1 mean, I think he was -- had a very specific task, I
2 mean, to evaluate the application and the proposed
3 design against the applicable regulatory standards for
4 purposes of the staff's safety evaluation report.

5 MR. TRAVIESO-DIAZ: I would also note that
6 the question assumes that, in fact, this is the first
7 instance in which the staff allows such testing, and
8 I don't think there's any basis on the record for
9 that.

10 MS. NAKAHARA: The first facility that Dr.
11 Ofoegbu's been involved in.

12 CHAIRMAN FARRAR: We will overrule the
13 objection, and he can -- if the explanations you all
14 have suggested make sense to him, he can state them
15 himself.

16 MR. TURK: Your Honor, there was an
17 objection to form. The witness testified previously
18 that this is the first application that he has
19 personally been involved in. Ms. Nakahara's question
20 is, well, if this is the first one that the staff has
21 done, and there is the disconnect.

22 CHAIRMAN FARRAR: I'm sorry. I didn't
23 hear that. If you'd restate the question and take
24 that -- deal with that objection.

25 BY MS. NAKAHARA:

1 Q With respect to the first facility that
2 you've been involved in, what in this case has given
3 you comfort to allow testing, assuming that it was
4 your decision to allow testing to occur after the
5 license has been issued versus previous licenses that
6 you've been involved in, license proceedings?

7 MR. TURK: That he's been involved in?

8 MS. NAKAHARA: Yes.

9 THE WITNESS: Well, first of all, I didn't
10 allow; I don't have the authority to allow anything of
11 any applicant. What we were tasked to do was review
12 the design submitted, and that is calculations,
13 material properties, and determine whether this design
14 satisfies the regulatory requirement.

15 Now, of course, in reviewing the material
16 properties, we will look to see whether they have
17 specified something that is, you know, out of this
18 world that is not likely to be achieved, and that's
19 what we did, and our finding based on the information
20 we presented by the applicant and information
21 available in the literature is that the design
22 satisfies the regulatory requirement and that the
23 material properties that are proposed are within the
24 range of what is available in the literature.

25 BY MS. NAKAHARA:

1 Q Whose decision was it to not require the
2 testing to occur before the SER was issued,
3 essentially approving the design? Was it your
4 decision?

5 A No, it wasn't my decision, but we did
6 inquire about it and found that there is in NRC --
7 there is provisions within the NRC licensing program
8 that provides for tests being done to satisfy material
9 property requirement as specified in design, and that
10 such tests can be done as part of post licensing
11 activity.

12 CHAIRMAN FARRAR: Dr. Ofoegbu, I take it
13 that even though it wasn't your decision, but it was
14 your recommendation that the matter be handled this
15 way? Even though you don't have final decision making
16 power, you were comfortable with that decision?

17 THE WITNESS: Yes, I'm comfortable with it
18 because we were told that there is regulatory
19 precedence for it.

20 BY MS. NAKAHARA:

21 Q And do you know what the regulatory
22 precedence is?

23 A I think that report have a longer history
24 in the analyses.

25 THE REPORTER: If you would just stay back

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1 from that mic, we really would appreciate it.

2 MS. NAKAHARA: We need to combine our
3 voices.

4 THE WITNESS: The people have a longer
5 history with in the analysis program can answer that
6 question better. We were told that there is
7 regulatory precedence for testing being approved based
8 on specified material properties, and such properties
9 being demonstrated by testing.

10 BY MS. NAKAHARA:

11 Q And do you know a specific regulation that
12 allows that?

13 A No, I don't, but I don't think it's -- I
14 think it's a range of requirements in it.

15 Q From a technical perspective, would you
16 prefer to see the tests conducted now prior to
17 licensing or after licensing?

18 A Actually there is no reason to take an
19 opinion on that because as I told you, what we did in
20 our review was determine whether the specified
21 properties are achievable based on information in the
22 literature. And that information, the available
23 information shows clearly that the specified
24 properties are achievable.

25 So when it is done is really not important

1 to our review of the design.

2 Q And if the properties are not achieved,
3 what happens then?

4 A Well, achievable, I said. If we have
5 determined that the properties were not achievable, I
6 made that known to the Nuclear Regulatory Commission.

7 Q But post licensing, if, in fact, PFS could
8 not achieve the required properties, material
9 properties, what happens then?

10 A Well, my understanding is these are
11 specified properties. That's part of the design. So
12 if they cannot meet the design, they will have to come
13 back to analysis. NRC --

14 MR. O'NEILL: Your Honor --

15 THE WITNESS: -- with an amendment
16 application or something, I don't know.

17 MR. O'NEILL: Your Honor, I think we may
18 be delving into the realm of legal consequences or,
19 you know, the specific legal regulatory mechanisms
20 that may come into play. So it calls for a legal
21 conclusion.

22 CHAIRMAN FARRAR: You have a point, but I
23 think this is sufficiently close to the point that
24 State is trying to make that we'll allow it.

25 MR. TURK: May we note also, Your Honor,

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1 that Dr. Ofoegbu works for the Center for Nuclear
2 Waste Regulatory Analyses. He's not a direct NRC
3 employee. Asking him to state NRC regulatory
4 requirements may be a bit of a stretch.

5 MS. NAKAHARA: To the extent he knows is
6 all I'm asking, sir.

7 MR. TURK: Yes, but the question seemed to
8 call for the legal conclusion which at best would be
9 offered by counsel and at worse would be offered by
10 NRC employees who are used to applying the
11 regulations.

12 CHAIRMAN FARRAR: There is a difference
13 between staff managers, staff employees, and
14 consultants to the staff. So there's only a limited
15 range allowable for the questions here, but keep
16 going. You're all right.

17 BY MS. NAKAHARA:

18 Q Dr. Ofoegbu, in your opinion, has PFS
19 demonstrated their design without the test to show
20 that they can achieve the material properties
21 specified?

22 MR. O'NEILL: Do you understand the
23 question, Dr. Ofoegbu?

24 THE WITNESS: I don't understand the
25 question, and I would prefer you repeat or so.

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1 BY MS. NAKAHARA:

2 Q In your opinion, has PFS proven their
3 design using cement treated soil and soil cement will
4 work without having conducted the test program?

5 A Yes, they have.

6 Q And that's based on the literature?

7 A Well, that's based on the analysis they
8 conducted and the information in the literature that
9 shows that these properties are within the range that
10 can be achieved.

11 Q Will you explain how PFS' analyses
12 demonstrate material properties?

13 A I didn't say the analyses demonstrate
14 material properties. You asked me about safety of
15 their design. I said the analyses they conducted
16 demonstrated that their design would be safe, and that
17 the analysis in addition to information in the
18 literature that demonstrates that the material
19 properties used in their design are achievable.

20 Q In your opinion, would PFS' design for the
21 use that they propose with cement treated soil and
22 soil cement -- has that been shown without these
23 tests?

24 MR. O'NEILL: Excuse me. What do you mean
25 by show the design or prove the design? Are we --

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1 have they demonstrated the adequacy of the proposed
2 design as opposed to demonstrated the specific
3 material properties that are, you know, part of that
4 design?

5 MS. NAKAHARA: Okay. Let me withdraw that
6 question.

7 BY MS. NAKAHARA:

8 Q In your opinion, has PFS shown that its
9 design will work as proposed without the tests to be
10 conducted at some time in the future for the cement
11 treated soil or soil cement?

12 A Yes.

13 Q And how have they done that?

14 A Well, through the analysis that they
15 presented which are reviewed and the result of our
16 review documented in the safety evaluation report. We
17 can discuss specific aspects of that based on your
18 questions.

19 MS. NAKAHARA: I have no further
20 questions. Thank you, Dr. Ofoegbu.

21 THE WITNESS: Thank you.

22 CHAIRMAN FARRAR: Thank you, Ms. Nakahara.

23 Judge Lam has a question.

24 JUDGE LAM: Dr. Ofoegbu, I do not know if
25 you are the right expert to answer this question. If

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1 you have any doubt, please decline to answer it.

2 within this proceeding the State of Utah
3 has consistently raised this issue, that the Applicant
4 is caught in the dilemma regarding the cement treated
5 soil underneath the storage page. The dilemma that
6 the State has raised is this, before the Applicant.

7 On one hand, the Applicant needs to have
8 a strength of 40 psi for the cement treated soil to
9 successfully resist sliding.

10 On the other hand, the Applicant does not
11 need a Young's module to excess 75,000 psi so that it
12 would meet the cask drop and the tip-over requirement.

13 My question to you is twofold. Is this,
14 indeed, the dilemma, Part 1?

15 Part 2, is this something that's
16 relatively easy or difficult to resolve?

17 THE WITNESS: Actually I don't think it is
18 a dilemma, and that's based on two considerations.
19 One of them is information available in the literature
20 that indicates that for a 40 psi soil, the Young's
21 modulus, dynamic Young's modulus may actually not
22 exceed about 40,000 psi, and this is based on
23 published research.

24 Of course, the Applicant would not rely on
25 that. What that shows is that this is achievable.

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1 You have to do tests to show that they have achieved
2 the specification.

3 The other one is that the NRC staff
4 evaluation of the sliding safety of the parts relies
5 on the argument that says that sliding of the parts
6 will be small if it did occur; that there are no
7 safety -- there are no connections to the parts that
8 will be ruptured or misaligned as a result of sliding,
9 and that sliding, that the potential for cask tip-over
10 would, in fact, be reduced if the pads were free to
11 slide.

12 So the uncertainty then regarding meeting
13 the 40 psi specification which is -- which they are
14 required to meet the factor safety of 1.1 through the
15 status analysis of sliding stability; the uncertainty
16 there is then reduced because of the analysis of the
17 potential effects of sliding on the safety function of
18 the study parts.

19 JUDGE LAM: Thank you.

20 CHAIRMAN FARRAR: Any redirect by the
21 staff?

22 MR. O'NEILL: Just a few points, Your
23 Honor.

24 CHAIRMAN FARRAR: All right.

25 MR. O'NEILL: Can we possibly take a few

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1 minutes to consult?

2 CHAIRMAN FARRAR: Sure.

3 MR. O'NEILL: Thank you.

4 CHAIRMAN FARRAR: Do you want to take a
5 break or --

6 MR. O'NEILL: In place.

7 CHAIRMAN FARRAR: In place. All right.

8 MS. NAKAHARA: Your Honor, I have one
9 question, a follow-up.

10 CHAIRMAN FARRAR: All right. Go ahead.

11 CHAIRMAN FARRAR: To Judge Lam's.

12 FURTHER CROSS EXAMINATION

13 BY MS. NAKAHARA:

14 Q Dr. Ofoegbu, could you name the literature
15 reference that you responded to Judge Lam in which a
16 40 psi strength was in the range of a 40,000 psi
17 dynamic Young's modulus?

18 A Yes. Actually this particular reference
19 was cited in my testimony not in relation to this, but
20 is the paper by Lambridge (phonetic) and the group of
21 others that discussed the analysis for the Boston
22 panel. And on page 167 of that paper, they refer to
23 published research from a Japanese group that shows --
24 that gives these numbers, which they give the ratio of
25 unconfined compressive strength to Young's -- I mean,

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1 elastic modulus to unconfined compressive strength
2 being in the range of 350 to 1,000.

3 There is another paper. This I have cited
4 before. It's publicly available. It's called
5 "Estimations of Dynamic Modulus of Soil Cement." It
6 has charts.

7 If we go 90 -- page 94, Figure 9 of that
8 paper, it shows the range of values, and when we were
9 reviewing this subject, I did some calculations using
10 these just to look the range of values that could be
11 expected.

12 MS. NAKAHARA: Thank you.

13 CHAIRMAN FARRAR: All right. We'll take
14 a short break in place here.

15 (Whereupon, the foregoing matter went off
16 the record at 4:26 p.m. and went back on
17 the record at 4:31 p.m.)

18 CHAIRMAN FARRAR: All right. The staff is
19 ready for its redirect.

20 Go ahead, Mr. O'Neill.

21 MR. O'NEILL: Just a few quick questions,
22 Dr. Ofoegbu.

23 REDIRECT EXAMINATION

24 BY MR. O'NEILL:

25 Q There was some discussion of the

1 compressive strength of 250 psi. In your view this is
2 -- do you consider this to be a value that is
3 achievable, technically achievable, a compressive
4 strength of 250 psi?

5 A Yes, that is achievable, and as the
6 Applicant witnesses have testified, because there
7 isn't a stiffness restriction on this particular --
8 on those two soil cement layers, the one around the
9 part and the one around the canister transfer
10 building, the minimum strength specified -- I mean the
11 strength doesn't have to be cut at the minimum. In
12 fact, it appears that the durability requirements work
13 upon the mixed design for that, and the strength may
14 end up being much higher than 250 psi.

15 Q In response to questions from Ms.
16 Nakahara, I believe you stated something to the effect
17 that you had prior experience with that kind of soil.
18 You're referring to the Bonneville clays, but you had
19 not necessarily worked specifically with Bonneville
20 clay.

21 Could you elaborate or amplify on that a
22 little bit?

23 A Well, what I was trying to -- what I was
24 referring to was the fact that this is silty clay,
25 clay in silt, and there are a lot of materials that

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1 fall within that classification through a lot of
2 soils, and that maybe specific about Bonneville clay,
3 but not that any testing has shown that the Bonneville
4 clay is different from other clays that -- it is
5 sufficiently different from other clays within that
6 category to request that somebody has to have
7 specifically as walk-in in order to review a design
8 conducted on it.

9 Q And with respect to the significance of
10 specific properties of Bonneville clay or properties
11 that may be of significance to obtaining an
12 appropriate soil-cement mix, you would expect the
13 testing that the applicant has committed to to bring
14 out such significant properties, assuming they exist,
15 correct?

16 A Of Bonneville clay?

17 Q Yes, yes. Well, I'm sorry. We're dealing
18 with the eolian sites, silts. Okay.

19 A The Bonneville clay is not --

20 Q Directly being used?

21 A -- directly involved in the --

22 Q I'm sorry, sir. I misspoke.

23 You made reference to a particular
24 professional paper or literature study. You
25 mentioned Figure 9 in particular that relates to the

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1 dynamic Young's modulus and the compressive strength
2 that could be achieved either simultaneously or exist
3 simultaneously in the soil cement.

4 Could you provide a full reference for
5 that paper?

6 A Yes, I can provide a copy of full
7 reference for that. I have the paper here.

8 Q Would that be "Assignations of Dynamic
9 Modulus of Soil Cement" by S.N. Doshi (phonetic) or
10 Doshee (phonetic) and M.S. Misderry (phonetic)?

11 A That's correct. It was published in the
12 Australian broad -- Volume 15, Number 2, 1985.

13 Q And Figure 9 is located on page 94 of that
14 document, correct?

15 A That is correct.

16 MR. O'NEILL: I think that's all I have
17 for now. Thank you.

18 CHAIRMAN FARRAR: Mr. Travieso-Diaz?

19 MR. TRAVIESO-DIAZ: I have just a
20 question.

21 RE CROSS EXAMINATION

22 BY MR. TRAVIESO-DIAZ:

23 Q Good Afternoon, Dr. Ofoegbu.

24 A Thank you.

25 Q During the cross examination by Ms.

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1 Nakahara, you testified that there would be a thermal
2 gradient that would drive moisture away from the
3 native soil underlying the pad. So despite the fact
4 that there could be an impermeable barrier above,
5 there still would be no accumulation of moisture on
6 that soil. Do you remember that?

7 A Yes, I remember that.

8 Q Can you give us a reference or the basis
9 for that view? In other words, is there any paper or
10 any other preference that provides the basis for that
11 view of yours?

12 A Well, I couldn't give a reference right
13 here, but there are -- it's a well known phenomenon.
14 In fact, there's a textbook in my office that
15 discusses the interactions of moisture and heat and
16 all such with that soil. Moisture flows down the
17 temperature gradient. So if you increase the heat at
18 the point in the soil mass, you tend to drive moisture
19 away.

20 Q So this is kind of a well known phenomenon
21 that is even discussed in textbooks; is that right?

22 A That's correct.

23 MR. TRAVIESO-DIAZ: That's all I have.

24 CHAIRMAN FARRAR: Ms. Nakahara?

25 MS. NAKAHARA: No further questions, Your

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1 Honor.

2 CHAIRMAN FARRAR: All right. All right.
3 We're getting better at this.

4 (Laughter.)

5 CHAIRMAN FARRAR: Less than an hour on and
6 off.

7 Dr. Ofoegbu, thank you for you testimony.
8 You're excused for now.

9 (The witness was excused.)

10 CHAIRMAN FARRAR: I take it then we're
11 ready for the State's panel, Dr. Bartlett and Dr.
12 Mitchell; is that right?

13 MS. NAKAHARA: That's correct.

14 CHAIRMAN FARRAR: All right. Why don't we
15 get them on and get their testimony in place, and then
16 we'll see where we are.

17 (Pause in proceedings.)

18 CHAIRMAN FARRAR: Dr. Bartlett, it seems
19 we've seen you before. So you're -- consider yourself
20 still under oath.

21 Whereupon,

22 DR. STEVEN BARTLETT

23 was recalled as a witness by counsel for the State
24 and, having been previously duly sworn, was examined
25 and testified further as follows:

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1 CHAIRMAN FARRAR: Dr. Mitchell, would you
2 stand and raise your right hand, please?

3 Whereupon,

4 DR. JAMES MITCHELL

5 was called as a witness by counsel for the State and,
6 having been first duly sworn, was examined and
7 testified as follows:

8 CHAIRMAN FARRAR: Thank you.

9 (Pause in proceedings.)

10 MS. CHANCELLOR: I was just waiting. I
11 didn't know if you were set.

12 CHAIRMAN FARRAR: Oh, we're ready. Go
13 ahead.

14 DIRECT EXAMINATION

15 MS. CHANCELLOR: Good afternoon, Dr.
16 Mitchell and Dr. Bartlett. Do you have in front of
17 you "State of Utah Testimony of Dr. Steven F. Bartlett
18 and Dr. James K. Mitchell on Unified Contention Utah
19 L/QQ (Soil Cement)," dated April 1, 2002?

20 MR. BARTLETT: Yes.

21 MS. CHANCELLOR: Are there any changes you
22 wish to make to this testimony?

23 DR. MITCHELL: Not to my responses.

24 MR. BARTLETT: No.

25 THE REPORTER: I couldn't hear your

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1 response.

2 DR. MITCHELL: Not to my responses.

3 MR. BARTLETT: No.

4 MS. CHANCELLOR: Was this testimony
5 prepared by you or under your direction?

6 MR. BARTLETT: Yes.

7 DR. MITCHELL: Yes.

8 MS. CHANCELLOR: Do you accept this
9 testimony as your sworn testimony in this proceeding?

10 DR. MITCHELL: Yes.

11 MR. BARTLETT: Yes.

12 MS. CHANCELLOR: Your Honor, I request
13 that the testimony of Drs. Bartlett and Mitchell be
14 bound into the record as if read.

15 CHAIRMAN FARRAR: Any objections?

16 MR. O'NEILL: No.

17 PARTICIPANT: No.

18 CHAIRMAN FARRAR: All right. Then the
19 testimony will be bound into the record at this point
20 as if read.

21 (Insert prefiled testimony of Drs.
22 Mitchell and Bartlett.)

23

24

25

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))	April 1, 2002

STATE OF UTAH TESTIMONY OF DR. STEVEN F. BARTLETT AND
DR. JAMES K. MITCHELL ON UNIFIED CONTENTION UTAH L/QQ
(Soil cement)

Q. 1: Please state your name, affiliation, and qualifications.

A. 1: (SFB) My name is Dr. Steven F. Bartlett. I am an Assistant Professor in the Civil and Environmental Engineering Department of the University of Utah, where I teach undergraduate and graduate geotechnical engineering courses and conduct research. I hold a B.S. degree in Geology from Brigham Young University, a Ph.D. in Civil Engineering from Brigham Young University and I am a licensed professional engineer in the State of Utah.

My qualifications are described in my soils testimony, which is being filed concurrently with this prefiled testimony. Relevant to this testimony, my tenure at the Utah Department of Transportation and Woodward-Clyde Consultants in Salt Lake City have given me a background knowledge and understanding of local soil conditions, especially the upper Lake Bonneville sediments. I have also been involved in the design and performance monitoring that used lime-cement column stabilization underneath a mechanically stabilized earth wall for the I-15 Reconstruction Project. My curriculum vitae is included with my soils testimony as State's Exh. 92.

Q. 2: Dr. Bartlett, do you consider it necessary to present testimony with another witness?

A. 2: (SFB) Yes. Dr. James K. Mitchell has expertise specific to soil cement. His testimony will overlap my testimony especially with respect to the effect soil cement may have on native soils. It would be expedient for the Board to hear our testimony together.

Q. 3: Please state your name, affiliation, and qualifications.

A. 3: (JKM) My name is Dr. James K. Mitchell. I hold a Sc.D. in civil engineering earned in 1956 from the Massachusetts Institute of Technology. Presently I am a University

Distinguished Professor Emeritus at Virginia Tech and Professor Emeritus at the University of California at Berkeley. I serve as an individual consultant on geotechnical problems and earthwork projects of many types, particularly soil stabilization, ground improvement for seismic risk mitigation, earthwork construction, and environmental geotechnology, to numerous national and international governmental and private organizations. My curriculum vitae listing my qualifications, experience, and training is included as State's Exhibit 105.

I have more than 40 years' experience in the field of geotechnical engineering. I was on the faculty of the University of California, Berkeley, Department of Civil Engineering for more than 35 years, serving as Department Chair for five years. I developed and taught graduate courses in soil behavior, soil and site improvement, and foundation engineering as part of the Geotechnical Engineering Program within the Civil Engineering Department. At the same time, I was Research Engineer in the Institute of Transportation Studies and in the Earthquake Engineering Research Center. Since 1994, I served on the faculty of Virginia Tech, via Department of Civil and Environmental Engineering, and was appointed University Distinguished Professor in 1996 and University Distinguished Professor, Emeritus, in 1999.

My primary research activities focused on experimental and analytical studies of soil behavior related to geotechnical problems, admixture stabilization of soils, soil improvement and ground reinforcement, physico-chemical phenomena in soils, the stress-strain time behavior of soils, in-situ measurement of soil properties, and mitigation of ground failure risk during earthquakes. I have authored more than 350 publications, including two editions of the graduate level text and reference, "Fundamentals of Soil Behavior," and several state-of-the-art papers and guidance documents on soil stabilization, ground improvement, and earth reinforcement.

Some of my recent and currently active projects include the evaluation of seismic stabilities and design of liquefaction mitigation options for Success Dam in California (U.S. Army Corps of Engineers) and Pineview and Deer Creek Dams in Utah (U.S. Bureau of Reclamation); ground improvement aspects of the Port of Oakland Wharf and Embankment Strengthening Program (Harding Lawson Associates); ground improvement and fill stabilization for the proposed San Francisco Airport Expansion (Fugro West); design review - ground improvement for the I-95/Rt.1 Interchange section of the Woodrow Wilson Bridge replacement project (Haley & Aldrich, Virginia Geotechnical Services, URS, HNTB); and as a member of the Peer Review Panel for the Seismic Vulnerability Study of the Bay Area Rapid Transit System in California.

I am licensed as a Civil Engineer and as a Geotechnical Engineer in California, and as a Professional Engineer in Virginia. I am a Fellow and Honorary Member of the American Society of Civil Engineers, and have served as an officer of the Geotechnical Engineering Division of ASCE; the United States National Committee for the International

Society for Soil Mechanics and Foundation Engineering; the ASCE Committee on Soil Properties, the Committee on Placement and Improvement of Soils; the San Francisco Section of ASCE and the California State Council of ASCE; the Transportation Research Board Committee on Physico-Chemical Phenomena in Soils; the Geotechnical Board of the U.S. National Research Council; the International Society for Soil Mechanics and Foundation Engineering. I recently completed service as Vice Chair of an NRC study committee for development of science needs for remediation of contaminated Department of Energy weapons sites and as a member of an NRC study committee to advise the Department of Energy on Remediation Science and Technology for the Hanford Site. I presently serve as Chair of a National Academies panel to develop recommendations for peer review of U.S. Army Corps of Engineers civil works projects.

Specifically relevant to soil cement are my many years of research on the properties of cement stabilized soils and the use of soil cement in pavement structures, involvement as a consultant on the Koeberg nuclear power plant project in South Africa, and my current work involving deep soil mixing.

Q. 4: Dr. Mitchell, do you consider it necessary to present testimony with another witness?

A. 4: (JKM) Yes. Dr. Steven Bartlett's expertise in native soils in Utah will complement my testimony. In addition, he has had more involvement than I have in the overall review of PFS's analyses relating to soils and the dynamic forces imparted to foundations and soils. Together, we can better inform the Board on PFS's proposed use of soil cement than if we were to testify independently.

Q. 5: What is the purpose of your testimony?

A. 5: (SFB, JKM) The purpose of our testimony is to explain the basis for our professional opinion that (1) PFS's proposal to use soil-cement and cement-treated soil to provide additional seismic sliding resistance and stability to shallowly embedded foundations subjected to intense strong ground motion is a new and unique application of this technology; (2) to our knowledge, there is no prior precedent for PFS's proposed use of this technology; (3) site-specific analyses and testing is required to verify the design at the PFS site to ensure that the soil cement and cement-treated soil will perform their intended functions during earthquake shaking and that target performance requirements are met for cask drop and tipover scenarios; (4) the potential impact of construction and placement of the soil cement and cement-treated soil on the underlying native soils has not been addressed; and (5) PFS's proposal to conduct a soil cement testing program after, rather than before, it obtains a license will not prove the design concept that will form the basis of a licensing decision.

Q. 6: What has been your involvement in reviewing and analyzing PFS's intended use of soil cement and cement-treated soil? NEW

A. 6: (SFB) I have been assisting the State since 1999 and have reviewed PFS's sliding and stability calculation both prior to PFS's intended use of soil cement and also where, through design creep, PFS has expanded its use of soil cement and cement-treated soils. I assisted and gave technical support to the State in filing Contention Utah QQ and the two modifications thereto. I am familiar with sections of PFS's Safety Analysis Report ("SAR") and calculation packages with respect to PFS's characterization of soils, the cone penetrometer testing, PFS's stability analyses and its seismic exemption request. Some of these topics are described in my soils and dynamic analysis testimonies filed concurrently with this testimony.

(JKM) I began assisting the State shortly before the State filed Contention Utah QQ. I provided technical support for filing that contention. My role is generally limited to review of PFS's most recent proposal for use of soil cement and cement-treated soil.

Q. 7: Please describe PFS's intended use of soil cement and cement-treated soil at the proposed Skull Valley ISFSI site?

A. 7: (SFB) PFS states that it intends to use soil cement around the Canister Transfer Building ("CTB") and around the storage pads. Under the storage pads, PFS will use a weaker cement mix, a cement-treated soil.

The placement of soil cement around the perimeter of the foundation for the CTB is intended to provide additional resistance against sliding during the design basis earthquake by acting as a buttress. Without the additional resistance provided by the soil cement around the CTB, the Applicant has calculated that sliding of the CTB is possible (Calc. G(B)-13-4). Thus, the concept of using soil cement as buttress for the CTB has become an integral part of the seismic design of the CTB design.

The placement of cement-treated soil underneath the storage pads is intended to act as an "engineered mechanism" to transfer inertial forces of the casks and pads to the underlying upper Lake Bonneville sediments in order to prevent sliding. SAR, p. 2.6-61. Shear stresses are intended to be transferred through the approximately 2-ft thick cement-treated soil layer to the underlying silty-clay/clayey-silt. The Applicant also implies that additional sliding resistance will be provided by the continuous layer of soil cement between the pads (SAR, p. 2.6-61). Like the CTB, the concept of using cement-treated soil underneath the pads and soil cement between the pads has become an integral part of the seismic design of the storage pads.

The soil cement between the pads is also intended to provide a stabilized base for the support of the cask transport vehicle. SAR, p. 2.6-67d.

Q. 8: Has PFS conducted tests and analyses that are necessary to determine whether soil cement will provide additional resistance against sliding and whether cement-treated soil will act as an "engineered mechanism" in transferring shear stresses to the native soils?

A. 8: (SFB, JKM) No. PFS has conducted a few tests, which we describe later in our testimony. Basically, PFS has decided to wait until after it obtains a license to conduct most of the testing and analyses.

There are only two documents that describe PFS's soil cement program: (1) SAR 2.6-108 through -121 (Rev. 22), included as State's Exhibit 106, and (2) Engineering Services Scope of Work for Laboratory Testing of Soil-Cement Mixes between Stone and Webster and Applied Geotechnical Engineering Consultants, Inc. ("AGEC"), ESSOW No. 05995.02-G010 (Rev. 0), dated January 21, 2001, included as ~~State's Exhibit 107.~~ **MS EXHIBIT 444**

Those two documents describe what PFS intends to do in the future. We do not understand how PFS can go forward with its seismic design not knowing whether soil cement and cement-treated will perform its intended seismic function. We see no practical reason why PFS should not perform testing and analyses now rather than at some future date. Some of the questions - but not all of them - we raise here would be resolved through such testing and analyses. Also, if in the future PFS finds that soil cement and cement-treated soil will not support PFS's seismic design, then the licensing basis for approving the PFS facility design will be invalid.

Q. 9: Dr. Mitchell, do you consider there to be any direct precedent for PFS's soil-cement program?

A. 9: (JKM) For pavement structures and as a structural fill - yes; as a restraining buttress and for development of sliding resistance - no.

Q. 10: What is the basis of your opinion?

A. 10: (JKM) Over my 40 year career, I have been involved with or had an academic interest in numerous projects that have used cement to increase certain properties of soils. The use of soil cement for pavement bases and sub-bases goes back to the early 1900s and today it is widely used as a strengthening base for pavement structures. Starting in the late 1950s soil cement has been used for hydraulic structures such as slope protection on dam faces or reservoirs and for canal linings.

¹ ~~The State obtained a copy of the ESSOW under a PFS confidentiality agreement; PFS claims that the methodology that may be contained in the ESSOW still remains confidential. As a precaution, the State is filing Exhibit 107 as a proprietary filing but in doing so the State does not agree that the document is confidential.~~

More recently, soil cement has been used as structural fill in seismic areas and for constructing roller-compacted concrete to build dikes and dams. The latest development in the use of soil cement is deep soil mixing.

Q. 11: Does the use of soil cement as a strengthening base for pavements and for hydraulic structures provide a precedent for PFS?

A. 11: (JKM) Not as regards the proposed development of sliding resistance and a buttressing effect.

Q. 12: Are there examples of using soil cement in seismic design?

A. 12: (JKM) Yes. But none of the cases apply to PFS's intended use. The one application I am most familiar with is in Koeberg, South Africa - one of the cases PFS cites in the SAR at 2.6-113 (Rev. 22), State's Exh. 106.

During the late 1970s and early 1980s, I was involved as a consultant on the soil cement issues at the Koeberg nuclear power project located in the coastal area of Cape Town, South Africa. The project required a large excavation, approximately 24 meters deep, to remove an eight meter thick potentially liquefiable layer of saturated loose sand. The sand was mixed with cement, then replaced and recompacted.

Q. 13: Why is the South Africa case not analogous to the PFS case?

A. 13: (JKM) The Koeberg case is not analogous because the soils there were loose, saturated sands. The soils at PFS are plastic, fine grained, cohesive materials. At Koeberg the purpose was to eliminate the potential for liquefaction of the loose sand beneath the reactor building under seismic loading. The fine-grained soils at the PFS site are not liquefiable, and the purposes of the soil cement and cement-treated soil are to provide sliding resistance and buttressing, as stated above.

Q. 14: Are there other examples of soil cement used in seismic design?

A. 14: (JKM) Yes, but again the application is not really relevant to the PFS site. The latest use of soil cement for seismic design is in deep soil mixing. In this application, mix-in-place columns and walls extend down as much as a hundred feet below the ground surface for both support of structures and excavations and for containment of potentially liquefiable soils.

Q. 15: Is deep soil mixing analogous to the PFS case?

A. 15: (JKM) No. Deep soil mixing applications are not at all like the proposed PFS use of soil cement.

Q. 16: What is the difference between soil cement and cement-treated soil and why is the difference important?

A. 16: (JKM) Cement-treated soil may contain any amount of cement. To be a soil cement requires that the cement content and compaction conditions be sufficient to attain minimum durability standards as measured by American Society for Testing and Materials ("ASTM") wet-dry and freeze-thaw tests. More cement is needed as the fines content in the soil to be treated increases. The strength of soil cement generally decreases as soil plasticity increases. At treatment levels less than those needed to produce a soil cement, the durability may be inadequate under severe exposure conditions, such as at the PFS site, to prevent degradation of the material over time.

Q. 17: Specific to the PFS site, approximately how much cement is needed to create soil cement and cement-treated soil?

A. 17: (JKM, SFB) The Applicant has not submitted the design of the soil cement and cement-treated soil for the PFS site, so this has not been determined. However, the SAR (p.2.6-67c), State's Exh. 106, implies that about 1 percent cement will be required to create cement-treated soil and about 6 percent will be required to create soil cement in order to meet the target compressive strengths of 40 and 250 psi, respectively. It should be noted that by itself, attainment of a designated compressive strength cannot guarantee a material to be a soil cement. Durability testing is required for this purpose.

Q. 18: The term soil cement seems to imply a fairly strong material. How does the compressive strength of 250 psi soil cement compare with the compressive strength of concrete?

A. 18: (JKM, SFB) Concrete is much stronger. It has typical compressive strengths of at least 3000 to 4000 psi. Also, the concrete that PFS plans to use for the cask storage pads and CTB mat foundation has steel reinforcement so that it can withstand tensile as well as compressive forces.

Q. 19: Why is it important to have reinforcing steel to resist tensile forces in reinforced concrete design?

A. 19: (SFB) Concrete is relatively weak in tension and steel has high tensile capacity. Thus, the reinforcement allows the pad or mat to resist tensile stresses created by bending and torsion of the foundation during the design basis earthquake.

Q. 20: Were the concrete storage pads designed to resist tensile and bending stresses?

A. 20: (SFB) Yes, the storage pads were analyzed and designed for dynamic

loading conditions using a soil-structure analysis that was performed by International Civil Engineering Consultants Inc. (Calc. G(PO17)-2).

Q. 21: Does a similar analysis exist to evaluate the dynamic stresses developed in the soil cement and cement-treated soil?

A. 21: (SFB) No.

Q. 22: In your opinion, is a similar calculation necessary to assess the feasibility of the proposed treatment and if so, why?

A. 22: (SFB) Yes. The Applicant has assumed that the soil cement and cement-treated soil will act as an integral mat, thereby keeping each individual pad in place and in-phase with the other adjacent pads during strong ground motion (SAR, pp. 2.6-61 and 62). The Applicant has not considered the potential for out-of-phase motion between pads in the longitudinal direction and the consequences of this out-of-phase motion. However, to act as an integral mat, the soil cement and cement-treated soil mat must resist compressional, shear, bending, torsional and tensile stresses induced by the design basis earthquake both underneath the pads and between the pads. The Applicant has not performed soil-structure interaction analysis to evaluate the magnitude and orientation of these stresses in the mat and how these forces will impact the seismic performance. The magnitude of bending, torsional and tensile stresses developed in the mat could be important because of the very low tensile strength of the soil cement and cement-treated soil. The tensile strength of these materials is typically only about a fifth to a third of the unconfined compressive strength. Thus, even rather low tensile stresses can cause cracking. The Applicant has not calculated the magnitude and orientation of these stresses; thus a rational assessment cannot be made of the seismic performance of the proposed cement treatment.

Q. 23: In your opinion, are there other possible mechanisms that may cause cracking of the soil cement and cement-treated soil beside the dynamic forces?

A. 23: (SFB, JKM) Yes. Other potential mechanisms for cracking of the soil cement and cement-treated soil may include: (1) delamination or debonding along a soil cement lift interface or an interface with the concrete pad or the native soil during a seismic event; (2) shrinkage cracking during curing and drying; (3) settlement cracking resulting from differential settlement at the perimeter of the pads and CTB mat foundation; (4) frost penetration and expansion cracking; and (5) cracking or overstressing due to vehicle loads (eg, canister transport vehicle).

Q. 24: Of these possible mechanisms, which one would seem to be of most concern?

A. 24: (SFB, JKM) Of most concern is shrinkage cracking of the soil cement

between and around the pads and of the soil cement surrounding the CTB. Shrinkage cracks form during the process of curing and aging of soil cement. These are relatively thin generally vertical cracks to subvertical cracks that will develop in the soil cement. From a seismic performance standpoint, the real issue is not thickness of the crack, but its potential for continuity. If these cracks are somewhat continuous, then the tensile resistance has been completely lost along the surface of the crack. This loss of tensile capacity in the mat is extremely deleterious when the mat has to resist dynamic tensile stresses. Loss of tensile capacity will in turn impact the mat's capacity to act as an integral mat and resist out-of-phase motion between individual pads or out-of-phase motion between the CTB concrete mat foundation and the perimeter soil cement mat. Such out-of-phase motion will introduce inertial interaction as discussed in the dynamic analysis testimony by Drs. Farhang Ostadan and Steven Bartlett.

Q. 25: What might be other consequences of cracking and inertial interaction?

A. 25: (SFB) If the cracking or interaction is significant, then there can be a loss of the buttress effect (*i.e.*, passive earth pressure) that is relied upon by the Applicant to resist sliding of the CTB foundation. Also, there can be a reduction or loss the cement-treated soil's ability to transfer shear stresses to the underlying upper Lake Bonneville sediments. These losses, depending on their magnitude, will reduce the factor of safety against sliding, or if large enough, lead to sliding.

In addition, the cracks would provide a pathway for ingress of water through the soil cement between the pads and around the CTB. This water could cause a strength reduction in the underlying Bonneville clay.

Q. 26: In addition to shrinkage cracks, are there other mechanism that may lead to cracking?

A. 26: (SFB, JKM) Differential settlement around the perimeter of the CTB and pads, as well as beneath the pads may be important. The Applicant has estimated about 2 inches of total settlement of the pads (SAR, p. 2.6-50) and 3 inches of total settlement for the CTB. It is anticipated that much of this settlement will be distributed around the perimeter of the pads and CTB due to the abrupt change in vertical static loading conditions between relatively heavily loaded foundations (about 1.5 to 2 kip per square foot) and the adjacent unloaded perimeter area. Also, it is important to keep in mind that the most compressible layer (*i.e.*, the upper Lake Bonneville sediments) lies just below the foundations.

Q. 27: Beyond the target compressive strength of 40 and 250 psi for cement-treated soil and soil cement, respectively, identified by PFS in the earthquake sliding calculations, has PFS identified any other requirements for the cement-treated soil and soil cement?

A. 27: (SFB, JKM) It has. The soil cement between the pads must have a target strength of 250 psi to provide a good subbase for the cask transporter (SAR p. 2.6-67d). The cement-treated soil beneath the pads must have a Young's modulus of 75,000 psi, or less.

Q. 28: What is the purpose of limiting Young's modulus to 75,000 psi?

A. 28: (SFB) In the drop/tipover analysis of the casks (*PFSF Site-Specific HI-STORM Drop/Tipover Analyses*, Rev. 0 and Rev. 1, Holtec Report No. HI-2012653, Apr. 3, and May 7, 2001 respectively), Holtec places constraints on the thickness and modulus of elasticity (i.e., Young's modulus) of the cement-treated soil. The cement-treated soil is limited to a maximum thickness of 2 feet and Young's modulus is limited to a maximum value of 75,000 psi. These constraints are placed on the cement-treated soil in an attempt to limit the decelerations from a hypothetical cask tipover event or end drop accident. The Holtec calculation shows that there is a very small margin against the deceleration limit. If the Young's modulus exceeds 75,000 psi, then the deceleration limit is likely to be exceeded. The Stone and Webster stability analysis of the casks identifies the 75,000 psi as the static Young's modulus of the cement-treated soil. Dr. Ostadan has testified, in the Dynamic Analysis testimony, that the use of the static Young's modulus to analyze dynamic impact is not appropriate for the cask drop/tipover scenario. Furthermore, the Geomatrix calculation for development of ground motion, soil springs and damping effectively assigns a much higher modulus to the cement-treated soil.

(SFB, JKM) The Applicant has not provided any site-specific test data that demonstrate this rather low modulus can be achieved for a cement-treated soil with a minimum compressive strength of 40 psi. There is not very much published test data for these low modulus values. Further, the cement content and the placement conditions are tremendously important in determining the strength and stiffness properties of the cement-treated soil. In sum, whether or not PFS can achieve a Young's modulus of 75,000 psi or less, while meeting the minimum compressive strength requirement of 40 psi, depends on the quantity of cement that is used, the site soil, and the placement conditions (water content and density).

Q. 29: To your knowledge, who is working on the PFS soil-cement program?

A. 29: (SFB) From deposition testimony, it appears that Mr. Paul Trudeau of Stone & Webster was primarily responsible for authoring the description of PFS's soil-

cement program in SAR 2.6-108 through -121 (Rev 22). Trudeau Tr.² at 18. Mr. Trudeau also developed the ESSOW No. 05995.02-G010 for the Laboratory Testing of Soil-Cement Mixes between Stone & Webster and AGECE. *Id.* at 54-55. AGECE has conducted a few tests and reported the results to Mr. Trudeau but most of the AGECE testing program is on hold for now. Trudeau Tr. at 67, 72-73.

(SFB, JKM) PFS may retain Dr. Anwar Wissa to assist it with its soil-cement program but as of the date of his deposition on March 15, 2002, there was no formal agreement between Dr. Wissa and PFS. Wissa Tr.³ at 42-44; Trudeau Tr. at 89, 110, State's Exh. 108.

Q. 30: How will PFS construct the soil cement in its foundation system? -

A. 30: (SFB, JKM) From the deposition testimony it appears that PFS has not yet developed a plan for the specific construction techniques that will be employed in excavating the eolian silts and mixing them soil cement and replacing them. State's Exh. 109, Wissa Tr. at 15-34; State's Exh. 108, Trudeau Tr. at 91-92. Irrespective of the methods that are used, it is important that the native soils upon which the soil cement will be placed not be disturbed as this would likely lead to loss of subgrade support and increased post-construction settlement. If PFS chooses to haul eolian silt off site to a central plant for mixing, the time between mixing the water at the central plant and final compaction could affect the properties of the soil cement. Wissa Tr. at 24.

Q. 31: What effect would there be from potential disturbance or remolding of the native clays?

A. 31: (SFB) As I described in my soils testimony, the engineering properties of the native clays - *i.e.*, upper Lake Bonneville sediments - are very important because PFS relies on the shear strength of this layer to provide resistance to sliding. Any disturbance or remolding of these clays could substantially decrease their shear strength.

During his deposition testimony, Mr. Trudeau acknowledged that cohesion available in the upper Lake Bonneville sediments is required as part of the design of the pads and that construction equipment and techniques have the opportunity to destroy the surface of the subgrade if PFS is not careful in protecting those soils. State's Exh. 108, Trudeau Tr. at 96.

The SAR at 2.6-108 (State's Exh. 106) describes the following regarding the

² Excerpts from the deposition transcript ("Tr.") of Mr. Paul Trudeau (March 6, 2002) are included as State's Exhibit 108.

³ Excerpts from the deposition transcript ("Tr.") of Dr. Anwar Wissa (March 15, 2002) are included as State's Exhibit 109.

construction of the soil cement:

The layer of soil cement beneath the storage pads will have a minimum thickness of 12 inches and a maximum thickness of 24 inches. In the event the eolian silt layer extends to a depth greater than 2 ft below the elevations of the bottoms of the storage pads, compacted clayey soils will be used to raise the elevation of the subgrade that will support the soil cement layer to an elevation of 2 ft or less below the design elevations of the bottoms of the pads.

Mr. Trudeau estimated that only about two percent of the entire pad area would need to be recompacted with compacted clayey soil. Trudeau Tr. at 33-34, 97-99, State's Exh. 108.

There is insufficient evidence to suggest that only two percent of the site will be affected. In any event, recompacted clay will have a decrease in shear strength from the design values PFS is relying upon for the native soils. PFS is again constrained by Holtec's cask tipover analysis because PFS cannot construct cement-treated soil that is deeper than two feet without exceeding Holtec's bounding conditions on cask tipover. Therefore, PFS must use recompacted and remolded clays.

(SFB, JKM) Another way in which there can be remolding of native clays is from traffic and heavy construction equipment disturbing the crust of the clays. Even small disturbances could cause a decrease in shear strength.

Q. 32: Are there any concerns about the potential changes in moisture content of the clays, and if so, what are they?

A. 32: (SFB, JKM) Yes. When clays gain moisture they soften and there is a decrease in their undrained shear strength. PFS is only testing undrained shear strength of samples at their moisture content as collected from the site. When a cement cap - such as the storage pads - is placed over cement-treated soils and the native soils, there is a potential to increase the moisture content of the native soils.

Experience has shown in conditions such as those at the PFS site you can accumulate water beneath the paved area. This will have a detrimental consequence on the engineering properties of the clay layer.

Changes in moisture content can occur from upward migrating moisture that can no longer evaporate because of the sealed surface above. You do not need to have saturated conditions to cause changes in moisture content of the native soils. By changing the evapo-transpiration environment of the soils, you can actually change the moisture content, and, therefore, the strength of those soils. Moisture that is already present in the soil will likely be

redistributed until a new equilibrium is established.

Precipitation, runoff and construction activities could also cause a change in the moisture content of the native soils.

Q. 33: Please describe PFS's soil cement program.

A. 33: (SFB) The PFS soil cement program is described in SAR 2.6-108 through -121 (Rev 22) and the ESSOW between Stone & Webster & AGECE (State's Exhs. 106 and PFS Exh. 107, respectively). Trudeau Tr. at 88-89, State's Exh. 108. The ESSOW calls for AGECE to complete the testing program in 13 months. PFS Exh. 107 at 5.5. AGECE starting the testing program in about March 2001. Trudeau Tr. at 71-72. To date, AGECE has completed Phase 1 (indexing property) and Phase 2 (moisture density) testing. PFS experienced problems with Phase 3 testing for durability and placed the entire testing program on hold. Trudeau Tr. at 72, 110.

Q. 34: Will the tests that PFS has conducted to date prove its design concept?

A. 34: (SFB) No. There are several tests that PFS says it will conduct in the future, most likely after PFS obtains a license from NRC. First, PFS must re-do the failed durability tests. The durability tests are to show that the soil cement around the pads and CTB can withstand freeze/thaw wet/dry cycles and will take approximately two months to complete. The next tests will be the compressive tests to show what mix of Portland cement PFS needs to add to the silts to obtain 250 psi for the soil cement around the pads and around the CTB. Moduli testing of the cement-treated soil to determine whether PFS could achieve a mix that complies with the limitations of the 75,000 psi Young's modulus could be conducted in parallel with the compressive tests. These two phases of testing would take about 2 to 3 months. Trudeau Tr. at 77-81, State's Exh. 108. Thus, there is about 4 to 5 months of testing to be completed before PFS can determine whether it has the correct "recipe" for the soil cement and whether it can concoct a cement-treated soil mix that will not exceed 75,000 psi.

This is not the end of the soil cement program. Next PFS will have to conduct interface strength tests and a bonding study to determine whether there is sufficient adhesion between the cement-treated soil with both the underlying native soils and the bottom of the concrete storage pads. Trudeau Tr. at 80-81. Mr. Trudeau admitted that only then will PFS have proven the design. Trudeau Tr. at 81

Even if PFS does complete all the tests described above, there still will not be proof of the design concept. As described in greater detail in the dynamic analysis testimony that I have presented with Dr. Ostadan, there could be cracking of the cement-treated soil under the pads and separation of the soil cement around the pads and the CTB. In other words,

PFS has not shown that the use of soil cement and cement-treated soil will provide an acceptable seismic design for Skull Valley site where up to 4,000 spent nuclear fuel casks will be stored.

Q. 35: Does this conclude your testimony?

A. 34: (SFB, JKM) Yes.

1 MS. CHANCELLOR: There are certain
2 exhibits to the testimony. Exhibit 105 is the
3 curriculum vitae of James Kenneth Mitchell. I'll go
4 through them all and move them all in and then see if
5 there are any objections.

6 CHAIRMAN FARRAR: All right.

7 MS. CHANCELLOR: One, oh, six are portions
8 from PFS SAR, Section 2.6.4.11, Revision 22.

9 I'll skip 107 for the moment, Your Honor.
10 There may be a problem with that.

11 One, oh, eight, excerpts from a transcript
12 of a deposition of Paul J. Trudeau, dated March 6,
13 2002.

14 One, oh, nine are excerpts from a
15 deposition of Dr. Wissa, dated March 15, 2002.

16 And I would move that Exhibits 105, 106,
17 108 and 109 be bound into the record.

18 CHAIRMAN FARRAR: Or admitted?

19 MS. CHANCELLOR: Be moved into evidence.

20 CHAIRMAN FARRAR: ny objection on any of
21 these?

22 MR. TRAVIESO-DIAZ: No.

23 MR. O'NEILL: No, Your Honor.

24 CHAIRMAN FARRAR: All right. Then 105,
25 106, 108 and 109 will be admitted.

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1 (Whereupon, the documents
2 referred to were marked as
3 State's Exhibit Nos. 105, 106,
4 108 and 109 for identification
5 and were received in evidence.)

6 CHAIRMAN FARRAR: What do you want to do
7 with 107, Ms. Chancellor?

8 MS. CHANCELLOR: One, oh, seven, if you
9 will recall, Your Honor, we submitted this as a
10 confidential document because that's how we received
11 it from PFS. PFS has since removed the
12 confidentiality claim on this document.

13 And while it is duplicative of PFS' GGG,
14 as it's referred to in Dr. Bartlett and Dr.
15 Mitchell's testimony, I would request that this also
16 be -- that 106 nevertheless be admitted into evidence.

17 CHAIRMAN FARRAR: One, oh, seven?

18 MS. CHANCELLOR: One, oh, seven.

19 CHAIRMAN FARRAR: I take it this is
20 referred to in their testimony.

21 MS. CHANCELLOR: It's actually a PFS
22 Exhibit GGG. We both filed the same exhibit.

23 CHAIRMAN FARRAR: No, but in --

24 MS. CHANCELLOR: Oh, in --

25 CHAIRMAN FARRAR: -- in Dr. Bartlett's and

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1 Dr. Mitchell's testimony they refer to 107 rather than
2 GGG?

3 MS. CHANCELLOR: That is correct, Your
4 Honor.

5 Same objection from the parties; same
6 ruling by the Board?

7 MR. TRAVIESO-DIAZ: Well, let me clarify,
8 however, Exhibit GGG is properly on the record now,
9 has been admitted with all of the proprietary markings
10 removed. My problem with State Exhibit 107 is that it
11 shows those markings.

12 I am willing to stipulate for the record
13 that wherever they refer to State Exhibit 107, the
14 reference should be read as meaning Applicant Exhibit
15 GGG, but I would object to having State 107 because it
16 appears that we have let a proprietary document in the
17 record.

18 CHAIRMAN FARRAR: Yeah.

19 MS. CHANCELLOR: I have another
20 suggestion, Your Honor. We'll take PFS' new Exhibit
21 GGG and substitute that for State's Exhibit 107,
22 without the proprietary marketings.

23 MR. TRAVIESO-DIAZ: We end up then with a
24 duplicative exhibit. I just don't see the point on
25 that.

1 CHAIRMAN FARRAR: How many -- where in the
2 written testimony?

3 MS. CHANCELLOR: It's footnote on page 5,
4 and it's Footnote 1 on page 5, as well as the second
5 paragraph of --

6 CHAIRMAN FARRAR: Wait a minute.

7 MS. CHANCELLOR: -- AH.

8 CHAIRMAN FARRAR: Footnote on five?

9 MS. CHANCELLOR: As well as the text on
10 five.

11 CHAIRMAN FARRAR: Right. There's one on
12 13, Answer 33.

13 MS. CHANCELLOR: You're faster than I am.
14 That's correct. Just those two places, I think.

15 CHAIRMAN FARRAR: Given the problems that
16 either proprietary documents or documents that look
17 like they're proprietary, even if they aren't, given
18 the problems that causes, let's go to Plan B here, and
19 you all can make sure in your written proposals, and
20 we will make sure in our opinion that we footnote this
21 and indicate that anything in this testimony that
22 refers to State Exhibit 107 is now taken as a
23 reference to PFS GGG.

24 MS. CHANCELLOR: Is it too late to change
25 the testimony that's being bound into the record?

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1 CHAIRMAN FARRAR: No. You gave the
2 reporter three copies?

3 MS. CHANCELLOR: I have given her three
4 copies of the testimony and of 107.

5 CHAIRMAN FARRAR: But why don't you before
6 we leave tonight just interlineate that in the three
7 copies the several places we've noted?

8 MR. TRAVIESO-DIAZ: Also, Your Honor, and
9 this is only a technicality, but Footnote 1 refers to
10 the document being confidential being filed
11 separately, and so on. I would suggest that that
12 footnote needs to be changed as well.

13 The footnote could be deleted actually.

14 CHAIRMAN FARRAR: Yes. Good idea. We'll
15 delete the footnote, change the three or four
16 references in the text. Just handwrite those in, and
17 then with the steps we'll take later, there won't be
18 any confusion.

19 And so then there is now both -- well,
20 State Exhibit 107 will not be admitted.

21 MS. CHANCELLOR: That's correct.

22 The witnesses are now available for cross
23 examination, Your Honor.

24 CHAIRMAN FARRAR: All right.

25 MS. CHANCELLOR: The witnesses are not

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1 available for cross examination, Your Honor.

2 CHAIRMAN FARRAR: All right. How much
3 time do you need, Mr. Diaz?

4 MR. TRAVIESO-DIAZ: Well, I expect that I
5 will be finished with these witnesses by lunch time
6 tomorrow. It is going to take me approximately three
7 hours.

8 CHAIRMAN FARRAR: Where do we stand on two
9 things, first we started a little late, today. We
10 could either argue that we would go a little late,
11 past five. But you all, particularly the State, did
12 a lot of moving over the weekend, to get themselves
13 here.

14 So if you want to adjourn, and --

15 MS. CHANCELLOR: I'm happy to stay at it,
16 Your Honor. I'm just concerned that we are going to
17 get everything done this week, and I would rather put
18 in the extra time.

19 CHAIRMAN FARRAR: Well, that was my second
20 question. Where, in terms of the outline you gave us
21 this morning of what we hope to accomplish this week,
22 are we ahead, or behind where you had hoped we would
23 be at 10 of 5 today?

24 MR. TRAVIESO-DIAZ: I think we are
25 slightly behind, but not seriously so. I would have

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1 expected to start with this witness like at 3 p.m.,
2 that was my calculation.

3 CHAIRMAN FARRAR: But all you wanted to do
4 was finish them by tomorrow night, is that not right?

5 MR. TRAVIESO-DIAZ: That is correct.

6 CHAIRMAN FARRAR: Well, that is what you
7 told me, that you had these witnesses for Monday and
8 Tuesday.

9 MS. CHANCELLOR: That is correct. There
10 was a hope that we might get to them, finish by noon
11 tomorrow, because we have, Mr. Trudeau has some
12 rebuttal left over from Section D, and that may
13 promote rebuttal by our witnesses.

14 CHAIRMAN FARRAR: I got you.

15 MS. CHANCELLOR: And then we don't know
16 how long the Luk testimony will take, rebuttal.

17 CHAIRMAN FARRAR: How much cross will the
18 Staff have of these witnesses?

19 MR. O'NEILL: Your Honor, I have two and
20 a half pages of questions. Of course it is
21 conceivable that some of them will be answered. An
22 hour to two, tops.

23 CHAIRMAN FARRAR: All right.

24 MR. O'NEILL: I don't want to shortchange
25 myself.

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1 (Pause.)

2 CHAIRMAN FARRAR: Let's see how much we
3 can get done by 5:30, and that is not an
4 encouragement, Mr. Travieso-Diaz for you to talk fast.

5 MR. TRAVIESO-DIAZ: I was going to promise
6 to talk fast.

7 CHAIRMAN FARRAR: But let's see what we
8 can get done, but keep an eye on your watch, and when
9 you reach a stopping point, a break in topics, let us
10 know, and we will adjourn some time before 5:30.

11 MR. TRAVIESO-DIAZ: Thank you.

12 CROSS EXAMINATION

13 MR. TRAVIESO-DIAZ: Good afternoon,
14 gentlemen.

15 DR. BARTLETT: Good afternoon.

16 DR. MITCHELL: Good afternoon.

17 MR. TRAVIESO-DIAZ: My name is Matias
18 Travieso-Diaz, I'm an attorney representing PFS in
19 this Proceeding.

20 I'm going to be asking you, today, and
21 perhaps tomorrow, some questions with respect to what
22 has been identified as the soil cement portion of
23 subsection C-3 of contention LL-QQ in this Proceeding.

24 Since you are testifying today as a panel,
25 I will be directing questions to one of you, or the

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1 other, and I will ask that the person that I ask the
2 question to answer it first. If the other person
3 perhaps has something to add, that may be appropriate.

4 But in any event I would ask that the
5 person that I ask the question to be the first one to
6 answer. And sometimes I may ask the question of both
7 of you, in which case either of you can answer, or
8 both.

9 The only thing that I ask is that you
10 don't talk to each other while a question is pending.
11 Is that correct, understood? That you don't talk to
12 each other while a question is pending. Is that
13 understood?

14 While a question is still on the floor,
15 and it is unanswered, I'm asking that you don't confer
16 with each other.

17 DR. MITCHELL: Yes.

18 DR. BARTLETT: Yes.

19 MR. TRAVIESO-DIAZ: Let me ask a few
20 preliminary questions of both of you. Are you aware
21 that the Applicant, and the NRC Staff, have filed
22 direct testimony for this hearing on the soil cement
23 issue, or portion of Section C of contention L/QQ?

24 DR. MITCHELL: Yes.

25 DR. BARTLETT: Yes.

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1 MR. TRAVIESO-DIAZ: And this is for you,
2 Dr. Mitchell. Have you reviewed that testimony filed
3 by the Applicant and the NRC Staff?

4 DR. MITCHELL: Yes.

5 MR. TRAVIESO-DIAZ: And have you had
6 occasion to review the transcripts of the other
7 testimony previously given by the Applicant, the
8 Staff, and the State witnesses, in the prior seismic
9 hearings in Salt Lake City?

10 DR. MITCHELL: No.

11 MR. TRAVIESO-DIAZ: You have reviewed,
12 however, the testimony that has been prefiled by the
13 other parties on this issue, and you sat today while
14 they testified, is that correct?

15 DR. MITCHELL: Yes.

16 MR. TRAVIESO-DIAZ: And, of course, Dr.
17 Bartlett, you have been in the same condition, only
18 more, because you have sat through this hearings,
19 haven't you?

20 DR. BARTLETT: Yes.

21 MR. TRAVIESO-DIAZ: Is there anything that
22 you have read, or heard, given by the other parties,
23 that would cause you to want to change or modify any
24 portion of the testimony that you presented as your
25 prefile direct testimony?

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1 DR. BARTLETT: The only thing I'm aware of
2 is some more thermal calculations have been done that
3 I haven't seen, or reviewed, regarding the thermal
4 gradients underneath the pads, and in the Bonneville
5 clay.

6 But I don't think I will change an
7 opinion, yet, until I've heard that presented and
8 reviewed it.

9 MR. TRAVIESO-DIAZ: But, so at this point
10 you are not going to make, or don't think you need to
11 make any changes to your testimony, is that right?

12 DR. BARTLETT: Not at this point.

13 MR. TRAVIESO-DIAZ: How about you, Dr.
14 Mitchell?

15 DR. MITCHELL: Not at this point.

16 MR. TRAVIESO-DIAZ: Dr. Bartlett, talking
17 about the Utah hearings, a few days ago I asked you
18 whether you consider yourself a soil cement expert.
19 And you deferred to Dr. Mitchell in those issues,
20 although later you clarified that your contribution to
21 soil cement was to discuss how it would perform
22 seismically, is that correct?

23 DR. BARTLETT: Yes. To understand the
24 soil cement and its application for resisting sliding,
25 overturning, bearing capacity during a seismic event.

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1 MR. TRAVIESO-DIAZ: Thank you. Now, when
2 I took, I took the depositions of both of you at
3 various points in March. And both of you indicated
4 that you had not performed any analysis, calculations,
5 or tests, in connection with soil cement issues.

6 Is that still the case?

7 DR. BARTLETT: That is correct.

8 MR. TRAVIESO-DIAZ: How about you?

9 DR. MITCHELL: You are referring to with
10 respect to this project?

11 MR. TRAVIESO-DIAZ: To the soil, yes, to
12 this project.

13 DR. MITCHELL: That is correct.

14 MR. TRAVIESO-DIAZ: I would like Dr.
15 Mitchell, as we said, I took your deposition back in
16 March. I would like to mark for, as Applicant's PFS
17 exhibit 228, the transcript of that deposition.

18 MR. TRAVIESO-DIAZ: While this document is
19 being distributed let me advise the Board what my
20 intent here is. I intend, from time to time, to refer
21 to Dr. Mitchell's deposition, to summarize some of the
22 views that he presented there.

23 And these views are offered in more detail
24 in the deposition itself. But what I intend to do is
25 to try to summarize some of those views, at this

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1 point, with the witness. And I think that that will
2 be efficient in terms of saving time during the cross
3 examination.

4 CHAIRMAN FARRAR: The Reporter will mark,
5 and this is the entire deposition, not excerpts?

6 MR. TRAVIESO-DIAZ: Yes, it is.

7 CHAIRMAN FARRAR: The reporter will mark
8 Dr. Mitchell's deposition as PFS exhibit 228 for
9 identification.

10 (Whereupon, the above-
11 referenced to document was
12 marked as PFS Exhibit No. 228
13 for identification.)

14 DR. MITCHELL: May I ask a question?

15 CHAIRMAN FARRAR: Certainly.

16 MR. MITCHELL: I was sent a preliminary
17 small version of the transcript, and asked to go
18 through it, and correct any changes, which I did, and
19 returned.

20 But I have not seen the transcript of the
21 deposition since. So is it safe to assume that the
22 corrections I made are in this version?

23 MR. TRAVIESO-DIAZ: I'm afraid that it is
24 not safe to assume so. So I would encourage you, when
25 I refer you to portions of the transcript, if what it

1 says in this exhibit is incorrect, would you make a
2 correction at that time.

3 CHAIRMAN FARRAR: Dr. Mitchell, do you --
4 did you happen to keep a copy of the changes you sent
5 in, in that little transcript?

6 DR. MITCHELL: I'm looking.

7 CHAIRMAN FARRAR: Look hard.

8 JUDGE LAM: And, Mr. Travieso-Diaz, do you
9 have an extra copy for our law clerk?

10 MR. TRAVIESO-DIAZ: Yes.

11 MS. CHANCELLOR: Your Honor, I've got a
12 copy of the changes that Dr. Mitchell made, if I could
13 give them to him?

14 CHAIRMAN FARRAR: All right.

15 MR. GAULKER: I would suggest that we mark
16 that as 228A so all the changes are part of the
17 record, as well as the deposition itself, so that
18 there be no confusion later on.

19 CHAIRMAN FARRAR: Why don't you give him
20 that now, and maybe overnight we can get copies of
21 that made.

22 MS. CHANCELLOR: PFS may borrow my copy
23 and make copies, if they wish.

24 CHAIRMAN FARRAR: That is a fair deal.

25 MR. GAULKER: Could we go off the record

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1 for a moment?

2 CHAIRMAN FARRAR: Yes.

3 (Whereupon, the above-entitled matter
4 went off the record at 5:02 p.m. and
5 went back on the record at 5:03 p.m.)

6 CHAIRMAN FARRAR: Let's proceed as
7 planned. We will go ahead with the questioning now.
8 Mr. Travieso-Diaz, why don't you ask questions based
9 on the old one, and Dr. Mitchell, you answer based on
10 the corrections you sent in, point those out, where
11 the correction is significant.

12 And then by tomorrow we will have the
13 corrected version also marked.

14 MR. TRAVIESO-DIAZ: Also to avoid
15 potential problems I'm going to try to refrain from
16 referring to this exhibit as much as I can today, and
17 save it for tomorrow.

18 CHAIRMAN FARRAR: Okay.

19 MR. TRAVIESO-DIAZ: Dr. Mitchell, you told
20 me, when I took your deposition back in March, that
21 you had never visited the site. Is that still
22 correct?

23 DR. MITCHELL: That is correct, I have not
24 visited the site.

25 MR. TRAVIESO-DIAZ: Okay. What

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1 involvement, Dr. Mitchell, have you had with this
2 licensing proceedings, since I took your deposition
3 last March?

4 DR. MITCHELL: The only involvement since
5 last March is to go through the transcript, and to be
6 sent copies, work on the testimony that has now been
7 admitted here, and be sent copies of that, prior to
8 coming here.

9 And I was sent two or three of the
10 Applicant's documents over the weekend.

11 MR. TRAVIESO-DIAZ: When you say you
12 reviewed the transcript, you mean the deposition
13 transcript, exhibit 228?

14 DR. MITCHELL: Yes.

15 MR. TRAVIESO-DIAZ: You did not review any
16 other transcripts, other than that?

17 DR. MITCHELL: Well, I was sent Dr.
18 Wissa's transcript, and I'm trying to think if since
19 then I've been sent any of the others. I don't
20 believe so. I've scanned through them.

21 MR. TRAVIESO-DIAZ: Would you turn to your
22 prefiled direct testimony, Dr. Mitchell? And turn to
23 question and answer number 5, which is on page 3.

24 DR. MITCHELL: Yes.

25 MR. TRAVIESO-DIAZ: Okay. If I understand

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1 the question and the answers given there, you indicate
2 that the purpose of your testimony is to explain the
3 basis for a five part professional opinion that you
4 are rendering on the proposed use of soil cement at
5 the PFS site, is that correct?

6 DR. MITCHELL: Yes.

7 MR. TRAVIESO-DIAZ: And since you are
8 giving this testimony, together with Dr. Bartlett, is
9 there any part of those opinions that are not yours,
10 were only Dr. Bartlett's?

11 DR. MITCHELL: May I take a minute to read
12 it, please?

13 MR. TRAVIESO-DIAZ: Please.

14 (Witness reviews document.)

15 DR. MITCHELL: Those purposes are
16 consistent with my involvement.

17 MR. TRAVIESO-DIAZ: All right. Now, taking
18 a look at just parts 1 and 2, of the opinions that are
19 presented in answer 5, would it be fair to paraphrase
20 those opinions as saying that the use that PFS intends
21 to give to soil cement at the PFS facility is a new
22 and unique application of this technology for which
23 there is no precedent?

24 MS. CHANCELLOR: Objection, the testimony
25 is what the testimony is.

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1 CHAIRMAN FARRAR: He asked if it was fair
2 to paraphrase it, and either it is, or it isn't.

3 MR. TRAVIESO-DIAZ: It is either fair or
4 not.

5 DR. MITCHELL: It is fair, keeping in mind
6 this is to the best of my knowledge.

7 MR. TRAVIESO-DIAZ: I take it that based
8 on your knowledge you don't agree with the opinions
9 that have been expressed, including today, by Mr.
10 Trudeau and Dr. Wissa, and Dr. Ofoegbu, as to the fact
11 that their opinion is that there is precedent for the
12 use of soil cement in the manner that it is intended
13 to be used at the PFS?

14 DR. MITCHELL: I'm not aware of a
15 precedent for use of soil cement under seismic loading
16 conditions in the manner that it is being proposed for
17 this particular site.

18 MR. TRAVIESO-DIAZ: I would like to turn
19 your attention, for a second, to your deposition
20 transcript, exhibit 228, and to page 43.

21 And I will note, for the record, that the
22 correction sheet that we received, which -- let me
23 strike that question and start over again.

24 I am having distributed, and I would like
25 to mark for identification as PFS exhibit 228A, a copy

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1 of the transcript corrections that Dr. Mitchell
2 provided.

3 (Whereupon, the above-
4 referenced to document was
5 marked as PFS Exhibit No. 228A
6 for identification.)

7 MR. TRAVIESO-DIAZ: Now, first looking at
8 what is now exhibit 228A, which are the transcript
9 corrections --

10 MS. CHANCELLOR: Excuse me, I didn't get
11 a copy. I got my own copy back, but I didn't get a
12 copy of --

13 MR. TRAVIESO-DIAZ: Let me try again.

14 CHAIRMAN FARRAR: You want marked as?

15 MR. TRAVIESO-DIAZ: As 228A.

16 CHAIRMAN FARRAR: As 228A these three
17 pages of --

18 MR. TRAVIESO-DIAZ: They are double sided,
19 so it is actually six pages.

20 CHAIRMAN FARRAR: -- corrections. So this
21 is what we were talking about a few minutes ago, as
22 opposed to a transcript that had markings on the
23 transcript?

24 MR. TRAVIESO-DIAZ: Let me ask a
25 clarifying question of the witness.

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1 Dr. Mitchell, would it be your
2 understanding that exhibit 228, which is the original
3 transcript, as corrected by the document that has been
4 marked 228A, represents your testimony at the
5 deposition that I took?

6 DR. MITCHELL: Yes.

7 CHAIRMAN FARRAR: And just so I'm doubly
8 clear. Dr. Mitchell, this document is what you were
9 referring to before, when you said you marked up
10 something and sent it in, you did not mark up the
11 transcript itself and sent it in, you made these
12 notations and sent that in?

13 DR. MITCHELL: Yes. I was sent these
14 forms, so I did that.

15 CHAIRMAN FARRAR: No criticism, I just
16 want to make sure we know what we are talking about.
17 Okay, fine.

18 MR. TRAVIESO-DIAZ: Let me go back to the
19 question I was going to ask.

20 First, take a look at exhibit 228A, which
21 are the corrections. I don't see there, any
22 correction for page 43, is that correct?

23 DR. MITCHELL: Correct.

24 MR. TRAVIESO-DIAZ: So the transcript in
25 228 of what is said on page 43 is accurate as it

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1 reads?

2 DR. MITCHELL: Yes.

3 MR. TRAVIESO-DIAZ: Okay. Now, on -- I
4 asked you, on page 43, whether you attach any
5 significance to your conclusion that the use of soil
6 cement in the manner proposed by PFS was a new
7 application.

8 And you said, and I'm reading from line
9 16, I'm not sure that there is any significance. We
10 are always finding new applications for our materials.
11 I don't see anything inherently wrong with the basic
12 concept that is being proposed here.

13 Is this still your view?

14 DR. MITCHELL: Yes.

15 MR. TRAVIESO-DIAZ: Thank you. Would it
16 be a correct way to characterize your view, your
17 opinion, to say that you believe that the use that PFS
18 intends to make of soil cement is new, or you don't
19 see anything wrong with being new, not with the
20 concept itself, that PFS intends to implement?

21 DR. MITCHELL: I think that the concept is
22 okay, but it is based on the assumption of certain
23 properties and behavior. And these properties and
24 behavior have not yet been demonstrated.

25 MR. TRAVIESO-DIAZ: So would it be fair to

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1 say that you think that -- you don't see anything
2 wrong with the concept, but you would like to see it
3 demonstrated by testing?

4 DR. MITCHELL: I think it is prudent to
5 demonstrate the properties that are going to be relied
6 upon can indeed be obtained.

7 MR. TRAVIESO-DIAZ: Okay. And your
8 understanding of the PFS design concept that you think
9 is okay is as described by Dr. Bartlett in the answer
10 to question 7? That is on page 4 of your testimony.

11 DR. MITCHELL: This answer to question 7
12 is Dr. Bartlett's answer, not mine.

13 MR. TRAVIESO-DIAZ: Yes. My question is,
14 when you said that you think that your view is that
15 the concept, the design concept that PFS wants to
16 implement using soil cement, is in principle correct,
17 but you would like to see it shown by testing.

18 That design concept is it properly
19 described in Dr. Bartlett's answer?

20 DR. MITCHELL: Oh, I see. To my
21 understanding, yes.

22 MR. TRAVIESO-DIAZ: All right. Go back
23 to, if you will please, to answer 5 on page 3. Moving
24 to the third part of your opinion, again, would it be
25 fair to summarize that view as saying that you believe

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1 it will be necessary to conduct site-specific testing
2 to verify that the soil cement that PFS intends to
3 use, meets the intent of the design?

4 DR. MITCHELL: Yes, I think that is fair,
5 that it would be, again, a prudent thing to do, once
6 it is determined that the properties that are required
7 can be obtained in the laboratory, to go to the field
8 and demonstrate that the construction procedures that
9 are proposed will give the result that is being called
10 for.

11 MR. TRAVIESO-DIAZ: Dr. Mitchell, for your
12 convenience, I'm having handed to you a copy of the
13 prefiled direct testimony of Dr. Wissa and Mr.
14 Trudeau, and exhibits.

15 Would you take a look at exhibit JJJ,
16 which is part of the testimony? And that exhibit is
17 section 2.64.11 of the PFSF safety analysis report.
18 Are you familiar with this document?

19 DR. MITCHELL: I think I have seen it,
20 yes.

21 MR. TRAVIESO-DIAZ: What is your
22 understanding of the purpose of this document?

23 DR. MITCHELL: It describes what they
24 intend to do in constructing the soil cement.

25 MR. TRAVIESO-DIAZ: Does it also describe

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1 how PFS intends to qualify the soil cement mixture, or
2 mixtures, for use?

3 MS. CHANCELLOR: Dr. Mitchell, you should
4 take whatever time you need to review the document.

5 MR. TRAVIESO-DIAZ: Yes, please.

6 (Witness reviews document.)

7 DR. MITCHELL: How many pages are you
8 asking me to review?

9 MR. TRAVIESO-DIAZ: Well, I asked you a
10 specific question, which was, is it your understanding
11 that this document presents -- you talk about
12 constructing the soil cement. Does it also present
13 PFS' intended approach to testing the soil cement for
14 qualifying it for use?

15 DR. MITCHELL: It says that the required
16 characteristics of the soil cement will be engineered
17 during detail design, which I interpret to mean that
18 design that is determined the 40PSI compressive
19 strength for the cement treated soil, with a modulus
20 upper bound of 75,000 PSI. And the 250 PSI
21 compressive strength for the soil cement.

22 Then it talks about the excavation, and
23 mixing the cement to the design elevations and storage
24 pads, the thickness of the pads. The control, so it
25 doesn't exceed two feet in thickness.

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1 It describes what the construction
2 procedure will be, and the properties that the
3 materials should have, but I haven't yet found here
4 where it says when they are going to determine them,
5 or how they are going to determine them.

6 MR. TRAVIESO-DIAZ: All right. Let me ask
7 you, specifically, since you have taken the time to
8 review this. Would you turn your attention to page
9 2.6-117 of exhibit JJJ?

10 CHAIRMAN FARRAR: Before you do that,
11 counsel, Dr. Mitchell, had you reviewed this before?

12 DR. MITCHELL: I think I have read through
13 it before.

14 CHAIRMAN FARRAR: But this is a fairly
15 lengthy document. Before you answer a lot of
16 questions do you need more time to review it?

17 DR. MITCHELL: Yes. I know that I have
18 seen it before.

19 MR. TRAVIESO-DIAZ: Okay. Let's do this,
20 Your Honor. I'm going to ask him one more question on
21 this document tonight, give him the opportunity to
22 review it overnight, and perhaps we will have more
23 questions tomorrow, that way he won't have to spend a
24 lot of time looking through it, and trying to find
25 stuff.

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1 CHAIRMAN FARRAR: All right, let's proceed
2 that way.

3 MR. TRAVIESO-DIAZ: On the question that
4 I have pending, if you would look at page 2.6-117 of
5 exhibit JJJ.

6 DR. MITCHELL: Yes.

7 MR. TRAVIESO-DIAZ: Is it your reading of
8 the document, indicate to you that this page describes
9 the techniques that PFS intends to use to install the
10 soil cement, and the cement treated soil at the
11 facility?

12 It starts on page 2-117, and it goes into
13 the next two pages.

14 DR. MITCHELL: It seems to describe, it
15 describes the procedures.

16 MR. TRAVIESO-DIAZ: Okay. Starting on
17 page, looking at the last paragraph on page 2.6-117,
18 the paragraph that starts with the words "The design",
19 do you see that?

20 DR. MITCHELL: Yes.

21 MR. TRAVIESO-DIAZ: That paragraph
22 references the state of the art report on soil cement
23 issued by the American Concrete Institute, or ACI, in
24 1998, as providing the basis for the mix
25 proportioning, testing, construction, and quality

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1 control of soil cement. Is that right?

2 DR. MITCHELL: Yes.

3 MR. TRAVIESO-DIAZ: And would you take a
4 look at exhibit HHH in that package, and confirm for
5 me that exhibit HHH is the state of the art report on
6 soil cement, that is referenced on page 2.6-117 of the
7 safety analysis report?

8 DR. MITCHELL: It probably is the same.
9 The one in exhibit HHH is reapproved 1997, the
10 reference on page 2.6-117 says ACI 1998.

11 MR. TRAVIESO-DIAZ: Yes. We don't have
12 that list of references here, but I would represent to
13 you that that is just a different publication dates.
14 But, again, we can confirm that at a later time, if
15 necessary.

16 Do you have any doubt that it is the same
17 document?

18 DR. MITCHELL: I think it is the same
19 document, yes.

20 MR. TRAVIESO-DIAZ: Okay. Now, do you
21 agree, or do you believe that it is appropriate for
22 PFS to follow the guidance of the state of the art
23 report on soil cement with respect to the various
24 aspects of the soil cement program described in page
25 2.6-117 of this --

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1 DR. MITCHELL: Well, I think that this is
2 a fine reference to be used as a basis for preliminary
3 analysis and design.

4 MR. TRAVIESO-DIAZ: Okay. You turn to the
5 next page now, 2.6-118. I'm going to ask you about
6 the first paragraph that has a bullet, and the header,
7 soil-cement mix and procedure development.

8 MS. CHANCELLOR: Your Honor, I thought Mr.
9 Travieso-Diaz was going to ask one question. Dr.
10 Mitchell, if you, as Judge Farrar mentioned, if you
11 need to sit and study this, if you haven't seen it for
12 some time, maybe these should be deferred until
13 tomorrow?

14 MR. TRAVIESO-DIAZ: Actually, Mr.
15 Chairman, this may be a good breaking point, because
16 I'm going to have several more questions on this
17 document, and it might be inefficient to spend
18 everybody's time here waiting.

19 CHAIRMAN FARRAR: Now, that is a good
20 idea. Do you have any other documents you are going
21 to ask him about tomorrow, that might fit into the
22 same category, where having him review them tonight
23 would be an advantage?

24 MR. TRAVIESO-DIAZ: I think it might be
25 convenient, Dr. Mitchell, if you look at the exhibits

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1 to Mr. Trudeau and Dr. Wissa's testimony, GGG, HHH,
2 III you don't need to look at, and JJJ, because I may
3 have, during the course of my questions to you, refer
4 to those from time to time.

5 DR. MITCHELL: Okay.

6 CHAIRMAN FARRAR: We appreciate your
7 willingness to do that homework tonight.

8 If we finish this witness tomorrow, excuse
9 me, after we finish this witness tomorrow, we will
10 then have Mr. Trudeau, and that is the rebuttal that
11 you prefiled with us in Salt Lake City, but we never
12 got to? Is that correct, or is it some other
13 rebuttal?

14 MS. CHANCELLOR: I've got to get through
15 rebuttal on soil cement first.

16 MR. TRAVIESO-DIAZ: The order tomorrow
17 will be we will have examination with this witness,
18 then we will have the rebuttal of Dr. Wissa and Mr.
19 Trudeau.

20 CHAIRMAN FARRAR: Which you had
21 volunteered to do all at once today, but --

22 MR. TRAVIESO-DIAZ: But we deferred. And
23 we will have additional rebuttal by other parties.

24 MS. CHANCELLOR: And then there is Dr.
25 Singh, too, that we have to hook in by

1 videoconference.

2 CHAIRMAN FARRAR: And at the end you would
3 like to squeeze in Mr. Trudeau, and you would like to
4 squeeze Mr. Trudeau to Salt Lake City?

5 MR. TRAVIESO-DIAZ: I would like to
6 squeeze Mr. Trudeau whenever it is possible, any time
7 during the week.

8 CHAIRMAN FARRAR: Okay. Then we all know
9 what is in front of us tomorrow. I encourage counsel
10 to do their homework, and make sure the questions are
11 as sharp and relevant as possible, and non-
12 duplicative.

13 Is there anything else we can usefully do
14 tonight to prepare for tomorrow, any housekeeping, or
15 other matters that we don't want to have slow us down
16 tomorrow?

17 MS. CHANCELLOR: Your Honor, can we leave
18 our documents in this room, or should we take them
19 back to our room, our breakout room? Is it okay to
20 leave things on the table, stacked behind us?

21 CHAIRMAN FARRAR: Okay.

22 MS. CHANCELLOR: And second question, is
23 the public invited to attend the hearings here?

24 CHAIRMAN FARRAR: Oh, yes.

25 MS. CHANCELLOR: They weren't sure

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1 downstairs. We actually have someone who might come
2 and attend.

3 CHAIRMAN FARRAR: Anyone from the public,
4 downstairs meaning security?

5 MS. CHANCELLOR: Yes, they weren't sure
6 whether the public would be allowed when we asked
7 about that.

8 CHAIRMAN FARRAR: I mean, they have to go
9 through normal security. It means they just have to
10 sign in, say who they are going to see, someone has to
11 escort them.

12 MS. CHANCELLOR: The security personnel
13 weren't aware whether this hearing was open to the
14 public. And I told them it probably was, but maybe
15 someone needs to advise them.

16 CHAIRMAN FARRAR: Mac, can you have
17 somebody get the word to them, please?

18 MR. TRAVIESO-DIAZ: Mr. Chairman, I just
19 want to clarify, on the record, in the perhaps
20 unlikely event that we have time left over tomorrow
21 afternoon, would the plan be to proceed with Mr.
22 Trudeau's pending rebuttal from section B?

23 MS. CHANCELLOR: Probably.

24 MR. TRAVIESO-DIAZ: Well, the only reason
25 I'm asking is I need to prepare documents and other

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1 things that we may need to bring to the Board's
2 attention. So I need to be prepared one way or the
3 other.

4 CHAIRMAN FARRAR: It is an ambitious
5 schedule. It sounds like an ambitious schedule
6 tomorrow, but --

7 MR. TRAVIESO-DIAZ: But in the event that
8 there is time to, I understand that the State has a
9 few questions for Mr. Trudeau, so it would be great if
10 we could get that portion of the section B here
11 finalized.

12 MS. CHANCELLOR: What we had planned to
13 do, Your Honor, was to file some written rebuttal, but
14 I have to rely on Dr. Bartlett for that, and he is on
15 the stand. So that is why I'm hedging a little bit.
16 He also has problems with his computer.

17 So we will do the best we can.

18 CHAIRMAN FARRAR: And what do we need to
19 have if we are doing Dr. Singh by video, or
20 teleconference, what documents will we need to have
21 ready?

22 MR. TRAVIESO-DIAZ: There is only one
23 document which is the thermal analysis. I could, in
24 fact, distribute copies of that document tonight. And
25 that way all the parties will have it. The State has

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1 had it for a week, but the Board hasn't had it.

2 So perhaps I could hand copies --

3 CHAIRMAN FARRAR: And do you have any
4 written rebuttal?

5 MR. TRAVIESO-DIAZ: No. My examination
6 here was going to ask him to identify the document,
7 and when he prepared it, and I will make him available
8 for what his conclusions are, I will make him
9 available for examination.

10 So my rebuttal testimony will be very
11 brief.

12 CHAIRMAN FARRAR: Ms. Chancellor, we --
13 what is your position?

14 MS. CHANCELLOR: We won't make an
15 argument, Your Honor, with respect to, at this time,
16 with respect to having Dr. Singh offer rebuttal. We
17 will wait to hear what he has to say, and then deal
18 with it, either through objections, or through cross
19 examination.

20 CHAIRMAN FARRAR: What he is going to say
21 is that he believes in this report, which has just
22 been handed to me, which you apparently have had. So
23 what he is going to say remains a mystery to us at
24 this moment.

25 You know what he is going to say.

1 MS. CHANCELLOR: We haven't had the report
2 for a week, I just want to clarify that. But we will
3 be prepared to cross examine him on this report at one
4 o'clock, or one thirty tomorrow.

5 CHAIRMAN FARRAR: But what I want to know
6 is whether if you anticipate arguing that this is not
7 proper rebuttal? Because if you do anticipate that,
8 I would just as soon have that argument now, rather
9 than tomorrow morning, rather than spend time
10 tomorrow.

11 MS. CHANCELLOR: I think we have to wait
12 and see what comes up on cross examination of these
13 witnesses.

14 MR. TRAVIESO-DIAZ: Mr. Chairman?

15 CHAIRMAN FARRAR: These right here?

16 MS. CHANCELLOR: These two right here.

17 MR. TRAVIESO-DIAZ: Mr. Chairman, as long
18 as this --

19 CHAIRMAN FARRAR: Wait, he would be
20 rebutting --

21 MS. CHANCELLOR: The State on soil cement,
22 thermal effects of --

23 MR. TRAVIESO-DIAZ: I don't know that
24 there is much more we can do today. The one thing
25 that I would like to do, given that this document has

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1 already been distributed, is to mark it for
2 identification as PFS exhibit 229.

3 MS. CHANCELLOR: Your Honor, I think we
4 should hold off. I would like to review the document,
5 I don't see why we need to mark it now. It is
6 rebuttal testimony, we are now in the middle of cross
7 examination of direct testimony, it will just be too
8 confusing.

9 MR. TRAVIESO-DIAZ: Well, I intend to use
10 this document in cross examination as well, so I think
11 it is in place.

12 MS. CHANCELLOR: I don't know that you can
13 use this until it has been sponsored by a witness.

14 MR. TRAVIESO-DIAZ: Well, I beg to
15 disagree, and if you don't like the way I do it, you
16 can object. I would like to have it marked as exhibit
17 229, please.

18 CHAIRMAN FARRAR: Well, he is entitled to
19 do that, Ms. Chancellor. He may or may not be
20 entitled to do anything with it, but he is certainly
21 entitled to have it marked, and so we will have it
22 marked as 229 for identification.

23 (Whereupon, the above-
24 referenced to document was
25 marked as PFS Exhibit No. 229

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1 for identification.)

2 MS. CHANCELLOR: Your Honor, I would like
3 to place an objection, on the record, that I will
4 object to anything that Mr. Travieso-Diaz asks about
5 these witnesses, with respect to this document,
6 because there is no sponsor of the document, it is not
7 sponsored by Dr. Wissa or Mr. Trudeau, it doesn't form
8 part of PFS' direct testimony, and there is no way to
9 vouch for the reliability of the evidence, of the
10 information.

11 MR. TRAVIESO-DIAZ: If I may remind
12 counsel that on cross examination you are entitled to
13 bring anything under the sun, to use it and present it
14 to the witness, and what the witness does with that is
15 up to the witness.

16 It doesn't have to be evidence, it doesn't
17 have to be in the Proceeding, and the fact that there
18 may not be anybody to introduce it into evidence at
19 this point, that doesn't preclude me from asking
20 questions related to it.

21 CHAIRMAN FARRAR: Mr. Travieso-Diaz you
22 are, I think, entirely correct that you can use this
23 on cross for whatever purpose you want. But when we
24 get to the point of Dr. Singh, you are trying to
25 introduce it through Dr. Singh?

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1 We have, again, stuff showing up very late
2 in the day.

3 MR. TRAVIESO-DIAZ: Well, that is what
4 happens with rebuttal, Mr. Chairman. I'm going to do
5 my best to limit the scope of the document being
6 introduced, but in the nature of having to present
7 rebuttal sometimes you have to present materials that
8 you were not planning on using.

9 And that is the nature of the beast. I
10 will --

11 CHAIRMAN FARRAR: That raises, again, the
12 question of what can fairly be anticipated in advance,
13 and it runs us into the Contentions Rule, again. And
14 even-handedness.

15 MR. TRAVIESO-DIAZ: Well, I think that
16 conceptually that could raise that type of issue. I
17 will indicate, for the record, and I think it should
18 be no mystery, this calculation achieves a very simple
19 purpose, which is to quantify the view that, in fact,
20 even Dr. Ofoegbu would testify to that today, that it
21 is black letter technical knowledge that if you have
22 a heat source in the vicinity of materials where
23 moisture can accumulate, that that moisture is going
24 to move away.

25 All that this calculation does is quantify

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1 the amount of the heat that is available to put into
2 effect that principle.

3 MS. CHANCELLOR: Your Honor, I would like
4 to note, for the record, that every time the State
5 raises something it goes into a Holtec analysis, and
6 we get it at the last minute.

7 And this is not, as you note, this is not
8 the first document. Dr. Solar, during the seismic
9 hearings, was cranking out more analysis than we could
10 deal with. And here is another document.

11 And I would also note that until Dr. Singh
12 sponsors this document, it should be treated as
13 hearsay.

14 MR. TRAVIESO-DIAZ: Two things, Mr.
15 Chairman. I don't want to get argumentative here.
16 But the reason we had to introduce all the testimony
17 by Dr. Solar at the last hearing, is because we kept
18 on getting new claims raised by Dr. Ostadan at the
19 time.

20 But putting that aside for the moment,
21 again, hearsay is not an objection to using documents
22 in cross examination.

23 CHAIRMAN FARRAR: I'm not -- the Board's
24 concern is not the use of it on cross examination,
25 because whatever use you make of it, it will amount to

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1 nothing unless it is later admissible, or sponsored
2 and so forth.

3 So anything you do with that is subject to
4 being connected up. But it is just -- maybe the
5 introduction of evidence at a trial is -- no, let me
6 not go any further.

7 MR. TRAVIESO-DIAZ: Mr. Chairman, if I can
8 only offer one thought here? Because the Applicant
9 has the burden of proof, perhaps we tend to put more
10 than we really need.

11 But the alternative is not tenable. With
12 99.9999999 percent of the issues, and if we lose on a
13 single one we may have bad consequences. So you have
14 to bear with us to the fact that we may, perhaps,
15 engage in overkill, and putting testimony that perhaps
16 is unnecessary, and perhaps put in late, but I don't
17 have much of a choice.

18 CHAIRMAN FARRAR: I have no problem with
19 your trial strategy, and approach, and what you just
20 said. I just have a problem reconciling the kind of
21 rulings you want us to make now, with the kind of
22 rulings you wanted us to make against the State over
23 a several year period.

24 That is my only problem, not with the way
25 you are trying the case. Because you are right, if

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1 you lose on anything you lose, and so you've got to
2 have your case in there.

3 But the, at some point, in some
4 Proceeding, the rulings that you asked for, for
5 keeping Intervenor's contentions out of the case, are
6 going to have to be applied to your client as well, on
7 the same basis they are applied to the Intervenors.

8 MR. TRAVIESO-DIAZ: I understand the
9 concern, and I share it. However, you have to keep in
10 mind, also, that at the initial stages of an NRC
11 Proceeding, particularly a complex one like this,
12 there is a potential for having an infinitely
13 unbounded set of issues.

14 And the purpose of the Contention Rule is
15 to establish a set of agreed-upon issues upon which
16 the parties disagree, so that we can have a road map
17 as to what we are trying to achieve.

18 Having contentions and limiting when you
19 can have them, and what you need to prove in order to
20 bring new ones in, serves the purpose of keeping a
21 Proceeding from becoming totally amorphous, and
22 extended forever.

23 So there are different considerations, I
24 would say, although I share your concern of trying to
25 be fair to everybody.

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1 CHAIRMAN FARRAR: Ms. Chancellor could
2 take what you just said, change a few words, and say
3 the same thing about your guys with their computers,
4 and their reports, any time anything is said out comes
5 something new.

6 And the State wasn't given that
7 opportunity when they wanted to -- and the rulings the
8 Board made followed the Contentions Rule, followed the
9 jurisprudence. But at some point the imbalance
10 becomes very difficult to deal with.

11 MR. TURK: Your Honor, may I address the
12 issue?

13 CHAIRMAN FARRAR: Yes.

14 MR. TURK: I won't comment on the
15 admissibility of a specific document that we are
16 looking at, this document that has been marked for
17 identification as PFS exhibit 229.

18 But I would like to make two points.
19 First I wasn't present during the testimony on July
20 3rd and 4th. I'm sorry, June 3rd and 4th, when that
21 other document came forth from Holtec.

22 But I would have to note my view that we
23 have to be careful not to elevate form over substance.
24 If these documents that bear these Holtec cover sheets
25 instead of coming in as a Holtec analysis, had been

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1 presented as question and answer testimony, then we
2 would look at it to see, is this testimony that
3 addresses an issue that is fairly within the
4 contention?

5 In other words, it would be evidence,
6 rather than raising a new issue. I think it is
7 important not to rule on documents based upon whether
8 they are in question and answer format, versus some
9 other format.

10 The issue that has to be addressed is, did
11 the contention raise the issue on which the evidence
12 is being proffered? There is a distinction that we
13 have to make between the Contention Rule, which says
14 only issues that are fairly identified in the
15 Contention are admissible, or may have evidence
16 presented on them, and raising new evidence that
17 addresses an issue presented in the testimony of
18 another witness.

19 CHAIRMAN FARRAR: Let me interrupt you for
20 a second. When I talk about the Contentions Rule, I'm
21 talking about the late filed aspect of the Contentions
22 Rule, not necessarily the Rule itself.

23 MR. TURK: The correct ruling on
24 Contentions is, was something raised within the scope
25 of the contention, such that it may be addressed in

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1 testimony.

2 If an issue was raised in a contention,
3 that is different from saying that new evidence that
4 addresses that issue be admitted in a proceeding. The
5 issues are defined by the Contentions.

6 If a witness, in its testimony, presents
7 some evidence which another party wishes to rebut,
8 with respect to that admitted issue, that is
9 permissible. The only thing that would not be
10 permissible would be for a rebuttal witness to say,
11 here is testimony on a new issue that was never raised
12 in the Contention itself.

13 CHAIRMAN FARRAR: Or a new theory. In
14 other words, they shot down my first theory, so here
15 is a new theory. Let's be specific about this
16 document. As I understand this document, the
17 witnesses, the Applicant's witnesses originally
18 testified there was this thermal impact.

19 The State's witnesses are contesting that
20 to one degree or another. So the company comes back
21 and says, we told you there was a thermal impact, and
22 now we are going to prove it to you.

23 Are you suggesting that is different than
24 if they said, well okay, we lost on the thermal
25 impact, but here is another theory that amounts to the

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1 same thing? You are suggesting that?

2 MR. TURK: There is a difference between
3 those two.

4 CHAIRMAN FARRAR: That is the difference.

5 MR. TRAVIESO-DIAZ: I would also make the
6 point, if I may, that just as Dr. Solar asked to
7 repeat, to paraphrase what you said, kept on cranking
8 analyses, nothing prevented the State from providing
9 additional evidence.

10 And, in fact, they do it every day,
11 through cross examination, they bring new documents
12 they are putting into evidence, cross examine the
13 witness, get them admitted.

14 I think that the point that Mr. Turk made
15 is one that bears thinking about a little bit. Just
16 the fact that it takes the form of a report doesn't
17 elevate it to a higher degree of weight, or
18 admissibility, or worth of evidence, there is no
19 different ranks of evidence.

20 It is what it is, and it proves what it is
21 able to prove. But the fact that it is a report, and
22 generated by a computer, doesn't give it any
23 additional weight, as far as I'm concerned.

24 It is no different than exhibit 212 that
25 the Staff used today, that the State used today. So

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1 I'm sympathetic to the idea that fairness needs to be
2 there. But I believe that evidence is different than
3 raising claims, raising issues.

4 You were in a civil case, civil trial, the
5 allegations of the Plaintiff would be bounded by the
6 things that he says in his complaint. And if he wants
7 to change his allegations he will have to file an
8 amended complaint, and have the Court accept it.

9 That is exactly the same situation here.

10 MS. CHANCELLOR: Your Honor, if I could
11 just comment on the merits of whether this is
12 rebuttal, or not?

13 Dr. Wissa and Mr. Trudeau in their
14 testimony mentioned the thermal effects. I think it
15 is question 51 or 57. The thermal effects of the pad
16 heating up to 190 degrees Fahrenheit, and how that
17 will drive moisture off.

18 The State's witnesses do not mention
19 thermal effects, at all. The State's witnesses
20 mention moisture pulling under the storage pads. PFS
21 had the opportunity to introduce this report as part
22 of Dr. Wissa and Dr. Trudeau's testimony.

23 So I believe that the road map that Mr.
24 Travieso-Diaz was talking about was well laid out in
25 the State's issues at the time we, prior to filing

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1 prefiled testimony. Nothing has changed between the
2 State's position when Dr. Mitchell and Dr. Bartlett
3 had their depositions taken.

4 So to the extent that the cross
5 examination goes to whether there is a need to rebut
6 State's witnesses, based on this thermal report by Dr.
7 Solar, I think that we will just have to wait and see
8 tomorrow.

9 But I think it could have come in earlier.

10 MR. TRAVIESO-DIAZ: Mr. Chairman, I hope
11 that we are saving time for tomorrow by having this
12 argument today, rather than tomorrow.

13 But answer 32 in the testimony of Dr.
14 Mitchell and Dr. Bartlett clearly says that when, I'm
15 reading from the second sentence, when a cement cap,
16 such as the storage pads, is placed over cement
17 treated soils, and the native soils, there is a
18 potential to increase the moisture content of the
19 native soils.

20 Exhibit 229 is intended to rebut that
21 assertion by demonstrating that, in fact, it is not
22 going to happen because there is a significant degree
23 of heat that comes down.

24 So I think it is proper rebuttal, and it
25 is addressing something raised in their testimony.

1 CHAIRMAN FARRAR: All right, thank you for
2 those arguments. We will be prepared, I think, having
3 those arguments tonight will enable us to rule more
4 quickly tomorrow, on any matters that we need to rule
5 on.

6 If there is nothing else --

7 MS. CHANCELLOR: I just have one point.

8 CHAIRMAN FARRAR: Yes?

9 CHAIRMAN FARRAR: On Answer 57 of Dr.
10 Wissa's and Mr. Trudeau's testimony, there is a
11 reference to a high storm thermal analysis report for
12 PFS. It appears to be an older report.

13 And the report that Mr. Travieso-Diaz is
14 now placing before us as exhibit 229 appears to be
15 something that is newly generated by Holtec, it is
16 dated June 10.

17 So I guess my point is that once again we
18 have to deal with another new analysis at the last
19 minute.

20 CHAIRMAN FARRAR: All right. We will bear
21 all this in mind in getting ready for tomorrow. We
22 will see you at 9 o'clock here, and continue with the
23 cross examination of these witnesses. Thank you.

24 (Whereupon, at 5:52 p.m. the above-
25 entitled matter was adjourned.)

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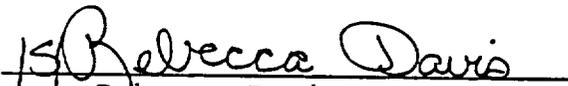
Name of Proceeding: Private Fuel Storage, LLC

Docket Number: Docket No. 72-22-ISFSI

ASLBP No. 97-732-02-ISFSI

Location: Rockville, Maryland

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


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