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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of	)	Docket No. 72-22
	)	ASLPB No. 97-732-02-ISFSI
PRIVATE FUEL STORAGE L.L.C.	)	
	)	DEPOSITION OF:
(Private Fuel Storage Facility)	)	BARRY J. SOLOMON

Wednesday, October 18, 2000 - 3:41 p.m.

Location: Parsons, Behle & Latimer

201 S. Main, #1800

Salt Lake City, Utah

Reporter: Vicky McDaniel

Notary Public in and for the State of Utah

APPEARANCES

For the Intervenor: Denise Chancellor, Esq.
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For the Applicant: Paul A. Gaukler, Esq.
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For the NRC: Sherwin E. Turk, Esq.
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Also Present: John A. Stamatakos
Martin McCann, Jr.
Walter J. Arabasz
James C. Pechmann

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EXHIBITS

* * *

PROCEEDINGS

BARRY J. SOLOMON,

having first been duly sworn to tell the truth, was examined and testified as follows:

EXAMINATION

BY MR. GAUKLER:

Q. Good afternoon.

A. Good afternoon.

Q. Would you please state your full name for the record.

A. Barry J. Solomon.

Q. And what is your current position and employer?

A. I'm a senior geologist with the Utah Geological Survey.

Q. Mr. Solomon, my name is Paul Gaukler, and this afternoon I'm going to be asking you a series of questions related to Utah Contention L, and then my colleague, Mr. Travieso-Diaz, will be asking you some on a particular area. If at any time you don't understand one of our questions, will you please ask us to clarify the question?

A. Yes.

Q. Thank you. What's your familiarity with the Private Fuel Storage project?

A. I provided some of the original review comments for the SAR in 1997, and I participated in several meetings in the intervening time, provided technical assistance to the attorney general's office.

Q. When you say you provided review comments with respect to the original SAR, you're talking about the original Safety Analysis Report --

A. Yes.

Q. -- that was filed in the summer of 1997?

A. Yes.

Q. And what parts of the Safety Analysis Report did you review?

A. Essentially all geotechnical parts of it, although I must say that some of the comments in the original Contention L were not mine.

Q. I'd like to have marked as Exhibit 15 -- have marked as Exhibit 14 your resume; we'll come back to that in a second -- a three-page document dated August 13, 1997 from Barry Solomon, senior geologist, applied geology program, to Lee Allison, director of Utah Geological Survey.

(Exhibit 15 marked.)

Would you take a look at what has been marked as Exhibit 15.

A. Okay.

Q. Do you recognize this document?
A. Yes.
Q. What is this document?
A. This was the original set of review comments for the license application.
Q. And this original set of review comments became part of -- or part of Utah Contention L?
A. Correct.
Q. Looking at Utah Contention L, if you would, please, which is Exhibit No. 3, what part of Utah Contention L did your comments comprise?
A. Surface faulting, item No. 1 on page 80.
Q. That's Basis 1 of the contention?
A. Yes. And that also -- there was a contribution from Lee Allison on that as well.
Q. So your comments on surface faulting, plus some comments from somebody else, comprise Basis 1 of the contention?
A. Correct.
Q. Did anything else comprise Basis 1 of the contention besides what you provided and what Dr. Allison provided?
A. No. Item No. 2 on page 82 is mine.
Q. That's Basis 2 of ground motion?
A. Yes.

Q. And you were the sole provider for that basis?

A. Yes. Item No. 4, page 92.

Q. And that's labeled Soil Stability and Foundation Loading?

A. Yes.

Q. Basis for it?

A. Yes.

Q. And were you the sole author of that basis for this contention?

A. Yes.

Q. Did you have any involvement or input with respect to Basis 3 of the contention?

A. I reviewed the comments of Mr. White from Versar, but I essentially agreed with most of his comments. And I might have changed some of the language to fit in with the rest of the language in the contention, but it was essentially not my comments.

Q. Did you disagree with some of the comments put forth in Basis 3?

A. No.

Q. Did you supply any additional comments beyond what Mr. White --

A. White.

Q. -- provided?

A. No, I didn't.

Q. Did you have any part in drafting the final language for the bases for 1, 2, and 4 as it appears in Contention L?

A. Only in that as it was taken out of my memo to Lee Allison. I didn't specifically write the contention.

Q. So you wrote the memorandum which as shown as Exhibit 15?

A. Right.

Q. And then obviously some of this language was pulled and put into the contention, correct?

A. Correct.

Q. Beyond providing this, the original comments on the Safety Analysis Report, what else have you done with respect to Utah Contention L?

A. Other than reviewing various regulatory documents and comments that have come in to the attorney general's office and they have passed them on to me to look at, essentially nothing, because once it got beyond Contention L we then felt it required the expertise of other individuals.

Q. Required the expertise of other individuals in what sense?

A. At the time that I reviewed the original

license application, I was essentially the only one -- I -- the review team consisted of myself. After I made the original comment, Dr. Arabasz and Pechmann and Drs. Ostadan and Bartlett were called in to deal with very specific aspects of the comments.

Q. Have you reviewed the various updates to the Safety Analysis Report as they've been filed with the NRC and copies provided to the state?

A. I have looked at them and I have read them, yes.

Q. With whom, other than legal counsel, have you discussed this case?

A. Lee Allison, Drs. Bartlett and Pechmann, Dr. Arabasz and Dr. Ostadan. I believe that's it.

Q. What were the purposes or circumstances of these various discussions?

A. Just in the nature of once various regulatory documents were provided the attorney generals, we all got together to discuss or general impressions of the documents.

Q. Would that be a group discussion?

A. Sometimes, yes.

Q. In person or by telephone?

A. Generally in person.

Q. What did you do to prepare to today's

deposition?

A. The attorney general's office provided me with a set of binders with the contention, the various comments from our review team, responses from PFS. I've also looked at the SER that was issued earlier this month, looked over the original license application and SAR and the 1999 Geomatrix report.

Q. Besides the original review comments, what other documents have you been involved in preparing related to Utah Contention L?

A. I can't think of any. I have essentially not really contributed much, other than the casual comment, since my original document.

Q. I'd like to have you look at what's been marked as Exhibit 14. And is that an accurate summary of your -- is that your resume?

A. It is, but I provided a more recent update. I believe it's -- was it submitted to the NRC? It doesn't differ much from this, other than summarizing some more recent projects in the three years since this was written.

MS CHANCELLOR: If we haven't submitted it to, I'll --

Q. Okay. What additional projects have you added based upon your recent experience in the last

three years?

A. In the last three years I've been involved as a co-principal investigator for grants from the National Earthquake Hazard Reduction Program. They consisted of a surficial geology map of the West Cache fault zone in northern Utah.

Q. Where is that located?

A. That's about 60 to 70 miles north of Salt Lake City, and it extends up to the Idaho border.

Q. And what was that project, again?

A. I did a surficial geologic map of the West Cache fault zone, which is an active fault zone on the west side of the Cache Valley. And it's in a format that's consistent with other strip maps of the Wasatch Front zone and the East Cache fault zone in Utah done by various other investigators.

Q. What other projects have you added to your resume?

A. I've been working on a seismic hazard assessment of the central Cache Valley for the last couple of years, and I've also just started a seismic hazard assessment for a scenario earthquake for the Salt Lake City segment of the Wasatch fault zone.

Q. What has this latter project consisted of?

A. For the scenario earthquake?

Q. Yeah.

A. It's a GIS mapping project, a geographic information system mapping project. It consists of mapping various hazards associated with a predefined earthquake. That earthquake is defined as a magnitude 7, and it involves rupture of only the Salt Lake City segment of the Wasatch fault zone. And we have assumed generally that earthquake effects will range from as far north as Ogden and as far south as Provo, and earthquake hazards that will be mapped include liquefaction, earthquake-induced landslide hazards, ground shaking.

Q. When you say from Ogden to the north, that's north of Salt Lake City?

A. Yes.

Q. And Provo is south of Salt Lake City?

A. Yes.

Q. So it includes the Salt Lake City area specifically?

A. Correct.

Q. And was the driving force for undertaking this assessment?

A. Yes.

Q. What was the driving force for undertaking this assessment?

A. It's essentially a tool for emergency

response. This will provide, first of all, the input to a computer model called HAZUS, which was jointly developed by the Federal Emergency Management Agency and I can't remember the name of the other -- it's a building institute. So the more accurate earthquake hazard information that's input into HAZUS, the more accurate the assessment of the resultant damage and needs for emergency response can be arrived at. And it's also a tool for both technical and nontechnical people, for engineers, planners. It's a regional planning tool, but it's not meant to replace site specific assessments.

Q. What other projects have you added to your resume?

A. Just those three.

Q. Are you familiar with the earthquake study or the study of hazards with respect to what's called the Salt Palace here in town?

A. Yes.

Q. Will you describe for me briefly the studies that have been done with respect to the Salt Palace?

A. Initially when they were excavating for the foundation for the Salt Palace extension in downtown Salt Lake City, I believe it was two years ago, they uncovered a number of features which appeared to

displace surface, near surface sediments. They continued to excavate trenches to investigate these features. They drilled a number of shallow boreholes to demonstrate continuity over the site, and they finally drilled a number of cone penetrometer holes.

Q. Who did this?

A. Private consultants for the city. Excuse me -- I should say for the county. It's a county facility within the city limits. And the main participants were a company called Kleinfelder and a local consultant called Simon Bymaster.

Q. And what conclusions were drawn from the studies?

A. Two consultants actually came up with different conclusions. Simon Bymaster concluded that the displacements were actually due to faulting. Kleinfelder determined -- I shouldn't say that so precisely. Simon Byfelder (sic) felt that there was enough uncertainty in the data that an interpretation of faulting could be reached. Kleinfelder reached a conclusion that these displacements were related to liquefaction.

Q. And were there any design features added to the Salt Palace to take those findings into account?

A. I'm not familiar with that.

Q. Did you have any official involvement with those studies?

A. No.

Q. Did Utah Geological Survey have any official involvement?

A. The only involvement we had, and myself as well as others, is typically whenever there's a large construction project locally we're called in to look at any excavations and suspicious features. So we did that.

Q. Did you have any particular findings from that?

A. We each had our own individual interpretations, but we never submitted a formal report of our findings.

Q. What were your individual interpretations?

A. I tended to agree with Simon Bymaster that there was enough uncertainty in the data that these faults could have been capable of generating earthquakes.

Q. How would you describe your general area of expertise as it relates to Utah L matters?

A. Generally my area of expertise lies in the field of geologic hazard assessment and also Quaternary geology.

Q. When you say "geologic hazard assessment," what do you mean by that?

A. It's related to the determination of whether various hazards may or may not have an affect on local development. Hazards including landslides, both seismically induced and non-seismically induced. Earthquake hazards which I've listed before in relation to my other studies. Debris flows, flooding debris flows are one of the more common hazards in Utah.

And typically we're called in to do both regional studies, such as I've outlined earlier, and also we're requested to assist local governments because they don't have the geotechnical staff. We assist them in assessing geologic hazards and also reviewing the reports of consultants prior to development.

Q. Do you do earthquake hazards assessments?

A. I do, but not in the sense that it's been discussed here. I don't do seismic hazard assessments. I'm not familiar with the detail the and techniques of that.

Q. So you've not done a deterministic hazard assessment?

A. No.

Q. Or a probabilistic hazard assessment?

A. No.

Q. Does the UGS do deterministic hazards assessments?

A. No.

Q. They don't do probabilistic hazard assessments, either?

A. No.

Q. You also mentioned in your areas of expertise qua --

A. Quaternary.

Q. Quaternary. I'll get those down. Quaternary period. What's your area of expertise with respect to the Quaternary period?

A. Basically I've done a substantial amount of mapping. One of them that I mentioned earlier is the mapping of the West Cache fault zone. I mapped the west half of the Cache Valley in northern Utah. I've also mapped the Oquirrh fault zone in the east side of Tooele Valley.

Q. Oquirrh fault zone, that's the line of mountains on the east side of Rush Valley?

A. Tooele Valley.

Q. Tooele Valley?

A. Right. And the Oquirrh fault zone is the fault that lies at the base of those mountains.

Q. And the next range of mountains to the west

of the Oquirrh mountains is the --

A. Stansburys. I also did a Quaternary geologic map of the entire Tooele Valley, northern Rush Valley, as well as mapping the Quaternary geology of the West Desert hazardous industry area.

Q. When you say you did a Quaternary mapping, what does the mapping involve? What do you mean by that?

A. It's essentially just observations of surficial outcrops and wherever possible try to tie it into shallow excavations and borings that have been done previously, but we did not do any ourselves.

Q. So you would take information -- you'd take surface information or whatever boring or other subsurface information that was available to develop a map of the Quaternary period for the area?

A. Right, correct. And there's two purposes to that -- actually two related purposes. One is to provide a framework in which to assess geologic hazards, because geologic hazards generally occur in younger material, at least in these areas. Most of the development occurs in the younger surficial deposits as well.

The other, as far as the strip maps and the fault zones, is to provide a framework for future

paleoseismic investigations in fault zones to determine their activity.

Q. Say the second purpose again, please.

A. It's to provide a framework or a basis on which to conduct future paleoseismic investigations.

Q. And paleoseismic would refer to what? What's the definition of that?

A. Generally it consists of trenching across fault zones in locations that are determined to be best suited to study the fault zone from the strip maps. And in trenching you log the various strata within the trench, observe any offsets, and collect the material you can use to date the offsets.

Q. And that's what Geomatrix did in its report here for the Private Fuel Storage Facility?

A. Similar to that.

Q. Have you reviewed that report?

A. Have I reviewed it, yes.

Q. And that's what they did here, generally?

A. Correct.

Q. Did you do any Quaternary mapping for the Skull Valley area?

A. No.

Q. Does the Quaternary mapping that you did for the West Desert area relate in any way to what you would

expect in the Skull Valley area?

A. Actually, the Skull Valley area lies between the two areas of mapping that I did in Tooele Valley. The West Desert hazardous industry area is an administrative unit set up by Tooele County to accommodate what at one time had hoped to be an industry of hazardous waste disposal facilities, and it lies west of the Cedar Mountains. Skull Valley lies east of the Cedar Mountains between the Cedars and the Stansburys, and then Tooele Valley lies east of the Stansburys. So I did mapping on both sides of Skull Valley but not within the valley itself. And the geologic setting of all three areas is very similar.

Q. So what you did in your mapping would be relevant to the Skull Valley?

A. Yes.

Q. And in general, I've heard it said that the Quaternary period involves deposits in large part from Lake Bonneville.

A. The geologic deposits exposed at the surface are largely from Lake Bonneville, but they only comprise a very small part of the Quaternary.

Q. How long, about?

A. Lake Bonneville was around from about 30,000 to 10,000 years ago.

Q. Do you know a Dr. Donald Currey?
A. Yes.
Q. What is his area of -- recognized area of expertise?
A. Geomorphology, the history of Lake Bonneville. And he's also been quite involved in the use of -- the interpretation of Quaternary geology and geomorphology, using that as a tool to interpret recent fault activity.
Q. And do you have any opinion as to his qualifications and professional expertise?
A. Very qualified.
Q. I'd like to have marked as Exhibit 16 what I believe is the Quaternary mapping that you did for the West Desert area and Tooele Valley.
(Exhibit 16 marked.)
Do you recognize what's been marked as Exhibit 16?
A. Yes.
Q. And what is that document?
A. It's an open file report published by the Utah Geologic Survey that reports on my mapping in Tooele Valley and the West Desert.
Q. So this is the report of your mapping, the results of your study?

A. Correct.

Q. Turning back to Exhibit 15, if you would, please, which was your original comments on the Safety Analysis Report. If you would, please, summarize what your -- what you believe the deficiencies were that you identify with respect to surface faulting and ground motion studies with respect to the original Safety Analysis Report.

A. Essentially related to surface faulting. This was -- particularly reflects the input of Lee Allison, that the original geophysical studies done for the Safety Analysis Report did not adequately show displacements and evidence of fault offsets.

Related to -- did you say ground motion?

Q. Yes.

A. Related to ground motion. What I attempted to do was from my limited experience with assessing seismic hazards at that time, I didn't feel that the Safety Analysis Report adequately addressed ground motions, and I provided one example, which was the example of Somerville and others of a deficiency. But I did not mean that to be an exhaustive list of what I considered to be deficiencies in ground motion.

Q. That's the only example you identified in this document here?

A. Correct.

Q. And I take it that's the only example that's identified in Utah Contention L?

A. Correct.

Q. In terms of surface faulting, have you reviewed the work that's been done by Geomatrix and Bay Geophysical with respect to the site investigation?

A. Yes.

Q. Do you have an opinion on the adequacy of that work to resolve the issue that you identified with respect to surface faulting?

A. I guess I have to defer to the judgment of Lee Allison and the interpretation of the geophysical data, because I'm not a trained geophysicist. As far as the studies of, for instance, Dr. Currey, I agree with him and don't find any problems with that.

Q. How about the studies on the geological setting as described in the Geomatrix report?

A. I agree with that.

Q. You don't have any -- don't take issue in any respect with respect to those?

A. No.

Q. How about the analysis of the ground motion with respect to the -- that's been done by Geomatrix for the site? Do you take issue on that in any respect?

A. I neither do or don't take issue. I don't feel I'm really qualified to assess the accuracy of it, and that's why Drs. Arabasz and Pechmann were asked then.

Q. Did you review the work that had been done with respect to near-source effects that relate to the Somerville reference you made in your original comments on the Safety Analysis Report?

A. Again, I could identify the deficiency to begin with or what I perceive to be a deficiency, but how it was handled, I'm not qualified to say whether it was handled correctly or incorrectly.

Q. So you have no opinion on that?

A. No.

Q. So I take it that with respect to the interpretation of the geophysical data, there is nothing that you take issue with with respect to the investigation of the site that was done by Geomatrix?

A. That's correct.

Q. Do you know what's meant by a geomorphic setting?

A. Yes.

Q. And what's meant by that term?

A. Generally a geomorphic setting is the collection of land forms that reflect the underlying

geology.

Q. And what's its relevance in terms of evaluating the potential for faulting at a particular site?

A. There are certain geomorphic features that are associated with faulting and also certain geomorphic features that can be used to demonstrate continuity in the absence of faulting. Specifically I don't -- is there a specific question regarding --

Q. No.

A. -- a certain feature?

Q. And that's what you rely upon in part when do you the Quaternary mapping?

A. Correct.

Q. And you believe that the Geomatrix report provides a reasonable interpretation of the geomorphic setting for the Private Fuel Storage Facility?

A. That's reasonable, yes.

Q. Would you look at Table 3.2 of the Geomatrix report. With respect to Table 3.2, do you believe that the ages assigned to the geomorphic surfaces and stratigraphic units are reasonable?

A. Yes, I do.

Q. Have you reviewed the Geomatrix interpretation of the Stansbury Bar as a geomorphic

feature in the area of the Private Fuel Storage Facility?

A. I have, but I must say it's been some time since I looked at it. I didn't look at it recently.

Q. Well, did you believe that it was a reasonable explanation or use of the Stansbury Bar?

A. Yes.

Q. Have you looked at the location of the East Fault at its closest approach to the site in terms of what Geomatrix found?

A. Yes.

Q. And did you believe that was consistent with the available geomorphic and stratigraphic and geophysical data?

A. Whether it's consistent with any subsurface data I can't say, because that's still open to discussion, particularly with Lee Allison and his coworkers.

Q. Did you identify a particular issue that you took with respect to it?

A. No.

Q. Would you agree that the Stansbury Bar is an appropriate geomorphic feature to evaluate the location, recency, and amount of surface displacement associated with active faults?

A. Yes.

Q. You agreed with Geomatrix's conclusions concerning the surface displacement of the Stansbury Bar?

A. Yes.

Q. Have you reviewed the fault displacement history at the site that was outlined in the Geomatrix report?

A. Yes.

Q. And do you find that to be consistent with the geomorphology of the site?

A. Consistent with the geomorphology?

Q. Yes.

A. Yes.

Q. Have you reviewed the geochronology data that was evaluated as part of the Geomatrix report?

A. Are you talking about --

Q. The age dating on certain pieces of the --

A. I have. Is there specific aspects of it?

Q. Do you recall reviewing some dating done by a Dr. Nash?

A. Oh, yes, with tephrochronology.

Q. Do you agree with that?

A. Yes, I do.

Q. And Dr. Nash --

A. I should say I agree with it in that it's reasonable. I have no reason to disagree with it.

Q. And what's your professional opinion of Dr. Nash's expertise?

A. He's highly qualified.

Q. And have you reviewed any dating done by Dr. Perkins?

A. Yes.

Q. And he's also with University of Utah?

A. Correct.

Q. And so is Dr. Nash?

A. Correct.

Q. And you have -- do you find his, Dr. Perkins' data to be reasonable?

A. Yes.

Q. And what's your opinion of Dr. Perkins' --

A. Again, highly qualified.

MR. GAUKLER: Let's take a break right now.

(Brief recess.)

Q. (BY MR. GAUKLER) Back on the record. Would you agree that the geologic setting for the Skull Valley area during the Quaternary period is generally well defined?

A. The generally geologic setting, yes.

Q. And would you consider the sequence of

lacustrine Lake Bonneville deposits to be a relatively simple geological setting?

A. The sequence is relatively simple, but the recognition of some of the subsurface beds within it is not that simple.

Q. In what sense?

A. Very few exposures exist of some of the underlying marker beds within the Bonneville sequence, so whatever correlations are made may be based upon exposures that are quite some distance away from whatever subsurface evidence you've got. And there may be some changes that have not been found in evidence in surficial exposures, but they still may occur.

Q. Then you would do a subsurface investigation to try to identify them?

A. Correct.

Q. Would you agree that the geological studies that PFS and Geomatrix has done is consistent with the geological setting of Skull Valley?

A. Yes, in general.

Q. And will you agree that the Geomatrix study adequately characterizes the late Quaternary stratigraphy at the site needed to evaluate the location and activity of faults?

A. That's difficult to say. There may be areas

which may require more closely spaced subsurface exploration to determine true relationships. I can't identify any single instance like that. In general they've done a good job. Because of the uncertainties, I can't say that they have done the correct job.

Q. What uncertainties are you referring to?

A. Similar to what I discussed earlier regarding the lack of any real good exposures locally.

Q. Have you reviewed the stratigraphy work that Geomatrix has done?

A. Yes.

Q. Have you identified any deficiencies in that work?

A. No, nothing specific.

Q. Do you believe that there are faults with greater displacement hazard than those identified by Geomatrix in the study?

A. I think that sufficient questions have been raised by Dr. Allison that the question remains open. Whether there are additional faults, I can't say.

Q. Would additional faulting be suggested by any of the geomorphology or anything else in the area that you're familiar with?

A. Some of it may be. And I don't see evidence, surficial evidence that there is additional

faulting. But because of the relatively young age of surficial deposits, there may be fairly geologically recent faults that may not have evidence at the surface.

Q. But you would find those; you would get the subsurface investigation in terms of trenching and boring?

A. Not necessarily trenching and boring, particularly trenching, because trenching is limited by the length of the equipment you're using. You can generally only get down to 10, 15, 20 feet.

Q. Have you reviewed the boring and the trenching that Geomatrix did?

A. Yes.

Q. Did you find any deficiencies in the boring and trenching that they did?

A. Not in the data that was presented.

Q. Are you aware that you've been identified as a witness with respect to Utah L?

A. Pardon me?

Q. A witness for this proceeding with respect to Utah L?

A. Yes.

Q. What areas of Utah L do you expect to testify to?

A. Essentially many of the areas that you've

been questioning me now regarding surficial expression of faults, interpretation of Quaternary stratigraphy and structure. Essentially those areas.

MR. GAUKLER: No further questions from me. Turn it over to my colleague here.

EXAMINATION

BY MR. TRAVIESO-DIAZ:

Q. Good afternoon, Mr. Solomon. For the record, my name is Matias Travieso-Diaz and I'm an attorney for PSF. I will be asking you a number of questions in regard to a limited area. Before I do, however, I would like to repeat Mr. Gaukler's admonishment that if any of my questions you don't understand what I'm asking, please ask me to repeat, rephrase, or clarify my question. Will you do that?

A. Yes, I will.

Q. Thank you. In the first few questions I'm going to be referring to both or either of Exhibits 3 and 15, 3 being the Utah L as propounded and Exhibit 15 being your memorandum with respect to your analysis that you testified to earlier. So if you could have those handy.

Looking for the moment at Exhibit 15, which I believe is dated August of '97.

A. Yes.

Q. the review that you conducted of the initial submittals by the applicant included a review of the original version of the SAR; is that correct?

A. Yes.

Q. And that was revision zero?

A. Yes.

Q. Now, you were here today when Dr. Arabasz testified that additional significant work has been done by the applicant in seismic areas, various seismic areas since revision zero was originally presented. Is that correct?

A. Yes.

Q. Do you agree that in fact significant additional work has been done?

A. Yes, I do.

Q. Have you had the opportunity to review your initial concerns versus the work that has subsequently been done by the applicant in the areas in which it raised concerns?

A. Yes.

Q. Has that review led you to conclude that any of the concerns that you have raised have been resolved?

A. I think with consultation with the other experts that I've come to the conclusion that some of my concerns have been answered.

Q. Could you, in danger of exploiting the conversation, tell me which concerns have been resolved?

A. I think particularly -- should I refer to the memorandum or to the contention?

Q. Why don't you refer to Exhibit 3, which is Contention L.

A. Specifically let's work backwards. It may be easiest. Comments regarding item 4, soil stability and foundation loading.

Q. So I understand: your concerns as expressed in Basis 4 have been resolved?

A. Yes, they have.

Q. All right. Can I ask you to turn to -- so you have -- so I understand what you're saying: you have no remaining concerns from the ones that you expressed with respect to the Basis 4?

A. Not with those specific comments, no.

Q. Could you now turn to Exhibit 10. That is a document that was entered earlier, which is called State of Utah's Objections and Responses to Applicant's Second Set of Disclosure Requests with Respect to Groups II and III Contentions.

A. Yes.

Q. Have you seen this document prior to today?

A. Yes, I have.

Q. Did you play any role in preparing the answers to interrogatories that are presented here?

A. Let me briefly review it to make sure.

Q. Please.

A. No, I did not.

Q. I am going to ask you one question that may require you to take a couple minutes, so please feel free to do that. I want to turn your attention to the answer that starts on page 51 that refer to Interrogatory No. 8. And I believe the answers are numbered A through -- bear with me for a second -- to AS, and they go from page 51 to 71.

Now, would you look at those answers and answer for me whether any of the matters raised in items A through AS were part of the concerns you raised with respect to issue 4. Take whatever time you need to answer that.

A. No, none of these relate to item 4.

Q. Thank you. Now, you said a moment ago that your concern with respect to issue 4 or Basis 4 have been resolved.

A. Yes.

Q. Is there any portion of the other remaining three bases as to which your concern as originally stated has been resolved? Could you take a look at it?

A. No, I don't believe any of the other concerns have been addressed.

Q. Is that because there are questions that remain with you as to the various concerns, or because all the experts are looking at the issue, or a combination of either?

A. It's principally because it's beyond my area of expertise, and others have raised questions that I believe have been unanswered.

Q. Are you familiar with any work that has been done apart from what other experts' view may be that might think to resolve any of the concerns that have been expressed with respect to Basis 1 through 3?

A. Boy, that's an awfully broad question.

Q. To the extent you can answer.

MS. CHANCELLOR: Would you repeat the question?

MR. TRAVIESO-DIAZ: Maybe I should have it read back. I don't think I could repeat myself.

(The record was read.)

Q. I'd be glad to restate for you.

A. Yeah, offhand I can't think of any specific additional work that's been done to respond to these questions, but that may be because of my lack of expertise in the areas we're dealing with now.

Q. Conversely, is there any work that has been done that you have reviewed that in your view is insufficient to answer the concerns that you raised?

A. Again, my -- because my only remaining questions deal in areas that are not my area of expertise, I would find it difficult to say -- give you a definitive answer like that. Whatever remaining questions remain open are because of the concerns of others who are more qualified than myself.

MR. TRAVIESO-DIAZ: Can we go off the record for a second?

(Discussion off the record.)

MR. TRAVIESO-DIAZ: Well, I don't have any more questions.

THE WITNESS: Thank you.

MR. TURK: I don't have any.

MS. CHANCELLOR: I have no questions.

(Deposition was concluded at 4:50 p.m.)

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COPY OF TRANSCRIPT

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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In the Matter of	) Docket No. 72-22
	) ASLPB No.1 97-732-02-ISFSI
PRIVATE FUEL STORAGE, L.L.C.	)
	) Deposition of:
(Private Fuel Storage Facility)	) LEE ALLISON
	)

Wednesday, October 25, 2000

Location: Parsons, Behle & Latimer
201 South Main Street, #1800
Salt Lake City, Utah

Reporter: Diana Kent, R.P.R.

Notary Public in and for the State of Utah

Dr. Arabasz's shop, although I don't recall specifically. I used to be able to tell you what report it was that generated those vertical accelerations that was the basis of recognizing that seismic zone 4 standards or criteria were met.

Q. What is Dr. Arabasz's area of expertise as far as you know?

A. Earthquaker seismology.

Q. Earthquake hazard analysis, then, is another word for it?

A. I want to be careful because within specialties some of those words can be buzz words or code words so I would say earthquake seismology and he has been professionally involved in earthquake hazard analysis.

Q. And how do you define earthquake seismology?

A. Okay. Understanding the origin and movement of shock waves in the ground as a result of earthquakes or tectonic movement.

Q. Is that it? Anything else you would add?

A. I hadn't thought about it for a long time so I don't feel comfortable trying to give an accurate definition.

Q. I would like to introduce as Exhibit 26 a document which I believe is your curriculum vitae.

(EXHIBIT-26 WAS MARKED.)

Q. Do you recognize what's been marked as Exhibit 26?

A. I do.

Q. And is that an accurate summary of your educational and professional background and expertise?

A. Yes, it is.

MR. TURK: Can we go off the record for a moment?

MR. GAUKLER: Yes.

(Discussion off the record.)

Q. (By Mr. Gaukler) How would you describe your area of expertise based on your area of expertise as set forth in this resume?

A. Based on my education and work experience, I would consider myself a structural geologist with an emphasis on oil and gas exploration and structural interpretation of -- well, structural interpretation of rocks. Structural interpretation.

Q. And when you say you are a structural geologist, what does that mean?

A. Structural geology involved the folding and breaking of rocks, how rocks are deformed, displaced, moved.

Q. And you say with emphasis on oil and gas

exploration. How does that affect your focus as a structural geologist when you say you have an emphasis on oil and gas exploration?

A. Much of my professional work experience as a scientist as opposed to an administrator or manager was in the oil and gas industry, and I particularly interpreted geologic and geophysical data to develop structural interpretations of oil and gas prospects or fields.

Q. In terms of oil and gas exploration, typically what age of rock are you looking for the oil and gas?

A. I have worked in enough different areas around the country that I have explored in rocks from 1.1 billion years old up to within a few million years of age. I should say up to rocks within ages of just a few million years. So pretty much the full range of age of rocks in which any oil and gas has been found.

Q. Now, please help me with these geological terms. What is the Quaternary period, as far as you understand it? What age of rocks?

A. Approximately 1.6 million years ago until about 10,000 years ago.

Q. And prior to the Quaternary period, what period do you have?

A. The Tertiary. And then prior to that, running from 1.6 million back to about -- well, back to 65 million years ago with the age of the dinosaurs at the end of the Cretaceous.

Q. That's the Tertiary period; 1.6 million to 65 million?

A. Right.

Q. And another term I heard used was the Cambrian period, what is --

A. Cambrian is the earliest age after the Pre-Cambrian. There's -- I haven't kept track. There's been changes in when the Cambrian period was thought to have started, but roughly 500 to 600 million years ago it began and ran for, I'm just guessing now, perhaps 70 million years. I have forgotten.

Q. So between 500 and 600 million years old?

A. Yes. That's a rough approximation.

Q. So your exploration for oil and gas involved rocks from the Tertiary age and older?

A. Yes.

Q. Have you ever been involved with earthquake hazard analysis in your professional career prior to this case here?

A. I have been involved with looking at earthquake hazards. I'm not sure if it meets a

definition of earthquake hazard analysis, if that is intended as a formal definition.

Q. Do you understand the term earthquake hazard analysis to be a formal definition of a --

A. I would not use it as a formal definition.

Q. What has been your involvement with respect to earthquakes?

A. While I was doing my master's thesis out of San Diego State University there was a magnitude 4.8 earthquake on the Elsinore fault in San Diego County which was in the center of the area. I was working, I was mapping the Elsinore fault using a variety of geophysical techniques. Cal Tech put a portable array of seismographs in the area and I incorporated the data that they collected as a section of my thesis and used it to help try to delineate a previously poorly mapped section of the Elsinore ^ fault and in an informal way evaluate the earthquake hazard from that.

In the late 1990s I --

Q. Approximately when was your master's thesis?

A. Oh, this was '72 to '74. I think the earthquake was in '73. So I spent a modest amount of time at the Cal Tech seismological laboratory processing the data and interpreting it.

Q. And when you say "processing data", what

data are you talking about?

A. The earthquake reportings from the portable seismic array that Cal Tech deployed around the Elsinore fault.

Q. What is the nature of that type of data? Was it accelerations, geophysical reflections?

A. No. It was a passive recording of shock waves coming from earthquakes. And I'm trying to remember if it was -- no, it wasn't digital. It was all paper records. So it was paper records with kind of a pen and ink type of recorder that would vibrate as the shock waves came through the ground. They would hit the instrument and the instrument had a built-in response and then the pen would record on the trace of paper. So I would interpret those ink recordings, pick the arrival times, the phase of the arrival, enter those into a computer program and try to find a best fit for the origin of the earthquake event.

Q. And go to your next example.

A. Okay. In the late 1980s I was involved in a drilling project in Ascension Island in the South Atlantic looking for geothermal resources. We were having trouble finding a source of high temperature steam and we devised a plan to install a portable network of earthquake seismometers to see if we could

find microseismic events, small earthquakes that might delineate a potentially active fault zone that would be a target for us to drill. So my responsibility was to arrange for the equipment, get it to the island, get it installed, monitor the data, interpret it, and come up with an analysis. And that was approximately -- I think we ran that network for only a few months. It was of limited duration and I believe we had eight stations set up, portable stations, around the island. So we hired consultants to help us install it and after the first month I was back on the island and I ran the network for the remainder of the operation and then interpreted and processed data on the island.

Q. And what was the nature of the data?

A. Same kind of data. These were smoked paper recordings on a drum, and a stylus then would scratch the smoke off when it was triggered by a shock wave coming from an earthquake.

Q. So the data represented the shock wave?

A. It was a passive recording of shock waves coming from an earthquake.

Q. The same type of data you reviewed with respect to your thesis?

A. Very similar to the work on my thesis.

Q. Any other past experience?

A. There is, and I'm trying to -- mind if I take a second and review?

Q. Go ahead.

A. Once I became the director of the Utah Geologic Survey I was more actively involved in evaluating earthquake hazards in Utah and working with ways to better identify them and mitigate them. And through most of my ten years with the UGS, earthquake hazards were a significant component of my work almost on a daily basis.

Q. And in terms of -- what type of involvement did you have in identifying and mitigating earthquake hazards as director of the UGS?

A. I was appointed to an earthquake advisory board. I can't remember the state agency. It was a state-sanctioned body that wanted to look at that. And our recommendation, both mine and Dr. Arabasz and others, encouraged them to look at earthquake hazards so an earthquake advisory board was set up. We evaluated the state of knowledge in Utah and made recommendations on what a state earthquake program needed to be better prepared to respond to an earthquake, recover from an earthquake, and mitigate future earthquakes.

After the Los Angeles area earthquake of 1984, I believe it was, a legislator called and asked

what we could do to better prepare Utah to deal with earthquakes. And we had a 33 point program that we had developed as part of this previous board. So I met with him, laid out those options, and after discussion his recommendation or his decision was that we would establish a Utah seismic safety commission as a first step that would then prioritize all of the other 32 items on this list and develop a plan for addressing those. So at his request I drafted the legislation, which he adopted. There was some minor modification to it and it was submitted and passed in that legislative session. In that, I was designated as one of the members, being the state geologist. I was designated as one of the permanent members of the council.

Q. What council is this?

A. Utah Seismic Safety Commission. We met quarterly then during the rest of the time that I was state geologist.

Q. Any other committees or boards or activities that led to earthquake hazards?

A. I was involved with the Western States Seismic Policy Council, I believe it was, which was a coalition of thirteen western states plus Guam, and I believe they have added one or two Canadian provinces as kind of ex officio members. This was an organization

with support from the management agency to bring state geologists and state emergency managers together and look at seismic hazards throughout the Western U.S., to cooperate to exchange information, to work together basically on a regional level and have influence on a national level. The same kinds of things we were doing with the Seismic Safety Commission in Utah.

Q. Any other activities or positions referring to earthquake hazards?

A. I think there were quite a few activities within the survey that I oversaw that I either conferred with my staff on or in some cases may have initiated or advised them on. We had a very aggressive and active engineering geology program called Applied Geology, and earthquake hazards were one of the principal hazards that that group dealt with. And so I worked with them on almost a daily basis preparing proposals, evaluating reports, deciding what approaches we might take on projects or initiating new programs. During my ten years at the Utah Geologic Survey, earthquake hazards were one of the principal activities I was involved with.

Q. Going back, you were talking about the earthquake advisory board, Utah Seismic Safety Commission, and then you had the Western States Seismic

Policy Council. Did any of your work with respect to those boards and commissions and council involve the gathering, field gathering of seismic or geological data?

A. Generally no, not of me personally. There were projects, activities. I served mainly in an administrative and managerial role, but I'm trying to remember if -- I believe that during that time I was involved in at least reviewing technical reports.

Q. But you weren't involved in terms of responsibility for going out and gathering data and evaluating the data and preparing such reports?

A. I'm trying to remember if I did any of those, and let me review publications here and see if there was anything that I'm not recalling.

Q. Certainly.

A. Okay. I can recall a few instances here.

Q. Looking at Exhibit 26, I take it?

A. Yes. On my resume. In 1990, I published a short paper on remote detection of active faults using borehole breakouts. That was using measurements of in situ stress from well logs. And I was developing a technique to recognize active faults from the relative strengths of in situ stresses among a variety of, in this case, of geothermal wells in southern California.

In 1991 I published an abstract and gave a presentation at a Geological Society of America meeting on variations of in situ stress in extensional areas of the Western U.S. Again, in situ stresses are current active stresses today, so that was looking at how stresses are related to active faulting.

Q. Can you point on your resume where those are?

A. That's page 11. The remote detection of active faults is the eighth one down, I believe. And the next one is five below that; variations of in situ stress.

Third from the bottom on that page I was second author on an abstract, and again it was a presentation at the American Association of Petroleum Geologists meeting. We determined fracture directions in Cane Creek shale in Paradox Basin, Utah in part using in situ stresses that I use to define active fractures and their orientations.

The next one below that is again an invited talk I gave at the Geological Society of America based on a summary of my work over the previous few years of looking at active stresses from well bores and how that affected faulting.

Q. And that title is --

A. Variations in crustal stress orientations.

Q. Okay.

A. At the beginning of page 12, another talk again with AAPG with published abstracts, Exploration Targets in the Great Basin of Utah. This was aimed at new targets for oil and gas exploration and among those I used seismic reflection data from the Great Salt Lake, from the Sevier Desert, and identified potential oil and gas places that the industry might be interested in.

Q. So that didn't involve earthquake hazards?

A. No. I'm sorry. That was not earthquake hazards. I apologize. I don't see anything else on earthquake hazards that rings a bell.

Q. Okay. And you mentioned I think four specific articles that involved in situ stresses?

A. Yes.

Q. And what do you mean by in situ stresses?

A. In situ stresses are the active stresses in the rocks today. The state of stress that's currently operating in a rock.

Q. And did you gather data on this?

A. Yes.

Q. And what type of data did you gather?

A. I was primarily using borehole breakouts

which are an elongation of a borehole drilled into the earth where the stress concentrations around the borehole are as a result of the orientation and magnitude of the in situ stresses, causing a spalling of the borehole. And by measuring the orientation of that spalling you can then determine the in situ stress orientation.

Q. And would this be used on previously identified faults to identify stresses along those faults?

A. I was using those to primarily determine the orientation of the stress, principal stress orientation. And we would use that then to interpret which fractures are most likely to be active and open and thus be conduits for fluids like oil. A principal stress perpendicular to a fracture would tend to close that fracture. A principal stress parallel to a fracture would tend to open that fracture and allow it to become a conduit for fluids.

Q. So this purpose of looking at these stresses was for oil and gas exploration then?

A. That was one avenue for it. It was also to determine what stress field is operating on faults.

Q. And this would be previously unidentified faults?

A. Yes. And during these investigations I developed a technique which I believed would or which I think I demonstrated could indicate previously unmapped faults because we could find stress fields associated with them. We found stress fields associated with active faults. We found some stress fields where we had previously not seen a fault. And by mapping the stress fields and a number of well bores, I was able to define a fault that had been previously unrecognized.

Q. Do you know who else has used this method of in situ stresses with respect to earthquake analysis, if anybody?

A. With earthquake analysis, Mark Zoback of Stanford University has been very active in this for at least a dozen years. Mary Lou Zoback, his wife, with the U.S. Geological Survey, compiled the world stress map and used borehole breakout data extensively. I contributed all of my analyses to her and particularly she was interested in my analyses of the borehole breakouts from Ascension Island in the South Atlantic because there was no other data from within at least a thousand miles. So that was a unique data set.

There are dozens of researchers around the world who are using borehole breakouts. There's a fairly extensive literature using borehole breakout for

in situ stresses. In situ stresses are a very active field in structural geology, and there's a variety of other ways of measuring in situ stresses. So my emphasis has been on the use of borehole breakouts, but there's probably scores if not hundreds of researchers who work with in situ stresses.

Q. With respect to your work, other work at UGS, you said you work with your applied geology staff. To what extent in your work with your applied geology staff do you get involved in gathering and assessing data with respect to the earthquake hazards?

A. I don't specifically remember gathering any data. I do remember reviewing many field projects, trenches that we had dug for paleoseismic investigations, reviews of liquefaction features, reviews of reports. We did informal internal reviews where the results of projects would be presented and I would review those and critique them. So that was a fairly common occurrence.

Q. So you were in a position as the head of the UGS but you weren't in the field doing the actual work?

A. I can't think of any specific case where I was actually out collecting data other than the examples I mentioned.

Q. You mentioned paleoseismic investigation.

A. Yes.

Q. What does that mean?

A. It is principally trenching across a fault to determine the location, the precise location of the fault, the displacement history and the age of faulting. Perhaps the nature and extent of it.

Q. And you also mentioned liquefaction?

A. Liquefaction is the situation during shaking of the ground when the sand grains or other grains making up an unconsolidated layer become separated so you no longer have grain-to-grain contact, no longer have that support. And they will be surrounded by water. And so the rock loses or the layer loses its structural integrity or its strength, and essentially the soil liquifies. In some ways it is like quicksand. And so a structure on a layer of soil that liquifies may not be supported and may tilt or fall.

Q. What has -- you are familiar with the Private Fuel Storage project, I take it?

A. Yes.

Q. What has been your role or involvement with that project?

A. Initially, while I was at the UGS, I assumed the role of advising the -- I'm trying to remember who. I believe it may have been the executive director of the

steps". What do you mean by that statement? That is on interpretation, seismic lines?

A. I would repeat what I just said.

Q. Would you read that back?

(Answer beginning on Page 137, Line 22 was read back.)

Q. What type of steps did you purposely avoid taking in that respect then?

A. I can't describe those.

Q. Rick Miller would be able to describe those?

A. Rick Miller could describe those.

Q. And you also talk about using standard basic procedures. What is the basis for stating that your procedures are basic standard procedures; do you know?

A. Again, talking with Rick Miller.

Q. You go on to say, down in the next paragraph, "The velocity structure varies 15 to 20 percent across the seismic lines. This is a prominent variation that could mask relief on subsurface layers of up to 60 feet." What does that mean?

A. The Exhibit 28 that we provided you was prepared by Rick Miller to show variations both in stacking and interval velocities across the section of line A that we reprocessed. He found variations on any given horizon of 15 to 20 percent -- I'm sorry. Of any

given depth, I guess it is, of 15 to 20 percent across the line. And if a uniform velocity was used in processing the data, that variation, that 20 percent variation could account for 60 feet of difference in depth.

Q. Do you know how the velocity that you identified on your stacking velocity, interval velocity compared to the velocity that Bay Geophysical used to calculate fault offsets?

A. No, I do not, because we only received the Bay Geophysical velocity data last night.

Q. Doesn't the report refer to the velocities that were used in terms of calculating fault offsets in their report?

A. I'm not sure. Could you point me to a reference on that?

MR. STERLING: In table 1 of the tables. It states the velocity.

Q. Did you look at table 1?

A. Yes.

Q. Now, are the values that they have used in calculating fault offsets --

A. Yes. I'm sorry. I didn't completely understand the question when you asked it. Yes, I am aware of the numbers, and in questions we asked

yesterday we brought the numbers up.

Q. And how are they compared to the velocities that you have calculated on your interval velocity? Are they encompassed by the velocities that you have calculated?

A. I do not have a detailed printout of our velocities.

MR. STERLING: I have one that I can go retrieve that was faxed to me.

Q. Let's go on and we will come back to that.

Further down in that paragraph you say that, "Bay Geophysical's use of the time section only to infer geologic interfaces and structure is not valid and could hide potentially large vertical offsets on faults." What is the basis of that claim, and the significance?

A. The basis is that the only seismic reflection lines that we were provided are in time rather than in depth. As we note in the sentences and paragraphs above the lines you just read, we determined that there was a significant variation of velocity across the line that we looked at and that if those were not compensated for, there could be variations in the actual depth that would not be evident from the time section.

Q. If we used a velocity greater than what you

calculated, then that would not be a problem; correct? If we used the interval velocity on table 1 that you looked at and are greater than those that you calculated in your figure, Exhibit 28, that would not be an issue?

A. It would still be an issue. It would be different velocities that would indicate that the depth conversion or that the time depth is incorrect. I'm not saying that it is incorrect to your advantage or someone else's advantage. It is just incorrect.

Q. But if you used a larger velocity to calculate the offset than what you indicated in your figure, which is Exhibit 28, then we would have calculated a larger offset than what you would have predicted using your velocities?

A. Yes. That's correct.

Q. Okay. So it would be more conservative in the sense of calculating a greater offset than what you would have calculated.

A. If it was correctly -- yes, yes.

Q. Okay. The next paragraph?

MR. STERLING: I believe you may have brought it down with your stuff, John.

MR. TURK: Off the record for a minute?

MR. GAUKLER: Yes.

(Discussion off the record.)

Q. Okay. Will you be testifying -- you won't be testifying with respect to ground motion, is my understanding.

A. No. If I'm testifying I will be testifying to Basis 1 only. Yes. I'm sorry.

Q. What is your understanding of Basis 1 as it is written here?

A. This, as I recall, was done before the Bay Geophysical lines were run and the data we had at that time were the Geosphere lines. So when I commented here buried faults and Paleozoic bedrock, the seismic reflection survey, that would have been the Geosphere reflection survey.

Q. So when you are talking about the survey, you would be referring to the Geosphere seismic reflection survey?

A. Yes.

Q. And the contention raised in Basis 1 was the alleged adequacy of adequate investigation of the area for faulting?

A. That is correct.

Q. And that was before the Geomatrix report was done, too; correct?

A. That is correct.

Q. So it is based upon the initial ex officio

evaluation as filed in June of 1997 and the work done for that?

A. I don't recall that specifically, but the timing is correct. So I'm presuming that is correct.

Q. Okay. You would agree that since the contention was written by the state, PFS has done extensive additional investigation of potential surface faulting at the site; correct?

A. I would agree.

Q. And you have reviewed the work done by Bay Geophysics which we have talked about so far today?

A. Yes.

Q. And you also reviewed the work done by Geomatrix with respect to surface faulting and the Geomatrix report?

A. To some extent, yes.

Q. To what extent did you review that work?

A. I have looked at their cross sections A, A prime, and B prime. I have reviewed their Plate 1 -- well, I have reviewed all of the plates, I think, with particular emphasis on Plate 1. I have either read or surveyed the rest of the report to varying amounts of detail.

Q. Okay. I have also talked with Mr. Solomon whose deposition we took last week. He is also going to

summary of Ages of Major Stratigraphic Units in the Site Area.

A. I would consider this a version of age dating that I don't have any particular expertise in this area, so I would not expect to testify on that.

Q. Okay.

A. Would you like me to look at the plates, as well?

Q. Yes.

A. Plate 1, I do expect to testify on. I do feel like I have expertise on some of the data that is represented on Plate 1.

Q. And what do you expect to testify about with respect to Plate 1?

A. Fault orientation location. Perhaps the gravity data, gravity interpretation. The origin of Hickman Knolls.

Q. What about the origin of Hickman Knolls?

A. I think there's an increasing discussion as to whether this is a rooted block, in other words a fault block that is uplifted and it is a smaller version of either the Stansbury or Cedar Mountains, or whether it is unrooted, it is a landslide block that has come down off an adjacent mountain range and is partially buried by sediments in the valley.

Q. You heard Mr. Clark testify that the gravity data supported that it was not rooted to the bedstone or the bedrock. Do you disagree with his interpretation of the gravity data?

MS. NAKAHARA: Objection. I don't think that quite characterizes his testimony.

A. My understanding of his testimony was that that was a possibility but that gravity data is not unique and that alternative explanations can be made, but that he saw relatively parallel gravity contours going through it, through the Hickman Knolls area, which was not or did not provide strong evidence that it was rooted. But it didn't deny it.

Q. Okay. Do you disagree with his interpretation of the gravity data as you described it?

MR. TURK: I don't know if that was a correct paraphrasing of the testimony, but do you agree with the statement you just made?

Q. Do you disagree with that -- were you going to say something?

MR. TURK: With that characterization of the testimony.

A. I have lost track of what the question is here.

Q. Do you agree -- you have characterized Mr.

Clark's testimony as you understood it. Okay?

A. Yes.

Q. Do you agree with that characterization of his testimony as you have just stated it?

MS. NAKAHARA: Just a minute, please. You mean Lee's characterization of Mr. Clark's testimony?

Q. Right. You just characterized what you believe to be Mr. Clark's interpretation.

A. Yes.

Q. Do you agree with that interpretation as you have stated it?

A. I see. Would you read back what I said?

(Answer beginning on Page 162, Line 7 was read back.)

A. I agree with that statement.

MS. NAKAHARA: For clarification, the entire statement?

THE WITNESS: The entire statement.

Q. Do you have a professional opinion right now whether it is rooted or separate?

A. I think it is -- I think both possibilities, both explanations are possible. I have seen both situations in other valleys in the Basin and Range Province so I have seen rooted basement blocks that are

forming horst block roughly in the centers of valleys. I have also seen slide blocks off of mountains carried out into the valleys. And the one I'm thinking of in particular in Butte valley was completely buried in the sediments, so there was no surface expression of it. So I think both are reasonable alternative explanations.

Q. Have you reviewed Geomatrix's evaluation of that issue?

A. Yes, I have.

Q. Do you take issue in any respect with Geomatrix's evaluation of the issue as set forth in the report?

A. I'm going to have to review the criteria on which they made that basis. I didn't memorize it. You don't happen to recall where that discussion was?

Q. No, I don't. I'm sorry. Do you know where it is?

MR. SOLOMON: Page 33. Section 4.3.

A. As I read section 4.3 in the Geomatrix report, I concur -- well, let me back up. The identification of a major west dipping normal fault west of Hickman Knolls would be supportive of a rooted structure. The lack of a major fault extending through Hickman Knolls with any significant offset, I think, is ambivalent; could support it or could provide some

evidence against, perhaps. The majority of deformation --

Q. Where are you reading from?

A. They have four points that they make in 4.3.

Q. Top of the page?

A. And moving into the top of page 34.

Q. Okay.

A. The majorityh of deformation consistent with transitory brechiation and an early post-depositional environment, again I think is ambivalent because we know that there's been multiple phases of deformation in this part of the state and this could be related simply to preservation of one of those earlier phases of deformation. And then the low strain brittle deformation in the north, south, east, west vertical fractures, I don't think are indicative of either one of the hypotheses. So based on the evidence described there, there's nothing that would, I think, work against it being rooted.

The one piece of evidence presented that would be particularly supportive of it being rooted as a horst block would be the interpretation of a major west dipping normal fault west of Hickman Knolls.

Q. And was there such a fault, do you know?

A. There is one identified by Geomatrix. I

believe that is the west fault, if I recall. Yes. Plate 1 from the Geomatrix report demonstrates a fault west of Hickman Knolls that they call the west fault, with displacement to the west.

Q. In terms of Plate 1, anything else you are going to be testifying to with respect to Plate 1?

A. I expect to testify on that, yes. I'm sorry, maybe I didn't understand the question.

Q. Is there anything else you expect to be testifying about?

A. Yes. I'm sorry. We got away from that and went off in different directions. Well, I think I mentioned faulting overall. So do you want me to go into more details about what aspects of faulting?

Q. You would be talking about the faults underneath the site in particular?

A. I think all of the faulting shown on this plate and to some extent the faulting under the site.

Q. Okay.

A. I think the faulting and gravity are the dominant features on here that I would be testifying to.

Q. Okay. With respect to Hickman Knolls, do you plan to do any further investigation of any sort?

A. I don't think that I have any additional data that I could use to do additional investigation. I

haven't thought about it. I only read Mr. Stamatakos's report in the last week and I found it interesting and fascinating. So I haven't thought in great detail about what I might do to follow up on that.

Q. Have you reviewed the borehole data and trenching data interpretation in the Geomatrix report?

A. I have looked at the trenching data on trench one to some extent, trench two to a lesser extent, and the borehole data to an even lesser extent.

Q. Did you find anything in particular that you disagreed with in those things or not?

A. As I recall, there was a statement about the faulting in trench one, T1, that suggested that it was all of Tertiary age, that there was nothing that extended into the Quaternary. But in looking at the cross section, there seemed to be a number of fractures and/or faults that extended in some areas into the Quaternary sediments. So I'm not sure if I misunderstood qualifications in the report or it's a difference of opinion.

Q. Anything else that particularly stood out to you?

A. When you say borings, would you include the CPT data?

Q. No. Not the CPT because they weren't

MR. GAUKLER: They are either in this version or chapter, or there may be some in Exhibit 17 that aren't in there.

MS. NAKAHARA: What I'm implying is are figures 20 through --

MR. GAUKLER: Yes. That's Bay Geophysics that you are talking about on those.

MS. NAKAHARA: Okay.

Q. (By Mr. Gaukler) Have you reviewed the NRC safety evaluation report?

A. I'm not sure. I'd have to see it to know.

Q. Would you take a look at Exhibit number 6.

A. Yes, this does look familiar. I have reviewed this.

Q. Section 2.6.1 discusses basic -- section 2.1.6.1 discusses basic geologic and seismic information.

A. I have that on page 2-27.

Q. And that section continues for quite a few pages. You reviewed that section in particular; do you recall?

A. I remember reviewing this to varying degrees within it.

Q. Okay.

A. Certain areas caught my interest and I went

back and read those in more detail.

Q. The conclusion of that section, I will just ask, SER is on 2-33.

A. That being the Staff Review heading?

Q. Yes. And it states there, "The staff reviewed the information in 2.6.1 of the SAR," referring to the Private Fuel Storage Safety Analysis Report, "and found it acceptable because the basic geologic and seismic characteristics of the site and vicinity have been adequately described in detail to allow an investigation of seismic characterization of the Facility. The staff has determined that this information is acceptable for use in other sections of the Safety Analysis Report to develop the design bases of the Facility, perform additional safety analysis, and demonstrate compliance with regulatory requirements." Based on your review of the safety evaluation report, do you agree with the staff's conclusion there?

A. I guess I'm confused in that the staff reviewed the information in section 2.6.1 of the SAR. And that is not pages starting on 2-27.

Q. That -- 2.6.1 of the SAR is the applicant's filing and safety analysis report. And the pages I showed you is the staff's review of that section.

A. I'm sorry. I see. Yes. Now I understand.

I have some disagreements with the comments made in section 2.1.6.1.

Q. And what are those disagreements?

A. The second full paragraph on page 2-31 indicates that the horst and graben model is conservative for predicting an earthquake. It appears that they make that interpretation by arguing that the planar fault would extend to a greater depth in the valley than a commonly called spoon-shaped fault would. And a planar fault could reach seismogenic depth and could be the source of an earthquake.

My concern is that by using planar faults, which earlier in this same section are described as inappropriate and not realistic, that we have created or this analysis uses an inappropriate and incorrect interpretation of the faulting. And so the intent to use a planar fault may geometrically constrain the rest of the interpretation to eliminate the possibility of other faults in other locations and other orientations. In other words, they have created a knowingly incorrect fault orientation for arguably a noble purpose, to be conservative. But in doing that, they deform the cross section out of reality into something that is likely incorrect and may eliminate a fault or more faults that might be geometrically constrained to accommodate the

data if a realistic fault orientation was used.

Q. Go ahead.

A. On page 2-32, Secondary Faults.

Q. At the bottom of the page?

A. The bottom paragraph on the page. It determines that the faults identified as fault zones A to F - and I presume these are from the lettered faults on the Bay Geophysical seismic lines - are secondary splays and are considered too small to be independent seismic sources. I would argue we don't have sufficient information to make that conclusion. The length of those faults is purely controlled by the displacement between the seismic lines on which they were reported. We don't know if they extend beyond the distances as indicated on Plate 1 in the Geomatrix report because there's no additional data to the north or south to determine if those faults can be traced further. So I would be concerned that those faults could extend a greater distance, have a greater capability of being an independent seismic source.

Q. Do you consider yourself to be an expert on faults that are seismogenic?

A. I consider myself to be an expert in structural geology with an emphasis on mapping and characterizing faults, whether they are ancient faults

that are inactive or whether they are active faults. An active fault may have the capability of being a seismogenic source.

Q. So I guess I don't understand your answer. Do you consider yourself to be an expert in determining whether faults are seismogenic?

A. I would consider myself an expert in being able to determine the extent, depth, orientation, and shape of a fault which has implications for its capability as a seismogenic source.

Q. Is Dr. Arabasz's area of expertise seismogenic faults, as you understand it?

A. I believe he has expertise in that area.

Q. Would you defer to him in that area, whether a fault was seismogenic or not?

A. I would defer to him on the depth of faulting as an indication of seismogenic source. I believe I would have greater expertise in the characterization of the shape and orientation of a fault. So there are two aspects of defining a seismogenic fault.

Q. And one aspect is depth?

A. Yes.

Q. Okay. Go ahead.

A. There's a comment on page 2-31. The second

full paragraph down. I'm sorry. I may have identified the wrong paragraph. I've lost it. It is the last sentence in the paragraph there. It states, "This is acceptable because the faults act independently." I don't recall where the discussion was among the various reports I have read that argued that the east and west faults were independent. And I believe that is what they are referring to. So I'm not fully convinced or I didn't fully understand the argument to say that those are independent.

Q. Referring to the east and the west?

A. The east and west faults. I think in general those are the areas where I have concerns.

Q. Okay. On page 2-44, 2-45, it refers to Surface Faulting. Again it is Exhibit 6. Have you reviewed this section of the Safety Analysis Report?

MS. NAKAHARA: Safety Evaluation Report.

Q. Excuse me. Thank you. Safety Evaluation Report.

A. I believe I have. But I think I would need a moment to refresh my memory.

Q. Okay.

A. Yes, I recall it now.

Q. Do you agree or disagree with the discussion

of this section of the Safety Evaluation Report?

A. I disagree with significant discussion and conclusions made in this section.

Q. And the basis of your disagreement?

A. The faulting recurrence rates that were determined from boreholes for one fault or fault system. The F fault with its splays appears to have been used to indicate the recurrence for all faults under the site and that all faults will behave in the same manner, so their determination that multiple events occurred on that fault. And I'd like to note that when they call it the F fault, they refer to four strands, two strands, F1 and F4. They identify two events and suggest that that indicates repeated movement on one fault. But we have two faults or two splays that they have identified. So it is not clear whether the two episodes of deformation were on one fault or on two faults. I think that's a minor point.

The larger point is that they use that to infer that every other fault shows repeated episodes of offset on that fault. I think that is unwarranted and is not consistent with information we see on other normal faults in Utah and on other faults we see elsewhere around the world. That it is not uncommon, in fact, it is quite common to have each rupturing

earthquake occur on a new strand, a new splay, or a new fault within a fault system. So that the offset attributed to a single fault or fault splay or fault strand is the result of a single earthquake, a single displacement event. And there are examples of that on the Wasatch fault here in Salt Lake valley as well as other places. The San Andreas fault in some areas in California show that each time there's a large surface rupturing earthquake, it has created a new strand or new splay within a relatively small distance, but a new splay. So the offset on each splay is indicative of a single event.

Q. That's strike slip fault?

A. That's correct.

Q. And we have a different type of fault here in Skull Valley.

A. Right. That's why I referred to the Wasatch fault, which is a normal fault comparable to the normal faults we see in Skull Valley. So I think it is inappropriate to uniformly apply the results of a single fault, which is represented in a slightly ambiguous manner, to all the other faults and then imply that every displacement has to be the result of cumulative displacement due to many events.

Q. Have you reviewed the Geomatrix analysis in

that respect in that Geomatrix report?

A. I believe I did, but I don't recall it.

Q. Do you recall taking issue with any part of the Geomatrix analysis and their report on whether or not the events on these faults -- whether or not the displacement and offsets that they identified were the result of multiple or a single event?

A. Yes. I'm very concerned that the interpretation by Geomatrix that it's multiple events on faults is not documented and, I would argue, based on comparison to other known well-documented faults would not necessarily be expected.

Q. My question, though, is have you reviewed the Geomatrix evaluation why they concluded in this instance that most likely they were due to multiple events as opposed to single events? And is there anything you take specific issue with in terms of the Geomatrix evaluation?

A. I don't remember specifically in the Geomatrix report where they did that, where they made that analysis. But I take exception with the conclusions. But I don't recall specifically what the data were and how they came up with that analysis.

Q. Okay.

A. I could go back through the report and try

to find that.

Q. Go ahead with the Safety Evaluation Report there, please.

A. On page 2-45, second paragraph, the first full paragraph, it states that Geomatrix considered other possible distributed faulting between the mapped faults and found small displacements. My interpretation is that this is irrelevant and --

Q. What sentence are you referring to in particular?

A. Let's see. The entire paragraph.

Q. That begins on page 2-45?

A. Yes. The first full paragraph. The second paragraph on the page.

Q. Okay.

A. That identifying an area between two faults and saying there's very limited cumulative displacement across it indicates that the surface faulting is not a concern. To me the surface faulting is -- at the faulting is where the faults occur, and to say that we don't find displacement on horizons between faults, I guess I don't understand the significance of it. But it seems to be used here to suggest that since we can't find significant displacement on unfaulted horizons, that the hazard is less.

Q. I guess I don't understand that, the way you phrased it.

A. I may not have phrased that the best.

MS. NAKAHARA: Let's have the answer reread please.

THE WITNESS: I don't think I need it.

MS. NAKAHARA: Okay.

A. In this review that is used as evidence to support the third bullet listed in the lower part of 2-45, that surface faulting near or at the site will be too small to affect site safety. Again, as I remember from the Geomatrix report, this discussion was used to argue that since there is no displacement on these sediments between faults, that therefore there's less of a surface faulting hazard. And I believe that is circular logic and does not contribute anything to making that conclusion.

Q. Let me understand what you are saying because I don't understand what you are saying and I'd like to understand. You take issue with Geomatrix's conclusion because there's no surface displacement between these secondary faults they have identified on the fault, like the E fault or F fault. But you take issue with their conclusion --

A. I'm not taking issue with their observation

that there's no displacement. I take exception with the interpretation that that means or that supports the idea that surface faulting will be too small to affect the site safety. I think that is neutral or irrelevant to making that conclusion.

Q. With respect to the faults identified or with respect to --

A. My understanding of reading this is that they have identified a section of rock that is not faulted and as they have analyzed it they found two inches of displacement across this unfaulted terrain. And therefore, this will not contribute to surface faulting hazard. That seems to me a no-brainer. It is like yes, it is correct. But then to use that to support a conclusion that surface faulting will be too small to affect a site, I think that is unwarranted.

Q. Well, are you saying that the surface faulting in this area where they identified no faults is a hazard?

A. No. I'm saying it has no bearing on the conclusion.

Q. Are there other parts of this section that bear on that conclusion?

A. Yes. I believe the section I talked about previously which was that their conclusion that there

are multiple events on faults reduces, in their mind, the amount of offset that occurs with -- I'm sorry. The amount of offset that would occur with any given earthquake on a fault and therefore that reduces the surface faulting hazard, I disagree with the conclusion there and I think that is significant and that is relative. That is important to their conclusion that surface faulting is a smaller hazard because any fault displacement that is recognized by Geomatrix is automatically reduced by the number of events that they hypothesize may have occurred on that fault.

Q. So going back to the paragraph on 2-45 that we were just talking about, the paragraph at the top.

A. Yes.

Q. What you are saying is to the extent that that paragraph is read to support the conclusion on bullet number 3, you disagree with that because there's no logical connection?

A. Yes. I would agree with your interpretation.

Q. But wholly apart from this, you don't disagree with the paragraph by itself?

A. No. I believe their observations. I trust their observations and say those appear to be correct and reasonable.

Q. Okay. I want to make sure we understand or I understand what you are saying.

A. I think those, if this ends on 2-45, yes, I think those are the significant comments I have on that section.

Q. Going on to -- I'd like to go now to Exhibit 10. Do you want to take a break or what is your feeling?

A. I'm okay for the time being.

Q. Would you look at Exhibit 10. That is the state of Utah's Objections and Responses to Applicant's Second Set of Discovery Requests with Respect to Groups II and III Contentions. And if you will look at the declarations at the back of the affidavit. There's -- at the back of this document. There's a declaration from you about the fourth page in from the back.

A. I have found it.

Q. And according to the declaration, you were responsible for swearing to the truth of the State's Responses to Admission Request Numbers 1-4 and Interrogatory Responses Number 1, and 2, and part of 5. Do you see that?

A. That is correct.

Q. Would you review those and confirm that's correct in your mind?

A. So I recall you asked --

MS. NAKAHARA: Just for clarification, the larger map means the smaller scale, correct?

THE WITNESS: Yes.

MS. NAKAHARA: I want to remember this when I get the transcript.

MR. GAUKLER: Good thinking, Connie.

THE WITNESS: The main map.

The correlations of the faults such as F1 on line D to F1 on line A to F1 on the commercial line that was reprocessed, purchased by Geomatrix and reprocessed by Sterling, appear to have been drawn with rulers. It's unclear -- oh, let's see.

MR. TURK: Can we go off the record for a minute?

(Discussion off the record.)

Q. Back on the record again.

A. Let me take a moment to look at the seismic reflection lines. Does someone have a copy of line D that I could look at? Bay Geophysical line D?

MR. CLARK: Here you go.

A. Thank you. I don't seem to have that.

Q. It is probably hidden somewhere.

A. Okay. Thank you. I don't believe that the faults identified, most of the faults identified on the

Bay Geophysical lines have sufficient unique characteristics to correlate them between the seismic lines; that the correlations are based more on a paralegal orientation with the east fault or the Stansbury fault and there's not strong evidence to label and correlate the faults as they are done.

Q. Do you know of any contrary evidence?

A. If I recall, in my response here I did identify some of the correlations. It's been a while since I have looked at these, so referring back to page 20 and 21, fault D1 on line A as I wrote, offsets the Q/T, Qp, and younger reflectors but D1 on line B is shown as terminating below reflector Q/T. So there's a difference of the age, the latest age of displacement on D1 as shown on one line, on line A, and then as shown on line B. Conversely, fault E1 offsets reflector Q/T on line B but terminates it below that reflector on line A. A more reasonable explanation might be that fault D1 on line A is better correlated with fault Eon line B of a similar age of apparent offset and displacement. It is not uncommon to have faults at modest to high angles to the dominant structural trend of a basin or any area --

Q. When you say modest to high angle to the dominant trend, what do you mean?

A. -- in plan orientation. So the faults shown

in the or on the Bay Geophysical lines and identified as secondary faults tend to be parallel to subparallel to the east fault. My speculation is that the correlation of those was strongly influenced by an attempt to mimic the structural orientation and that there are some evidences that an orientation that might be at a different angle to that might be more appropriate based on apparent ages of offset.

Q. Assuming that you were correct, that they should be oriented different as you suggested might be a possibility in your answer, what consequence would that have in terms of hazard with respect to surface displacement or rupture?

A. If you don't understand the orientation and location of the faults under the site, it is going to be much more difficult to conclude that they are not a hazard. We really don't know the length of these faults because, as I mentioned, we don't have sufficient data north and south to see if they extend in those directions or how far they extend in those directions.

If the orientation of the faults is dramatically different, perhaps more in an east/west direction, then the three east/west lines shown by Bay Geophysical might miss significant east/west trend in faults because there's no more south seismic reflection

line to tie or connect and cross those faults. So if the faults are at a significant angle or oriented significantly different than shown so that they are parallel to subparallel to the reflection lines, there could be significant faults that we have missed in the surveying.

Q. In terms of displacement, of offset, does it mean anything different in terms of the offset or the faults identified in terms of surface rupture?

A. It could. What I find helpful in evaluating faults when you are tracing them from one line to another, and this is a problem I dealt with in mapping oil and gas structures, we were always looking for faults that might serve as closure on an oil and gas prospect, is that we would contour the structural data so we would contour a mapped horizon such as the Qp or the Q/T horizon; and in mapping that, you might find systematic variations or irregularities in the contours that can be best explained by a fault.

It is also useful to map the offset on a fault wherever you have data because then you can recognize more easily trends or anomalies in the offsets which would suggest the possibility of a miscorrelation, misidentification, not only of a fault but maybe of the displacement across that fault. So to me, structural

contouring of the mapped horizons and of offsets along the fault are a very useful tool to evaluate the data and give you greater confidence that the fault correlations you are making fit the data.

Q. Do you disagree with Mr. Clark's statement that jump correlation is a practice in --

A. I do not disagree with that.

Q. Number three, you talk about inappropriate processing of seismic reflection data. I believe you raise two points there. Use of trim statics and smoothing.

A. Yes.

Q. We have already talked about trim statics I think in response to the earlier or earlier today.

A. Yes.

Q. But we have not talked about smoothing today.

A. I thought we had covered that.

Q. You and I have not talked about it.

A. Okay. Perhaps I did yesterday and earlier this morning.

Q. Okay. You heard Mr. Clark's explanation of the smoothing. In fact, his statement that he, in fact, evaluated the seismic reflection lines without smoothing. Do you believe there's an issue with respect

of the blue reflector - I'll see if I can characterize this correctly - on either side of that jump are correctly located except for a short segment of shot points at about 1130 to 1160 or 1150 to 1160 and that that would be, the blue horizon would be dropped down on the left, I'm sorry, would be dropped down to the right of the shift to connect. So basically remove the vertical shift, the vertical blue line, and restore that line. Would that be a correct description?

Q. Basically, yes.

A. And I would accept that as a reasonable, not necessarily the correct, but a reasonable interpretation of that data.

Q. The bottom of page 23 to the top of page 24 talks about fault displacements, and I believe that we have already discussed that issue in other parts today of your deposition as far as what you took issue with.

A. I believe we have covered most of that.

Q. On page 26, you refer to obscuration of faults by surficial deposits and erosion.

A. Yes, I see that.

Q. That's where we are talking about line 98-B where part did not have useful data on it.?

A. That's correct.

Q. And you speculate there about some potential

consequences, maybe potential faults because you didn't have the seismic reflection data there?

A. Yes.

Q. Have you reviewed the Geomatrix evaluation, generally, of potential faults in this area?

A. Yes, I have.

Q. And does that satisfy you in terms of lack of faults in that area?

A. No, it doesn't.

Q. Okay.

Q. Page 26 to 27. You talk about lack of resolution of features in the seismic reflection data; correct?

A. Yes.

Q. There you hypothesize, you say or refer to the fact that Bay Geophysics used a velocity of, let's see, 1100 feet per second in table one as one of the interval velocities you used to calculate fault displacements.

A. Yes.

Q. And you speculate that if it was as high as 1500 feet per second, then the smallest resolvable fault would be greater?

A. That is correct.

Q. Are you aware, based on the borehole data

that identified by Geomatrix that the D1 fault that they confirmed, that Mr. Clark identified in his seismic reflection data and was confirmed by borehole data was less than 3 feet?

A. I don't recall that specifically but I won't challenge that.

Q. Does that answer your concern in terms of resolution that you would only be able to find faults of three feet or more, assuming that to be correct?

MS. NAKAHARA: Is that on D1 or --

Q. D1. I'm referring specifically to D1 fault I believe it was.

A. Can you refresh my memory as to where the borings, along which line these borings were taken?

Q. Seismic line A.

A. I don't believe I have that plate. Am I correct in understanding that the orange horizon is the Qp? Yes, there it is. It is not clear to me that the Qp horizon is offset on line A, that the reflector is offset. There is a slight inclination to it and there is, it looks like, a slight dropout in data to the east of the fault or a lower amplitude. But it appears to be continuous with no termination. So I cannot agree that fault D1 is evident on the seismic reflection data at horizon Qp.

For instance, to elaborate on that, I can see moving along horizon Qp if I look at the black reflector that forms immediately under the yellow horizon. As I move to the right or to the east, I see numerous small areas of apparent greater dip or angularity than the dip that is indicated to be an offset. So if that is a fault, then it would suggest that there may be dozens of other faults with perhaps larger offsets along much of the length of this line.

Q. So it means, at least in this instance, Mr. Clark interpreted something more aggressively than you would have interpreted something?

A. I'm not sure what you mean by "more aggressively". If you mean that the conclusion that a smaller offset is visible on the seismic data, that is more aggressive than I'd be willing to admit. Without the D1 fault drawn on there, I am unlikely to have identified a fault through the Qp horizon at that location using the process data that we were provided.

Q. But doesn't the borehole that was dug there confirm the existence of a fault?

A. The boreholes appear to confirm the existence of a fault.

Q. As interpreted by Mr. Clark?

A. Perhaps on data that we have never seen.

Q. But it confirms the data as interpreted by Mr. Clark?

A. It supports the data. I'm sorry. It supports the interpretation of Mr. Clark.

Q. Okay.

MS. NAKAHARA: For fault D1.

A. For the location of fault D1 at the Qp horizon.

Q. Thanks. We have been going for two hours since our last break.

(Discussion off the record.)

Q. I'd like to have you look at Exhibit 13, Dr. Allison. One other thing. With respect to deposition Exhibit 10, the document we were just looking at, there were a large number of other responses there and you were not identified as being responsible for any of the other responses to other parts of Interrogatories or Discovery requests. Could you just take a look at that over the night or at some point in time to confirm you didn't have input on anything else other than those for which you were identified in the declaration?

A. I can do that, although by the time I get to bed and get up tomorrow morning I may not have a lot of time. I can say that in previously reviewing these documents, I don't recall seeing any place where it was

PROCEEDINGS

LEE ALLISON,

having previously been duly sworn to tell the truth, was examined and testified as follows:

EXAMINATION (Continued)

BY MR. GAUKLER:

Q. Good morning, Dr. Allison.

A. Good morning.

Q. May I remind you that you're under oath.

A. I'm aware of that.

Q. Could you look at Exhibits 20 and 21.

A. Okay, I have them.

Q. And also I want you to look at Plate 1, Exhibit 17. You mentioned that one of the areas that you would testify about would be Exhibits 20 and 21.

A. That's correct.

Q. Do you have any idea in terms of what your testimony would be with respect to these exhibits, what points will you be trying to make with respect to them?

A. I haven't done a complete analysis of these cross-sections, but on a preliminary review I was concerned that the faults that are identified on both the cross-sections are planar rather than lystric or curvilinear.

Q. Say that again, please.

A. Planar, p-l-a-n-a-r, rather than lystric or curvilinear as was suggested as appropriate for faults in this part of the country.

Q. What are planar faults?

A. Planar means forming a plane. It's a relatively flat surface.

Q. What do you mean by forming a relatively flat surface? You mean the angle at which goes down?

A. The faults -- this is a cross-section. These are cross-sections. The faults that are shown on here are lines intersecting this cross-section. Because they're straight, they imply that the fault has a planar character -- not characterization, but planar -- is a planar feature. Looks like a plane --

Q. Looks like a plane, a piece of paper?

A. -- as opposed to a curved surface. And my understanding is that that was done in order to try to project these faults in greater depth rather than to meet geometric requirements of balancing the cross-section.

I was concerned that in at least a couple of places I saw an interpretation of a fault block, meaning the layers of rocks between two faults, in an orientation that seemed internally inconsistent.

Q. What are you referring to specifically?

A. Well, I'm -- if we look on Exhibit 20, cross-section 8-85. Let me make sure this is the one that I was looking at recently. Yes. If we look at Exhibit 20, there is a roughly triangular-shaped area shown on the cross-section below the area identified as Cedar Mountains on the left and Skull Valley on the right. If we look directly below the space between those two headings, there is a block of rock bounded by two faults. The fault on the left is dipping to the east or to the right; the fault on the east is identified as the West Fault, which shows dip in displacement to the west, or down to the west.

The offset on the horizons across the western-most fault can be delineated by looking at the layer identified as "Dsd." We can find out on either side of that fault, and it would be -- the displacement indicates a thrust fault or movement upward along that fault to the west.

But notice also that the dip of the beds on either side of that fault are essentially parallel. Now, if we look to the left side of that triangular fault block, we can see two slightly wiggly lines truncating against the West Fault, and they are shown to be offset across the West Fault in a normal fault or dip slip pattern. But as you continue them across the

fault, you'll see that they are parallel -- they continue in parallel orientation.

Q. Talking about --

A. Across the West Fault.

Q. Up to the East Fault?

A. Yes. To the -- wait. Is that to -- that's to the East Fault, yes. So in the block between the West Fault and the East Fault, the horizons are shown to be parallel to the horizons across the fault.

If you look at that fault block as an entity, we show essentially clockwise rotation in the cross-section with movement up along the western fault and down along the West Fault. If that was the case, we should expect to see those horizons rotated out of parallelism from the units on either side of those faults.

So I would suggest that the -- one of the causes that may have contributed a geometric implausibility, if not an impossibility, is using planar faults as opposed to a more realistic lystric or curved faults might account for some of that.

The orientation of the beds may be misinterpreted or misspeculated. And because we used planar, or planar beds were used rather than the lystric beds, it -- we can't really reconstruct this

cross-section to show what the orientation of beds would look like prior to their displacement accurately.

So this is not a truly balanced cross-section. It doesn't meet the requirements for a balanced cross-section as generally accepted by such experts as Woodward and Boyer. And I believe their reference -- their manual on balancing cross-sections was referenced in the Geomatrix report.

Q. Now, these features you've been talking about, they're way down in the bedrock, right?

A. Yes, they are.

Q. About three kilometers down, roughly; is that correct?

A. In a general sense, about three kilometers below the surface.

Q. Also, you referred to the line Dsd. That doesn't even make it to the East Fault, correct? Or West Fault.

A. That's correct, it does not. On this cross-section it does not. I simply noted the Dsd horizon. It's not a line, but the Dsd refers to a geologic unit between those two lines. And I refer to that to demonstrate the direction and relative amount of offset on that western fault.

I'd also like to note: I believe there's a

Oklahoma, that was what was considered a virgin basin. There had been very little exploration, very little understanding of the oil and gas potential, and so we looked at the entire stratigraphic column of rocks. There were oil seeps in some areas, and so we looked basically from the surface down to I would say 20,000 feet in depth. In Texas, perhaps a few thousand feet down to 10,000 feet.

In Wyoming, again I did some field work in the Wind River Basin looking at outcrops of the muddy sandstone with oil leaking to the surface. And then we were mapping that in the subsurface with seismic data and with other geologic information. So again, from the surface down to about 6,000 feet, as I recall, in that part of Wyoming.

Q. That shows quite a variety of depths.

A. Yes.

Q. You had expressed a concern yesterday that there may be, as you put it, many more faults in Skull Valley than Mr. Clark had found. Is it correct that you're not aware as you sit here of any faults other than those which have been described in the Geomatrix report, ones that you feel certain exist?

A. There are other faults that I would interpret or identify on the Bay Geophysical or Bay

reflection lines. There are faults that I saw and were identified by Geosphere on their seismic reflection lines that I don't believe were adequately displayed or displayed at all in the Geomatrix report.

So there is evidence on the Bay Geophysical lines that appear to me as good as the criteria that Mr. Clark used in selecting his faults. So I would -- I believe there's a potential for dozens of additional faults to be interpreted using the same criteria that Mr. Clark used in identifying his faults on those lines.

Q. Why was a cone penetrometer test utilized?

A. I'd never seen one in operation. I've heard them described. My understanding that it's a tool that's basically pushed or pounded into the ground, and the amount of resistance to penetration is recorded and is used as an indicator of rock strength or compressibility or penetration, and it's used to correlate subsurface units based on the number of blows or the amount of force that's used to force the tool into the ground.

Q. How deep into the ground is it drilled ?

A. Well, it's not drilled, it's pounded or pushed. My understanding is that they're generally used in the upper 20 to 40 feet and that it's difficult to pound them much deeper than that.

FURTHER EXAMINATION

BY MR. TURK:

Q. Dr. Allison, Mr. Gaukler was asking about this set of interrogatories that are in Exhibit No. 10. And one of the interrogatory answers there is Interrogatory answer No. 8, beginning at page 51. Did you have a role in responding to that? I don't see it on the list of information.

A. No. From the title I would say no, it doesn't look familiar.

Q. And it's not listed in your declaration?

A. No, I did not have any involvement in that one.

Q. Have you ever provided a document or have you ever prepared a document in which you provide an estimate of the amount of displacement, either horizontal or vertical, in Skull Valley?

A. No, I have not.

Q. You indicated that you strongly disagreed with the staff's SER, page 245, which indicates that vertical displacement of less than one meter is suggested to have accumulated across the entire width of the site approximately 5,000 feet during the last several million years. Why do you say you strongly disagree with that?

A. I've seen sufficient number of faults with sufficient offset on the Bay Geophysical seismic lines to indicate to me that it will be more than one meter, although I have not calculated that or measured it. But I am confident that I could identify more than enough faults to show more than one meter across that.

Q. Which you have not provided an estimate of that until now?

A. I have not.

Q. I don't have anything else on that line.

During our luncheon break I happened to look out the window and I saw what I observed to be the Salt Palace and its extension. Did you look out that window with me and see that the Salt Palace extension has in fact been built now?

A. I did look out the window and I did see the extension of the Salt Palace appearing to be complete in its construction.

Q. Roger Bond?

A. Bon, B-o-n.

Q. B-o-n. What was his title at the time that he was involved in discussing the Skull Valley Goshute economic development?

A. He was a geologist in the Utah Geological Survey. An informal title was our minerals geologist,

COPY OF TRANSCRIPT

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

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

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

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

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

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

understanding is that the text of what's known as subsection or Basis 3 of Contention L was originated from Mr. White -- or Dr. White and Mr. Solomon?

A. (Dr. Bartlett) Yes.

Q. Do you -- and I take it Mr. White is no longer -- Dr. White is no longer among the experts in the group that you work with?

A. (Dr. Bartlett) That's correct.

Q. Do you have any knowledge of the circumstances that led to your replacing Mr. White?

A. (Dr. Bartlett) I had just been told the state no longer decided to retain him as a consultant. Other than that, I don't know.

Q. All right. Now, in getting prepared or in discharging your functions that you described a moment ago with respect to Contention L, what documents have you reviewed of those prepared by the applicant in connection with the issues that are part of Contention L?

A. (Dr. Bartlett) The Safety Analysis Report has been the basis of my review, the supporting calculations that are in the SAR that's a part, mainly 2.6. I don't believe I've gone beyond the SAR in supporting calculations, and attachments and appendices.

Q. From time to time we might refer to a

Did I answer all of your question?

Q. Yes. But now my question is, did you seek to -- in light of this new information that you have looked at, have you sought to review the text of Issue 3 as appears in Exhibit 3? And you can please do this with me now, to figure out if there is any portion of what is described between pages 83 and 92 of Exhibit 3 that is no longer applicable because it has been resolved or taken care of by subsequent reviews.

A. (Dr. Bartlett) It may be difficult for me to find exactly the pieces that have been resolved, but I can tell you at least in generalities what I think has changed since the initial submission of Contention L to where we stand at this particular point in time.

Q. Will you please do that?

A. (Dr. Bartlett) Sure. I do not believe there are any issues of liquefaction at this site. Dynamic settlement does not appear to be a major issue at this site. The calculations supporting consolidation settlement and secondary consolidation settlement.

Q. Anything else?

A. (Dr. Bartlett) Not that jumps out at me at the moment.

Q. Rather than forcing you to rely on your memory, could I ask you to take a minute to review,

actually go over and these ten pages. We may take a couple minutes break for to you do that, so if anything else comes to mind that you believe has been resolved, you can tell us.

A. (Dr. Bartlett) Sure.

(Recess from 10:30 to 10:36 a.m.)

Q. (By Mr. Travieso-Diaz) Do you need the question read back to you?

A. (Dr. Bartlett) Yes, please.

(The record was read: "A. It may be difficult for me to find exactly the pieces that have been resolved, but I can tell you at least in generalities what I think has changed since the initial submission of Contention L to where we stand at this particular point in time.

Q. Will you please do that?

A. (Dr. Bartlett) Sure. I do not believe there are any issues of liquefaction at this site. Dynamic settlement does not appear to be a major issue at this site. The calculations supporting consolidation settlement and secondary consolidation settlement.

Q. Anything else?

A. (Dr. Bartlett) Not that jumps out at me at the moment.")

Q. And then I asked, will you review the text of Basis 3 of Contention L that goes from page 83 to 92

of Exhibit 3 and tell me if any of the matters raised on those pages has been resolved, to your understanding.

A. (Dr. Bartlett) I want to refer to page 84. I do not wish to make a lot of comments on the geology and structural geology and engineering geology of this site because it's not my area of expertise, but there has been further work done in that, and so I'll defer you maybe to other experts about those particulars that are mentioned there -- structural geology, geological history, and engineering geology.

One thing on page 84, the estimation of thicknesses of the layers, and that I think has been resolved from an engineering standpoint by the cone penetrometer.

Q. Can you tell us where on page 84 you're referring to?

A. (Dr. Bartlett) Oh, it's the second line. It talks about uncertainties in estimation of the thicknesses of various materials.

Q. That's the second line from the top of the page; is that correct?

A. (Dr. Bartlett) Yes. I think the cone penetrometer gives us reasonable estimates of thicknesses and, from an engineering standpoint, the stratigraphy of the site.

Q. Sorry. So I understand your last comment: do you believe that from the engineering standpoint the stratigraphy of the site has been also defined?

A. (Dr. Bartlett) In the upper 30 to 35 feet where the cone penetrometer's been pushed, the stratigraphy and thicknesses of those units.

Q. Sorry. Are you finished with the answer?

A. (Dr. Bartlett) Are reasonably described as far as thickness.

The rest of 84 still talks more about geology, geochemical analyses. I will defer on speaking on those. So that would finish that page.

Under "sampling and analysis" on page 86, there's some discussions about not taking particular soil samples in -- I'm reading in the middle of the page where it starts "for example."

Q. The second sentence in the second paragraph of the page?

A. (Dr. Bartlett) The second sentence, yes.

Q. All right.

A. (Dr. Bartlett) Well, it's actually the third where it starts, "For example, the soil test data" --

Q. Okay.

A. (Dr. Bartlett) -- "did not include samples

taken from each of the soil strata, did not include each foundation of buildings or structures, and did not include the PMF diversion dike foundation, and did not evaluate compacted soils." There's been additional borings done that cover some of those areas.

Q. So do you consider that the concern expressed in that sentence is not applicable?

A. (Dr. Bartlett) Pertaining to not placing borings under certain areas, yes, or in certain areas.

On to page 87. Second sentence beginning with "The Applicant must obtain representative undisturbed samples of each of the site soils and determine their dynamic properties." We have seen additional testing done to determine the dynamic properties of certain soil layers. We're still not sure whether all layers have been sampled and tested. But there has been additional testing to determine dynamic properties.

Q. So the statement made in that sentence, "The Applicant must obtain representative undisturbed samples of each of the site soils and determine their dynamic properties," is that statement still applicable or not applicable?

A. (Dr. Bartlett) It's applicable to the extent that they have determined additional dynamic

properties. Whether they have sampled all undisturbed samples from all layers, we would not agree with. Definition of layering may differ between your layering system and our layering system.

Q. All right, please go.

A. (Dr. Bartlett) Okay. On page 88 it's talking about, in the first full sentence on that page, "For example, throughout calculation number 04-3, the criteria for assignment of unit weight," and then it has, "typically used in all soil analysis (strength, consolidation, and dynamic response) are assumed." There's been enough characterization to define the unit weights, I think, of this profile.

Q. So again, is it your understanding that this sentence is no longer --

A. (Dr. Bartlett) Only dealing with unit weights.

Q. Only to the extent of units weights?

A. (Dr. Bartlett) Yeah, this is referring to -- just one moment. Let me read it. This is only referring to unit weight. Yes, the unit weights are needed for other analyses, but relating to unit weight, we think that has been resolved.

Q. And as you understand the sentence, it does refer to unit weights; is that correct?

A. (Dr. Bartlett) Yes. It's talking about the criteria for assessment of unit weights, then it says typically used for soil analysis -- or all soil analysis, and those would be strength, consolidation, and dynamic response, are assumed. And I believe the current calculations are not using assumed values.

Q. Okay.

A. (Dr. Bartlett) And any other discussion in this paragraph about unit weights. I don't believe unit weights are a significant issue.

Q. So for example, the next sentence in that page that starts -- well, the next -- the sentence after next on that page that starts with "The justification of the values should be provided," is it your understanding that that refers to unit weights?

A. (Dr. Bartlett) Correct.

Q. And to that extent, that sentence has also been resolved?

A. (Dr. Bartlett) Pertaining to unit weights.

Q. Now, the next sentence, does it also pertain to unit weights, or is it a different thought? The one that starts with "calculation number 04-3."

A. (Dr. Bartlett) Yes, I see it. Just a moment. I think the remainder of this paragraph is trying to point out some discrepancies in unit weights

between calculations, and I don't believe those would be major issues anymore.

Q. So would you say, then, the rest of this paragraph starting with calculation 04-3 is also resolved?

A. (Dr. Bartlett) Regarding unit weights, yes.

Q. Do you think it refers to anything else? I'm just trying to understand what --

A. (Dr. Bartlett) I don't believe so.

Q. Okay. All right, please go on.

A. (Dr. Bartlett) On the second -- the first full sentence on page 89 beginning with "For strengths conducted in the laboratory, full details must be given; for example, how saturation of the sample was determined and maintained during testing and how the pore pressures changed," that does not appear to be applicable, at least regarding the pore pressure changes, because we're dealing with unsaturated sediments.

Q. So I take it that your understanding is that this particular concern is no longer applicable because we don't have the type of soils to which it would apply?

A. (Dr. Bartlett) The saturation of the samples and measuring of pore pressures does not appear to be applicable in most instances for these soils.

The next sentence beginning, "For sites that

Q. Could you please go on?

A. (Dr. Bartlett) I think that's -- let's see. Got one more paragraph, don't I?

The last paragraph talks about some standard types of engineering properties tests, and it cites, for example, "unit weights, porosity, compaction, etc., which should be performed for layer 1 and 2 soils."

As I've stated earlier, I do not believe unit weights are a significant issue here. Porosity is a function of void ratio, so we're really again talking about void ratio when we say porosity. We just discussed that matter. And compaction, though I don't recall seeing standard compaction curves for this site, I would assume those would be done when one would begin to develop a design. I do not believe those type of compaction issues are a problem.

Q. Sorry, I didn't hear you.

A. (Dr. Bartlett) That any issues relating to compaction or standard compaction curves will really be an issue here.

Q. Before I ask you my next question, so the record is clear: when you said the last paragraph, you meant the last paragraph of subsection 3 --

A. (Dr. Bartlett) In that subsection, correct.

Q. -- which is on top of page 92?

A. (Dr. Bartlett) Yes, beginning with "Further, the Applicant performed only limited."

Q. Could you clarify for me what is meant in that paragraph that you just read by layer 1 and layer 2 soils?

A. (Dr. Bartlett) That I am not sure of.

Q. But you said earlier that you were not too sure of whether your definition of layers was the same as applicant's.

A. (Dr. Bartlett) That's correct.

Q. Could you elaborate on that?

A. (Dr. Bartlett) Our information and understanding of the layering of the system has changed since this document was published, and admittedly so. And as I recall in the earlier versions of the SAR we were talking about soils in the upper 30 to 35 feet and then a deeper, denser layer. And I'm assuming these mean for those -- that system. But now it seems we have progressed to the state where we've been talking about the upper layer and as many as possibly five subunits. So when it refers to layer 1 and, 2, I assume it's talking about the original layering as discussed in the SAR.

Q. But for purposes of the rest of our discussion today, when we speak of layers, do you mean

the layers that were discussed in -- strike that question. Start a new question. Were you here yesterday when Mr. Trudeau and Dr. Chang gave their testimony deposition?

A. (Dr. Bartlett) Correct.

Q. Do you recall there being a discussion in their deposition of several layers that were identified against particular figures of the SAR?

A. (Dr. Bartlett) Correct.

Q. Now, for purposes of our discussion today, when we refer to layers, are you speaking for those layers that are now currently depicted in the SAR for the top 30 feet?

A. (Dr. Bartlett) Correct. In fact, we could bring the SAR out and identify them if you'd like.

Q. We'll do that very soon, but I just wanted to make sure we're speaking of the same --

A. (Dr. Bartlett) Since this document is historical, I think it's talking about an older layering system. The layering system has evolved.

Q. Thank you. I would ask you to keep this Exhibit 3 handy, since we'll be probably talking about it a lot more.

With whom, other than your legal counsel, have you discussed issues relating to Contention L in

this proceeding?

A. (Dr. Bartlett) Of legal counsel?

Q. Apart from legal counsel.

A. (Dr. Bartlett) Oh, apart from legal counsel.

Q. Please.

A. (Dr. Bartlett) Could you restate the question?

Q. Okay. With what parties, other than the lawyers, have you discussed the subject of Contention L?

A. (Dr. Bartlett) My immediate supervisors for the Utah Department of Transportation. I've had -- I guess my supervisors now at the University of Utah have asked me questions about my involvement in Contention L. I've just told them what I'm doing, just more as in passing so they know where I'm at and what I'm about.

When you mean "besides," do you want also me to include those that are also state expert witnesses?

Q. Yes.

A. (Dr. Bartlett) Okay. That would also include, then, Dr. Lee Allison, Walter Arabasz, Jim Peschmann, Dr. Ostadan, Barry Solomon. I believe that's all.

Q. Now, what is your understanding of the respective roles of the experts that you mentioned in

this proceeding?

A. (Dr. Bartlett) We've broken it up into different disciplines and expertise for our review. And Dr. Arabasz and Dr. Peschmann have taken the lead in the Basis 1, though we have had some comments and input into Basis 1 also. When I mean "we," myself and also Dr. Ostadan.

For the geology and geotechnical issues would be Barry Solomon, Lee Allison, myself, Dr. Ostadan.

Within that trichotomy, I guess, if you will, Barry would be reviewing the geology; I would be reviewing the geotechnical engineering related to the site characterization, the foundations; Dr. Ostadan would deal with issues of dynamic loadings and dynamic analysis and response. Finished.

Q. I didn't want to cut you off. You testified earlier that you did not consult with Dr. White.

A. (Dr. Bartlett) No, I did not.

Q. To the extent that Dr. White was the person who wrote this Exhibit 3, do you believe it would be useful for you to find out what he meant, for example, here in discussion of layer 1, layer 2?

A. (Dr. Bartlett) Yes, that would have been useful.

Q. And can I ask you why you didn't speak with him?

A. (Dr. Bartlett) I was never given the opportunity as part of the team in the project.

Q. Did you seek to contact Dr. White?

A. (Dr. Bartlett) No, I did not. He was no longer retained by the state.

Q. Explain to me what you mean by you were never given the opportunity.

A. (Dr. Bartlett) Well, normally when I would consult on something of this issue in these matters, I would consult with those that would be part of the project team. He was no longer part of the team. I didn't feel it would be appropriate to seek him out once he had been removed from the team.

Q. I see. You mentioned a little while ago that your first involvement, or earlier in your involvement with this project that there was a team meeting that you attended.

A. (Dr. Bartlett) That's my first recollection of, yes, getting together with the group.

Q. What happened at that meeting?

A. (Dr. Bartlett) Well, as usual, there were some introductions. There was a fair amount of discussion about the seismic refraction, reflection

data. I remember Dr. Allison was there and discussed that to some extent. Myself being new to the team, I didn't take a large part in that, of the conversations during the meeting. Dr. Arabasz was there. I'm sure there was some discussion of the design basis ground motions, how they were being developed, derived. Denise and Connie were there. That's my recollection. It was a year and a half ago, two years ago.

Q. Have there been subsequent meetings of that time among the state experts that are working on this Contention L?

A. (Dr. Bartlett) From time to time, but usually not quite that extent. That was the first really full panel meeting that I recall.

I do recall at that time I think someone else had made the recommendations that we may consider bringing in an expert in soil dynamics at that meeting.

Q. I'm getting ahead of the story. I want to pursue that Dr. Ostadan was not part of the team then.

A. (Dr. Bartlett) You'll get him later. Fair enough. This was before Dr. Ostadan was part of the team.

Q. All right. And you said you have had less --

A. (Dr. Bartlett) Yes, not -- not I think the

encompass the full valley, so there are parts of the Bonneville clays that are in parts of the design, part of the design segment that Terracon did that may be above water table. But my experience in this valley with the Bonneville sediments were below water table.

Q. Were any samples taken at PFS below the water table?

A. (Dr. Bartlett) Oh, no. Not in the Bonneville.

Q. At PFS, I said.

A. (Dr. Bartlett) Well, I think water tables down to 120 feet. I think it was initial issue about whether borings went down to that depth. I can't recall in subsequent investigations whether we went below the water table 120 feet. But if we did, there was only a few boreholes that did.

Q. As you recall now, and we may talk more about this later, were any of the samples for which you saw test results in the SAR taken from below the water table?

A. (Dr. Bartlett) No, not to my knowledge.

MR. TRAVIESO-DIAZ: All right. Can we go off the record again?

(Discussion off the record.)

Q. (By Mr. Travieso-Diaz) Have you performed

or directed the performance of what is referred to as cone penetration tests?

A. (Dr. Bartlett) Yes, I have.

Q. And would you describe for the record what cone penetration tests are and what their purpose is?

A. (Dr. Bartlett) Cone penetration test is another type of in situ test where we push essentially a device, a sensor shaped like a cone. It has pressure transducer to measure the pressure at the tip. It also measures the side friction at the sleeve. Cone penetrometer testing can also involve a piezo cone, which has a pore pressure transducer to measure pore pressure changes due to shearing. It's pushed from a, we call it a cone rig, and used to determine stratigraphy and other engineering correlations with it to determine properties.

Q. I should have asked the question in two parts. It would have been easier, because I have to ask you again now. What information typically is obtained by geotechnical analysts of the cone penetration tests?

A. (Dr. Bartlett) The base information that comes from the cone is the tip stress, sleeve stress, and pore pressure transducers. One can also get shear wave velocities from a seismic cone. Those are the base data that come from this type of device.

Q. And what design information or soil property information do you get from tip stress and sleeve stress?

A. (Dr. Bartlett) There are numerous correlations to engineering properties from those values.

Q. And those are?

A. (Dr. Bartlett) Shear strength, consolidation parameters, moduli, density, shear wave velocity. Well, the shear wave velocity is really measured directly. Maybe even the time of day if you're lucky.

Q. I take it you think these are useful tests?

A. (Dr. Bartlett) I think the cone is a useful test. It is useful specifically for determining stratigraphy. One of the challenges a geotechnical engineer has is stratigraphy, and it gives us a good idea of the layering of the system, its relative strengths. When one begins to correlate engineering properties, you have to be careful. And a prudent investigation includes both cone penetrometer data and other types of testing to confirm what the cone penetrometer is telling us. I use it.

Q. Do you know whether applicant conducted cone penetration tests at PFS?

A. (Dr. Bartlett) It did.

Q. Based on your review -- well, did you review the way in which they conducted those tests?

A. (Dr. Bartlett) Please repeat the question. I'm sorry.

Q. Did you examine or review the manner in which those tests were conducted?

A. (Dr. Bartlett) They were performed by ConeTec, which is a vendor here locally. They did it according to common ConeTec procedure. I've seen other ConeTec reports. I didn't review it in detail. But we've also used the same people, "we" meaning UDOT and Woodward-Clyde.

Q. Do you have any concerns about the manner in which the cone penetration tests were conducted by ConeTec for applicant in this job, by that meaning PFS?

A. (Dr. Bartlett) Not particularly. One issue we have had with ConeTec in other sites, and it's probably not that important here, is that pore pressure transducers, they tend to have a problem with keeping their porous stone in the cone tip saturated, and we've noticed that their pore pressure data may not be necessarily reliable.

Q. Have you observed the problem here at PFS?

A. (Dr. Bartlett) No, not as much, because

we're again above the water table. Though in some clays there still could be enough saturation that we could generate some pore pressures. And I would just say that if I did have a problem with the cone penetrometer data by itself and not the correlations with it is that the pore pressure data may not be reliable for unsaturated soils.

Q. Specifically with respect to the cone penetration test data collected at PFS, do you have a concern about the pore pressure data collection? Have you observed anything --

A. (Dr. Bartlett) I have a general problem with pore pressure data collected by ConeTec, and specifically in unsaturated soils. Yes, I do. I do not believe the data is reliable.

Q. But with respect to the data on this particular parameter collected by ConeTec at PFS, did you review it to determine whether your general concern about ConeTec applies also to their work on this parameter of PFS?

A. (Dr. Bartlett) I didn't make that specific review. I guess I would have probably prejudged that data.

Q. All right, fair enough. You said a moment ago that a prudent investigator would supplement the

cone penetration test data with other types of tests.

A. (Dr. Bartlett) Correct.

Q. Did the applicant do that at PFS?

A. (Dr. Bartlett) Not the way I would do it, but they did do other investigations, yes.

Q. Would you explain for the record how what they did differs from the way you would do it?

A. (Dr. Bartlett) Normally when I plan an investigation I like to involve the cone penetrometer first. In that way, I do know the layering, the significant layers involved, and have somewhat of an idea of their relative performances and strengths and compressibilities. That then means I have a clear picture of what I'm going to do now when I come in and drill and take samples, and I can focus my investigation.

Also, one objection I had with PFS's investigation -- well, first is that the cone was not used first, it was used later. And also that the boreholes were -- the data from where the cone was collected versus where the borehole information are too far apart really to do any meaningful correlations. My experience is I like to keep a borehole in a cone when I do do a parallel investigation generally within five to ten feet of each other.

Q. Let me see if I understand your -- the difference between the process that you favor and what PFS did.

A. (Dr. Bartlett) That's correct.

Q. The differences are, and please correct me if I'm wrong, first, that you would rather have done the cone penetration test first, and PFS did them last?

A. (Dr. Bartlett) They did them not last, but they did it somewhere in the middle of the investigation.

Q. And second, you have selected the boreholes to be close to the cone penetration locations?

A. (Dr. Bartlett) Correct, because what we are then trying to do is later gather samples from those borings and correlate the results from the cone penetrometer to the results of the undisturbed sampling, or whatever we're doing in the borehole. It's not just undisturbed sampling. And when we get too far apart spatially, then one cannot be confident that what we've seen in the cone penetrometer can be correlated directly with what's been observed in the borehole.

Q. As you recall, if you recall, how far apart were the cone penetration tests performed of PFS vis-a-vis the boreholes?

A. (Dr. Bartlett) Well, there's several cones

questions that they had.

I think one has to also consider depth of investigation. One thing that was not done at this site is the drillings were not done down to bedrock. It's ambiguous how depth -- the depth of bedrock and types of analyses especially involve ground response -- well, at least my frame of reference is the Savannah River. We drilled several hundreds of feet down to bedrock and characterized the soil column all the way from bedrock. That was not done here, so the boreholes were all relatively shallow. We do not have real deep, or at least one or two very deep borings. So that remains an area of uncertainty to me.

There's been no -- investigations are usually phased. And in each subsequent phase you have issues that you're trying to resolve and what you're trying to do in those, and I'm not sure I get a sense in reading the documentation why some things were being done and why they were doing additional borings and investigations, other than just to satisfy a few questions from the NRC.

Q. With respect to your observation that the borings and the cone penetration tests are often or sometimes too far apart to be able to correlate the data, what is the significance of the fact that you

might not be able to correlate the data as you would like to?

A. (Dr. Bartlett) Well, we saw yesterday that cone penetrometer data were used to adjust the shear strengths for layer 4, and if you get too far apart between the data which you're trying to adjust, your adjustment factors may be meaningless.

Q. You're saying, if I understand you, and correct me if I'm wrong, that to the extent that you want to be able to refer to cone penetration test data, to adjust some of the information that you get from the boring data --

MS. CHANCELLOR: Objection. Is this a question?

MR. TRAVIESO-DIAZ: Yes. I'm getting there.

Q. (By Mr. Travieso-Diaz) You might not be able to do so because the two sets of measurements are too far apart?

A. (Dr. Bartlett) Yes, correct. Because there's lateral variability in this direction, and the further you get apart, the less the data are correlated. So you run the risk of essentially developing correlations upon which there are no -- they don't correlate. So in other words, part of your distance that you space boreholes, whether they be CPT or SPT, is

fundamentally based on your understanding of how much you think the soils are variable, particularly in the lateral direction.

Q. So I take it that to the extent that this presents a problem, it's only if you're trying to correlate for some reason to assess the data. Is that fair?

A. (Dr. Bartlett) I may have to think about that. I'll answer this way. Yes, if your main premise or what you're trying do in an investigation is correlation. To me, it's obvious that they have to be very close or reasonably close. If you're using the two types of data to supplement one another, I can see cases where they would not necessarily have to be in close proximity to each other. However, one then has to go back and consider the density of both types of data, because they are different types of data, and whether you're putting in the appropriate number of borings and sampling to fully characterize the site.

Q. How many cone penetration tests in your practice do you typically correlate to a single boring? Is there any ratio or any way you correlated the measurements?

A. (Dr. Bartlett) If I'm trying to correlate?

Q. Yeah.

A. (Dr. Bartlett) So you're asking how many paired boreholes, CPT and boreholes would I do in an investigation to develop correlations?

Q. Yes. One to one? One to two? I don't know. I'm trying to get a sense for how you do the correlation.

A. (Dr. Bartlett) Well, let's see if this answers your question. If my purpose is correlating data from a borehole, I would always have a CPT adjacent to it.

Q. And to the extent that you are trying to correlate cone penetration tests and boreholes, typically how many of those do you do?

A. (Dr. Bartlett) It depends on the size of the facility. So there's a density issue now; how many data do I need. And different agencies, whomever you're working for, have different somewhat suggestions. I won't call them requirements. It's usually still left up to the discretion. But they have densities that they suggest to you.

Q. Is there any -- talking about agency requirements, is there any NRC guidance or regulations that control the spacing of the placement of boreholes?

A. (Dr. Bartlett) Yes, they are.

Q. Where would those be?

A. (Dr. Bartlett) I believe they are found in Reg Guide 1.132, Appendix C, I believe.

Q. Did you review Appendix C or Reg Guide 1.132 to determine whether the program that was put in place at PFS comply with the requirements of that appendix?

A. (Dr. Bartlett) Yes, I did.

Q. And what was your conclusion?

A. (Dr. Bartlett) They did not.

Q. In which respect?

A. (Dr. Bartlett) There were not enough boreholes. May I qualify that?

Q. Okay.

A. (Dr. Bartlett) For the pad emplacement area. I'm not sure I would make that statement about the canister transfer building right now. I'd have to, again, look at the -- count the borings again in that footprint.

Q. So you're not sure?

A. (Dr. Bartlett) Right. And the reason I'm not sure is because when we divide -- when we split this project team up to do the review, I really primarily looked at the storage pad -- or emplacement pad area, excuse me, and Dr. Ostadan looked more at the canister transfer building. However, I have looked at the laboratory testing and boreholes from both areas.

Q. May I refer to Dr. Ostadan. Don't think I'm forgetting you. In your review of the canister transfer building, did you develop a view as to whether the number of boreholes that were drilled or that were done by PFS complies with Reg Guide 1.132?

A. (Dr. Ostadan) I did not specifically review the investigation performed for the canister transfer building to see whether it's in compliance with the NRC guidelines or not.

Q. Okay. Let's move to something else.

A. (Dr. Bartlett) Sure.

Q. I take it, as we discussed before, that one of the purposes of drilling boreholes is to take samples for later testing in the laboratory?

A. (Dr. Bartlett) Yes.

Q. And I take it that you have in fact gone through the process of first collecting samples and then having tested them or having them tested?

A. (Dr. Bartlett) Generally having them tested, because most of my commercial experience we did not have our own on-site laboratories. Those were sent to either others in the firm or laboratories which we were contracted with. But yes, I have taken samples to submit them for laboratory testing.

Q. What kinds of tests are typically run with

soil samples taken from projects such as the ones you have been involved with?

A. (Dr. Bartlett) What types of tests or samples?

Q. No. No. What type of tests are conducted in the laboratory with respect to samples taken from borings?

A. (Dr. Bartlett) Shear strength tests, consolidation tests, general Atterberg and classification tests. Once in a while permeability testing.

Q. Has, to your knowledge, applicant performed tests on samples taken from borings on the PFS site?

A. (Dr. Bartlett) Yes, they have.

Q. What kind of tests did they run?

A. (Dr. Bartlett) Regarding shear strength, to my knowledge, they've performed unconsolidated-undrained, UU tests; consolidated-undrained; direct shear. I believe that's all I recall as far as shear strength testing. Consolidation testing, and the oedometer, o-e-d-o-m-e-t-e-r. And then again typical classification tests that we would do -- moisture contents, Atterberg limits, those type of routine tests.

Q. In terms of the kinds of tests that the applicant performed, was there any category of tests

that they failed to perform that you wish they had?

A. (Dr. Bartlett) Restricting ourselves to laboratory testing, correct?

Q. Yes, restricting ourselves to laboratory testing for the moment.

A. (Dr. Bartlett) Okay. Yeah, I think a direct simple shear test. Some of that might be useful instead of the direct shear. Also strain controlled triaxial testing, cyclic triaxial testing.

Q. Why do you feel that they should have done strain controlled triaxial tests?

A. (Dr. Bartlett) We have issues with degradation, degrading of the strength and modulus of some of these soils at the level of strains that we see that have been produced by the earthquake. And really we cannot assess whether those degradations are real or not, because the type of testing they perform doesn't really lead us any. They performed --

I'm not sure quite what I said. Can I start again?

Q. Sure.

A. (Dr. Bartlett) Okay. Let me focus on first the direct simple shear test.

Q. Okay.

A. (Dr. Bartlett) The direct simple shear test

does not allow really any strain concentrations along one predefined plane. So it may give us a better indication of what the shear strength is across the entire sample. The direct shear test which was performed by the applicant tends to concentrate stresses on one predefined failure plane.

Now on to the strain controlled cyclic triaxial tests. Those would give us a better idea, or an idea, really, of how the stiffness or modulus and the strength may degrade or behave at the levels of strain that we see from the shake analysis.

A. (Dr. Ostadan) May I add to that?

Q. Yes, please.

A. (Dr. Ostadan) One of the points raised in Contention L was the soil properties used to take into account soil linearity or the so-called soil curves or generic curves. I have not seen in the package, in the calculation any laboratory data that was developed in order to come out with the site specific soil curves.

Q. Let me clarify your answer to make sure that you're saying what I understand you to be saying. Are you saying, Dr. Ostadan, that there is no data developed in the laboratory for specific soil properties for the PFS site?

A. (Dr. Ostadan) No, I'm not saying that.

Q. Or are you restricting yourself to a particular type of soil test?

A. (Dr. Ostadan) I'm restricting myself to a particular soil test. You asked -- your question was, what other tests should have been done in the laboratory. And my answer to that, in addition to what Dr. Bartlett said, is that cyclic triaxial tests could have been done to develop site specific soil curves as is stated in the Contention L.

Q. Is it your testimony that they did not conduct cyclic triaxial tests?

A. (Dr. Ostadan) They did not conduct cyclic triaxial tests to develop soil curves.

Q. I need you to explain the second part of the answer. What do you mean by "to develop soil curves"?

A. (Dr. Ostadan) Soil curves are used primarily in a ground response analysis, such as those done by the applicant here using computer program Shake, S-h-a-k-e. As shown in the calculation currently, the curves are generic curves, published in the literature.

Q. When you say that they should have run cyclic triaxial tests to develop soil curves, what would those curves be? Of what? In other words, how would you be plotting the curves?

A. (Dr. Ostadan) The curve have two branches,

actually. There are two types of information present in these curves. One is shear modulus of the soil and the function of shear strength, and it's in a linear curve that shows degradation of the stiffness versus the strain.

The second piece of the information is the soil material damping as a function of shear strength that generally shows an increase of damping versus strain.

Q. And your testimony is that these type of tests for the purpose of developing this type of curves were not done?

A. (Dr. Ostadan) Yes.

A. (Dr. Bartlett) May I add to my testimony?

Q. Please.

A. (Dr. Bartlett) One other test that we discussed a little bit yesterday is the types of triaxial testing that were done were all in compression. I believe also in helping to understand maybe the part of the failure surface that we look at when we look at general bearing capacity that's in -- it actually goes into extension. So the triaxial extension test too would appear to be appropriate for parts of that failure surface.

Q. So your testimony is that in addition to the

triaxial tests that they did in compression --

A. (Dr. Bartlett) Right.

Q. -- they should have done a similar test that was in extension as opposed to compression?

A. (Dr. Bartlett) Correct. And I would also add that we would -- we see a conceptual design of a soil mat that we need to also, instead of seeing compression of that soil cement, we also need to understand its behavior and tension. So we need tensile tests done on the proposed design of this soil cement mat.

Q. Let me ask you the following question. The simple shear test that you mentioned before, are these commonly performed in the industry? And we're talking about any of these tests, starting with the simple shear tests, specialized tests.

A. (Dr. Bartlett) The direct simple shear test, I'm not sure I could call it specialized, but it may be hard to find from a small commercial geotechnical laboratory. Larger laboratories in a fair amount of universities can perform these type of tests.

Q. Have you done any of these yourself in your program?

A. (Dr. Bartlett) I have not.

Q. How about the triaxial extension tests or

versions of the SAR about wetting, when we should wet, when we shouldn't, when we were looking at collapsible soils. But I think subsequent RAI's kind of cleared up what was going on with wetting and inundation and those type of things.

It would be nice to be able to measure matrix suction, but it's a difficult thing to do. These are unsaturated soils, and it would be nice to know what are those capillary stresses that are in these unsaturated soils, because these soils upon any changes in moisture content could be sensitive to that. Though I haven't had a lot of familiarity with that type of testing, either.

Do you wish to add anything?

A. (Dr. Ostadan) But maybe as a reminder, one point that was discussed yesterday was the concern about loss of moisture for the samples that was there over two years. And your question was, I believe, what difference you would have liked to see in the way the lab test was conducted. I would have gone out to take fresh samples and tested them.

Q. Do either of you -- I know that both of you have expressed a concern about the possibility that the samples may have lost moisture while they were waiting to be tested.

A. (Dr. Bartlett) Correct.

Q. Apart from having a concern, does either of you have any evidence that would lead you to believe that that in fact occurred?

A. (Dr. Bartlett) We do not. But there are really, from what we understood yesterday, no data collected to prove either yes or no. So it's inconclusive.

Q. I recall that the testimony that I believe it was Mr. Trudeau gave yesterday was to the effect that these samples were sealed.

A. (Dr. Bartlett) Correct.

Q. Were kept sealed. Is that to you sufficient protection against the possibility of losing moisture?

A. (Dr. Bartlett) No. Seals can, especially after two and a half years in a laboratory, not be good, and there is a potential for drying out. I guess we can speculate whether they did or didn't; but in my common practice, to allow a sample to sit for two and a half years before I test it seems a long time. And the chance for drying or -- is increased just because of that long duration.

Q. With respect to your concern about the 90-minute wait before the actual shearing testing --

A. (Dr. Bartlett) Correct.

Q. -- Do you -- are the concerns, again, what? That you may lose moisture while you are waiting those 90 minutes?

A. (Dr. Bartlett) Correct. I don't know if the shear box -- it's not airtight, and so it -- the samples are fairly thin, and if left for prolonged times, they can begin to dry out.

Q. Again, to both of you, aside from the concern that this may have happened, do you have any evidence that it did happen?

A. (Dr. Bartlett) We do not, other than the concern to not wait so long before one shears.

Q. I understand. One type of test that I heard mentioned yesterday that neither of you has referred to is resonant column tests. Is that a type of test you normally do in your soils work?

A. (Dr. Bartlett) Depends on the facility and the nature of what's going on. Resonant column testing -- and I'll defer to Dr. Ostadan; I'm going to just speak very briefly -- is done to develop the dynamic properties. And in some projects particularly that we've been involved in the past that involved nuclear safety issues, those types of tests have been done for those sites. If I'm doing a design that may not require nuclear safety issues, maybe one may not

choose to do that type of test. So I guess it depends on the safety issues and the complexity of the project.

Q. Have you done that type of test in the projects that you have been involved with?

A. (Dr. Bartlett) Yes, we have done that.

Q. Which projects?

A. (Dr. Bartlett) The Savannah River site, the ITP project.

Q. And that was an NRC --

A. (Dr. Bartlett) That was DOE.

Q. DOE, I'm sorry. Yes. And did the applicant do resonance column tests?

A. (Dr. Bartlett) We were the applicant.

Q. I'm sorry. I'm switching horses on you. I apologize. I'm talking about PFS, did the applicant do residence column tests?

A. (Dr. Bartlett) Yes.

Q. And are these lab tests or in situ tests?

A. (Dr. Bartlett) They're lab tests.

Q. Okay. That wasn't clear. And do you have any concern about the way in which applicant did their resonant column test?

A. (Dr. Bartlett) I'm not an expert on the resonant column test.

Q. How about you, Dr. Ostadan?

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

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

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

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

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

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

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

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

A. (Dr. Bartlett) Contention L.

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

the number "a" entitled "Subsurface investigations." You have that?

A. (Dr. Bartlett) Yes.

Q. Let's take a look at the first sentence in that paragraph that says that "The location plans for completed subsurface investigations, cross-sections, and profiles showing subsurface soil and rock layering at the site contained in the license application is deficient in that these data could not be compared with the Applicant's boring logs." Do you see that?

A. (Dr. Bartlett) Sure.

Q. Is this paragraph accurate today in light of the additional soils work the applicant has conducted?

A. (Dr. Bartlett) I'm struggling with in the sentence it refers to "these data." I'm not sure exactly what "these data" are referring to. Could be possibly to the location plans or maybe referring to the subsurface investigations, cross-sections, and profiles. I know I'm responsible for this, but I did not author it.

Q. That's why I was asking you earlier whether you talked to Mr. White to determine what he meant in the sentence.

A. (Dr. Bartlett) I would say the location plans seem adequate. I haven't seen any problems with

the location plans showing borehole locations and cross-sections and whatnot.

Q. This sentence appears to raise a question whether you can correlate the location plans and the actual boring logs. Do you see that?

A. (Dr. Bartlett) I'm going to read on to see if I can get the sense of what's going on here.

A. (Dr. Ostadan) Can I answer?

Q. Sure.

A. (Dr. Ostadan) I believe the statement that is deficient, identifying rock layering at the site --

Q. Where are you reading from? The sentence that says "Profiles showing subsurface soil and rock layering at the site"?

A. (Dr. Ostadan) "-- and rock layering at the site."

MS. CHANCELLOR: It's the second line.

Q. Yes.

A. (Dr. Ostadan) Right.

Q. And what inference did you draw from that?

A. (Dr. Ostadan) I think we just didn't know where the rock is at the site.

Q. But this appears to say that you couldn't correlate that with the applicant's boring logs. That's what I'm trying to understand, what is being claimed

here.

A. (Dr. Bartlett) I think when it uses the terminology "cross-section" and "profiles," comparing back to the applicant's logs, there are issues regarding whether one could determine the appropriate cross-section, layering, stratigraphy, if you will, from the boring logs. I would answer that at least in the zone where the cone penetrometer was performed, that layering, cross-sections, and profiles I assume is somewhat related to a cross-section, and still some two-dimensional view of the subsurface profile is -- at least for determining the layering at the site is sufficient.

Now, when we talk about the deeper profile, deeper than where the cone penetrometer could go, you probably still have difficulty determining the exact layering. The borings were done and sampled at approximately five-foot intervals, and we've already mentioned that they go to approximately a hundred feet. So there are deeper parts of the profile that remain undefined, and specifically "rock" is not defined.

Q. Since the author of this paragraph is not here, let's just try to look at some of the things that are said, see if we can make sense out of them.

A. (Dr. Bartlett) Sure.

foundation profile, I just have to look at these two drawings and they will match that way?

A. (Dr. Bartlett) Yes. One could easily determine for practical purposes where the boring falls on the plan view shown in Figure 2.6-2.

Q. So you wouldn't have any difficulty correlating these two sets of drawings, and by that I mean, what's now Exhibit 52, page 1 and Exhibit 53, page 1, in terms of location?

A. (Dr. Bartlett) In terms of location.

Q. Okay. Now, can you do the same thing -- well, strike that. Finish first trying to describe what is here.

There is a continuous line, broken line, that starts a little above 4460 on the left and runs all the way to almost 4480 on the right.

A. (Dr. Bartlett) I see it.

Q. What does the line represent? Do you know?

A. (Dr. Bartlett) That represents an inferred layer. Usually when they're being inferred, we dash them. If we're fairly confident about them, they would be solid lines. At least that's standard practice.

Q. But I'm talking about the solid line at the very top.

A. (Dr. Bartlett) I went above you, sorry.

I'm one line down.

The solid line on top, the solid, thin line, represents ground surface.

Q. So that would be the undisturbed ground surface?

A. (Dr. Bartlett) Correct, at the time of the survey when these were prepared.

Q. And again, if you wanted to know what the surface looked like in terms of the topography, I don't know if that's the correct word, at the time that this survey was taken, you just need to look at this?

A. (Dr. Bartlett) Correct, to the nearest foot.

Q. All right. Now, again for purposes of understanding what's in this drawing, there is a set of dashed lines -- by the way, are you -- I don't know if this drawing allows us to make a determination, but would that be the actual grade at the time this drawing was made, or the anticipated grade of this area once construction is finished? If you know.

A. (Dr. Bartlett) That I might have to check into. I was assuming it was the grade at the time the drawing was prepared. It may represent the finished grade.

Q. Now, there is a series of what appear to be

rectangles throughout the start of the surface and go down a few feet?

A. (Dr. Bartlett) Correct.

Q. What would those rectangles represent?

A. (Dr. Bartlett) Those are projections of the pads into the cross-section.

Q. Why is it that some of them look bigger than the others?

A. (Dr. Bartlett) Because we're cutting at different angles across these.

Q. Oh, I see. Okay. Now to the question that I believe you were referring to. There is a dashed line that is sort of parallel to the surface, but it's, what, appears to be like five foot underground.

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

Q. What does that line represent?

A. (Dr. Bartlett) That represents an inferred layer boundary.

Q. And it's a boundary between what and what?

A. (Dr. Bartlett) Changes in material type.

Q. And is there something that identifies what -- do those layers have names?

A. (Dr. Bartlett) Yes, sir, their names.

Q. Okay. What are their names?

A. (Dr. Bartlett) The name above the line is

Eolian silt.

Q. And the name below?

A. (Dr. Bartlett) Is a silty clay/clayey silt.

Q. And those names appear to be reproduced throughout each horizontal band, like, for example --

A. (Dr. Bartlett) Downward?

Q. No, no. From left to right.

A. (Dr. Bartlett) Oh, yes. They're periodically reproduced. I imagine that's just for reader's ease. Though once in a while there may be lateral changes and we might see a change in those names.

Q. But in this drawing it appears --

A. (Dr. Bartlett) I don't see any of those in this type of drawing except when we get deeper.

Q. All right. And so that we can clarify what we have been talking about before and may be talking about later, I see one, two, three, four, five -- six continuous -- and by that I mean continuous going from left to right -- dashed lines, and then two lines that start a short distance and then they end.

A. (Dr. Bartlett) Correct.

Q. If you can explain what these various lines are, what they mean. Could you do it?

A. (Dr. Bartlett) The ones that start and then

terminate with question marks?

Q. We'll get to those. The other ones, would you -- your understanding be that the ones that do go from end to end are intended to represent what you call -- what do you call them? Inferred?

A. (Dr. Bartlett) Inferred layer boundaries, yes.

Q. All right. So this drawing would --

A. (Dr. Bartlett) -- infer that those are continuous across this cross-section.

Q. And it has essentially seven such layers?

A. (Dr. Bartlett) One, two, three, four -- five that I count that are continuous.

Q. Oh. You mean the one that starts -- there's one that starts off --

A. (Dr. Bartlett) I'm counting layers, not lines now.

Q. Oh, Okay. All right. So you believe five --

A. (Dr. Bartlett) Five layers.

Q. And those would be --

A. (Dr. Bartlett) Eolian silt; underneath it the silty clay/clayey silt; underneath it the clayey silt/silt; underneath it the clayey silt/silty clay; and underneath that, the silty sand/sandy silt.

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

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

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

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

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

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

A. (Dr. Bartlett) Right.

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

A. (Dr. Bartlett) Correct.

Q. -- and an additional layer called silty

sand/sandy silt?

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

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

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

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

A. (Dr. Bartlett) Right.

Q. What does that line represent?

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

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

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

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

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

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

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

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

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

A. (Dr. Bartlett) Yes.

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

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

MR. TRUDEAU: Big bills.

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

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

Q. All right. Now, one more thing. I'm sorry. Just looking at the legend on the right.

A. (Dr. Bartlett) Correct.

Q. That wiggly line on the right, does that correspond to the wiggly lines on the left that we just talked about?

A. (Dr. Bartlett) The only ones that I see on

presented. I can infer their thicknesses from this and somewhat about significant features that the geologists mapped in their trenches, namely, fractures, in-field fractures. Seems that they were most interested in obtaining the strike and dip or the orientation of those, and then they did a rose diagram to figure out if there was any preferential orientation to this data. That's what I see.

Q. Now, let's go back again just so we can move to the bottom line. We were talking about the sentence in Exhibit 3 that said, "Structure specific cross sections and profiles were not prepared utilizing the boring log records." And you said that that is a true statement. And my question to you is, in light of all the information that I just displayed before you, does it matter? Or how does it matter? Is this a significant concern?

A. (Dr. Bartlett) When this Contention was written, structure specific cross-sections and profiles were not prepared using the boring logs or from the boring logs that were obtained during the first phase of the investigation. This Geomatrix report postdates that, postdates this statement; and whether structure-specific cross-section profiles were not prepared using the boring logs from the current data as

it now exists, including the CPT and the borings done by Geomatrix, the shallow borings we see, I'm going to defer whether we've really met that or not, because again, we're in the realm of geology and that's really outside of my review.

Q. Okay. I'm trying to understand, to what extent did you personally regard this statement here in Contention L?

A. (Dr. Bartlett) I did not draft this statement.

Q. I understand, but it's on the record now. I'm trying to get your interpretation as to how significant you considered this observation to be.

MS. CHANCELLOR: Objection. He already said he's deferred to somebody else.

MR. TRAVIESO-DIAZ: I'm asking for his opinion if he has one.

A. (Dr. Bartlett) I think that along the lines of where the trenches were investigated, these seem to be reasonable and consistent types of data and presentation of them. Whether all borehole data including the geotechnical and geological investigations have been compiled and reconciled in site-specific structural cross-sections, I don't see that all here, but again, I haven't reviewed this report.

Q. Well, assuming this statement is still true today, does it concern you? Is it something that causes you concern as to the state of the investigation of the site performed by PFS?

A. (Dr. Bartlett) Probably not from a geotechnical perspective, but geologists have other reasons for wanting to know the orientation of these layers, which could infer dips, faults and other things. And so there -- these are not geotechnical cross-sections, they are geological cross-sections. I'm going to defer from trying to really say whether I -- what was the question? I'm not sure I'm answering it.

Q. Okay. I only want to know, since you are the person who's explaining to us this contention, whether you personally have a concern with this particular observation made in this paragraph. That's all I want to know.

A. (Dr. Bartlett) I personally don't have a concern. Others may on the team.

Q. All right. And others will be who?

A. (Dr. Bartlett) Barry Solomon, that prepared part of this document.

Q. All right. Let's move to the next sentence on that page. It says, "Only a generalization of the boring logs were used to establish the site geologic

characterization." Do you believe that statement to be correct today?

A. (Dr. Bartlett) I think what it means, a generalization of the boring logs was used to establish the site geological characterization. Again, since the words "site geological characterization," I'm going to defer.

Q. Do you know whether it was true at the time it was written, was accurate at the time it was written?

MS. CHANCELLOR: Objection. You're asking him to speculate about --

MR. TRAVIESO-DIAZ: If he doesn't know, he can say easily, "I don't know."

A. (Dr. Bartlett) I don't know if it was true. I don't know if --

Q. Do you know if it's true today?

A. (Dr. Bartlett) I do not know if it's true today. Again, the answer I think would be in the Geomatrix report to that question, and I have not reviewed it.

Q. Would you believe that these two statements would relate more as you're talking about the geology of the site as opposed to --

A. (Dr. Bartlett) Geotechnical.

Q. -- geotechnical issues?

A. (Dr. Bartlett) It seems to me that these are more geological, not geotechnical issues, yes.

Q. Do you understand that the scope of Issue 3 to be addressing geotechnical issues?

A. (Dr. Bartlett) Could you repeat the question?

MR. TRAVIESO-DIAZ: Could you read it back?

(The pending question was read.)

A. (Dr. Bartlett) Issue 3?

Q. Yes, what we have begun to look at, discussion on page 83 of Exhibit 3.

A. (Dr. Bartlett) I don't see, at least in the description of 3, geological or geotechnical used.

Q. All right.

A. (Dr. Bartlett) But in 3a, where they start referring to the sections, the words "geological" are used.

Q. All right.

A. (Dr. Bartlett) That's what I see.

Q. Let's go to -- I'm sorry. I didn't mean to interrupt you. Let's go to the next sentence of this paragraph that starts on the bottom of page 83, goes up to the top of page 84.

A. (Dr. Bartlett) Fair enough.

Q. It says, "It is not possible to ascertain

whether or not all of the data collected, particularly data on zones of soft/loose conditions encountered in the explorations, have been used to characterize subsurface conditions and to establish design values."

Let me stop there for a moment. Is that statement that I just read you, this portion of the sentence, true today?

A. (Dr. Bartlett) I have a hard time interpreting whether the sentence is true without completing the sentence.

Q. The reason I stopped is because I believe that what follows, you already told us that was resolved. The sentence that starts after the "and," or the clause that starts after the "and." So that's why I stopped. You can read the whole sentence if you will.

A. (Dr. Bartlett) Fair enough. If I could do that. I forgot that part, so...

Q. I'm sorry. That's where I stopped.

A. (Dr. Bartlett) I do not agree with your interpretation that everything that -- in the second half of that sentence that we have agreed that we are not concerned about.

Q. Okay. In what respect do you believe that it is not possible to ascertain?

A. (Dr. Bartlett) My characterization this

morning, as I recall it, and I underlined this in pencil, so that's why I am going back to that, is that we -- it talks about uncertainties with the estimation of the thickness. And I agreed that I -- from these cone penetrometer data that there's not a great uncertainty in the estimation of thickness. But this sentence also talks about "and to establish design values." And so inasmuch as we're talking only about estimation of thicknesses of design value, I do not see any significant issues.

MR. TRAVIESO-DIAZ: Could you read the answer back again? I don't think I followed it entirely.

(The record was read.)

Q. (By Mr. Travieso-Diaz) Are you saying that you still believe that it is not possible to ascertain whether or not all data collected has been used to establish design values? Is that the part you have a problem with?

A. (Dr. Bartlett) I'm sorry.

MR. TRAVIESO-DIAZ: I'm sorry. I think I got it right, but could you read it?

(The pending question was read.)

Q. (By Mr. Travieso-Diaz) Can I rephrase the question?

A. (Dr. Bartlett) Yes, please. I'm having a hard time with it.

Q. If I understood your last answer, you said that to the extent that we're talking about the characterization of subsurface conditions, you don't have a problem that all data collected have been used to do that. But you are restricting yourself to that, and I presume that you meant that with respect to the use of those data to establish design values, you may still have a problem or a concern. Is that fair?

A. (Dr. Bartlett) What I am stating is that thickness is a design value. We use it in calculations of settlements and other things. And inasmuch as thickness is a design value, the data that we have seem to be sufficient to estimate the thickness of the sediments, and I think I restricted that this morning in the upper 30 to 35 feet where the cone penetrometer data were collected. There are some uncertainties of thicknesses of layers deeper in the profile.

Q. I think I understand now. Thank you very much.

Let's go to -- would you like to take a break now?

A. (Dr. Bartlett) Your call. Yeah, it might be good for just a few minutes.

(Recess from 4:31 to 4:42 p.m.)

Q. (By Mr. Travieso-Diaz) Before the break you mentioned something, I don't recall the precise words, to the effect that the boundary, the actual boundary between the layers was of some significance or some interest?

A. (Dr. Bartlett) The thickness.

Q. Of the layers?

A. (Dr. Bartlett) Of the layers is a design value, because we have to use it in settlement calculations. We're also inferring how continuous in the vertical direction might be properties because those layers. So it is a design value, at least in the upper profile where the cone penetrometer's been taken. From a geotechnical viewpoint, the estimation of thickness throughout this pad emplacement area and the canister transfer building do not seem to be significant issues, but only with regard to the thickness.

Q. All right. Let me show you another exhibit here.

(Exhibit 56 marked.)

I'm showing you what has been marked as Exhibit 56.

A. (Dr. Bartlett) Correct.

Q. And I will identify it for the record as

being Section 2.6.1.12.1 of the SAR, entitled "Stability and Settlement Analyses--Cask Storage Pads." This section -- this exhibit goes from pages 2.6-46 to 2.6-54 of the SAR. And for the moment I'm going to ask you to look at page 2.6-49 and to the last paragraph on that page. Do you see that paragraph?

A. (Dr. Bartlett) Beginning with "analyses"?

Q. Exactly, yes. You have that.

A. (Dr. Bartlett) Yes.

Q. As I read this paragraph, it appears to say that in performing bearing capacity analysis, the applicant assumed that the top 30 feet of subsurface soil was uniform, and assigned to that layer the minimal value of strength measured in the tests that were taken on depths -- that were performed on samples obtained from depths of approximately 10 to 12 feet. Do you see that?

A. (Dr. Bartlett) Yes, the UU test. I see that.

Q. Correct. Is it your understanding that in fact based on this sentence and of what Mr. Trudeau testified yesterday, that that is what the applicant did?

A. (Dr. Bartlett) They used a minimum value of the UU test with an undrained shear strength of 2.2 ksf.

That's the best of my recollection. We can review the calculation, but I don't think it's necessary.

Q. Assuming that in fact that is what they did, would any concerns as to whether the boundary between the various layers that are comprised in the upper 30 feet have any significance, at least insofar as this calculation is concerned?

A. (Dr. Bartlett) I don't understand the question.

Q. All right. This is what I understand applicant did. They measured strength in the layer from locations of depths of approximately 10 to 12 feet.

A. (Dr. Bartlett) Correct.

Q. And they selected the minimum value of strength that was shown by those tests.

A. (Dr. Bartlett) Correct.

Q. It's reported here as 2.2 thousand pounds per square feet.

A. (Dr. Bartlett) Correct.

Q. And they used that as the presumed strength of the entire top 30 feet of subsoil. Is that what they did?

A. (Dr. Bartlett) That's apparently what they did.

Q. All right. And assuming that's what they

did, would that choice of design parameters resolve or address any concerns there might be with respect to what the thickness or the location or the layers that are comprised in the upper 30 feet would be?

Do you understand the question?

A. (Dr. Bartlett) No.

Q. Okay. Let me ask the question differently. Assuming that they picked the lowest value of strength that was available and what was perceived as being the least strong layer --

A. (Dr. Bartlett) Okay.

Q. -- okay? And they used that as their design value of strength in their analysis of bearing capacity.

A. (Dr. Bartlett) Okay.

Q. Assuming they did that.

A. (Dr. Bartlett) Uh-huh.

Q. Would that choice, that decision, resolve any concerns there might be, at least with respect to that calculation, as to what the relative locations or the various layers comprised the 30 feet would be? Do you care whether one layer is five feet or six feet or seven feet if you're going to take the lowest value and use it for all three?

A. (Dr. Bartlett) Let me interpret what I read here.

Q. Okay.

A. (Dr. Bartlett) That a sample was taken approximately 10 to 12 feet, presumably in layer 2. We must be careful when we look at that 10- to 12-foot depth to make sure that that was layer 2. Because it's my recollection layer 2 can sometimes end as shallow as eight feet. So there's a little bit of uncertainty of whether this exactly came from layer 2. So we first need to ascertain that.

Then it's the minimum value coming from a set of UU tests where the state has always contended that the quantity and number of triaxial testing done in this area has been insufficient for a design facility of this size. I cannot tell whether it is the minimum value in layer 2. I have insufficient data to determine whether it's the minimum, maximum, mean, or if it even is actually from layer 2.

Q. All right. So -- and this becomes a hypothetical question because you don't have the answers to all these items that you said. But assuming hypothetically that the lowest value that was in fact measured in this upper 30 feet corresponded to the measurements of 10 to 12 feet and was this value 2.2, with those assumptions, assuming the things that you don't have to assume because you don't know --

MS. CHANCELLOR: I'm going to object. This is going to call for lots of speculation.

MR. TRAVIESO-DIAZ: Well, I would ask him -- I would like him to answer if he can.

Q. (By Mr. Travieso-Diaz) Assuming -- with those assumptions, would that design choice obviate the concern that you may have defined your layers not completely accurate?

A. (Dr. Bartlett) No. Because we discussed yesterday that even if we assume that the 2.2 ksf represents the minimum value for this layer and that we assume that the minimum is of layer 2, we talked about yesterday that there are still free field ground motions that have to be resisted by this particular structure and that some of this 2.2 ksf capacity will not be available, the full capacity will not be able to resist the motions of the structure. And we still have issues with this value even at 2.2 ksf.

Q. All right. Okay.

A. (Dr. Bartlett) Do you want to add to that, Dr. Ostadan?

A. (Dr. Ostadan) Yes. I think -- just a reminder, you discussed anisotropy and some cone penetrometer testing, and whether the shear strength under extension would be different or not.

A. (Dr. Bartlett) Yes, I remember now. Also an additional issue is the types of testing done were triaxial compression, and we've talked this morning and somewhat yesterday in our line of questioning about the need to consider anisotropy and that this 2.2 ksf may not represent the average shear strength mobilized along the failure plane.

Q. All right. Let's move to the first full paragraph -- first sentence in the first full paragraph of page 84 of Exhibit 3.

A. (Dr. Bartlett) Excuse me. Did we finish our discussion of the last sentence on 83? I don't recall.

Q. I believe so, because you talked about the first half of the sentence, and you have told me earlier in the day that the second half, having estimated the thickness, was no longer a concern.

A. (Dr. Bartlett) Yes. And restricted it to thickness, yes.

Q. So that's why I believe we have finished that section. So let's just move to the next one that says that -- I'm going to paraphrase it slightly -- that the SAR section 2.6 defining geologic features is not acceptable because the discussions, maps, profiles of the site stratigraphy, structural geology, geologic

history, and engineering geology are not complete and are not supported by investigations sufficiently detailed to obtain an unambiguous representation of the site geology.

Now, do you believe that sentence that I read you to be correct today?

A. (Dr. Bartlett) That's beyond my expertise and scope of review.

Q. Based on your expertise, is there any portion of that sentence that you believe to be correct today?

MS. CHANCELLOR: Objection. He already testified it's beyond his scope.

Q. From where you sit as the designated expert on this Issue 3, would that, the matters raised in that sentence, if true, be of certain to you?

A. (Dr. Bartlett) If they were true, they would be a concern to me.

Q. How would they be a concern to you?

A. (Dr. Bartlett) One must understand the geology of a site in performing the interpretation of what has occurred and the geological processes that have acted upon this site.

Q. All right. And you don't know in fact whether this assertion is still true. Is that correct?

A. (Dr. Bartlett) Right.

Q. All right. Now, the next sentence says, "The maps do not provide the requisite detail to evaluate the assumed geologic conditions stated in the text." First of all, can you help me, tell me what maps are being described here?

A. (Dr. Bartlett) Well, again, with using the adjective "geologic," I assume it would be referring to geologic maps.

Q. What would be -- what would geologic maps be?

A. (Dr. Bartlett) Mapping of the surficial geologic units.

Q. And do you know the extent to which those maps have been prepared since SAR -- since this contention was written?

A. (Dr. Bartlett) I have not reviewed those maps.

Q. All right. So you have no knowledge as to this particular sentence?

A. (Dr. Bartlett) That's correct.

Q. Assuming this sentence was correct, would it present a concern to you?

A. (Dr. Bartlett) Geologic maps can be used to interpret features, for example, faults or surficial

geological features that could have implications and interest to the past history and potential future history of this site.

Q. Now, I'm going to ask you to read the next two sentences together, because I believe that -- and correct me, but I believe you need to read them together. The first sentence says, "The maps do not provide the requisite detail to evaluate the assumed geological conditions stated in the text." And then the next sentence says, "For example, only 25 borings were taken across the site, and from this a single generalized geologic profile in an obtuse angle across the canister fuel storage facility is presented." And the citation is given to SAR Figure 2.6-5.

A. (Dr. Bartlett) Correct.

Q. You see that?

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

Q. Here's my problem.

A. (Dr. Bartlett) I see your problem.

Q. SAR Figure 2.6-5 I do not believe is a geologic map, is it?

A. (Dr. Bartlett) It's probably a profile, I would assume.

Q. In fact, let's just not assume. Let's take a look at -- never assume when you can prove. Let's

take a look at Exhibit 51, and let's take a look at Figure 2.6-5, which is the third figure on the page.

A. (Dr. Bartlett) I see it.

Q. Okay. Does that look like a geologic map to you?

A. (Dr. Bartlett) No, that's a geotechnical cross-section.

Q. Right. And in fact, if now we look at the same Figure 2.6-5 as it sits today, it's 17 maps; is that correct? Or 14 and three maps.

A. (Dr. Bartlett) What I sense is happening here in this is that the geologist reviewed the original SAR and did not find the data that they needed to make their geological interpretations off of what is truly a geotechnical profile.

Q. All right. But what my concern is, are we talking here about a geological concern or a geotechnical concern? To the extent that he's talking about SAR Figure 2.6-5, that would indicate to me that he's talking about geotechnical, not a geological concern.

A. (Dr. Bartlett) And again, it may have been the only profile presented in the original SAR, and so it was perceived as both a geotechnical and a geological cross-section because it did show some type of layering.

Q. All right. When it says here that "a single generalized geologic profile in an obtuse angle across the canister fuel storage facility is presented," can you go back again -- I'm sorry to keep going back to it, but let's go back again to that Figure 2.6-5.

A. (Dr. Bartlett) Sure.

Q. It's defined as Foundation Profile A-A' Looking Northeast, and if you will correlate for me perhaps with Figure 2.6-2 from the same exhibit.

A. (Dr. Bartlett) I see it, okay. The cross-sectional line, I see it.

Q. All right. Is the line A-A' on 2.6-2 at an obtuse angle? Is that what he's talking about?

A. (Dr. Bartlett) I believe so. On an angle that's not perpendicular or parallel to the main -- to the building.

Q. Assuming that that's what he's talking about, that he's concerned there's only one of these lines, isn't it true that you now have, just for the pad emplacement area, 14, and there are two diagonal cuts and like half of those go east/west and half of those go north/south?

A. (Dr. Bartlett) Correct. Those are geotechnical cross-sections.

Q. Well, what I'm trying to understand, and

maybe you can help me, whether this concern now is still viable in light of all the additional information that we have.

A. (Dr. Bartlett) This, by using the term "generalized geological profile," to a geotechnical profile.

Q. Okay. If the wording of this particular sentence was changed from geologic to geotechnical profile, would you believe it's accurate today?

A. (Dr. Bartlett) In the extent that we've discussed our feelings of adequacy and inadequacy of the geotechnical profiles in this area, which we've had conversations, we've discussed those. Whether those same cross-sections meet the needs for a geological interpretation, I will not interpret that.

Q. From your standpoint, would those be sufficient?

A. (Dr. Bartlett) They may not be. They're geotechnical data, primarily, not geological data.

Q. But from a geotechnical standpoint, would they be sufficient?

A. (Dr. Bartlett) The cross-sections of the test?

Q. Yeah.

A. (Dr. Bartlett) We've discussed about their

adequacy, about delineating the stratigraphy in the upper five layers.

Q. Right, thirty feet.

A. (Dr. Bartlett) We've discussed some inadequacies we see even in the geotechnical perspective with depth.

Q. Below the top 30 feet?

A. (Dr. Bartlett) Yes, below the cone penetrometer data, CPT data.

Q. All right. And let's move on to the next sentence, that says, and I read, "The geologic profile cannot be correlated with surface topography, geological deposition soil characteristics, or seismic profiling completed for the site." Do you know whether that is an accurate statement today?

A. (Dr. Bartlett) Again, it uses the word "geological profile"; and inasmuch as I haven't really reviewed the main geological report for this site, which is the Geomatrix report, I defer from really answering any of those.

Q. And again, as you sit here today, would you consider this to be a concern to you?

A. (Dr. Bartlett) If one cannot correlate surface topography, geological deposition, soil characteristics, and deeper seismic profiling for the

site, it would be difficult to develop cross-sections that would show significant geological features, and those missing details could be important to this site.

Q. Okay. But to you is this a concern?

A. (Dr. Bartlett) From a geotechnical perspective?

Q. Yes.

A. (Dr. Bartlett) I'm not understanding that question. This is discussing geological data.

Q. Correct. I understand that you're not testifying as to what a geologist's concern might be with this statement. But as a geotechnical expert, would this statement in itself pose a concern to you?

A. (Dr. Bartlett) Yes. It might infer also, particularly with a couple aspects regarding seismic profiling, we also need some of those same types of data to develop shear wave velocity models. And so if those were incomplete, we would have difficulty also completing our analyses and characterizations.

It mentions soil characteristics. And even though -- if those soil characteristics are geotechnical, then I am concerned that they're -- that we need to better quantify the soil characteristics.

Q. Well, you would not turn to the geological profile to do that, would you?

A. (Dr. Bartlett) You bet I would.
Q. I thought you would be looking at the geotechnical profiles that we were looking at before.
A. (Dr. Bartlett) I'm also trained as a geologist, and I always look at a geological profile before I start my geotechnical investigations.
Q. Oh, so you have expertise in geology?
A. (Dr. Bartlett) I have a degree in geology.
Q. I see.
A. (Dr. Bartlett) But I am not the state's expert on that Geomatrix report.
Q. So your deferring on geology questions is not based on lack of knowledge, but it not your assumed role in this --
A. (Dr. Bartlett) I've practice as a geotechnical engineer for most of my profession. My geological skills are still there, but a little bit distant.
Q. Maybe you can help me, then, on the next sentence that says, "Details missing include the interrelationship of the subsurface conditions with the geologic history of the site." Would you just translate that for me and tell me what it means?
A. (Dr. Bartlett) I think what this is trying to do is establish the interrelationship of the

subsurface conditions and the profiles or cross-sections we talked about with the geological history: what are the geological origins of those units, what are their ages, how were they deposited, what are their characteristics from a geological perspective.

Q. To ask the question differently, would this mean a correlation with a particular subsoil level and the time in geological history in which that level was deposited?

A. (Dr. Bartlett) That's part of it, but it means more than that.

Q. What else does it mean?

A. (Dr. Bartlett) Could mean its physical characteristics. Could mean any anomalies or differences or subtle difference in this layering. Could mean also -- since it's a general term, subsurface conditions, it could mean faulting and fracturing or issues related to potential instability that's been recorded in the geological history of these sediments. It means many things.

Q. All right. Let's go back and take a look at Exhibit 50. I'm sorry, I didn't mean to cut you off. Are you finished?

A. (Dr. Bartlett) No, no. That's enough.

Q. Let's take a look at Exhibit 55. Black and

and I'm going to go on the record as either beyond the scope of his review or asked and answered.

MR. TRAVIESO-DIAZ: I'll go on the record as stating that to the extent that you have provided a witness who is going to be the expert in this contention, he ought to be able to address the matters raised in the contention unless they are dropped. And I think I have every right to explore whether he understands this particular sentence, which may or may not have been true at a time previous to today, and that's what I'm trying to find out. Because if his opinion is that this particular sentence is still true when it's litigated -- if he doesn't think it's true, then we don't need to go over it, and that's the reason I ask the questions. And I think I'm entitled to have an answer to the question. So that's my position on this, and that's what I'm asking.

DR. BARTLETT: Let's have a break.

MR. TRAVIESO-DIAZ: All right, let's have a break.

(Recess from 5:18 to 5:24 p.m.)

Q. (By Mr. Travieso-Diaz) If you can stand it, let me ask you one more question on this subject. As a geotechnical engineer, what use, if any, would you have for the geological history of a particular set of soil

layers? Do you use that information in any way?

A. (Dr. Bartlett) You bet.

Q. How?

A. (Dr. Bartlett) Qualitatively in that it helps me understand the geological origins of this site; and being trained as a geologist, I can also infer something about their engineering properties.

Q. And did you look at the Plate 3 that I showed you a moment ago when you were doing that, since it's useful to you?

A. (Dr. Bartlett) It tells me something about, yes, the Bonneville sediments.

Q. Did you look at it before I showed it to you today?

A. (Dr. Bartlett) I was provided the Geomatrix report. I have it. Whether I looked at that particular plate or not, I'm not particularly sure. I guess I can't recall whether I distinctly looked at that plate.

Q. You said that qualitatively it may be of some help to you. Quantitatively, in terms of your evaluations, do you use it in any way?

A. (Dr. Bartlett) Quantitatively, no; but qualitatively, having also studied that same Bonneville -- the same set of Bonneville deposits in this valley, I could understand at least that they're in

the same sequences, that they're roughly the same thicknesses. And also we've seen this Bonneville sediment, that it tends to have a clayier upper profile, more siltier intermediate profile, and then a deeper, clayier profile again. And that's consistent with my knowledge at the Bonneville here, and also in Skull Valley. But engineering-wise, no, because those are far enough apart that once you do site-specific investigations, you determine the properties.

Q. Thank you.

A. (Dr. Bartlett) It fits in my framework the way the -- the world makes sense.

Q. And having looked at table -- Plate 3 and in connection -- in conjunction with all the other drawings that you have looked, does that Plate 3 make sense to you compared to the other things that you have seen? Is there an inconsistency between the way that Geomatrix has characterized the subsurface conditions and the geologic history with what your analysis shows?

A. (Dr. Bartlett) I haven't compared, obviously, the individual layerings and where Geomatrix has broken a layer corresponding where the geotechnical borings and layers have been broken. The Eolian deposits are on the surface; the geotechnical report identifies them as such. The Bonneville deposits are

not necessarily identified on the geotechnical reports as Bonneville. But we see a Bonneville deep-water facies that's described in geological context: light gray, mottled white; very fine sand-clayey silt; irregular coarse angular blocky structure; plastic, sticky; abundant ostracods; manganese, iron oxide staining, so on and so forth.

It seems consistent with what I would expect to be the upper Bonneville and probably layer 2 from the geotechnical report, but we could verify if these contact boundaries matched the geotechnical report, which I have not done.

We see another Bonneville deep-water facies underlying that described as pale brown, fine sandy silt; fines upward; upward bedded; thinly laminated, abundant ostracods. I'd have to check that. I'm not sure if that's layer 3 in our correlation. Possibly. And then the deeper layers.

But having a geotechnical profile and a geological profile, I think I could interpret between the two.

Q. All right. Now, let's look at now to the next sentence on Exhibit 3, which is in the last paragraph on the page. The sentence starts with "further." Let me read it for the record.

Q. Yes.

A. (Dr. Bartlett) Do we need to worry also about from which layers they are and also from what depths they're coming from? Because there's other factors besides water content that affects strength.

Q. Assume they're from the same layer, to narrow it down somewhat.

A. (Dr. Bartlett) So this is a hypothetical set of data? We're not taking about real data?

Q. No, I'm talking about real data that is reflected in attachments to the SAR. And you can tell me, if the answer is I don't remember, that you don't remember whether the amount of water content in the sample had a significant effect in the measure of strength. That's what I'm asking you.

A. (Dr. Bartlett) Give us a moment and we'll research that.

MS. CHANCELLOR: Can we go off the record for a minute?

(Discussion off the record.)

A. (Dr. Bartlett) The issue is, could potential higher moisture contents indicate themselves in lower undrained shear strengths for unit 2? Is that what we're --

Q. Yeah, for measured samples that you have

data from for PFS.

A. (Dr. Bartlett) Correct. Let's go to Appendix B of Attachment --

Q. Are you just get a boring number, a boring sample?

A. (Dr. Bartlett) Can you do it from that? I'm looking at CTB-1. First figure --

Q. Do you have a sample number?

A. (Dr. Bartlett) Sample number U-3D. This sample has a water content of 47.9 percent. And also it's a consolidated-undrained triaxial test, we should say that. And we have plotted on the Y axis shear stress in kips per square foot. We have -- kips, k-i-p-s. Ksf. And on the X axis, axial strain percent. And we see that from the stress drain curves that the peak strength for this particular phi is somewhere between 2.8 and 2.9 ksf.

Now, in that same attachment, go to a -- and by the way, I might note it shows somewhat of a brittle behavior to me. It reaches a peak and drops off dramatically on larger strain.

When we go to Boring CTB-N, it's seven pages --

MR. TRUDEAU: Sample.

A. (Dr. Bartlett) -- U-2B. I should have

added, too, the depth from the previous sample was 8.4 feet, so it's probably within layer 2. It's -- at least the depth range seems appropriate.

When we look at this sample, which has a water content of 65.4, the peak strength is a much larger strain, and it is at about 2.4 ksf.

Q. Does that mean that the second sample is stronger than the first?

A. (Dr. Bartlett) This means that the second sample is weaker than the first.

Q. I am reminded to ask you, if you look at the void ratios for the two samples, if there is a significant difference also in the void ratio?

A. (Dr. Bartlett) One is 1.73, one is 2.76.

Q. Could the higher void ratio in the second sample result in lower strength?

A. (Dr. Bartlett) It could. Generally also unstrained shear strength is correlated with void ratios, but the data are inclusive.

Q. Oh, one more question. We're talking about water infiltration. I presume that your concern is water coming from above, not water coming from below.

A. (Dr. Bartlett) No, it's not coming from the ground water.

Q. I wanted to get that clear.

A. (Dr. Bartlett) Sure. We have that situation on buying beach front property.

Q. So that I understand one more aspect of your concern about water, your concern is that the soils will lose strength. Are you concerned that it will collapse altogether?

A. (Dr. Bartlett) In the sense we're using "collapse," I guess I'd better make sure you and I are using "collapse" in the right terminology, if collapse means something to me from --

Q. What collapse means to you, just to make sure we're not talking past each other.

A. (Dr. Bartlett) Collapse -- we do have collapsible soils in the west that are due to wetting and -- either collapse upon just wetting, or wetting and application of load, or just once in a while just the application of a load. I believe the main layer of concern for collapse was the Eolian silts.

Q. Layer 2 we were talking about?

A. (Dr. Bartlett) Layer 2 in my experience in the Bonneville is not really characterized as a collapsible soil. However, I must kind of reframe my knowledge to the Bonneville as a collapsible soil to this valley where it's saturated. But the Bonneville is not known as a particularly collapsible soil. However,

we have talked about loss of shear strength due to straining, due to cyclic motion. Some people use that as collapse, too.

Q. Actually, it may sound like bragging, but I was using the term the way you were, so --

A. (Dr. Bartlett) Fair enough. So if we're restricting ourselves to collapsible soils in the sense of wetting and collapse under static loads. There was an RAI about this. I think our main concern was the Eolian deposits. Those would be treated with soil cement, and I assume that will fix that problem.

Q. I apologize. I was not paying attention but looking at something else.

Let us move on Exhibit 3 to paragraph B on top of page 85. I'm referring to the paragraph that starts with the letter b and the caption "Sampling and analysis." Going on to the second sentence, which I believe the first sentence -- well, just going to the second sentence.

A. (Dr. Bartlett) Okay.

Q. Starts with "However." Do you see that?

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

Q. It says that "PFS's sampling program is not adequate in quantity (number of samples)" --

A. (Dr. Bartlett) Correct.

Q. -- "and quality (suitable recovery of disturbed and undisturbed samples)," and there is a footnote, 20, which I'm not going to read, "to ensure that all materials that are critical for geotechnical evaluation of the site have been adequately sampled."

Is this a concern that's accurate today?

A. (Dr. Bartlett) As we still have issues regarding the number of samples that have been performed, particularly in regards to strength characterization, and the quality of sampling -- "suitable recovery of disturbed and undisturbed samples." Again, we've talked this morning about disturbed versus undisturbed samples. In this context "disturbed" I believe is meaning split spoon sampling, and "undisturbed samples" would be for this case the Shelby tube sample.

I'm not sure sample quality is a large issue to us anymore, but certainly the number of samples and how they represent the lateral variability of these materials throughout the pad emplacement area and the canister transfer building area are still issues.

Q. How about the suitable recovery of disturbed and undisturbed samples? Is that unusual for you still?

A. (Dr. Bartlett) I think the recovery is -- you lose samples, but it seems like there's -- for a

particular borehole that disturbed and undisturbed samples were recovered and brought to the surface.

Q. Would it be correct if we -- to simplify this discussion that as far as this paragraph is concerned, your current area of concern is restricted to the quantity of samples being sufficient?

A. (Dr. Bartlett) And how representative that quantity --

MS CHANCELLOR: Could I clarify? Are you talking about the entire paragraph or just the sentence?

MR. TRAVIESO-DIAZ: No, no, the sentence.

MS. CHANCELLOR: You said paragraph.

MR. TRAVIESO-DIAZ: I misspoke, as I tend to do.

A. (Dr. Bartlett) The quality of the number of the samples, and it implies there to ensure that all critical materials have been properly represented and evaluated. So it's an assessment of not only the number, but is that number representative of the layer in its entirety throughout the whole area of the pad emplacement and canister transfer building.

Q. Fair enough. Now, could you describe a little bit more what the concern is as to the number of samples?

A. (Dr. Bartlett) There's been very limited

COPY OF TRANSCRIPT

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

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

Friday, November 17, 2000 - 8:40 a.m.

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

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

Q. Could you explain to us what X is?

A. (Dr. Bartlett) When we reviewed the calculations initially, it appeared to us that for the stability analysis or seismic stability sliding analysis of the pads that we could see shear strengths determined from two tests that were done. And we were concerned about, first, were those representative of this entire pad area, and also whether designers have considered if there was any potential variation in that value. It was hard to understand what this value meant. When we calculate factors of safety we like to know whether it's kind of a lower bound value that was being used, a medium or mean or upper bound. And we just really could not ascertain that.

Q. Now, there is a new calculation as we discussed earlier.

A. (Dr. Bartlett) Correct.

Q. Does the new calculation address this concern?

A. (Dr. Bartlett) Additional data have been gathered. We still have concerns about their adequacy. And yesterday when we started discussing the cone penetrometer data, that was the beginnings of discussing potential variation across this site. I don't know if you want to go into that or if we just want to defer

that to after --

Q. In the interest of getting Dr. Ostadan out of town early --

A. (Dr. Bartlett) Yeah, let's defer that, because I think we're going to go back to that.

Q. Definitely.

A. (Dr. Bartlett) Okay. So we can readdress the shear strength value for design when we start that discussion.

We had some initial concerns. Let's see if it's in here, too. Yes, there's a statement here that the Naval Facility Design Manual 7.2 provides an adhesion value of 950 to 1300 PSF. What the issue here was is when we reviewed the calculation, the applicant was using the full what we call cohesion of the clay. Some designers, instead of using full cohesion or cohesive strength of the clay, recommend that you should be using what's called an adhesion factor. In this case, it would have been between the concrete and the clay at that time. So we were concerned about using full cohesive strength and suggested that perhaps that adhesion would be more appropriate since we had concrete resting on top of clay.

That may be somewhat resolved with the addition of soil cement. We would still like to know

what, if any, issues of sliding with that bonding is between the concrete pad and soil cement interface. We assume that the lower interface, where the soil cement interfases with the clay, that that would probably be a fairly rough interface and that it might be appropriate then to use full cohesion. But we just don't really know much about that interface at this time until you submit a design.

Q. Would it be fair to say -- and I don't want to put words in your mouth, but would it be fair to say that the concerns that you have on Item X are -- whether they remain concerns or not depends on the review of the design of the soil cement foundation?

A. (Dr. Bartlett) Correct.

Q. Go to item Y. And this is back to you, Dr. Ostadan, I believe.

A. (Dr. Ostadan) Yes, thank you. This is -- actually, we've seen this comment before. At the time, every team has its own time history. So none of this comment's repeated here. I think the Stone & Webster develop their own time history, and this comment no longer applies. It's historic.

Q. And how about Item Z, checks for drift? This sounds very much like item N that we discussed before.

The applicant disagrees with the state with respect to whether foundation loading is contained in Basis 3, and we have agreed to disagree.

Is that a correct statement?

MR. TRAVIESO-DIAZ: That's a fair, correct statement. However, I would like you to add also that you do not anticipate that Dr. Ostadan will be testifying with respect to Basis 4.

MS. CHANCELLOR: Oh, that's correct. I'm sorry. I thought that I did that. No, Dr. Ostadan will not be testifying with respect to the -- the caption to Basis 4 is "Soil stability and foundation loading." Dr. Ostadan will be testifying with respect to foundation loading, but the text of Basis 4 does not address foundation loading.

MR. TRAVIESO-DIAZ: Will you stipulate that he will not present testimony on Basis 4?

MS. CHANCELLOR: Provided that foundation loading, you don't say that foundation loading is precluded because it's in the caption of Basis 4.

MR. TRAVIESO-DIAZ: I will stipulate that to the extent there is any foundation loading issue admitted into this, the litigation of this contention will be part of Basis 3.

MS. CHANCELLOR: So stipulated.

A. Right.

Q. But before you could print an opinion or have a conclusion based on Exhibit 59, wouldn't you with respect to unit weights have to look more into it?

A. Well, I think before we worry about whether we have a unit weight that could be somewhat variable, I guess the next approach would be is to go back in and look at the effect of sigma-V on the parameter that we're trying to calculate. Even if we looked at variations between 40 and 70, if the component of sigma-V which is contributing to the shear strength is not large, then this may be somewhat of a trivial thing we're doing here.

Q. Are you saying that perhaps if Q_c is so much larger, that --

A. Yes, that it may override the variation that we see in sigma-V.

Q. Okay. That's a fair consideration. But then you'd have to do that analysis?

A. I would just have to plug in the values. It's not a very difficult thing to do if we know the weights of the materials.

Q. Before we do that, let's talk now on N_k. I take it that you are assuming, as you said, N_k is a constant?

A. Well, N_k would vary according to different types of soils. That's reasonably known. In fact, it's unfortunately a very variable parameter, and that's what makes this correlation hard to apply to soils without some prior experience of calculating it. What I'm saying is N_k should be locally correlated and used not trying to apply an N_k for soils here versus soils somewhat quite a distance away.

Q. Let me ask the question this other way. In order for the relationship between the cone penetration tip resistance --

A. Correct.

Q. -- and the undrained shear strength to be able to draw up the conclusions, you testified earlier that you would need to have N_k be a constant across a layer?

A. It would have to be assumed if you're going to use it to predict a certain layer that it is constant, yes.

Q. All right. And what is your basis for assuming that N_k is constant across a layer of soil?

A. Just from the cone penetrometer data, it seems to be that the upper Bonneville clay seems to be relatively homogeneous, at least in the interval from about somewhere around five feet. It's hard, you know,

that five-foot boundary gets a little blurred. Sometimes it's as high as three feet. Down to about eight to ten feet we seem to get a monotonous, if you will, tip stress signature, and my prior experience with the upper Bonneville clay is it's somewhat of a monotonous clay. It can vary from a silty clay to clayey silt.

Q. Even within a monotonous layer, as you describe it, would N_k be a function of factors such as plasticity?

A. It could, yes.

Q. Let me show you -- let's mark this as an exhibit. Let's call that Exhibit 72.

(Exhibit-72 marked.)

Q. (By Mr. Travieso-Diaz) Now, what I have provided you as Exhibit 72 I believe is a portion of a treatise called -- or it's not a treatise, at least -- a monograph perhaps is the word, called "Cone Penetration Testing in Geotechnical Practice" by Tom Lunne, L-u-n-n-e, Peter Robertson, and John Powell.

A. Yes, I see.

Q. Are you familiar with this treatise or this monograph?

A. I haven't seen it in this form, but I may have seen parts of the equation. So it's -- there's

else that we can draw from this Exhibit 59?

A. No, other than it's just a potential approach to look at the variability. Do with it what you may. It was just something I was trying to understand.

MR. TRAVIESO-DIAZ: All right. Off the record for a second.

(Discussion off the record.)

MR. TRAVIESO-DIAZ: Let's go back on the record.

Q. (By Mr. Travieso-Diaz) And before we talked about Exhibit 59, we were beginning to go over Basis 3b as it is described on Exhibit 3, page 85.

A. Exhibit 3?

Q. Exhibit 3 is the statement of the contention.

A. Got it.

Q. If I recall, yesterday we did go through Basis 3.

A. Yes. This is the copy I had yesterday, because I recall my markings on it.

Q. Right. And we were on b on page 85.

A. Okay.

Q. And I am embarrassed to tell you that I don't recall exactly where on page 85 we were, but at

the risk of repeating what has been covered already, and if I have, I apologize, I believe we have not talked about the statement that starts in the middle of paragraph b on page 85 that says, "For example, only five undisturbed samples were collected." Do you recall our discussing that before?

A. I'm not sure.

Q. Am I in the right place? Thank you much.

Now, tell me first as to the numbers that are outside there. Are those correct numbers as of today?

A. Well, no, not of today, because there has been additional sampling, yes.

Q. So you will say that even though your opinion may be that the sampling, even though maybe it's not enough, the sampling certainly is significantly bigger than what's shown in that sentence?

A. There is more basis for undrained shear strength than there was when this was initially written.

Q. Okay. Now, if I remember, I asked you yesterday how many more you think would be sufficient, and you were not able to tell me how many more.

A. It's a difficult question, because it does again go back to our understanding of the potential variability within the layer. If it's perfectly

homogeneous, we need one sample. If there's variability, then our challenge is try to understand whether we've captured somewhat that variability in our sampling program. So that's why determining the number of samples is not always an objective process. But we try to keep it as objective as possible.

Q. Now, I am going to show you -- I'll mark as an exhibit, which is I guess now 73.

(Exhibit-73 marked.)

MR. TRAVIESO-DIAZ: For the record, Exhibit 73 consists of a two-page drawing identified as Figure 2.6-20 of the SAR, and it's entitled "Soil Properties Vs. Depth in Storage Pad Area." And again, has two sheets. It doesn't show a revision number. If it does have it, it's not on my copy.

Q. (By Mr. Travieso-Diaz) Are you familiar with this figure?

A. Yes, I've seen this before.

Q. As I understand, the intent of this figure was to try to group and present as a function of depth various properties of samples taken in various borings in the pad emplacement area. Is that a fair characterization of what this appears to be?

A. Yes. It's trying to summarize data versus depth for these borings.

Q. All right. And now looking at the first of the data sets, if you will, which is a plot of N blows per foot versus depth.

A. Correct.

Q. I take it N, as we discussed earlier, is the number of --

A. Blows to drive the split spoon sampler one foot with a 140 found hammer falling 30 inches.

Q. Now, it has as a key -- it's trying to do something similar to what did you in Exhibit 59, I guess, in that it's trying to superimpose the results of borings --

A. Correct. Data approximately taken every five feet, yes.

Q. And from four different borings, A-1, B-1, C-1, D-1?

A. Yes.

Q. Okay. Now, if you look at that data set and you try to look across again, we're interested in the layer between I guess zero and ten feet -- three and ten feet?

A. Yes.

Q. Okay. For that figure on top, I see that at least three of the data points, the N value is essentially the same. I don't know where the fourth one

lies. There may not even be a fourth one, or --

A. They may have done an undisturbed sample, so you're missing a blow count in that interval.

Q. Will you read that figure for me on that layer?

A. At five feet?

Q. Yes.

A. The blow counts -- do you want the blow count values?

Q. Well, yes, if you can do it.

A. Looks like approximately 8, probably 12 and then maybe 13.

Q. So the range is from 8 to 13 or so?

A. Correct.

Q. And if you look at -- the same figure looks at -- I'm sorry. The same type of information is presented in the graph immediately below?

A. Correct.

Q. Which is N versus depth. But now we're talking about Borings A-2, B-2, C-2, and D-2?

A. Correct.

Q. And if you look at -- again at 5, I think that you have here only two data points.

A. Yeah.

Q. Two data points are pretty close, correct?

were going to look only at the depth that we are talking about, which appears to be the one of interest which is layer 2, would you conclude based only on this data, and there may be limitations to using just this data, that the blow counts are going to be uniform for the 16 samples that we looked at?

A. No, you wouldn't conclude that. But we do get into the same issue again that we see some fairly high blow counts. For example, I'll point out the last diagram we looked at, the one approximately 17 or 18. Again, I would make sure that that didn't capture some of the bottom of the Eolian silts, because it certainly is inconsistent with the other data and it seems to be inconsistent with the monotonous layer that we've seen in the cone penetrometer.

And might I add that really I personally believe, and I think others would substantiate this, that the cone penetrometer data are better for trying to do just this, because there is -- the standard penetration test is, due to many, many different errors, the cone penetrometer test is a much more standardized test.

Q. Well, what I'm trying to gather is an understanding from you and taking into account the limitations of the data that you just mentioned -- and

by the way, if you have a higher blow count, it means that your soil is stronger?

A. It can mean two things. In sands, it means it's usually denser and stronger. In clays, we use the term "stiffer."

Q. And if you throw that data point out as being an outlier, you're being conservative in a way?

A. If you're trying to predict strength, that's correct.

Q. All right. But my question is, can you draw any inferences, or would it appear to you that understanding the limitations of using N --

A. Right.

Q. -- to predict uniformity, but at least as far as the N values that you agreed, they are reasonably uniform for layer 2?

A. I don't like that 17. Something just bothers me about it. I'm not going to include it in the data set. I just can't. Not in these units.

Q. Okay. You take the 17 out?

A. Yeah, I'll take the 17 out. Then we're looking at something between 8 and 12, 6 and 13, 5. So somewhere between 5 and maybe 12 to 13 blows would be a representative. That's a reasonable amount of differences in this unit. A factor of two, two and a

half.

Q. And what conclusion would you draw -- be able to draw, if any, based on that observation as to the possible uniformity of the soil in layer 2 using N only as a reference point?

A. But there's suggestion that there are stiffer or denser layers in here, if that's what we're truly measuring when we pound that thing in the ground.

Q. Let's go to -- let's go back to Exhibit 3.

A. Sure.

Q. I think you did testify that with respect to the next sentence that reads, "Unless subsurface conditions are predictably uniform across the site, the number of tests and analyses are inadequate to accurately model the expected behavior of the soil foundation under static and dynamic loading."

A. That I cannot remember what I've said.

Q. Well, if I recall, your testimony was that you consider this still to be a valid concern and that the reason it was a valid concern is that in fact you had some doubts as to where -- whether the soils on layer 2 were uniform horizontally across the site.

A. Yeah, that was I think the reason why I went to the cone penetrometer data to try to discover that variability, and it looked like the tip stresses varied

roughly by a factor of two. And maybe that's not a bad estimate, because we now see the standard penetration values varying by roughly a factor of two to two and a half. But I'm not inferring that the undrained shear strengths vary that largely, but we do see penetration values from both sets of data suggesting a variation by a factor of two, possibly two and a half.

Q. Going to -- I'm sorry.

A. I'm not sure if I said this yesterday, but I guess the reason why we're focusing in so closely on this issue is because we discussed Wednesday that the applicant has used the peak strength to estimate foundation loadings. And we've pointed out a couple things that concern us with using peak strength if indeed the values that they have picked are peak strengths.

First, the free field ground motion that comes up through the soil column mobilizes some of the shear strength. There has to be something to resist the free flow motions, and we do not know how much of that peak strengths is being mobilized, or, in other words, how much of the capacity is left of peak to resist for foundation loading. And we can't really determine that yet from the applicant's data.

And then secondly, we were concerned that

potential degradation -- I'm going to use degrading, degrading of peak due to cycling. The applicant has done stress controlled triaxlic cyclic shear, and we believe that it would be prudent to revisit the strains that are developed in this key layer from the 1-D shake analyses and run strain controlled tests at that level to see if there's any potential for degradation. And our concern for potential degradation really is not so much that the clays will degrade, because my experience with the Bonneville clay is it doesn't degrade significantly, but we have heard suggestions that some of the strength is derived from cementation. If there is cementation going on, we need to know at what strain level, not what stress level, but what strain level might that degradation occur.

And those I guess are our concerns under static and dynamics. So that's why this 2.2 kips per square foot or approximately there that's used in a lot of the analyses became -- become important to us. Fair enough?

Q. Yes. Let me ask you a question about cementation, though, because we really have not addressed that totally before.

A. Yes.

Q. And we'll talk more.

Q. How can I make the question better? Okay. Strike that question. We don't need to go into that.

A. We are taking the 2.2 ksf at face value. I have not seen anything that the applicant has said that there is no cementation in that value, so we have to assume that there could be some even of that 2.2 ksf that could be potentially cementation. We're just looking at the data at face value. We do not I think fully understand the mechanism that's going on with cementation and what role it is or is not playing to these shear strengths.

Q. Fair enough. You have raised a variety of issues which I think we may better take one by one at an appropriate point rather than trying to deal with them all at once. Let's just follow on, because they're going to come up, I believe, as we go through Exhibit 3.

Could you turn to the top of page 86. And the first sentence says, "The investigations (sampling and analysis) to determine the properties of the various materials underlying the site are not sufficient." And what I would like to understand is, because there is a discussion that follows through several sentences in the rest of the paragraph, and my question, see if you can follow what I'm asking you. --

A. Fair enough.

Q. -- whether the first sentence says anything different from what the totality of the others do say. We need to examine the first sentence separate from the rest.

A. Yes, this first sentence seems to be a general statement.

Q. So it is like a summary or a general --

A. Of what should follow, yes.

Q. All right. So let's keep that sentence and go to the others. Second sentence says, "The scope of investigations should match the design requirements of the facility and complexities of the site." Again, would you characterize this as a general statement as to what should happen?

A. It may imply that because we're dealing with a nuclear safety facility that we should pay prudent attention to the requirements for design at such a facility. That's what I would interpret maybe in the design requirements. And then complexity of the sites I guess is inferring that somebody's already got some idea about -- that this may be a very complex site.

Q. Okay. But in itself, is there any assertion that is made in that sentence with respect to the investigations that were conducted at the site?

A. Well, I think it also implies that when one

goes through a design that one should consider the appropriate tests to resolve design issues.

Q. Okay. Fair. But let's move now to the third sentence, which says, "For example, the analysis of soil is not based on the results of dynamic testing of insitu samples either in a stress or strain controlled manner."

A. Correct.

Q. Now, as I read that sentence, that one is making an assertion --

A. That is correct. It says that --

Q. -- of a problem.

MS. CHANCELLOR: It's got "for example," so I want to make sure that you're not limiting it to just this.

MR. TRAVIESO-DIAZ: Well, I think when you say "for example," it's hard to limit it to what follows grammatically.

A. So for example, it's saying at this point in time when this was reviewed that there were no dynamic testing in either a strain or stress controlled manner.

Q. And my question would -- just with respect to this, for example, is it -- has the concern raised with respect to this particular sentence remained viable based on the additional testing that has been conducted

by applicant?

A. I think we discussed Wednesday about, again, looking at the amount of strain developed particularly in layer 2 and doing cyclic triaxial strain tests to look at degradation. The applicant has done stress controlled testing, but it appears that the stress level at which those tests were done may not be applicable in light of some of Dr. Ostadan's comments about the foundation loadings. They may have been underestimated. And generally when we want to look at degrading of strength, a strain controlled manner would be preferable.

Q. I know it's hard to try to correlate a sentence I was reading three years ago with current concerns.

A. Correct.

Q. Now, what I'm trying to do throughout this examination is to figure out what your current concern is with respect to the issue that is addressed in the sentence that we're talking about; and if I hear you correctly, you have a concern with that the testing was done as of today only in a stress controlled manner and that no strain control tests have been conducted?

A. For cyclic triaxial.

Q. For cyclic triaxial. All right.

Now, take a look at -- well, the last sentence on that paragraph, if I remember your testimony and Dr. Ostadan's, is trying to correlate the fact that these tests have not been run with the ability or lack thereof to create a seismic profiling of the site. I'm trying to follow the text.

A. I'm trying to understand what this -- we did raise issues of, you know, potential adjustments that need to be made to the refraction data as a result of the seismic cone penetrometer. I remember those discussions with Dr. Ostadan. This sentence, though, I don't think is alluding to that. It's alluding again to the use, and I think it's -- when it says "these data," it's talking again about stress controlled or strain controlled manner. And I assume when it says "field seismic profiling," again that's out of my area of expertise, but in some way maybe these data from these laboratory tests help in determining shear wave velocities because one can also determine a modulus or stiffness from it.

Q. Okay.

A. So I think that, frankly, the seismic cone penetrometer data and how we suggested that looking at that and at the refraction data, because of -- in light of the seismic cone penetrometer data need to be

adjusted is a better way to go. And I do not see really any advantage in using stress or strain controlled triaxial data -- cyclic triaxial data and the appropriate -- and the moduli to go back and help with the field seismic profiling.

Now, let me see what the rest of this is.

Q. Let me try to help you in the rest of the sentence.

A. Okay.

Q. The last clause I think we already talked about earlier, "determine the potential for soil collapse." That's not really a concern?

A. No. We've seen cyclic triaxial testing done for that, and I think that's why some of the stress controlled tests were done initially is to try to determine the potential collapse of these soils. I'm not so concerned about collapse, and I think we've already talked about that in Basis 4 and dismissed that.

Q. Let me ask you something that I think I understood you to say.

A. Sure.

Q. And if I didn't get you right, just correct me. Did you say a moment ago that your recommended approach would be perhaps to enhance or increase your cone penetration data?

A. No. What I was saying is, Dr. Ostadan suggested that when the geophysicists develop their refraction profile that part of the assumption that they have to do in developing their model is make an assumed shear wave velocity profile. And that model is kind of, I think they call it an inversion process. You kind of guess and then take the data, and you keep going through this process until what you're gathering back and what you assume have some convergence, and then you think you have a realistic seismic model with depth. Again, I'm not a geophysicist.

But the initial survey was done with an assumed velocity model in the shallow layer. And we now see the seismic cone penetrometer showing that layer 2 perhaps had lower shear wave velocities than what was anticipated when the refraction survey was done. And I think he suggested that one should revisit that and see if the seismic cone penetrometer data would help in adjusting that deeper refraction data.

We do see some -- even some inconsistencies with the deeper data. Well, no, I'm not going to -- that may not be correct. I'm going to not go into that area.

Q. Okay.

A. And this sentence seems to suggest to me

that one could use the strain controlled or stress controlled cyclic triaxial data to help calibrate your geophysical model, but I think that the seismic cone penetrometer data is more valuable in doing that.

Q. It's a better tool?

A. Yes. Leave it at that.

Q. Let's go to the first sentence on the second paragraph on page 86. And the sentence indicates that -- I'm going to paraphrase it slightly -- that there is not enough test data to determine that the strength tests have been performed on undisturbed samples and that there is sufficient relevant test data to support the selection of the design parameters.

Now, I understand this to be saying two different things, and correct me if I'm wrong in my interpretation. But the first half is saying, you don't have enough test data to determine that you indeed have run your test on undisturbed samples. Is that how you read the first half?

A. Let me really focus on it.

Q. Yes. I'm sorry. It's difficult.

A. Yes, I think I read that the same way, that here is somebody trying to understand whether there has been disturbance on the tests, and there's not enough data to support that. Again, we've seen examples of

minor disturbance, but I don't think that that's a large issue here.

The second part of the sentence then again says that there are sufficient relevant tests to support the selection of design parameters. We still, as we've discussed, feel uncomfortable about the design with the few number of tests we've seen.

Q. So again, I thought that that's what you said earlier. But just concentrating on this particular sentence here, the first half isn't really your concern; what you're concerned about is that we haven't done testing to feel comfortable that we --

A. About the undrained shear strengths, right.

Q. It's ten minutes to seven. Do you want to take a break?

A. I'm fine.

May I offer a suggestion?

Q. Yes. Always open to suggestions.

A. Since it is such a key parameter and we do have I think some idea from the cone penetrometer where potentially weak zones may be, one could easily go through the data and select, like I did, looking for a fairly low value that's consistent through a reasonably thick interval, thick meaning two to three, four feet, and do somewhat targeted sampling around that. The

that has happened, perhaps not as much as you would like. And dealing with the foundations, again it has also happened.

So would it be fair to say that again the concern that is expressed in that particular sentence is still your concern with respect to the number of the samples that have been taken as to -- as it appears to say here as to whether samples are taken at all?

Is that an understandable sentence? No? I didn't think so. I tried. It sounded good to me.

A. I think we talked about this yesterday, and we now have information that we didn't have when this was written, a much better idea of the soil stratigraphy, at least in the upper 30, 35 feet where the cone penetrometer data are. We can now do more focused studies and resolve issues in key layers. I'm not implying that in this five layer system that we're looking at in the upper 30 feet, 30, 35 feet that we need to worry about fully -- worry about certain layers. There seems to be certain layers to me that are not of particular interest now. The Eolian silt is no longer a real particular interest to us. It may have some interest when you design your soil cement and some of the issues associated with it, but those are different types of testing we're talking about here.

Layer 2 we've discussed extensively.

Layer 3 appears to be siltier, denser, probably from a standpoint that I can see is not as great a concern.

Layer 4 is again a Bonneville clay sequence. At least it seems to be more plastic, but again stiffer because it's deeper. I'll leave it up to -- I haven't really gone through and seen the data in that layer. I again defer to Dr. Ostadan in maybe if there are some things that are unresolved in layer 4. But from a strength perspective, I don't see a lot there, because it's deeper and stiffer. And if N_k is somewhat constant between these two layers, I think you can figure out, and you've already done, that how to increase the strength in that layer. Fair enough.

Layer 5 is extremely dense.

Q. Layer 5 is where?

A. It's that dense -- I can't -- is it a sandy silt/silty sand that we start getting quite high blow counts.

Q. Just so that we on the record --

A. Let's look at that.

Q. We're talking about where potential depth. Let's see if we can get that. You know what I'm looking for. Here it is.

A. Let's use -- let's do the first one, because that's probably the best.

Q. And we are looking at Exhibit 53, which was the 14-sheet set of foundation profiles. And --

A. Correct.

Q. -- those foundation profiles have various soil layers identified, and we're just trying to figure out where layer 5 starts.

A. Layer 5 in this profile on the left-hand side where there's a labeling CPT-36 begins at approximately 433, 34 feet.

MS. CHANCELLOR: Four hundred?

A. Let's try 4,433 feet elevation. And you can see a marked increase in the penetration resistance as it's going up to about 36 there. Likewise we can see the cone trace going up to near refusal just below that depth.

Q. In terms of depth below surface, how many feet is that?

A. Oh, let's see. The ground surface is approximately 4,463. So it would be about 33 feet below ground surface, and is also labeled silty sand/sandy silt.

Q. Again, could you repeat the depth?

A. I believe I said 33 feet.

Q. So it's below 30 feet?

A. Yeah. I think it's characterized in the SAR somewhere between 30 and 35 feet. It has a little bit of variability in its depth.

Q. Would it be fair to summarize that from your standpoint, the layer of concern, using the classification that is on that exhibit, would be layer 2?

A. Layer 2 primarily, though I haven't really strongly focused on layer 4, but I don't see how it would affect sliding or perhaps bearing capacity calculations. But I will defer a little bit on dynamic response analyses if there's any issues remaining with it in its characterization.

Q. And not trying to short change, if you will, what has been said here. What I'm trying to -- if there is a way that we can summarize the concern to translate what is in this exhibit into things that the state is fairly worried about now in this area. And with that in mind, could you look at the last two sentences in this second paragraph of page 86 to tell me if there is anything in the discussion there that is different from what we have already discussed with respect to essentially we haven't seen enough data to feel comfortable that we have picked the design parameters

properly?

A. I'm a little bit hesitant to get into rock characteristics. But soil characteristics, again, other than maybe characterization for shake or dynamic response analyses, I'll defer to Dr. Ostadan's characterization. And what he said, I can't remember all of what's been said today about that, but from my perspective, the soils are fine -- well, not fine, but I'll defer to what I said the last ten minutes or so.

MR. TRAVIESO-DIAZ: Can we go off the record for a second?

(Discussion off the record.)

Q. (By Mr. Travieso-Diaz) Let me rephrase the question. My understanding of the current perception of the state of the concern expressed in the last two sentences of page 86 has to do that there is insufficient information in your perception with respect to the characteristics of the soil of layer 2 to make you feel confident that the design parameters for this facility have been selected appropriately based on the results of tests performed today.

A. That is correct.

Q. Would you like to elaborate on that?

A. Yes. The engineering analyses that deal with seismic dynamic sliding and dynamic bearing

capacity really rely upon soils that are in the shallow profile, namely layer 2, though for the canister transfer building are fairly wide foundations. I imagine that issues come up with even layers 3 and 4 because of the width of the foundation. I don't know how deep the bearing capacity, the bearing capacity circle goes. But it seems to me the key layer is layer 2. We understand from this data that apparently layer 3 is denser. It appears to be perhaps more granular, though it may have some plasticity to it.

Layer 4 is a much thinner layer. It has apparently higher tip resistances. I'll defer whether it's cohesive or cohesionless. It appears to be cohesive, and the applicant's already come up with, once they have determined the appropriate undrained shear strengths in layer 2, a way to ratio that layer 4 up, and they've used that already. We have no I think major objections to that.

So from my perspective, layer 2 seems to be the one that we just had outstanding issues with. I will defer for dynamic response to any additional data that maybe Dr. Ostadan may have suggested.

Q. Now, I take it that your response does not include, because he's not here to expand on it, concerns that Dr. Ostadan may have as to the dynamic performance

of some of the layers?

A. Correct. The dynamic characterization and the properties you get there are a little bit different than the shear strength properties that we've been talking about. And I believe he talked a little bit about some of the assumptions in the modulus and damping curves that were used in the shake analyses. And I'll defer to his testimony about those type of properties and how he derived those.

Q. Now, can we turn to the top of page 87? The first sentence on page top of 87 says that "The collected field data must be compared with the soil information found in the literature, and correlated with other data for similar soils when comparing the shear modulus values."

I have difficulty asking questions on this particular sentence because there's so much that I don't understand what I'm talking about. Can you help me? Do you -- can you try to actualize what the concern is, if any, with respect to this first sentence?

A. I think it's trying to state when we predict shear modulus values that one should compare the collected field data and the appropriate parameters. Again, for shear modulus I'm not an expert on, but for granular soils it's most likely a function of density or

something to that effect for clayey soils, plasticity, and make sure that one's using appropriate curves when you do -- when you assign shear modulus values from the literature.

I think Dr. Ostadan is a better -- his testimony is better on this issue, but I'll defer to -- he I think suggested that we had seen for this soil profile some resonant column testing data to develop shear modulus curves. I'm not sure exactly how they were applied and also whether they -- well, since they came from these soils, they would have to be considered more representative of textbook values.

Q. In fact, that's what my concern is. The concern that Dr. Ostadan expressed is exactly the opposite of what it says here, that we haven't given enough credence or haven't done enough with site specific data and would rely on the literature too much. So I don't know what to make of this concern based on his testimony.

A. Yes, I see what you're saying. I will just say I confer with Dr. Ostadan's recommendation. If we do have site specific data and curves developed, it seems to me always a more -- a better, better set of data because it is representative of the site. When one applies textbook values, then you have to be careful to

make sure that you can say that they are representative of this site.

I don't know exactly. Obviously there are not resonant column data for all of these layers in the system, and I'll defer to Dr. Ostadan's testimony where he believes that those site specific modulus curves should be applied. I believe they'll be predominantly in the shallow surface. For the deeper layers maybe textbook values may be appropriate. I'll defer to him. That's I think somewhat consistent with what's been said today.

Q. Isn't it a fact that general engineering principles, which I suspect apply to soils as much as is where, that to the extent you're able -- reasonably able to collect site specific data, you prefer to use that --

A. Correct.

Q. -- as opposed to resorting to literature?

A. That is correct.

Q. And the literature's a fallback when you have nothing better to resort to?

A. Or when maybe your analyses are not too sensitive to the assumed values. And I think that's what Dr. Ostadan was trying to say, and we're not -- we couldn't tell whether we saw that site specific data really being applied. So the question is why was it

not.

Q. Yeah, I believe that both you and Dr. Ostadan mentioned that before.

A. Sure.

Q. Now, look with me at the second sentence in that paragraph that says "Applicant must obtain representative undisturbed samples of each of the site soils and determine their dynamic properties." Again, this sentence is really not -- not what we're talking about anymore, is it? I mean, in terms of that you like to see more samples for the layers of interest, which in this case is layer 2, and perhaps --

A. Dynamic properties infers a couple different types of testing, perhaps. We just finished discussing the resonant column type testing. I'll defer to his testimony about what he thought about that resonant column data, how it should be applied. I think we've already discussed in layer 2 cyclic triaxial strain controlled testing that can also be inferred as a dynamic test. And we discussed our feelings about that. So I think we kind of already covered what this is saying.

(Recess from 7:17 to 7:35 p.m.)

Q. (By Mr. Travieso-Diaz) When when we took our break we were about to discuss the last sentence,

the next to the last sentence of the first paragraph of page 87, which starts with "The apparent differences in Poisson's ratio as cited in SWECO calculations should be evaluated, not assumed to be an appropriate value, and then used for safety related calculations." Is this an issue that has already been addressed?

A. Trying to decide what the SWECO calculation refers to.

Q. I believe that SWECO is Stone & Webster.

A. Okay. Poisson's ratio, from my perspective, is not usually used. However, in dynamic analyses it is an input. I don't recall any testimony by Dr. Ostadan that raised significant issues with this, but I guess all we can say at this point is go back and look at those assumptions of Poisson's ratio. If there are newer data that could help -- help in determining Poisson's ratio, fine, look at that.

Q. Do you personally have any concerns that you would like to discuss with respect to this sentence?

A. I do not in my review, no.

Q. Moving to the next paragraph, the first sentence that starts with "The license application does not provide a detailed and quantitative discussion." I won't read the rest of this paragraph into the record. Is there any concerns that are expressed in that

paragraph that have not been addressed in your prior testimony?

A. Did you say the paragraph or first sentence?

Q. I'm sorry. I do that all the time. The first sentence that runs for five lines on the second paragraph on page 87.

A. Thank you. I think most of the issues related with the sentence have been discussed. I have seen in my review citings of applicable ASTM standards. In some cases it may be well to look at those standards, but consider potential deviations from them. We have discussed some key issues, at least in resolving strength characteristics, and when explained why one's deviating from an ASTM standard, and the purpose for deviation is perfectly acceptable as long as it fits in with the -- within the framework of what we're trying to determine. For example, I was initially concerned about allowing a sample to sit for 90 minutes or more before we shear it because of potential moisture content changes. Perhaps ASTM standards suggest that you do that, but that didn't make sense for this particular program. So all I'm saying is that the appropriate standards appear to have been followed for the most part, but deviation from standards are allowable if there is reason to do it.

I think also we discussed one sample that was left two and a half years before testing. My preference is that that type of data would not really be used. Again, I think there's a little bit of a chance, a significant chance still of drying just due to the age of that sample, and perhaps not all seals are airtight. So just encourage relatively rapid testing after the sampling event has occurred. Those I think are the only issues that we've seen regarding ASTM standards.

So I guess what we like to see is good discussion of a test program, what standards are used and what procedures, and if you vary from them, why, and why did you vary from them. And sometimes you do vary from the ASTM standard because it doesn't make sense in light of what you're trying to accomplish for design input.

Q. Are you aware whether such standards are in place now for how the applicant conducts his test program?

A. Oh, yes, there are ASTM standards for these tests. Is that what you're --

Q. No, no. Are there also project specific standards that you have had the opportunity to review?

A. Project specific standards, the ones that I think that were most complete that I have been involved

with were developed at Savannah River. Those testing methods and sampling methods, some of them are applicable here, some may not be. I have seen, yes, the development of site specific standards, if you will, or procedures to meet the goals of an investigation.

Q. Actually, what I meant is, have you seen any specific standards developed for the PFS site with respect to how samples are taken and tested?

A. They seem to -- I saw a document that Stone & Webster provided us that it seems to be their manual for testing, field testing. And I can't recall if it included also laboratory testing, but I have seen, yes, their procedures, if you will. I didn't review them thoroughly.

MR. TRAVIESO-DIAZ: Let's put it on the record. Will you mark this as Exhibit 74.

(Exhibit-74 marked.)

Q. (By Mr. Travieso-Diaz) Describing this document is going to take a little while because the actual document starts, the pages of this document, there's a set of numbers on the bottom right-hand side, starting with 00857 and going through No. 911.

Now, the document itself, as I understand it, consists of or starts in the page that's marked 00868, which is like ten pages from the first page, and

is entitled "Engineering Service Scope of Work for Test Borings and Laboratory Testing." And that is dated October 14, 1996. Well, then the other ten pages that precede the one that I just identified appear to be addenda to that -- Addendum 1, Addendum 2, and Addendum 3 to the document, and that's why the first page of Exhibit 74 is labeled "Addendum 3."

A. Okay.

Q. Now, I believe that in the testimony that Mr. Trudeau and Dr. Chang gave a few days ago, they refer to this document as the ESSOW or Engineering Service Scope of Work. And what I would like you to do is just review with me the table of contents that appears on pages Roman Numeral i, ii, and iii at the start of the document, and the page numbers at the bottom are 869, 870, and 871, just for the purpose of telling me whether the document appears to include standards for taking samples and performing laboratory tests.

A. It does, yes.

Q. And it has also a section of quality assurance requirements that apply to these programs?

A. Yes.

Q. To the programs we're talking samples and performing tests. And I take it you have not reviewed

this document recently?

A. No, not recently. I recall seeing it. I think we requested this in discovery, or it was provided to us. So I think I have a copy of this, but it's reasonably lengthy, and probably most firms that do this type of work have such similar documents. I've seen them before.

Q. Okay. The next sentence on the second paragraph on page 87 indicates that "The basis for the selection of samples and the type of tests to be made is a function of the structure, anticipated loading, duration of loading (seismic) and the need to modify the soil's physical characteristics." Do you find anything in this sentence that has not been discussed before?

A. No. We've discussed reviewing the dynamic loading of Dr. Ostadan and making sure that the sampling program, whether it be strain control, cyclic triaxial testing, reflect those anticipated loadings. We've also discussed degradation and making sure that that program to investigate potential degradation considers the strains.

I see a sentence here talking about the need to modify the soil's physical characteristics. I believe we talked about -- I think that refers to some type of modification of the soil so that it becomes more

of an engineering structure or feature. The applicant has suggested to use soil cement. I think we've talked about the need to consider tensile strengths in the design and some way of understanding tensile strength.

We may have discussed some other items, but for the most part I think everything's fine.

Q. Okay, let's look at then the next sentence, because it indicates, "The boring location plan appears to be merely a grid across the site and not structure specific."

A. This has changed. This is a historical comment. When this review was done, it was done with a simple grid across the site. That was the plan of the first investigation, and perhaps that's not a bad plan. I assume at the time maybe the location of major facilities hadn't been identified. And there has been subsequent testing in at least the safety-related areas.

Again, we discussed our concerns about -- a little bit about some of the sparsity of the sampling and the number of borings, but those are already on the record.

Q. Let's move on, then, to the first sentence of the last paragraph on page 87, which says, "The descriptions of the test results for field and laboratory tests are generally insufficient to allow

detailed analysis." Let me ask you, is your understanding of this sentence that the complaint appears to be that the report that talks about the test doesn't provide enough information?

A. Which page?

Q. I'm sorry. Look at the first sentence at the bottom of page 87.

A. This seems to be addressing the issue to me about how the data are tabulated from those test results.

Q. Do you have a current concern as to the presentation as opposed to the content or the scope of the tests?

A. For a reviewer, since the layering system has somewhat changed, it would be nice to see the data now put into that layering framework and described according to that layering framework.

We earlier expressed concerns about averaging properties over a 30- to 35-foot interval. That seems kind of not useful to us anymore. So maybe putting the test results in a framework according to the stratigraphy we discussed.

Q. Is this a nice-to-have or a must-have kind of a --

A. I consider it not a nice-to-have. I think

it's a must-have, because one can be misled if the data are not put in their proper layering by simply just using -- the chance of using values that may not be appropriate for that layer. And we've seen a little bit of that today where we've been trying to compare standard penetration values very near a layer boundary. So if the parameter is being used for design, I think it should be just the best possible put in its proper layering context.

And I would also add that the CPT data, yes, this -- the cross-sections we've seen show this layering across the pad emplacement area and the canister transfer building, but at least I found it useful to do some composite plots similar to what I did. And I think one would have to do that to try to decide where is the actual lower strength zones if we do agree that tip resistance is somewhat correlated with undrained shear strength. It helped me do these exploratory plots that I did as a reviewer just to try to understand the variability laterally across the site. So composite plots might be considered at just the cone penetrometer data. Those are easily done. And that's not a very difficult effort if one has the data to do it.

The tabulation of the data, and I think even in the RAI's, I think there was some request to kind of

tabulate the data and present the data in type of the forms. I think those have improved over when this comment was made.

Q. Now, the next sentence goes from page 87 to the page top of page 88. It says, "While the conditions of the testing were explained to be in accordance with accepted testing procedure, any deviations from the normal procedure recommended in the standard test should be documented." Have we talked about this?

A. I think we have when we talked about ASTM standards. Again, ASTM standards are standard practice in the industry, but once in a while one is asking a specific question from a test program. So it's perfectly acceptable to deviate from ASTM standards if that deviation makes sense from what we're trying, as long as it's documented and explained what was being done.

Q. Are you aware that as the SAR is organized today, the attachments to Appendix 2-A reporting the results --

A. Right.

Q. -- of tests, at the front of each attachment there is a description --

A. Right.

Q. -- of the extent to which there are any

deviation from the standards?

A. And I've read them, yes. So I just encourage that to continue. I haven't found that markedly deficient. Once in a while if there are additional questions about a testing program, certainly maybe we'll request further explanation.

Q. But the concern would be whether the tests show as to whether do I understand how they did the tests. Is that a good way of saying it?

A. Yes. The concern is what do the tests show, and also was the test procedure set up specifically to resolve design issues that we have.

Q. But it no longer is, have you told me how you did it? Is that --

A. What's that?

Q. But there is no longer a concern as to whether the applicant explained how they did it and to the extent that there were exceptions?

A. Not what I reviewed in the most recent testing programs.

Q. Okay. Now, look with me at the rest of the paragraph that starts on page top of page 88 to the bottom, because I believe, according to my notes, that all of that was described to be historical and being now resolved. That's what I wrote when we talked about this

yesterday.

A. I think so. I recall talking about unit weights, and we felt that there was really no issues with unit weights. We've already gone on the record discussing our issues with strength and its characterization.

Consolidation, no, I don't see major issues with consolidation. Dynamic response, I think we've gone on the record our concerns about dynamic response and the testing that needs to support that.

Q. Why don't you go through the rest of the paragraph, you might as well do it, and if there is anything you want to add to either -- I understood you to say that these things were historical concerns, but to the extent that you have a current concern, just either state for the record that you already discussed it and identified, or else let's talk about it.

A. Okay. Well, also it says here with assumed values, so it appears that some of the values in the earlier calculations were assumed. There's now a body of data that assumed values do not have to be used. And in my review, at least for the most part, assumed values are not being used in response to strength. I think Dr. Ostadan had some talk about assumed values in his dynamic issues, and I'll defer to that testimony.

And the sentence, "The justification of the values should be provided before their use is permitted in the static and dynamic analyses, particularly when determining the dynamic strain response of the soils under cyclic testing." I think we've already gone on the record quite frequently about our beliefs on cyclic triaxial testing. Not our beliefs but our position about triaxial testing.

We've already gone on the record about stating that one should use site specific data when possible and obtainable in lieu of using, quote, textbook values.

The last part of this talks about a calculation involving bearing capacity reports. My review at least for the static bearing capacity suggests that that's not a large issue. I think this must be a bearing capacity on top of a structural fill. So this must be somewhat historical.

Q. Yes. I believe this predates the possible use of soil cement.

A. Okay. So I think that is historical, and the issues raised throughout the rest of the paragraph are historical and not an issue anymore.

Q. Then let's move to the first sentence in the last paragraph of page 88. Let's talk about the first

sentence on the last paragraph of page 88, which talks about "A major failing in the application is the lack of a detailed discussion of field and laboratory sample preparation for testing, the omission of which prevents independent review and assessment of the quality of data collected." That sentence appears to indicate to me that the concern of the writer at the time was that not enough was said on how the samples were collected and prepared for testing.

A. Correct.

Q. Is that your concern now? Or is that concern resolved?

A. In subsequent investigations that have gone on since this statement, I haven't noted that to be a major inadequacy. We've got a few points I think we've brought up through the last few days. It would be good to see maybe in the laboratory reports, specifically now if we're going into more refined issues of how the program was set up to resolve those design issues, specifically what the issues were and what was the test program set up to resolve specific design issues.

Q. In other words, you'd like to see for future tests not only a description of how the test was set up but what was it intended to accomplish and what issue it was trying to resolve?

A. Right. For example, we discussed maybe targeting certain CPT data according to the load tip stresses, how those were identified, how the samples adjacent to those CPT data were gathered, how the sampling was done, how the data -- how the samples were transported and preserved, and how the test program went through to resolve the specific issues at hand, whether they be changes in moisture content and how that affects the undrained shear strength. We discussed other issues, too. Now we need to be very targeted and specific about what we sample and what we -- how we do our testing. Not more just the generic get tests, take samples, report results. Not the more general initial type of sampling that one does of just going out and sampling blindly, testing, and reporting results.

Q. You wouldn't expect at this stage to be doing that anymore; is that correct?

A. No. We're focusing in and honing on specific issues. So our sampling is not generalized, but it's targeted specific to resolve specific issues. And one should go through and be very thoughtful and careful about those issues, and set up a program to make sure that when we get done those issues are no longer there.

Q. Fair enough. Could you move to the next

sentence, which is the last complete sentence on page 88 that indicates, "How samples are prepared and tests performed can significantly impact test results and their interpretation, potentially making the test results and interpretations meaningless." I take this sentence just to be caution as to what may happen if you don't do --

A. The right type of testing to solve the type of issues that are at hand, or if your type of testing program does not consider the type of loading that's going to be imparted to the soils. You can perform a test, but if it is outside the bounds of the loading that's anticipated, then the test results are meaningless. Well, I won't say meaningless to you, but they're not as valuable.

Q. Would it be fair to say that this sentence is a general description of why it's important to do the sample testing the right way as opposed to bringing up particular problems? In other words, is this a general sentence without any specific issues being raised by it?

A. Right. I think it's a general sentence, and I think through the last three days of testimony we've already discussed specific issues and how to make the testing more meaningful.

MS. CHANDLER: Could we just go off the

record for a second?

(Discussion off the record.)

(Recess from 8:06 to 8:27 p.m.)

Q. (By Mr. Travieso-Diaz) We were, if I recall, on the bottom of page 88. And we were discussing the sentence that starts at the end of page 88 and goes over to page 89. Starts with the word "Additionally, the test results may not reflect those conditions to be modeled in the field and therefore either underestimate or overestimate the response of the foundation system to actual field loading conditions." And I want to ask you to comment as to what your understanding is of the concern that is expressed here.

A. I think what is being said here is that when one sets up the test program, it's important to go through and look at the demand side. What I mean by the demand side would be the loads imposed on the soil by either the foundation system or, in this case also, since this is seismic, the earthquake loadings, and make sure that once one understands the demand side that what is being done in setting up the field test program, or now also laboratory test program, that you bound those conditions which the demand side may give you. It makes no sense to not have a program thought out that could potentially leave you still in an unsafe envelope when

you consider the dynamic loadings on -- just a moment.

I can just maybe give a couple examples from previous discussion of maybe what I'm interpreting this as saying. I know the state's had reservations about the soil cement mat particularly in tense -- tension, and it seems like that was never really considered. And certainly a large soil cement mat like that will not behave rigidly, and one must now consider not only compressive strength but tensile strength of this and also consider whether cracking is going to affect its tensile strength and how it's going to perform.

Q. Can I ask you a question for a second? Given that this sentence is worded kind of broadly, would it be fair to say that the specific concerns that you had that relate to this sentence have already been put on the record?

A. I think so. I just want to go on the record as stating that we feel it imperative to consider what we would call the demand side, i.e., the loadings, whether they be static or dynamic loadings, and to fully understand them prior to setting up a program, a laboratory program. And also making sure then that the test results and the analyses reflect those actual conditions. I guess we've gone on the record already with our issues regarding that.

Q. I'm going to skip the next sentence, because I believe you told earlier that this is a historical concern. Is that right?

A. That's correct. Let me -- I want to make one point, maybe, that I'm not sure has gone on the record quite as emphatically maybe as we could. It's the state's -- I do not want to use the word "concern," but we still have some uncertainty about how layer 2 seems to gain its apparently high undrained shear strength. And we have postulated that possibly it may be sensitive to changes in the moisture content. Perhaps the applicant can think of a reasonable test program to vary the moisture content somewhat within reasonable ranges -- we do believe that some drying and wetting do occur even when mats or foundations are placed upon these soils due to capillary action and unsaturated flow, which are documented phenomenon -- and see if within reasonable ranges that, all else equal, that these soils are not sensitive to dramatic losses in strength due to moisture content.

I don't believe the sample has to absolutely saturate it. That may be an extreme. But maybe some controlled increases in moisture content could help us better understand whether this apparent stiffness is due to some cementation phenomenon, or if it also might be

partly controlled by changes in moisture content and partial saturation.

Q. Now, the next sentence that reads, "For sites that are underlaid by cohesionless soils." I won't read the next sentence in its entirety. I don't think we need to. Could you summarize your current position on the issues discussed there?

A. This I think -- the cohesionless soils I think implies that the applicant should check to see if that potential cohesionless soil could become unstable due to liquefaction. And I think we've gone on the record already saying that liquefaction is not an issue.

We have discussed I think extensively the potential for some strain softening due to earthquake loading. I'm not sure we're completely resolved on that issue. We've gone on the record on that, so I guess -- and I'm not so much concerned about collapse. Maybe marked settlements, but I think the issue is could we lose capacity that we thought we had because of the strain levels and how much we're straining this layer 2.

Q. Okay. Let's go to the next sentence. "The Applicant must also show that the static and dynamic engineering properties of the soils, such as unconfined compressive strength, shear strength parameters for strength parameters from cyclic triaxial tests, were

properly determined and that reasonable and conservative values were used in the design."

A. Dr. Ostadan talked about this. I don't think I have anything really more to add to this.

Q. Going to the next sentence. "This demonstration should explain how the developed data were used in design analyses, how the test data were enveloped for design, and why the design envelope is conservative."

A. I think this was a concern of Dr. Ostadan, particularly talking about the design envelope and the margins of safety or factors of safety. I don't think I have any more substantial to add to this.

Q. The last sentence in section b reads, "A table indicating the values of the parameter used in design should be provided and should be supported by field and laboratory test records." What do you make of this sentence?

A. I think some of this has been met by the engineering calculations that try to -- well, the engineering calculation, and I don't know its number, trying to tabulate how different data were used and input in the various geotechnical analyses. I guess I would encourage maybe some kind of tabulation like I discussed before according to the current layering

system as we understand it. And then certainly anytime any calculation uses design parameters, that should be referenced in where those values are coming from. And I sense that that's improved over when this was written.

Q. Let me just bring to your attention two items that you probably are aware of. First, you're aware that now the attachments to the appendices of the SAR have tables that summarize the results?

A. Correct. I've seen those.

Q. Are you aware also that the geotechnical design criteria calculation G(B)05, I'm not sure if I can remember the complete name, but it does have a number of complete tables that appear to be trying to do what you just said?

A. Yes.

Q. Shall we look to Item c on page 89.

A. Uh-huh.

Q. Okay. Let's just go to the first sentence of Item c, the one that starts with the words "The static and dynamic properties of materials." Do you see that sentence?

A. Yes.

Q. Could you describe for me the current -- your current understanding of what the concern for this sentence is?

We've already discussed our uncertainties about the published data at this site.

Q. Can I ask you a question or two about something you just said, to clarify the record, which is, you said that you would like to see at least one boring down to rock. I take it that you mean down to the bedrock?

A. Yeah, I'll defer -- we've discussed that, I believe. And my experience at other sites has been that that's been typically done. Not being -- generally when we've done a deeper borehole site was to identify the exact depth to rock and log shear wave velocities in the deeper profile. I am going to suggest that if there's still uncertainties about the deeper profile, that that could be considered.

I can't remember in the last few days if we discussed large uncertainties other than -- we have discussed the refraction data. Whether that data would be -- a deep hole would be useful in resolving that, I don't know. And perhaps when we review the Geomatrix report it may say something about that issue and whether there's sensitivity to the analysis to that assumed depth, whether it makes a difference whether it's 800 feet or 500 feet.

Q. Can I put the question this way to you.

First from the geotechnical standpoint, do you care in any way --

A. From a geotechnical standpoint, I do not care. I am giving a lukewarm recommendation here about a deeper hole, not quite knowing whether there are issues with the dynamic profile and response, which really is somewhat out of my area of expertise.

Q. What you're saying, if I understand you, is that to the extent that there is a use or a need for such a big boring would be for issues such as surface -- as wave velocities in the deep layers and so on?

A. Yes, it would help maybe understand or clarify the design basis ground motion and its variability as it comes to the site. I -- from a geotechnical perspective relating to the stability of the pad emplacement area and the canister transfer building, and that hole doesn't really help with those. It's not needed because these are shallow profile issues.

Q. One question that maybe I need to ask. You are aware, of course, that there have been at least two borings that have come down below 200 feet. I don't believe they have reached the assumed layer of where bedrock is understood to be.

A. Okay.

Q. But they have gone fairly deep. Are you aware of that?

A. Yes. It's fairly distant in my memory.

Q. I don't want to examine you on this, but there is -- let me say this to refresh your memory. Are you aware that Borings CTB-1 and CTB-5 were drilled deeply, and CTB-5 in fact was used to install a monitoring well?

A. Yes, I do recall the discussion that a monitoring well was installed, that there was one on the site. I remember. That was one of our recommendations. I guess my -- I'm -- not knowing what data was collected in those two deep borings, I'm not sure what the purpose was.

MS. CHANCELLOR: I'd like to make a request. If there's any data that you get from a monitoring well, we'd like a copy of it.

MR. TRAVIESO-DIAZ: Well, in fact, I think it has been -- it's already included in the attachments to the SAR.

MS. CHANCELLOR: I see. Okay.

MR. TRAVIESO-DIAZ: Because those are -- those borings were part of the boring program. They served multiple purposes, as I understand it.

Q. And maybe you can confirm this. One purpose

was to get to the point where you could try to find where the ground water was and monitor the levels, but also you were taking samples as you were going down. Is that your understanding of what was done?

A. I don't know if sampling was done or not, because I obviously -- these holes, I haven't reviewed the data that was collected in them.

Q. Fair enough.

A. I think when I'm talking about a deep hole was if a deep hole was useful in helping resolve any of the shear wave velocities and any uncertainty in the geophysical or ground response modeling that was done for the site. But maybe others that reviewed this more thoroughly than I may feel maybe this may not be necessary or necessary. I'm not sure.

Q. Fair enough. I think this is very clear.

Okay. The next sentence that we haven't gone over yet I believe starts in the middle of the page with the words "Because of the limited number of tests and generalizations made with respect to the soil profile," etc. I'm only trying to identify the sentence to the record.

Could you address that sentence and tell us what the current state of your understanding is as to what the issue is and whether it has been addressed in

previous testimony?

A. I do not see anything in this that we have not discussed fairly extensively.

Q. Let's go to the next one, that simply states, "There is too much uncertainty regarding the applicability of published data to the site." Can you comment on that sentence?

A. I think we discussed our concerns about uncertainty, about certain key soil parameters and how they may impact mainly the seismic design.

Q. The next sentence starts, "For example, the dynamic analyses presented instead use published information from 1970 which is extrapolated to the site without any basis for such extrapolation." Do you see that sentence?

A. I think that sentence and also the following sentence Dr. Ostadan commented on, and I'll just defer to his testimony.

Q. How about the next sentence, which is the last one on the page and goes to the next page. It says, "This data is not applicable for characterizing dynamic properties of slightly cemented silts found at the site based on SW-AJA (1972) at 39 of SWECO calculation.

A. I think the concern here is that the

properties using that particular calculation, which I assume is somewhat historic, may not be applicable to slightly cemented soils. And we've discussed issues regarding the slightly cemented soils and particularly where -- in the shallow profile where they may affect ground response, that the applicability of standard, quote, textbook curves and relationships should be considered by the applicant. And we have seen the applicant gather some resonant column data for these that perhaps are more applicable than what was used in this calculation.

Q. Let me ask perhaps as a way to shorten the discussion with the next two or three sentences. Would it be fair to say that the sentence that you described and the sentence that follows it that talks about "please note the variation in shear modulus," etc. --

A. Right.

Q. -- is either historical to the extent that it addresses something that has been superseded --

A. Correct.

Q. -- or has been addressed by Dr. Ostadan and you in your testimony?

A. That statement would be correct.

Q. Okay. And then I take it that's also true with respect to the next sentence, that reads, "The

Applicant should explain why the data extrapolated from this curve is appropriate considering the various shear strain levels"?

A. Yes. And I think Dr. Ostadan discussed that and also the following sentence, so I'll just defer to his testimony.

Q. So that we are finished, then, with the first paragraph on page 91?

A. Yes.

Q. Let's go to the second paragraph. The first sentence of the second paragraph indicates that "some of the data do not fit together, and it appears data presented from different sources have been combined without assessing their applicability to the site."

A. I think there was concern as I see here regarding void ratio and consistency amongst void ratio and blow counts which had some inconsistencies. I think a lot of this was addressed in a subsequent RAI, as I understand it. The void ratios in some of these upper soils are reasonably high.

Q. If I recall, there's an extensive discussion --

A. There is.

Q. -- in the SAR now that addresses this issue. Is that correct?

A. Yes. And I'm not remembering quite fully. I guess I'm not sure what's been said in the SAR about this right now, about the high void ratio. But I believe it's been -- the reasons for it have been explained by the applicant.

Q. Okay. And then the next sentence that says, "the void ratio for soils indicate very loose soil conditions yet blow counts from standard penetration tests are indicative of dense soils." Would it be fair to say with respect to this particular sentence that there is a much better understanding today of the layering of the site?

A. Yes. This suggests there is potential for cross-layering where maybe void ratios were coming from one layer and standard penetrations from another. And I have seen this before. What happens when one is undergoing a test solely with a drilling program, you can change into different layers and essentially cross-layer or cross-stratify things and misclassify things. And I think with the cone penetrometer data, our chances of doing that are much, much less now.

Q. So I take it this in fact is sort of a historical concern as of today based on the information that we now have?

A. Yes. I guess the only thing I would add is,

we discussed about trying to put the data now in our new layering framework which will help probably clear some of these issues.

Q. Now, could you please maybe with respect to the next few sentences, you can deal with them together, because, if I understand it, the discussion on the sentence that starts with the words "the void ratio equation," and the sentence that starts -- that follows it and says -- well, "See laboratory data results," and then the sentence that says, "This soil structure may be typical of cemented sands," are all these sentences addressing the same concern as to what the meaning of the high void ratio was?

A. Yes, I think it's trying to explore why the large void ratio existed, and --

Q. In fact, that discussion goes all the way up to the end of this sentence -- this paragraph on top of page 92?

A. Yes. Again it's a concern about the high void ratio. And the last sentence, "The Applicant should verify if this abnormally high void ratio is typical of cemented soils." Again, the part in the SAR where this is discussed is not fresh in my memory, but I would encourage, if the applicant has not done so, go back and see if there are similar cemented soils

somewhere to verify that these high void ratios do fall in the ranges of similar calcarious or cemented soils elsewhere.

Q. And you have explained for the record what your concerns are with the potential cementation of layer 2; is that correct?

A. We have. We've discussed that extensively.

Q. So we don't need to go over that again.

A. Correct.

Q. Now, moving to the last paragraph on issue 3. It starts with the words "Further, the Applicant performed only limited soil engineering tests ... omitting a number of additional widely accepted index and engineering property tests." Rather than putting words in your mouth, can I ask you to update the discussion that appears in this sentence?

A. Well, we've already discussed our concerns with the limited engineering testing.

Q. So this paragraph doesn't add anything to what you already have said?

A. The first sentence certainly doesn't.

Q. How about -- I'm sorry. When you say the first sentence, where are you? Where --

A. I think it ends after "Annual Publication (1997)." Oh, excuse me. No. First sentence ends after

"layer 1 and 2 soils."

Q. And then the rest is citation?

A. That's correct, it is a citation.

Q. All right.

A. So those sentences, I did not see anything really to add to them.

Q. Okay. Now, going to the last sentence now on this paragraph under Contention 3, "Such additional tests will allow the reviewer," etc. Is there anything on that -- anything on that paragraph that has not been addressed before?

A. This seems to be somewhat of a summary sentence. So we've discussed these issues quite extensively. We still at this point in time have uncertainties about the performance of the soil and foundation system under seismic loading.

Q. Yes.

A. And we believe calculations should be revised. Additional mechanisms and loadings that were not considered should be considered. The soil mat -- at this point, the soil cement mat seems to be very conceptual, and we discussed our concerns about that philosophy and encouraged the applicant to consider those. And we cannot really comment further on the soil cement mat until further is known about its actual

design.

And we've discussed today a little bit about passive resistance that will be developed by the soil mat. We encourage the applicant maybe to think of maybe a field testing program. We could do that. And when I mean field testing, I mean not a sampling and submitting to the lab but perhaps some type of in-place prototype or full-scale test that could help us understand how much of the soil mat passive resistance can be mobilized.

However, there are still significant issues again with tensile and torsional stresses to such a large area of mat and how that will perform.

Q. Finished?

A. I'm just looking at a couple of other scratches that I have here.

Q. Okay. I'm not rushing you, just -- you paused.

A. Yes, at this point I guess we cannot say that the adequate margins of safety or factors of safety have been demonstrated according to our concerns.

Q. For the reasons you have been testifying about the last couple of days?

A. Right. I cannot think of anything I want to add. I know this is my last chance to say something,

Q. Could you, just so the record is very clear, give the title of the response?

A. Sure. It's the "Inadequate justification for qualifying for the Frequency-Category-1 design basis ground motion (1,000-year return period)."

The next one is found on page 40, Interrogatory No. 5. The first few sentences of this interrogatory just refer to other interrogatories for other types of data and deficiencies that are discussed in those interrogatories, so I don't see any need to go into that. So I guess I'll go to the general response part.

Q. That's part A?

A. That's part A.

Q. Page 40?

A. Correct. The first sentence just acknowledges that there was additional analysis still going on. And it's somewhat of a disclaimer that these statements may not have considered that additional data that was ongoing at the time that this was written.

Q. Is it your understanding that the test program that at least the applicant envisioned coming out is now completed?

A. Yes. That was the ConeTec report and the data gathered by ConeTec. I do not see anything in the

paragraph beginning "In addition Section 2.6 of the SAR is poorly written." I think this was expressing concerns about how to understand key design assumptions and put some parameters, tabulation of data, where the data actually came from, and difficulties in referencing. I believe subsequent revisions of the SAR improved and clarified much of that.

I believe part B, which begins "Geotechnical Design Profile Has Not Been Adequately Defined," refers to the old two-layer system. So there's really not much to discuss about this. We felt initially that that two-layer system was inadequate for the design.

Q. But that has been superseded by --

A. That has been superseded by Figure 2.6-5 and all of its various sheets.

Q. Yes.

A. We've already discussed the spacing of geotechnical borings. I think we referred to the Reg Guide 1.132, I believe, regarding spacings of borings in investigations. We've also discussed ways of removing uncertainties in key layers. We've discussed critical layers that we feel that were still undersampled.

At this time when this was written it appears that there were still no borings on the canister transfer building and other non safety related

record. Go back to Exhibit 75 for the second and look at the very last page of the exhibit. The very last page of the exhibit shows where Boring CTB-5 ends.

A. Yes. I see it's 158 feet.

Q. So when I said 200 feet respecting this particular boring, I misspoke. Is that correct?

A. Yes.

Q. Thank you.

A. Item No. E discusses no variability in the shear wave velocity profile. I believe Dr. Ostadan has commented extensively about this. And his concern again about thin layers near the surface and what the effects of that thin layer on the geophysical model, and how the deeper velocity may be adjusted because of the newer data that we saw from the seismic penetrometer. I don't believe there's anything really new to add to this.

Seems to express a concern that the seismic refraction data may not be able to resolve a thin layer, but the cone penetrometer certainly identified it.

Q. Do you have anything to add yourself to the statement?

A. No. The cone penetrometer data I think at least identified a lower velocity zone. It is now characterized. So the issue of the refraction survey missing a thin layer seems to be irrelevant now. It's

already been identified by other data.

Item No. F again points out that the depth to bedrock and the nature of bedrock has not been established by physical sampling. We've made recommendations to consider doing that. But again, not having read other testimony -- not having read the -- I don't want to use the term "read." Not having reviewed the conclusions about Geomatrix and whether they feel this data is valuable and other testimony, I'm just going to point out that it still has not been done. Fair enough?

Q. Only a clarification. When you mean -- when you say "the depth and nature of bedrock has not been established in the SAR," from the viewpoint of stiffness of soil or strength of the soil, there comes a point -- I don't know -- whatever number of feet below the surface, where from the geotechnical standpoint it doesn't make any difference whether you call it bedrock or something else, right?

A. Yeah, this issue does not have really to do with the geotechnical investigations. There's no need to go that deep with the geotechnical investigations. What I'm pointing out here is that there's uncertainty to the depth of the bedrock, and I'm not sure how that affects the characterization of the ground motion. And

if characterization of the depth of the bedrock and nature of the bedrock would remove uncertainties, it would be prudent to do that. But again, I'm not sure Geomatrix's conclusions on whether they would really need that data. Obviously it hasn't been drilled, so it seems like that they haven't needed that data.

I think we discussed some discrepancies a little bit between the shallow refraction data and the cone penetrometer data, but I'm not certain right now at this point whether a deep hole is beneficial or not. I guess at the time when one was reviewing initial investigation, my experience at other facilities is, we had done this. But I will defer to the experts who do this type of modeling, whether they need that data or not.

MS. CHANCELLOR: Can we go off the record for a second?

(Discussion off the record.)

MR. TRAVIESO-DIAZ: Back on the record. We were on Item G on page 43.

A. Item G addresses hydraulic gradient, seasonal variations. When this was written I was trying to anticipate perhaps the need for doing any ground water hydrological modeling. I understand the applicant has now installed a ground water well within the site,

expressed our concerns about the under-representation of undisturbed samples in layer 2.

Q. Item C, "Type of Undisturbed Sampling Used by Applicant May Still Cause Significant Disturbance."

A. Yes, I recognize this. In the first paragraph, and I think we discussed this -- I can't remember if it was yesterday or this morning, frankly. But it was the idea that our experience in saturated Bonneville deposits, that even with reasonably good quality Shelby Tube sampling, a significant portion of the Shelby Tubes indicate disturbance. This was surprising to us and actually something that was given to us by Chuck Ladd in his review of our data. And currently UDOT has a research topic looking into this issue, because we extensively use Shelby Tube sampling in general practice here in the valley. Probably not as great of an issue at the PFS site because of the stiffness of these soils.

Q. And in fact, if you recall, I showed you two or three curves of --

A. Oh, yes, the test you gave me yesterday.

Q. It wasn't a test.

A. The quiz. I hope I passed.

Q. Well, I think that you said that two of them appeared to be undisturbed or reasonably undisturbed and

one wasn't.

A. Right. And by the way, the reason why disturbance is not as large an issue here is because these are stiffer soils, and any disturbance would tend to most likely cause a conservative estimation on your part. So we're not going to make a big issue about disturbance.

And the sampling seems to be, at least the recent events of sampling, there has been some indication of minor disturbance, but I leave it up to the judgment of the evaluators to look that. And if they feel disturbance has occurred, potentially remove some of those sample on their program.

Q. Can we turn to Interrogatory No. 7 on page 49, which I believe has only two parts, and look to part A that talks about "RAI No. 1, Question 2.8 is Not Applicable to Addressing the Potential for Collapsible Soils." Did I understand your testimony before that the collapsibility, potentially collapsible soils has been a concern?

A. Yes. Our initial issue with this was potential collapse in the Eolian deposits. Those have had problems with collapse. The applicant intends to treat them with soil cement.

Q. How about Item B, which says "The Applicant