

June 16, 2002

**UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION**

Before the Atomic Safety and Licensing Board

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

**REBUTTAL TESTIMONY OF PAUL J. TRUDEAU AND ANWAR E. Z. WISSA
TO DIRECT TESTIMONY OF STATE OF UTAH WITNESSES DR. STEVEN F.
BARTLETT AND JAMES K. MITCHELL
ON SECTION C OF UNIFIED CONTENTION UTAH L/QQ**

A. Precedents for the Intended Use of Soil Cement at the PFSF

Q1. In his answers to questions 9 through 13 in the "State of Utah Testimony of Dr. Steven F. Bartlett and Dr. James K. Mitchell on Unified Contention Utah L/QQ (Soil Cement)" ("Bartlett/Mitchell Direct Testimony"), Dr. Mitchell indicates that there are precedents for the use of soil cement for pavement structures and as structural fill, but not for a "restraining buttress and for development of sliding resistance." Does the distinction that Dr. Mitchell makes between types of applications make a difference as far as their serving as precedents for the use of soil cement at the PFSF?

A1. (AW, PJT) No. The value of a particular application as a precedent is not the specific use that is made of the soil cement (e.g., strengthening of pavements), but whether the application draws upon the same mechanical properties of the soil cement. PFS proposes to use the shear strength and compressive strength of the soil cement to resist sliding for the Canister Transfer Building ("CTB") and the shear strength of the cement-treated soil under the storage pads to resist sliding forces due to the seismic loadings. The shear and compressive strength of soil cement are well-known and easily measured properties, relied upon in numerous previous applications with some going back to the early 1900s. The most common application for soil cement is as a base course underlying airport and highway pavements. In this application, the soil cement is subjected to repetitive static and dynamic loading with far greater frequency than under earthquake conditions.

Thus, the extensive use of soil cement for this application serves as a precedent for the use of soil cement to resist dynamic loadings. These applications serve as precedent for the use of soil cement at the PFSF.

Soil cement has been used to construct coal slots in seismic areas, as indicated in an article by Gary Van Riessen and Kenneth Hansen, "Cement-Stabilized Soil for Coal Retaining Berms," to resist shear forces imparted by seismic loadings – the same function that the soil cement provides at the PFSF. The shear strength and compressive strength of the soil cement used at the toe of the coal slots is relied upon to provide shear resistance to sliding at the toe of these coal slots.

Moreover, soil cement was used extensively to resist lateral forces and form permanent foundations for the five highway tunnels for I-90 and I-93 that converge at the Fort Point Channel crossing of Boston's Central Artery/Tunnel ("CA/T") Project. Lambrechts J.R., P.A. Roy, and E.J. Wishart, 1998, "Design Conditions and Analysis Methods for Soil-Cement Buttresses in Fort Point Channel," Design and Construction of Earth Retaining Systems, Proceedings 1998 Geo-Congress, Geotechnical Special Publication No. 83, Reston, VA: American Society of Civil Engineers. This resistance to lateral loads is provided by the shear and compressive strength of the deep soil-cement buttresses. This is essentially the same use of soil cement that PFSF has proposed.

Q2. In answers 14 and 15 of his direct testimony, Dr. Mitchell disclaims any analogy between deep soil mixing of soil cement and the use of the material at the PFSF. Does Dr. Mitchell's opinion affect your view of the similarity between the use of deep soil-cement buttresses used in the CA/T Project and the use of soil cement as a buttress at the PFSF?

A2. (AW, PJT) No. In fact, the intended function of the soil cement in the CA/T Project is the same as that at the PFSF, to resist lateral loads, relying on the shear and compressive strength of the soil cement. Dr. Mitchell is correct when he states that the deep soil mixing technique is not the technique that will be used to construct the cement-stabilized soils at the PFSF. However, the intended use of the soil cement around the CTB at the PFSF, i.e., providing a buttress (passive resistance) to resist sliding of the CTB, is the same application for which it was used in the CA/T Project (i.e., providing a buttress to resist lateral loads due to the excavations required for creating and supporting the CA/T Project tunnels). In both applications the soil cement is used to resist horizontal or sliding forces and

in both applications the soil cement functions in essentially the same manner from an engineering standpoint, i.e., providing a buttress to resist lateral loads.

Q3. In answer 13, Dr. Mitchell discusses the differences between the use of soil cement at the Koeberg nuclear power plant and its planned use at the PFSF. From an engineering standpoint, do the differences that Dr. Mitchell raises serve to differentiate the use of soil cement at Koeberg from its intended use at the PFSF?

A3. (AW, PJT) No. In fact, the Koeberg example is a good precedent for the use of soil cement to improve the shear strength of in situ soils as proposed at the PFSF, because the property of the soil cement that is being relied on in both instances is the same. The concern in the Koeberg project was soil liquefaction, and the soil cement was added to enhance the shear strength of the soils. In their in situ condition these soils did not have sufficient shear strength to resist cyclic loads from the design earthquake and, consequently, they were susceptible to liquefying due to shaking caused by that earthquake. In the PFSF design, cement is mixed with the in situ soils to increase the shear strength (i.e., cohesion or adhesion) of the soils and improve their compressive strength both beneath the storage pads and around the CTB. The fact that the in situ soils at Koeberg are of a different type than those at the PFSF site is immaterial, because the soil cement property that is relied upon in both instances for stability is the increased shear strength.

Q4. Is there any significance to the fact that soil cement has not been used in exactly the same application as its intended to be used at the PFSF?

A4. (AW, PJT) No. As Dr. Mitchell has stated, new applications are being found for soil cement all the time. Mitchell March 15, 2002 Deposition Transcript ("Mitchell Dep. Tr.") at 43. The properties of soil cement and its function are well established, and in particular the use of soil cement to improve the shear and compressive strengths of in situ soils has ample precedents, as we discussed above.

B. Dynamic Loading of the Soil Cement

Q5. In answers 21 and 22, Dr. Bartlett states that PFS has failed to analyze the dynamic loading conditions on the soil cement using a soil-structure analysis and that the absence of such an analysis makes it impossible to conduct a rational assessment of the seismic performance of the proposed cement treatment. Is such an analysis necessary?

A5. (PJT) No. Dr. Bartlett focuses on the possibility of cracking of the soil cement due to tensile stresses caused by bending and torsion of the soil cement under seismic loadings. This concern is unfounded for several reasons. First, PFS does not rely on the tensile strength of the soil cement in its design. PFS is relying on the soil cement to resist horizontal movement, for which the important attribute is the compressive and shear strength of the soil cement, not the tensile strength. Tensile forces and their effect, if any, on the soil cement will not decrease the compressive strength of the soil cement. Second, the cement-treated soil under the pads will not be subject to failure from tensile stresses because it will adhere to the concrete pad, which, being much stiffer than the underlying cement-treated soil and being heavily reinforced, will resist all tensile stresses. Third, the seismic design of the PFSF does not rely on the strength of the soil cement “picture frame” surrounding the pads; thus, tensile stresses imposed on that soil cement are of no consequence to the sliding stability of the storage pads. Finally, with respect to the CTB, if tensile stresses that exceed the tensile strength of the soil cement occur, they will tend to open existing shrinkage cracks, rather than create new cracks. These shrinkage cracks are thin, vertical cracks that are randomly oriented throughout the soil cement. If such cracks develop, the passive resistance of the soil cement adjacent to the building will be engaged after a slight horizontal motion to close any cracks that happen to be aligned parallel to the edge of the foundation mat. This process will not significantly affect the ability of the soil cement to provide the passive resistance required to prevent sliding of the CTB.

C. Potential Mechanisms Affecting Soil Cement

Q6. In answer 23, Dr. Bartlett and Dr. Mitchell state as a concern that Applicant has not addressed the possible delamination or debonding along a soil cement lift interface or an interface with the concrete pad or the native soil during a seismic event. Is this a legitimate concern?

A6. (AW, PJT) No. As SAR § 2.6.4.11 indicates, PFS will make certain that adequate bond strength exists at all interfaces between lifts, and between the soil cement and the pad and the underlying soil, to ensure that no delamination or debonding takes place. The SAR (pp. 2.6-114 – 2.6-116) sets forth the methodology that PFS can use to ensure that adequate bonds exist at all interfaces. As indicated by DeGroot, cement surface treatments, which consist of placing

small amounts of cement on the lift line as each lift is applied, are extremely effective in creating a bond along the interface that exceeds the shear strength of the soil cement itself. Thus, if the results of the interface strength tests that PFS is committed to performing demonstrate that such surface treatments are warranted, PFS will institute them as part of its construction procedures. It is expected that such techniques will be required where soil cement or the concrete for the pads is placed upon previously set soil cement or cement-treated soil lifts.

Q7. In answers 23 and 26, Dr. Bartlett and Dr. Mitchell also assert that PFS has not adequately addressed the possibility of settlement cracking resulting from differential settlement at the perimeter of the pads and the CTB foundations. Do you agree?

A7. (PJT) No. The estimated long term settlement of the pads is conservatively estimated as 1.75" in Stone and Webster Calculations 05996.02-G(B)-03, Rev. 3, *Estimated Static Settlement of Storage Pads*, and 05996.02-G(B)-21, Rev. 0, *Supplement to Estimated Static Settlement of Cask Storage Pads* (May 21, 2001). It is my opinion that, based on the conservatism in the pad static settlement analyses, the actual settlement will be approximately ½ inch. Such a small settlement will not result in any significant cracking in the soil cement. Moreover, any settlement that occurs will be less pronounced at the periphery of the pads than towards the center, thus, reducing the potential for formation of cracks at the interface between the pads and the soil cement. The same situation will exist with respect to any CTB mat settlement. Furthermore, the soil cement to be placed adjacent to the CTB mat is likely to be installed after most of the building has been constructed. Such a construction sequence would minimize the potential for differential settlements to occur at that interface between soil cement and the building mat, because much of the building settlement would have already occurred by the time the soil cement is installed.

Q8. In answer 23, Dr. Bartlett and Dr. Mitchell suggest that frost penetration and expansion may cause cracking that could affect the performance of the soil cement. Is that likely to occur?

A8. (AW, PJT) No. The durability of the soil cement mix will be tested according to standard (ASTM D560) durability tests, including freeze-thaw tests, to assure that the soil cement remains durable and free from cracks due to freeze-thaw cycles. Water seeping into shrinkage cracks might freeze and further extend such cracks; however, PFS will take appropriate measures to minimize the potential for crack

formation during shrinkage and curing, so this and other phenomena associated with shrinking and curing cracks will be minimized. Moreover, it is worth noting that soil cement is used extensively for protection from wave erosion on the slopes of earthen dams and reservoirs. In such applications, the soil cement may be subjected to far more severe climactic conditions, including inundation, freezing, thawing and frost penetration, than it would be at the PFSF. Under these extreme wet/dry and freeze/thaw conditions, soil cement has generally performed well. There should therefore be no concern that the far less severe wet/dry and freeze/thaw conditions at the PFSF will cause detrimental effects due to frost penetration and crack expansion. At any rate, PFS does not rely on the tensile strength of the soil cement; therefore, the potential degradation of the tensile capacity of the soil cement is immaterial.

Q9. In answer 24, Dr. Bartlett and Dr. Mitchell assert that shrinkage cracks may form during the curing and aging of the soil cement, that such cracks may be subvertical and continuous through the thickness of the soil cement, and that they may affect the performance of the soil cement for the use intended by PFS. Do you agree?

A9. (AW, PJT) No. As discussed above, the potential degradation of tensile strength is immaterial. Soil cement is not used at the PFSF for its tensile strength, but rather for its shear and compressive strength, which remain unaffected by the mechanisms they postulate. PFS has committed to taking appropriate measures during the soil cement installation and curing process to minimize the potential for crack formation and to take appropriate remedial measures to address any significant cracks that form during curing and drying. In any event, the cracking due to the curing and shrinkage of the soil cement will result in near vertical cracks that are fractions of an inch wide, as acknowledged by Dr. Mitchell. Such cracks do not diminish the compressive strength or shear strength of cement-stabilized soils. Likewise, the distinction between vertical and subvertical (subvertical, as we understand the term, means a few degrees off vertical) cracks is immaterial to the ability of the soil cement to provide shear resistance.

The concerns of Dr. Bartlett and Dr. Mitchell regarding the possibility of cracks being continuous through the soil cement are also unfounded for two reasons. First, as Dr. Mitchell has recognized, the large thickness of the soil cement would make it highly unlikely that a crack could run continuously from the top of the soil cement layer to the bottom. Mitchell Dep. at 134. Second, as described in

Section 2.6.4.11 of the PFSF SAR, the soil cement will be constructed in lifts. Each lift will be laid down separately and bonded with cement to the next applied lift. In all, there will be several of these lifts which will cure independently of one another. Thus, it is extremely unlikely that any crack would be continuous through each separate soil cement lift and the cement bond between each lift. For these reasons, we find it very difficult to conceive how a crack could propagate continuously from the top of the soil cement to the bottom.

Q10. Mr. Trudeau, Dr. Bartlett asserts in answer 31 that there is insufficient evidence to support the estimate you provided in your March 6, 2002 deposition that only about two percent of the pad emplacement area may have to be recompacted with compacted clayey soil. Dr. Bartlett also states that the use of recompacted soils will also result in decreased shear strength from the value assumed in the PFS design for the native soils. Do you agree?

A10. (PJT) No. The soil profiles shown in SAR Fig. 2.6-5, sheets 1 through 14, show that for most of the pad emplacement area, the eolian silt layer extends less than two feet below the pad. Only the far southeastern corner of the pad emplacement area has a section where the eolian silt layer to be removed may extend more than 2 ft below the bottom of the pads.

Second, Dr. Bartlett incorrectly asserts that the recompaction of the native clays will result in a shear strength that is less than the 2,100 psf selected by PFS based on the lowest strength measured in the unconsolidated, undrained triaxial tests of PFSF site soils. It is well established that recompacted clays can have shear strengths comparable to this value, particularly if a high degree of compaction is used. PFS expects to control the compaction of these clayey soils based on Modified Proctor densities, which require a higher degree of compactive effort and will result in a stronger compacted clay. Consequently, the strength of the compacted clayey soils should exceed the 2,100 psf used by PFS in its analyses.

Q11. Does this conclude your testimony?

A11. (AW, PJT): Yes.

1 MR. NELSON: And then I have a few brief
2 questions, oral rebuttal, covering what's come out in
3 testimony so far since the original rebuttal was
4 prepared.

5 CHAIRMAN FARRAR: All right. Go ahead.

6 MR. NELSON: This is for Mr. Trudeau. Dr.
7 Mitchell today discussed some of his concerns
8 regarding water infiltration and described the pad
9 emplacement area as a bathtub. Is this an accurate
10 description of the pad emplacement area?

11 MR. TRUDEAU: Of course not. There is
12 certainly a surface drainage system that's been
13 designed and installed in that pad emplacement area.

14 MR. NELSON: Could you describe a little
15 bit about the drainage system in that pad emplacement
16 area?

17 MR. TRUDEAU: Certainly. The flood design
18 considerations for the Private Fuel Storage facility
19 are described in the SAR in section 2.4.2.2. If you
20 were to read through that section you would find that
21 we planned to install berms to direct any of the
22 surface water from off the site around the pad
23 emplacement area. Within the pad emplacement area the
24 site is generally sloped from south to north and from
25 the center of the site to the edges where there are

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 concrete lined drainage ditches to transport the
2 surface water to the detention pond at the north.

3 MR. NELSON: Based on that design, would
4 you expect there to be any standing water following
5 either snow melt, run-off, thunderstorms, whatever
6 mechanism?

7 MR. TRUDEAU: Certainly not eight inches.
8 There may be isolated pockets where it might be a half
9 inch thick occasionally until it eventually
10 evaporates.

11 MR. NELSON: So the worst of the extent
12 would be a puddle here and there. Would that be an
13 accurate picture?

14 MR. TRUDEAU: That's correct.

15 MR. NELSON: Assuming given the
16 possibility of puddles, let's assume that there is
17 some cracking due to shrinkage cracking. Based on
18 your knowledge of the design, would you expect that if
19 there is water that enters into one of these cracks
20 that it would likely go all the way down to the
21 underlying soils under the soil-cement or the cement-
22 treated soil?

23 MR. TRUDEAU: No, I don't believe so.

24 MR. NELSON: And why not?

25 MR. TRUDEAU: We have essentially a five

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 foot thickness of cement stabilized soils out on that
2 area. This material will be constructed on thin lifts
3 so there will be several different lifts that will all
4 have cured at different times. Each of these lifts
5 will have their own shrinkage cracks but in my
6 estimation it will be very unlikely that subsequent
7 cracking in overlying lifts would line up exactly with
8 the underlying lifts.

9 MR. NELSON: To going back to Dr. Wissa's
10 analogy, what we have here is not just a sandwich but
11 is a multi-leveled club sandwich. Would that
12 accurate?

13 MR. TRUDEAU: I guess so.

14 JUDGE LAM: Mr. Trudeau, are there any
15 bonding materials between these layers?

16 MR. TRUDEAU: Yes, that is correct.

17 JUDGE LAM: What would they be?

18 MR. TRUDEAU: As Dr. Wissa discussed
19 yesterday, the surface of a soil-cement lift that has
20 set, has cured would most likely receive a cement
21 surface treatment before the overlying soil-cement
22 lift is placed because the group has indicated that it
23 is the most effective bonding agent for subsequent
24 lifts of soil-cement.

25 MR. NELSON: And just to clarify would the

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 cement that you are referring to would that be what
2 Dr. Mitchell referred to as neat cement?

3 MR. TRUDEAU: Yes.

4 MR. NELSON: Dr. Bartlett was particularly
5 concerned about the potential of water infiltration
6 around the storage pads. He postulated that the
7 possibility that there might be a path between the
8 soil-cement and the pad that water could get down
9 through that path. Do you see that as a potential
10 problem?

11 MR. TRUDEAU: Not as a potential problem.
12 I can see that it might be possibility that it might
13 occur but I believe that any water that did get into
14 such a gap that might open up between the pad and the
15 soil-cement there due to I understood differential
16 settlement I would expect that it would very quickly
17 be evaporated by the heat from the casks or just by
18 the semi-arid environment out there. We have an open
19 channel now for it to go down. We have an open
20 channel for the warm water to move up and evaporate.

21 MR. NELSON: Even if that postulated path
22 were as you or Dr. Bartlett hypothesized that path
23 still wouldn't reach all the way down into the
24 underlying soil, would it?

25 MR. TRUDEAU: No, that's correct because

1 of the continuous layer of cement-treated soil
2 underneath the pad that extends out beyond the pad.

3 MR. NELSON: Dr. Mitchell raised a concern
4 during his testimony regarding vehicle loads and the
5 potential for cracking of the soil-cement due to
6 vehicle loads. Have you done any analysis regarding
7 the loads imparted by a fully loaded cask transporter
8 which would consist of one cask and the transporter
9 what those loads would be?

10 MR. TRUDEAU: Yes. As indicated in answer
11 61 in my direct testimony.

12 MR. NELSON: Based on that analysis what
13 is your conclusion about the possibility of cracking
14 of soil-cement due to vehicle load?

15 MR. TRUDEAU: I think it's nonexistent.

16 MR. NELSON: Why?

17 MR. TRUDEAU: As my answer 61 says, we had
18 done an analysis that demonstrated that a two foot
19 thick layer of structural fill would be adequate to
20 distribute those transportal loads down to the
21 underlying clay soils.

22 We've now replaced that approximately two
23 foot thick structural layer with an approximately five
24 foot thick soil-cement layer that is obviously much
25 stronger than a structural fill would be. The loading

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 at the base of a transporter is about 10 ksf. The 250
2 psi soil-cement has a compressive strength of 36 ksf
3 so that's three to four times greater than the loading
4 that's applied at the surface of that.

5 MR. NELSON: Thank you. Going on to Dr.
6 Mitchell's discussion of the heat transfer that will
7 take place due to the loaded casks being on the
8 storage pads, actually this first question is for you,
9 Dr. Wissa. Isn't it true that the cement-treated soil
10 underlying the storage pad will be well cured before
11 any cask will be set on the pad. That is before any
12 heat transfer begins to take place. Is that accurate?

13 DR. WISSA: When you say well cured I
14 assume you mean it will be well in its strength gain
15 so it will probably be a year or more which would be
16 several years before you are going to have that
17 situation. In which case now as Dr. Mitchell said the
18 modulus has increased, substantial strength has
19 increased and as a result what you will find is that
20 the shrinkage that occurs is going to be much less.

21 If you had drying out during early stages
22 of curing then you would get substantial shrinkage and
23 cracking. But in this case you are speaking about
24 years down the road where moisture count exchange
25 should have an effect on the shrinkage cracks.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 MR. NELSON: Just to clarify so any
2 additional shrinkage due to this heat transfer effect
3 in your opinion would be minimal?

4 DR. WISSA: .Yes and it would probably
5 occur at the existing cracks. I don't think you would
6 develop new cracks in this case.

7 MR. NELSON: And those existing cracks are
8 vertical cracks. Or subvertical or nearly vertical.

9 DR. WISSA: The thing about vertical
10 cracks is they are essentially vertical but they
11 zigzag. They're not a perfect smooth plane so they
12 are like if you want to think of it not a perfect
13 sawtooth type crack but they are a bit rough as a
14 cracks goes. But essentially in the vertical
15 direction which is correct.

16 MR. NELSON: Assuming that there is due to
17 the heat postulated minimal increase in existing
18 vertical cracks in your opinion would that have any
19 effect on the intended function of the cement-treated
20 soil underlying the storage pad?

21 DR. WISSA: The issue has been all along
22 if you are looking at compression -- No the cracks are
23 already there so it should have no effect on changing
24 the performance of the foundation.

25 MR. NELSON: And it's the compressive

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 strength and shear strength that is relied on --

2 DR. WISSA: When I speak of strength I am
3 speaking of both compressive and shear strength.

4 MR. NELSON: That's what we are concerned
5 in the design to transect the shear forces.

6 DR. WISSA: That's correct.

7 MR. NELSON: Also for you, Dr. Wissa, Dr.
8 Mitchell has just testified a little bit concerning
9 the fact the Young's modulus will continue to change
10 over time, get higher, get larger over time. You
11 touched upon this already in your earlier answer just
12 now but is that a significant concern in the way he
13 was suggesting that you would get much larger than
14 75,000 psi?

15 DR. WISSA: I would like to clarify what
16 I'm proposing as a testing program and what I do
17 whenever I design a soil-cement mix. I am first
18 interested to make sure that the soil-cement increases
19 in strength in time. Sometimes you get a poor actor
20 or bad actor where it gives a little strength
21 initially and then stops giving strength or even
22 decreasing in strength.

23 So any program that I undertake I look at
24 the behavior or the strength and in this case the
25 modulus too as a function of time. I have done a lot

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 of work in this area of curing and strength change,
2 modulus change, properties with time. It turns out
3 what you have in most cases is a plot. If you plotted
4 strength on one axis, the vertical axis, and time on
5 the horizontal axis where the horizontal axis being a
6 semi-log plot basically, you have a log plot on the
7 horizontal and a linear plot on the vertical. You
8 would find a straight line.

9 The straight line is not in effect one to
10 one where you double your strength in one cycle. What
11 you find is a linear thing that goes up and I think
12 I've gone up to 300 days or nearly a year. Maybe I
13 have some data which goes up a year where you have
14 essentially a pretty much straight line on a semi-log
15 plot.

16 What that says is that the strength is
17 increasing at a much lower rate with time. You can
18 extrapolate that out to years for that matter. I have
19 never been out to 40 years but I think that would be
20 going to the extreme. So you can extrapolate out your
21 strength and your modulus to determine after five
22 years, ten years, 20 years.

23 The other point I would like to make here
24 is that when you are saying that you need a certain
25 strength I'm not sure we are talking about a 28 day

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 strength. I think the strength they are talking
2 about, compressive strength of 40 psi, is by the time
3 the earthquake occurs.

4 So let's say we know that we're going to
5 be putting these into use two years down the road
6 after construction, the pads, I could conceivably say
7 I will use 25 psi for 28 day strength. It will give
8 me 40 after two or three years. Similarly with the
9 modulus.

10 The work we're going to doing if my
11 company does it I should say is that I would be
12 looking at strength and modulus as a function of time
13 and take this into account in designing my mix. This
14 is especially true in the case of the modified soil.

15 MR. NELSON: To summarize would it be fair
16 to characterize to say this is something that when
17 you're doing it you're cognizant of it and when you
18 are coming up with your soil-cement mix it's something
19 that you can plan for and take into account?

20 DR. WISSA: Yes, but I do this generally
21 even if I don't have this criteria of a maximum
22 strength. I do it simply to be sure that I'm not
23 having a soil which is a poor actor or deteriorates
24 with time. Now in this case probably we would put
25 more emphasis in going out to let's say instead of 28

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 days maybe 56 days of curing and see that a trend
2 applies. So we can engineer around it in which case
3 we would have to convince everyone that let's say 25
4 psi at the end of seven days is sufficient to get me
5 40 PSI at the end of six months, or a year, whatever
6 that is, so knowing that there is a lineal relation,
7 or semi-log relation, it is possible to extrapolate
8 out and come up with what we want, and take into
9 consideration the concerns Dr. Mitchell has, which are
10 valid.

11 MR. NELSON: One last question. This one
12 is for you, Mr. Trudeau. There was some discussion by
13 Dr. Mitchell regarding potential difficulties with
14 compacting clay backfill in the field should it be
15 necessary to use clay backfill. Do you believe that
16 there will be such difficulties, if necessary?

17 MR. TRUDEAU: No, I don't believe so.
18 Unless we try and do it during a rainy day, those
19 soils are not going to be good to work on when they're
20 wet, but these soils are not soft clays. These are 2
21 KSF ungrained sheer strength clays, and they will not
22 respond in the manner that Dr. Mitchell was alluding
23 to. I've seen the pumping action that he's describing
24 that you get on saturated soft clays when you try and
25 place fill on it, especially if you're using a

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 vibratory roller, but I don't expect that we're going
2 to find that kind of a condition here for these upper
3 Bonneville Clays.

4 MR. NELSON: Just to clarify that, the
5 hard cells you're talking about are the underlying
6 clays that would have to be recompacted?

7 MR. TRUDEAU: I didn't understand what you
8 said.

9 MR. NELSON: I'm sorry. I just want you
10 to clarify which soils you were talking about in terms
11 of compacting.

12 MR. TRUDEAU: Which soils? We're talking
13 about the compacted clay that we might have to use in
14 some areas of the site if we find that the pads are
15 further than two feet from the top of the upper
16 Bonneville Clay.

17 MR. NELSON: Thank you. I have no further
18 questions.

19 MS. CHANCELLOR: Mr. Trudeau, you said the
20 pads are two feet from the top of the up -- you mean
21 the base of the pad?

22 MR. TRUDEAU: That is correct.

23 MS. CHANCELLOR: Thank you.

24 CHAIRMAN FARRAR: Thank you, Mr. Nelson.

25 Staff have cross?

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 MR. O'NEILL: No, we have no questions at
2 this time, Your Honor.

3 CHAIRMAN FARRAR: Thank you. Moving right
4 along, Ms. Chancellor. Do you need a --

5 MS. CHANCELLOR: I see someone crunching
6 numbers. Can we have just a moment?

7 CHAIRMAN FARRAR: Yes, go ahead. Let us
8 know when you're ready.

9 MS. CHANCELLOR: Your Honor, I have a
10 couple of questions, and then I might have to take a
11 little break to catch up with Dr. Bartlett.

12 CHAIRMAN FARRAR: That's fair enough. Go
13 ahead.

14 CROSS EXAMINATION

15 MS. CHANCELLOR: Dr. Wissa, you testified,
16 if I understood, that with respect to the compressive
17 strength of the cement-treated soils, you may try to
18 get a 25 PSI strength of 28 days, with the idea that
19 later it would gain up to a 40 PSI. I didn't quite
20 follow that.

21 DR. WISSA: Well, maybe it was a bad
22 example. I was just trying to use numbers. What I'm
23 saying here is that I would -- if I'm going to use 28
24 day as my criterion during the lab work, I know it's
25 going to increase, so I'd make sure that the strength

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 I use will achieve 40 PSI before the pads are put into
2 operation. And the example of 25 PSI is just out of
3 the air. It has no significance. I was only trying
4 to show that you'd use a lower strength at a -- let's
5 say I use 7 day strength. I know it's going to
6 increase, and I'll have measurements of it increasing
7 with time, so I know that by the time the pads are put
8 into operation, I need at least 40 PSI. So what I'm
9 saying is, I don't need to get a 7 day 40 PSI.

10 MR. TRUDEAU: May I add to that? What I'm
11 understanding Dr. Wissa to be saying is this. When we
12 get out to construct this facility, we're going to
13 want to know sooner, rather than later during the
14 construction that we've got a product that's going to
15 meet the design criteria, so we would rather control
16 the construction in the field with 7 day strengths,
17 than 28 day strengths, or 56 day strengths, or
18 whatever, so that we can let the material cure, and
19 then test it the following week to understand whether
20 or not we've got a problem area that needs to be
21 repaired. So his -- the point he's trying to make is
22 that if we're controlling construction in that manner,
23 and we get some cores from a 7 day strength program,
24 or we set up the program to look for 7 day strength,
25 the fact that we've got less than 40 PSI at the time

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 does not necessarily mean that we're not going to have
2 the 40 PSI that we need at a later date, like the 28
3 day strength, perhaps.

4 MS. CHANCELLOR: I guess I got a little
5 confused when you said that you'd need 40 PSI by the
6 time an earthquake occurs. And you're not suggesting
7 that you would wait a year or so with the idea that an
8 earthquake may not occur, but that you could gain the
9 40 PSI.

10 DR. WISSA: I think I said when they put
11 in operation, when the pads are put into operation.
12 Okay?

13 MS. CHANCELLOR: Right. But during your
14 questioning with PFS' attorney, I wrote down by the
15 time the earthquake occurs.

16 DR. WISSA: I misspoke. I apologize.

17 MS. CHANCELLOR: Okay. And you stated
18 that if you -- in a test program that you would
19 conduct, that you have quite a deal of experience with
20 curing of cement-treated soil?

21 DR. WISSA: I've done quite a bit of work
22 over the years of change of properties or strength,
23 and I believe modulus. I'm not sure if I have the
24 date on that, or behavior of cement-treated soil or
25 stabilized soils as a function of time, and I've

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 looked up to -- and I think 300 days, if not longer.

2 MS. CHANCELLOR: Maybe you could give us
3 an update. Have you had any further discussions with
4 PFS, or do you know whether you're going to be brought
5 on board for the testing program at PFS?

6 DR. WISSA: No, I haven't.

7 MS. CHANCELLOR: So back in March you were
8 still talking to PFS, and now you're still talking.
9 Is that it?

10 MR. NELSON: Your Honor, this is -- I
11 didn't ask him anything about his conversations with
12 PFS about a testing program, his scope of services, or
13 anything of the sort, so I think we're going a bit far
14 beyond the rebuttal testimony.

15 MS. CHANCELLOR: Your Honor, Dr. Wissa
16 testified that if he were doing the program, he has
17 all this experience with respect to material
18 properties. And if he's not going to be doing the
19 testing program, then this testimony is basically not
20 worth a whole lot, and so I'm trying to get into
21 whether we can rely on this testimony, based on
22 whether Dr. Wissa is going to be doing it, or is AGECE,
23 or is somebody else? We know already that AGECE has --
24 some of their tests have failed, so it does seem to
25 be important who does the program. And I'm just

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 trying to establish that Dr. Wissa -- to tie Dr.
2 Wissa's testimony up with respect to his experience.

3 MR. NELSON: If I may briefly reply, what
4 Dr. Wissa has testified about are industry practices,
5 whether these things are achievable, how they're
6 achievable, so on and so forth. That is completely
7 material. Going into whether or Dr. Wissa will be the
8 actual person who does this is beyond the scope of
9 anything we did on rebuttal. It is not material to
10 the issues here.

11 MR. O'NEILL: Your Honor, I think he's
12 providing expert testimony as to what can be done. I
13 mean, he's an expert in soil cement. I don't think
14 he's the only person capable of carrying out this
15 particular work.

16 MR. NELSON: If I may briefly -- I'm
17 sorry.

18 CHAIRMAN FARRAR: Go ahead.

19 MR. NELSON: If I may briefly add, I think
20 we're in the danger of becoming duplicative here since
21 Ms. Chancellor went over this extensively already
22 yesterday.

23 MS. CHANCELLOR: I'm asking for an update,
24 Your Honor, and maybe the other person who could do
25 this program is Dr. Mitchell, but I don't know that

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 there are a whole lot of people out there who can do
2 this. And Dr. Wissa testified that if he were doing
3 this program, he wasn't talking about industry
4 practices, he was talking about his practice. And all
5 I'm asking is a follow-up whether -- I'll leave it
6 there.

7 CHAIRMAN FARRAR: Right. There is -- the
8 objection is overruled. Go ahead. You may answer.

9 DR. WISSA: Well, to answer your question,
10 now that I've explained what I would do, I'd assume
11 that anyone who would take it over from me now would
12 copy what I did, so I've lost my advantage.

13 MS. CHANCELLOR: Are there a whole lot of
14 competitors out there, Dr. Wissa?

15 DR. WISSA: Yes, unfortunately.

16 MR. TRUDEAU: I thought you were helping
17 him out, by getting him a contract.

18 MS. CHANCELLOR: I'm trying, Mr. Trudeau.
19 Your Honor, I have no further questions.

20 CHAIRMAN FARRAR: Thank you, Ms.
21 Chancellor. Ms. Chancellor, you had said before you
22 might want a little bit of a break to see if you had
23 any other questions before you concluded.

24 MS. CHANCELLOR: No, I believe I'll be
25 able to take care of everything through either

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

1 surrebuttal or our rebuttal, like we did in the past.
2 We'll combine Dr. Mitchell -- we won't combine the two
3 witnesses. We will combine rebuttal and surrebuttal
4 by putting on Dr. Mitchell, and Dr. Bartlett, and we'll
5 deal with it there, Your Honor.

6 CHAIRMAN FARRAR: All right. Judge Lam
7 has a question.

8 JUDGE LAM: Dr. Wissa, Mr. Turk from the
9 Staff had earlier mentioned that at 28 days the soil
10 cement would make the maximum gain in its strength and
11 the modulus. Do you know approximately how much gain
12 that may be?

13 DR. WISSA: No, it's a function of soil
14 type, cement. Each soil behaves differently as it
15 cures. It isn't like concrete where we have a fixed
16 material and we can estimate that. But we know that
17 by 28 days, a lot of the strength has been achieved in
18 modulus, but it does continue, while I don't know
19 indefinitely, but for several years, at least a year.
20 And you'd get, I'd say, over 90 percent of the
21 strength well within a -- less than a year.

22 What you do is you can extrapolate --
23 well, you know the fallacy of a semi-log lot. It
24 goes out to infinity, and I'm not sure how it behaves
25 way out there after five or ten years, but in essence,

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 you'd see that most of the gain is in the first 28
2 days, and then 56 would be a little more gain, and
3 then it just increases at a slower rate.

4 JUDGE LAM: So Dr. Mitchell does have a
5 point.

6 DR. WISSA: Yes. And I agree that you do
7 gain strength with time. What I'm saying is you can
8 use that to your advantage in this design, and the
9 fact that we know it's a simple semi-log plot, you can
10 extrapolate out very easily.

11 JUDGE LAM: Thank you.

12 MR. TURK: Judge Lam, I have to apologize.
13 If I stated that the maximum gain is at 28 days,
14 that's not what I intended. I was describing the
15 process whereby most of the delta, most of the gain
16 occurs before you get at the 28th day. I wasn't
17 stating that the Staff believes that the gain has
18 reached its maximum at 28 days.

19 JUDGE LAM: Right. Thank you.

20 CHAIRMAN FARRAR: Any redirect by the
21 Company?

22 MR. NELSON: Yes. Just two questions.

23 REDIRECT EXAMINATION

24 MR. NELSON: Mr. Trudeau, following up on
25 Judge Lam's question, it's my understanding, and

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 please tell me if this is correct, that all the
2 analyses that have been done, Holtec's analyses and
3 the analyses where Young's Modulus has any affect is
4 benchmarked at 28 days. That is, everything is based
5 on a curing of 28 days, so that takes into account
6 whatever subsequent properties it might have beyond
7 that. Is that an accurate understanding? Is that how
8 these analyses are done?

9 MR. TRUDEAU: That's my understanding,
10 yes.

11 MR. NELSON: No further questions.

12 CHAIRMAN FARRAR: You asked for two, you
13 only used one.

14 MR. NELSON: Well, I'm making up for Mr.
15 Travieso-Diaz.

16 CHAIRMAN FARRAR: Thank you. Exactly.
17 Exactly.

18 MR. TRAVIESO-DIAZ: And the record shows
19 there's a lot to make up for.

20 CHAIRMAN FARRAR: Staff have anything?
21 Are we finished?

22 MR. O'NEILL: We're finished.

23 CHAIRMAN FARRAR: Okay. Good. Then
24 you're excused again, and is that the end of your
25 rebuttal case on this?

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 MR. NELSON: For now, assuming that we'll
2 see what happens on surrebuttal.

3 CHAIRMAN FARRAR: Right. I mean, you have
4 no more rebuttal witnesses at this time.

5 MR. NELSON: No, not at this time.

6 CHAIRMAN FARRAR: Okay. Thank you,
7 gentlemen.

8 MR. NELSON: Thank you, Your Honor.

9 CHAIRMAN FARRAR: The usual compliments,
10 but much shorter this time.

11 MS. CHANCELLOR: Your Honor, I was just
12 waiting to see if the staff had any rebuttal.

13 CHAIRMAN FARRAR: Oh, I'm sorry. I had
14 forgotten them. I was thinking it was your turn. Do
15 you have any rebuttal witnesses?

16 MR. O'NEILL: No.

17 CHAIRMAN FARRAR: Good. Thank you.
18 Moving right along.

19 MR. O'NEILL: I shouldn't change my mind,
20 right?

21 CHAIRMAN FARRAR: No.

22 MR. O'NEILL: It made us think though.

23 MS. CHANCELLOR: We're thinking very fast
24 over here too, Your Honor.

25 CHAIRMAN FARRAR: Ms. Chancellor, if you

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 need a minute or two longer to think.

2 MS. CHANCELLOR: No, I think we're okay,
3 but I would like to take a break after we do rebuttal
4 of these two witnesses, before we get to rebuttal on
5 Mr. Trudeau by himself, so I'd like to call Dr.
6 Bartlett and Dr. Mitchell as the State's rebuttal on
7 surrebuttal to Dr. Wissa and Mr. Trudeau.

8 CHAIRMAN FARRAR: All right. Gentlemen,
9 you've previously been sworn, so consider yourselves
10 still under oath, please.

11 MS. CHANCELLOR: Dr. Mitchell and Dr.
12 Bartlett, you have a copy in front of you of the
13 rebuttal testimony of Mr. Trudeau and Dr. Wissa that
14 was just entered into the record?

15 DR. BARTLETT: Yes.

16 DR. MITCHELL: Yes.

17 MS. CHANCELLOR: Dr. Mitchell, in answer
18 1, PFS in essence says that -- seems to say that
19 precedent means that you draw on different mechanical
20 properties. Would you agree with this definition of
21 precedent?

22 DR. MITCHELL: I have difficulty accepting
23 that as a definition for precedent. As I read it,
24 it's not the application that sets a precedent, it's
25 the use of different properties. If we think about

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 that for a minute, it would seem to me that all soil
2 cement projects have had a precedent, in that the
3 properties, the mechanical properties that you're
4 concerned about are the strength, the compressibility,
5 the stiffness or modulus, and the permeability of the
6 material. Every project involving soil cement that
7 was constructed since that first road in, was it
8 Sarasota, Florida in 1906 or 1908, draws on one or
9 more of those properties. Therefore, there have been,
10 according to their definition, no precedents in the
11 use of soil cement in nearly 100 years. And it's
12 difficult for me to accept that.

13 We might try another analogy that would
14 be, say high rise structures. I think until some
15 years ago reinforced concrete was used for structures
16 up to what, 50, 60 stories. In that highrise out in
17 Kuala Lumpur, they're up over 100 stories now with
18 concrete as the structure.

19 They both, the shorter structures and the
20 high structure rely on the compressive strength and
21 the modulus of the concrete, but I think it would be
22 difficult to claim that jumping up to that height of
23 a structure was not a precedent setting event. So it
24 seems to me that to say that you can only have a
25 precedent by using different properties doesn't really

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 hold much water.

2 MS. CHANCELLOR: And with respect to the
3 specific examples that are given in the Trudeau/Wissa
4 rebuttal testimony, could you describe in simple terms
5 why many of these may not be what you would call
6 precedent, for example, the deep soil mixing?

7 DR. MITCHELL: The deep soil mixing case
8 that they cite in question 2, answer 2 is the Central
9 Artery Tunnel project. It is true that both the PFS
10 and that project rely on strength and stiffness of the
11 material, so by their definition, there would be no
12 precedent in the new project. However, I think
13 they're distinctly different in terms of what is going
14 on.

15 In the Boston Central Artery project
16 you're looking at a very thick layer of treated
17 material. PFS is thin, relatively speaking. In the
18 deep mixing, you're working with a soft clay soil at
19 a quite high water content, whereas in Utah, we're
20 talking about a much lower water content material.

21 In the one project, the Tunnel project,
22 there was no compaction of the ground. In Utah, it's
23 proposed to compact the ground. In the one you're
24 making what is called a deep soil mix, which is not a
25 soil cement at all. It's a very high water content

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealgross.com

1 material with considerably different properties, so I
2 think in that sense those are different.

3 MS. CHANCELLOR: What about the South
4 Africa Koeberg?

5 DR. MITCHELL: Yeah. Well, we've talked
6 some about the Koeberg project. It seems to me that
7 mitigating risk from liquefaction and buttressing are
8 not really the same thing. The soil out in South
9 Africa that was being treated was to be beneath the
10 structure, not beside it. The issue there was not
11 sliding. In fact, the -- it's a rather interesting
12 project in the sense that the reactor building itself
13 was designed as a base isolated structure, and so its
14 salvation was to be sliding at that particular case.

15 In South Africa, it was a sand cement. In
16 PFS, it's a clay cement, or silt cement. So in my
17 view, they are different, and each in its own way was
18 sort of precedent setting. Although the Koeberg one
19 was not, to my knowledge, the very first application
20 for liquification mitigation. I think there's a power
21 plant down in the mid south some place or other where
22 they treated liquefiable soils with cement, back a
23 year or two before.

24 MS. CHANCELLOR: And I believe the Staff
25 mentioned an example with lateral walls, and the

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 passive resistance that soil cement is supposed to
2 give to the canister transfer building. Do you see
3 any analogy there?

4 DR. MITCHELL: Well, there's an analogy in
5 that there's a resistance of a lateral stress. I
6 think the canister transfer building and the pads are
7 different in these other cases because of the
8 dynamics, and the fact that we're looking at a
9 horizontal potential sliding of the whole stabilized
10 mass, which has really not been an issue in the
11 others.

12 MS. CHANCELLOR: Thank you, Dr. Mitchell.
13 Dr. Bartlett, is cracking of the soil cement a
14 prerequisite for pad-to-pad interaction?

15 DR. BARTLETT: No.

16 MS. CHANCELLOR: Is sliding of the pads a
17 necessary prerequisite to develop pad-to-pad
18 interaction?

19 DR. BARTLETT: No.

20 MS. CHANCELLOR: Is there potential for
21 cracking the soil cement due to earthquake loading?

22 DR. BARTLETT: Maybe, due to inertial and
23 kinematic action as you now have pad-to-pad
24 interaction. And in the case of the canister transfer
25 building, mat foundation to soil cement interaction.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 MS. CHANCELLOR: One final question. Do
2 either of you have any comment on any question I
3 forgot to ask you?

4 MR. TRAVIESO-DIAZ: I will object to the
5 form of that question.

6 MS. CHANCELLOR: I figured if Judge Farrar
7 could get away with it, maybe I could. No further
8 questions, Your Honor.

9 CHAIRMAN FARRAR: You sure you don't need
10 more time. This all is happening at a faster and
11 faster pace. If you need more time to consult with
12 your witnesses to -- I know your last comment was half
13 facetious, but that matter was also half true.

14 MS. CHANCELLOR: Your Honor, I think it
15 gets to the point of who's going to have the last
16 word, and rather than belabor some of these points,
17 there's a well-established record. I might note that
18 on answer 7 to the rebuttal testimony dealing with pad
19 settlement, that is also covered in Mr. Trudeau's
20 rebuttal testimony in Section D. And with your
21 permission, we would address any issues dealing with
22 pad settlement directly with Dr. Bartlett's testimony
23 in rebuttal to Mr. Trudeau's testimony in Section D.

24 CHAIRMAN FARRAR: Is that all right with
25 the Applicant?

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 MR. TRAVIESO-DIAZ: Yes, Your Honor.

2 CHAIRMAN FARRAR: Staff?

3 MR. O'NEILL: Yes, Your Honor.

4 MR. TURK: I'm not sure I understood.

5 CHAIRMAN FARRAR: It doesn't matter.

6 We're going to do it. In terms of -- okay. Once we

7 accept Ms. Chancellor's thoughts that she's completed,

8 what's the next step? I'm sorry. You're going to --

9 MR. NELSON: Cross examine them,
10 hopefully.

11 CHAIRMAN FARRAR: Maybe. All right. Ms.

12 Chancellor, why don't you do this, if you think of

13 anything else that would have been further direct

14 given the short time you had to prepare for this, if

15 you think of anything else that's further direct,

16 we'll give you another chance when we come back.

17 MS. CHANCELLOR: I appreciate that. Thank

18 you, Your Honor.

19 CHAIRMAN FARRAR: Okay. Go ahead.

20 MR. NELSON: All right. A few brief

21 follow-up questions to clarify, and these will all be

22 directed at Dr. Mitchell.

23 CROSS EXAMINATION

24 MR. NELSON: I think, and perhaps I wasn't

25 hearing correctly, perhaps the way you phrased it sort

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 of got turned around, at least in my mind, in that you
2 said that according to PFS rebuttal testimony, there
3 essentially were no precedents. I think you meant that
4 essentially everything was a precedent for the use of
5 soil cement. Is that the point you were trying to
6 make?

7 DR. MITCHELL: I think that's a good way
8 to put it since they contend a new precedent can be
9 established only by having different or new kinds of
10 mechanical properties. I don't know what they would
11 be.

12 MR. NELSON: And -- I'm sorry. Go ahead.

13 DR. MITCHELL: Since all these projects
14 rely on the same basic three or four different
15 properties, following their line of reasoning, there
16 could be no precedent after the first application of
17 soil cement, and I don't agree with that.

18 MR. NELSON: Right. And all these
19 projects do rely on the same three or four, I think
20 you mentioned mechanical properties of the soil
21 cement. Is that correct?

22 DR. MITCHELL: Yes.

23 MR. NELSON: So in one sense, it depends
24 on how you look at it. They could either all be
25 precedents, that could be a fair characterization if

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 you --

2 DR. MITCHELL: Yes.

3 MR. NELSON: -- rely on those three
4 properties, or four properties?

5 DR. MITCHELL: Right.

6 MR. NELSON: Or what you are sort of doing
7 is pointing out differences in soil types, differences
8 in this or that so, I mean, they could either all be
9 precedents or there could be no precedents if you get
10 specific enough, because if we get specific enough, in
11 essence everything is unique. Isn't that correct?

12 DR. MITCHELL: That's correct. Every
13 project is different.

14 MR. NELSON: All right.

15 DR. BARTLETT: May I add something about
16 precedents?

17 MR. NELSON: Sure.

18 DR. BARTLETT: I think we're missing an
19 important part of case histories, and what they do in
20 seismic analysis. Not only is it important to design
21 a system, but it's important to see how the system
22 actually responded and performed after an earthquake.
23 And so, when I talk about precedents too, I think it's
24 important that a precedence of a proper use of a
25 ground treatment, whatever it may be, the final proof

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 is that it was designed properly, it survived the
2 earthquake, and it performed properly.

3 MR. NELSON: Are you saying that there are
4 no precedents for anything unless a similar project
5 was subjected to an earthquake at some point in time?

6 DR. BARTLETT: No, I'm just saying that we
7 always -- when we launch into an area that's somewhat
8 new to us and do a design, we have a concept of how we
9 believe it's going to perform. And I think the final
10 thing that we like to rely upon on whether that
11 technology is used many, many times, and in repeated
12 use, is how did it actually perform during the
13 earthquake, because until we actually see the
14 performance and can measure it, this idea of
15 precedence, I don't think is completely fulfilled.

16 MR. NELSON: Now you've confused me a bit,
17 and perhaps that's just my lack of understanding, but
18 maybe Dr. Mitchell can clear this up.

19 Dr. Mitchell, aren't we concerned about
20 loads, and it really doesn't necessarily matter
21 whether those loads are loads from an earthquake or
22 loads from say passive pressure, or some other dynamic
23 pressure on a soil cement structure? Aren't, in
24 essence, loads, loads?

25 DR. BARTLETT: No.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 MR. NELSON: Dr. Mitchell, do you agree
2 with that?

3 DR. MITCHELL: No, there are loads, and
4 there are loads. I think that some are slowly applied
5 and remain constant or static loading conditions.
6 There are cyclic loads. For example, the vehicles
7 passing across the pavement or a bridge that's
8 repeatedly on and off. There are earthquake loads,
9 which are irregular in nature, but they go both ways
10 and cross an axis, so to speak. In other words, they
11 go up and down, whereas vehicle loads go down and up.
12 I mean, you know, they don't cross zero; whereas, in
13 the earthquake they do. They go back and forth. And
14 there are thermal loads. There are, you know, there
15 are a variety of kinds of loads.

16 MR. NELSON: Sure. And I think that goes
17 back to whether you look for similarities or
18 differences, and how fine you divide things. But when
19 you test, you test the same for any of those loads
20 essentially. Correct? I mean, you test, let's say a
21 pavement. You test its ability to withstand loads,
22 which would include both the vehicle loads and the
23 earthquake loads you would expect. Isn't that
24 correct?

25 DR. MITCHELL: You do, but there are

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 situations where you might use different kinds of
2 tests. For example, in the PFS situation, there's
3 concern about bonding between the layers of different
4 materials, and so the proposal is to use some sort of
5 a direct shear test, which is a simulated sliding.
6 There is concern about the compressive strength and
7 the sheer strength, and so it's proposed to use
8 compressive type loading tests, so there's a variety
9 of things that you can do.

10 MR. NELSON: And as I recall your
11 testimony so far, that in terms of the tests that PFS
12 has specified they will undertake, you consider those
13 adequate to determine whether the properties that are
14 relied upon will be there, will actually be achieved
15 before the cement is put down. Isn't that correct?

16 DR. MITCHELL: Well, as I testified,
17 generally yes.

18 MR. NELSON: No further questions.

19 MR. O'NEILL: Just quickly, Dr. Mitchell.
20 With respect to the proposed uses of soil cement at
21 the PFS site, and the Boston Central Artery project,
22 I know you made some -- pointed out some distinctions
23 between the two, but you're not saying there's
24 absolutely no common denominator, so to speak, between
25 the two. Say for instance, a desire to increase

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 resistance to lateral forces through the use of a
2 cement stabilized product?

3 DR. MITCHELL: Well, that's true. Yes.

4 MR. O'NEILL: Yes. And with respect to
5 Koeberg, I presume there was some desire to increase
6 the cohesion of the soils there in order to preclude
7 liquefaction. Correct?

8 DR. MITCHELL: The issue there was to
9 provide resistance to liquefaction. It was deemed
10 necessary to cement the material to prevent the
11 liquefaction, as opposed to using some other
12 densification technique that might have been employed.

13 MR. O'NEILL: That would entail increasing
14 the cohesion of those materials. Correct?

15 DR. MITCHELL: Increasing the cohesion
16 was, in fact, what was used. Yes.

17 MR. O'NEILL: Thank you. I have no
18 further questions.

19 CHAIRMAN FARRAR: The Board has no
20 questions. Ms. Chancellor, if you thought of anything
21 else you wanted to ask.

22 MS. CHANCELLOR: Just one brief follow-up,
23 Your Honor.

24 REDIRECT EXAMINATION

25 MS. CHANCELLOR: PFS counsel stated --

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 asked a question, or made a statement that every --
2 if you get specific enough everything is different.
3 And further, that if you split things too finely,
4 you'll get similarities or differences. In your
5 discussion of precedent, Dr. Mitchell, did you
6 consider that you were being super-specific, if you
7 will, as opposed to making general statements about
8 precedent, and not so much going to mechanical
9 properties? That's a horrible question. If you don't
10 understand it, I'll rephrase.

11 DR. MITCHELL: Well, I don't know that I
12 understand it completely and correctly, but I was
13 trying to address this issue that seems to be in Mr.
14 Trudeau's and Dr. Wissa's rebuttal, that application
15 is not a basis for precedent. And to me, if we go and
16 look at cement treatment of soils, I think that there
17 are a series of things that have happened since 1906
18 or 1908, or whenever it was, that have defined new
19 applications or new forms of cement as a material.
20 And we have plastic soil cement, which is a more
21 mortar-like material. It's good for laying in ditches
22 that came along fairly soon. We have cement treated
23 stuff, which is just a lower level of treatment like
24 we're talking about here for underneath the pads, that
25 was introduced at some stage.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 Following World War II in the 50s, they
2 started adopting soil cement for slope protection,
3 used very successfully on some reservoirs out west to
4 resist wind and wave, and banging logs and other
5 things that are floating in the reservoir.

6 Then came along deep soil mixing, which is
7 now a very important subject. And we have roller
8 compacted concrete that's used for construction of
9 dams and embankments, and so, you know, I think each
10 of these is a new application in its own right. And
11 that each was precedent setting in terms of
12 application, and each taught certain things when they
13 were first introduced that have been valuable lessons
14 learned. Not all worked perfectly the first time out
15 of the gate, and they required some modification, but
16 that's my opinion about precedent in this case.

17 MS. CHANCELLOR: One final question. Do
18 you consider the cement-treated soil that PFS intends
19 to use to resist sliding to be precedent setting?

20 DR. MITCHELL: In my view, the particular
21 application used here, this picture frame and the
22 passive abutment kind of thing around the CTB is
23 precedent setting under dynamic loading conditions.

24 MS. CHANCELLOR: Thank you. Thank you
25 very much.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 MR. NELSON: No questions, Your Honor.

2 MR. O'NEILL: Well, actually I had just a
3 clarification. I think you had mentioned some
4 untreated soil, which is just underneath the pads, as
5 opposed to what he was talking about, the stuff around
6 the pads.

7 MS. CHANCELLOR: He can answer my question
8 any way he likes.

9 CHAIRMAN FARRAR: Okay. Are we done then?
10 Then we're finished again with these witnesses. Thank
11 you for the -- your thoughts. Does the Staff have
12 anything?

13 MR. O'NEILL: No.

14 CHAIRMAN FARRAR: Does the Applicant have
15 any other witnesses, or --

16 MR. TRAVIESO-DIAZ: I think we agreed that
17 we're finished, as well.

18 CHAIRMAN FARRAR: Okay. Then this issue
19 is finished, soil cement is finished.

20 MR. NELSON: And I think that's the first
21 one so celebration is in order.

22 CHAIRMAN FARRAR: Nice going. Dr. Wissa
23 can be excused?

24 MR. NELSON: We hope so.

25 CHAIRMAN FARRAR: Let me advise you, sir.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 We have a habit when people sit in the audience, we
2 may call on them again, so we advise you to leave the
3 building and get on the Metro and go downtown, and
4 nice having you with us.

5 MS. CHANCELLOR: Judge Farrar, also Dr.
6 Mitchell, I believe, can be excused. He'd like to
7 head out of town too.

8 CHAIRMAN FARRAR: Okay. Dr. Mitchell,
9 thank you for coming and sharing your expertise with
10 us, you and Dr. Wissa both. Thank you.

11 Next is --

12 MS. CHANCELLOR: A break, please.

13 CHAIRMAN FARRAR: A break followed by?

14 MR. GAULKER: Rebuttal of Paul Trudeau in
15 D, Section D.

16 CHAIRMAN FARRAR: On D.

17 MR. GAULKER: That which we did not get to
18 on Saturday in Salt Lake City.

19 CHAIRMAN FARRAR: Right. All right then.

20 MS. CHANCELLOR: Could we have a little
21 longer break than usual, because we're sort of
22 scrambling.

23 CHAIRMAN FARRAR: Okay. And what else are
24 we trying to do today, other than Mr. Trudeau?

25 MS. CHANCELLOR: Any rebuttal by Dr.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 Bartlett to Mr. Trudeau.

2 CHAIRMAN FARRAR: Okay.

3 MS. CHANCELLOR: So just the two
4 witnesses.

5 CHAIRMAN FARRAR: I mean, do you want 20
6 minutes, 25 minutes?

7 MS. CHANCELLOR: How about 20 minutes,
8 Your Honor?

9 CHAIRMAN FARRAR: Okay. It's 10 of.
10 We'll be back at 10 after.

11 MR. TRAVIESO-DIAZ: To clarify, the goal
12 is to finish Section D, as well, today.

13 CHAIRMAN FARRAR: Let's do it.

14 (Off the record 2:51 - 3:14 p.m.)

15 Whereupon,

16 PETER TRUDEAU

17 was called as a witness by Counsel for the Applicant
18 and, having been previously duly sworn, assumed the
19 witness stand, was examined, and testified as follows:

20 CHAIRMAN FARRAR: Who will be doing the
21 direct?

22 MR. TRAVIESO-DIAZ: I will.

23 CHAIRMAN FARRAR: Thank you.

24 DIRECT EXAMINATION

25 BY MR. TRAVIESO-DIAZ:

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 Q Good afternoon, Mr. Trudeau.

2 A Good afternoon.

3 Q Do you have before you a document bearing
4 the caption of this Proceeding entitled: Rebuttal
5 testimony of Paul J. Trudeau on Section D of Unified
6 Contention Utah L/QQ?

7 A Yes, I do.

8 Q Was this testimony prepared by you, or
9 under your direct supervision?

10 A Yes, it was.

11 Q Do you have any corrections to make to
12 this testimony?

13 A No.

14 Q Are there also, do you have, also before
15 you, two documents, one entitled: Stone and Webster,
16 Inc., Calculation Sheet; and another document which
17 appears to consist of a series of excerpts from
18 documentation of various nuclear power plants?

19 A Yes, I do.

20 Q Is the testimony that we just described
21 true and correct to the best of your knowledge?

22 A Yes, it is.

23 Q And do you adopt it as your rebuttal
24 testimony with respect to Section D of Contention Utah
25 L/QQ?

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 A Yes.

2 MR. TRAVIESO-DIAZ: I would move that the
3 testimony of Mr. Trudeau be admitted into evidence as
4 if read.

5 CHAIRMAN FARRAR: Let me ask you, this is
6 dated June 18th, and when we were in Salt Lake City
7 you gave us a similar document dated June 7th. Are
8 they identical?

9 MR. TRAVIESO-DIAZ: Mr. Chairman, I think
10 there are three differences, and I will explain it to
11 you. The witness will have to give you one of them.
12 The date, of course, is different.

13 CHAIRMAN FARRAR: Right.

14 MR. TRAVIESO-DIAZ: Because it was
15 intended to be given on June 7, and it is now June
16 17th.

17 In a couple of places there is, there was
18 reference to a specific exhibit number that was
19 intended to be given at that time. The numbers have
20 changed. So in answer 3 --

21 CHAIRMAN FARRAR: That is okay.

22 MR. TRAVIESO-DIAZ: -- should be 231 and
23 232.

24 CHAIRMAN FARRAR: But in terms of having
25 read this it is essentially the same in terms of

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 preparation?

2 MR. TRAVIESO-DIAZ: I believe that there
3 is one typographical correction that Mr. Trudeau made
4 in the process of finalizing his testimony.

5 BY MR. TRAVIESO-DIAZ:

6 Q Isn't that correct?

7 A That is correct.

8 Q Which would that be?

9 A That is at the top of page 6, on the June
10 18th version that was just handed out today.

11 Q And what is the correction?

12 A At the end of the first line it reads plus
13 five inches. The original document had a six there
14 instead of the five. Five is the correct number.

15 CHAIRMAN FARRAR: Any objection to the
16 admission of the testimony?

17 MS. CHANCELLOR: No objection, Your Honor.

18 MR. O'NEILL: None for the staff.

19 CHAIRMAN FARRAR: Then we will have the
20 Reporter bind this testimony into the record at this
21 point as if read.

22 (Insert prefiled testimony of Peter
23 Trudeau here.)

24

25

June 18, 2002

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

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

**REBUTTAL TESTIMONY OF PAUL J. TRUDEAU
ON SECTION D OF UNIFIED CONTENTION UTAH L/QQ**

**I. REBUTTAL TO TESTIMONY OF STATE OF UTAH WITNESS DR.
FARHANG OSTADAN**

A. Accelerations Used in Dynamic Analysis of Pads

Q1. In his answer to question 37 in the "State of Utah Testimony of Dr. Steven F. Bartlett and Dr. Farhang Ostadan on Unified Contention Utah L/QQ (Dynamic Analyses)" ("Bartlett/Ostadan Direct Testimony"), Dr. Ostadan raises the concern that in the pad stability calculation G(B)-04, Rev. 9, PFS used the peak acceleration from the design ground motion instead of obtaining and using the correct acceleration values computed by Holtec. Do you agree with this criticism?

A1. No. I have reviewed the time histories of the forces in the springs representing the soil in Holtec's SSI analysis and find that the use of 0.711g in Calculation G(B)-04, Rev. 9 to estimate the dynamic loading of the pad was a reasonable approximation when compared to the acceleration applicable for the pad + casks based on the peak horizontal force (0.79g) between the pad and the soil in Holtec's SSI analysis. See the answer to Question 4 below for additional details.

Q2. In his oral testimony (Tr. 7530-7531) at the May 8, 2002 hearings, Dr. Ostadan asserted that the Stone and Webster stability calculation for the pad is also deficient in that it failed to include the seismic loading of the casks; e.g., "and Stone & Webster have to guess even the acceleration for the cask for sliding." Is this a legitimate concern?

A2. No. The base case for sliding stability of the pads is presented on p. 23 of Calculation 05996.02-G(B)-04, Rev. 9 (PFS Exhibit UU). It clearly uses the maximum horizontal dynamic cask loads acting at the top of the pad from ICEC's Calculation 05996.02-G(PO17)-2. This horizontal driving force equals 2,212 kips, and it is identified as EQh_{CE-W} in the calculation of the factor of safety near the top of that page. These forces were developed by ICEC based on the time histories they received from Holtec's SSI analysis and were reported in Table D-1(c) on p. 233 of ICEC's calculation 05996.02-G(PO17)-2, Rev. 3. Therefore, Dr. Ostadan's assertion that the cask stability calculation "guesses" the acceleration for the casks for sliding is erroneous.

Q3. In answer 28 of your direct testimony, you cite radiation damping values for vertical vibration of the pad + casks + soil system ranging from 48% to 52%, depending on the soil properties. At the hearing, Dr. Ostadan criticized these values as unrealistic. How did you compute these radiation damping values, and what is your response to Dr. Ostadan's criticism?

A3. As stated in answer 28 of my direct testimony, the radiation damping for the pad + casks + soil system can be calculated using a relatively simple formulation. Enclosed as PFS Exhibit ___ is a copy of the calculation that I performed on March 26, 2002 in support of my direct testimony. As noted in the exhibit, the values of radiation damping that I provided in the calculation are based on the methodology presented in the standard textbook by Newmark, N. M., and Rosenblueth, E., Fundamentals of Earthquake Engineering, Prentice-Hall, Inc., Englewood Cliffs, NJ, 1971.

I do not believe there is any basis for Dr. Ostadan's opinion that the damping values I calculated (48% to 52%) are unrealistic. To the contrary, those values are reasonable in light of the masses of the pads and casks and the properties of the soils beneath the pad foundations.

Q4. In his testimony at the May 9, 2002 hearing (Tr. 7634-7636), Dr. Ostadan also asserted that there is an apparent inconsistency between the pad acceleration of 0.757g and the results presented in answer 28 on p. 14 of your testimony, where you used the equation

$$FS_{\text{Sliding E-W w/oPassive}} = \frac{2.1 \text{ ksf} \times 30 \text{ ft} \times 67 \text{ ft}}{3,310 \text{ k} + 65.3 \text{ k}} = 1.25$$

which Dr. Ostadan claims gives approximately a 1g horizontal acceleration for the pad [by dividing a pad reaction force of 3,300 kips minus the cask dynamic force of 2,200

kips from ICEC's calculation by the weight of the pad, 904.5 kips]. What is your response to this assertion?

A4. First of all, the 0.757g figure quoted by Dr. Ostadan is erroneously cited, since it is the acceleration from the response spectrum of the *vertical* time history for 50% damping (not the *horizontal*, as stated by Dr. Ostadan in his testimony). The correct value should be 0.711g. In addition, Dr. Ostadan's calculation erroneously excludes the virtual soil mass that is included in Holtec's SSI analyses and in the 2,200 kips from ICEC's dynamic horizontal load from the casks to the pads.

To repeat Dr. Ostadan's simple calculation with this error removed, one should use a peak horizontal force – obtained from Holtec's SSI analysis that includes the virtual soil mass – of 3,310 kips (from the upper-bound soil case for the forces in the fault-normal direction, which was higher than the peak values from the lower-bound and best-estimate cases). The corresponding maximum cask dynamic forces for the fully loaded pad is 2,212 kips, as indicated in Table D-1(c) on p. 233 of ICEC's Calculation 05996.02-G(PO17)-2, Rev. 3. The virtual soil mass is calculated as shown on p. B-10 of Holtec's report HI-2012640 and equals $1.078 \times 10^3 \text{ lbf} \cdot \text{sec}^2 / \text{in.}$, which, multiplied by the acceleration of gravity, 386.4 in./sec^2 , results in a weight of 416.5 kips for this soil mass. Repeating Dr. Ostadan's calculation of the approximate horizontal acceleration of the pad for this case indicates that the apparent horizontal acceleration of the pad is 0.83g when the maximum cask dynamic force from ICEC is subtracted from the peak horizontal force from Holtec's SSI analysis that includes the virtual soil mass and the weight of the virtual soil mass is included; e.g.,

$$a_h \text{ of pad} = \frac{3,310 \text{ k} - 2,212 \text{ k}}{904.5 \text{ k} + 416.5 \text{ k}} = 0.83\text{g}$$

As discussed in answer 28 of my direct testimony, this acceleration needs to be adjusted because it overestimates the design response spectrum. In this instance, using the values in Table 1 of Calc. 05996.02-G(PO18)-3-1, the response spectrum of the PFS fault-normal horizontal time history overestimates the design response spectrum by approximately 5%. If this adjustment is taken into consideration, the applicable horizontal acceleration for the pad would be $0.83\text{g} \div$

1.05, or 0.79g. This value is much lower than the erroneous value of 1g cited by Dr. Ostadan.

This horizontal pad acceleration value of 0.79g is also reasonably close to the value of 0.711g that was used to calculate the horizontal inertial forces applicable for the pad + soil cement in the Stone & Webster pad stability analyses. Its use, instead of the 0.711g employed in the pad stability calculation, results in a slight decrease in the factor of safety against sliding of the base case from 1.27 to 1.22, which still provides a margin against failure of 22%. In short, there is no inconsistency between the pad acceleration used as input in the pad stability analyses and the formula used to calculate the factor of safety against sliding, nor is there a significant reduction in the margin of safety against sliding if one uses the acceleration values from Holtec's calculation instead of the acceleration used in the pad stability analyses.

B. Long Term Pad Settlement

Q5. In answer 29 of the Bartlett/Ostadan Direct Testimony, Dr. Ostadan indicated that the ICEC pad design calculation was deficient in that the long-term settlement of the pads was not considered in the design of the pads. At the May 9, 2002 hearing (Tr. 7486), Dr. Ostadan expanded this concern and alleged that long-term pad settlement may affect the dynamic response of the pads (Tr. 7481-7512). How do you respond to these claims?

A5. The estimated long-term static settlement of the pads is computed in Stone and Webster Calculations 05996.02-G(B)-03, Rev. 3, *Estimated Static Settlement of Storage Pads*, and 05996.02-G(B)-21, Rev. 0, *Supplement to Estimated Static Settlement of Cask Storage Pads* (May 21, 2001). As explained in those calculations, the settlement of the pad is calculated based on conservative assumptions so that an upper-bound estimate of the settlement is obtained; even so, the resulting estimated settlement is only approximately 1.75 in. It is my opinion, based on the conservatism incorporated in the pad static settlement analyses, that the actual long-term static settlement of the pads that can be reasonably expected to occur would be much less than the 1.75 in. that is predicted in the Stone and Webster calculations – likely only one fourth to one third of this estimated value, or approximately ½ inch.

In addition, because of the great stiffness contrast between the concrete pad and the underlying clayey soils, this settlement will be much more uniform across the pad than the “dishing” of the pad that would be expected based on typical elastic theory.

Q6. What is the significance of the long-term static settlement of the pads on their dynamic response?

A6. None. Since, as just noted, the actual long-term static settlement of the pads is expected to be small and essentially uniform across the pad, its effect on the dynamic response of the pads and the casks supported on the pads should be negligible.

Q7. Dr. Ostadan also asserted at the May 9, 2002 hearing (Tr. 7501, 7729, 7749-7750) that the anticipated long-term settlement of the pads at the PFSF, 1.75 inches, is significant for geotechnical work and may be unacceptable for nuclear facilities. Are there any standards that govern the acceptability of settlement levels in nuclear power plant structures?

A7. No. There is no criterion for allowable static settlement set in the NRC regulations and guidance documents. Instead, the regulatory materials provide only generic guidance regarding how static settlements should be taken into account. For example, Section 2.5.6.4, *Stability of Subsurface Materials*, in NUREG 1567, *Standard Review Plan for Spent Fuel Dry Storage Facilities*, states: “Ensure that the static analyses address settlement and lateral pressure and are accompanied by representative laboratory data.”

Q8. What is the experience at operating nuclear power plants in terms of long-term static settlement?

A8. In the analysis of long-term static settlement for nuclear power plant structures, it is typical to analyze settlements using conservative assumptions to obtain upper-bound values of the estimated settlements. It is not uncommon to see static settlement estimates that exceed 2 inches for nuclear power plant structures that are supported on soils. PFS Exhibit includes several examples in which nuclear power plants have operated with estimated long-term static settlements of the foundations of safety-related structures in excess of 2 inches. For example, at the LaSalle County Nuclear Generating Station, which is located in eastern LaSalle County, IL, the predicted settlements of the major structures ranged from 0.24 in. to 3.37 in, and predicted settlements of the Peripheral Dike used to impound

cooling water were 3 in. in the embankment, which was up to 40 ft high, plus 5 in. in the foundation soils beneath the embankment, for a total of 8 in. in some sections of this dike. The average settlement along the perimeter of the Reactor Containment at the Beaver Valley Nuclear Power Station – Unit 2 in Shippingport, PA was predicted to be 1.6 in., and the predicted settlement of the Reactor Building at the Shoreham Nuclear Power Station in Wading River, NY on Long Island was 2.9 in. Total settlements at the River Bend Station (nuclear power plant) in St. Francisville, LA ranged from ~3 to 4 in. for the Diesel Generator Building, Control Building, Turbine Building, E Tunnel, G Tunnel, and Standby Service Water Tower. Other structures had even higher values of predicted settlements; e.g., ~4 to ~5 in. for the Fuel Building, the Reactor Building, Auxiliary Building, and Main Steam Tunnel. These predicted static settlements at operating nuclear power plants demonstrate that the calculated long-term static settlement of 1.75 inches for the pads at the PFSF is not atypical of predicted settlements at several nuclear power plants and poses no safety concern.

II. REBUTTAL TO TESTIMONY OF STATE OF UTAH WITNESS DR. STEVEN F. BARTLETT

A. Pad-to-Pad Interaction

Q9. In answer 36 of the Bartlett/Ostadan Direct Testimony, Dr. Bartlett raises the concern that there may be pad-to-pad interaction due to the separation or gapping of soil cement from pads during a seismic event. Is this a realistic concern?

A9. No. By virtue of the interface strengths between the concrete pad and the underlying cement-treated soil and between the cement-treated soil and the underlying silty clay/clayey silt, the pads will be bonded to the underlying clayey soils; therefore, there will not be pad-to-pad interaction because the pads will not slide. The pad sliding stability calculation (PFS Exhibit UU) demonstrates that the factor of safety for this case exceeds 1.27, or in other words, there is a 27% margin available to resist sliding, and this is based on an analysis that includes several conservative assumptions. The pads are sufficiently close in the north-south direction that the pads and 5-ft wide soil cement plug between them will move in concert with the underlying soils when they deform due to the earthquake loading; thus, there will be no pad-to-pad interaction. This effect is similar to

analyzing the effects of adjacent structures in SSI analyses. I understand that ASCE 4-86 indicates that secondary effects due to presence of adjacent structures do not need to be considered in SSI analyses. This issue is addressed in the rebuttal testimony of Mr. Bruce Ebbeson filed simultaneously herewith.

Q10. In the same answer, Dr. Bartlett disagrees with your opinion that any cracks that form in the soil cement due to shrinkage, settlement, or earthquake loadings will be vertical and will not diminish the soil cement's passive resistance. How do you respond?

A10. It is well known that shrinkage cracks that form as soil cement cures are vertical or nearly vertical. The presence of these shrinkage cracks will minimize the potential for creation of new cracks due to settlement or bending stresses caused by the earthquake, since applied loadings will tend to open existing cracks rather than create new ones. The State's witnesses have concurred with my assessment that such cracks will only be fractions of an inch wide.

With respect to the effect of cracks on the soil cement's passive resistance, PFS relies on the passive resistance of soil cement only in the sliding stability analysis of the Canister Transfer Building. Should the horizontal loads from the earthquake exceed the shear strength of the clayey soils beneath the CTB, any existing cracks in the soil cement will close up and the soil cement adjacent to the CTB will provide its full passive resistance to sliding.

Q11. In answer 40 of the Bartlett/Ostadan Direct Testimony, Dr. Bartlett raises concerns about the potential effects of cracking of the soil cement buttress that will be constructed around the Canister Transfer Building. He testifies that "PFS has not considered the deleterious effects of separation and cracking of the cement-treated soil buttress caused by out-of-phase motion of the CTB mat foundation and the cement-treated soil buttress. PFS has not calculated the bending and tensile stresses that will develop in the soil cement and how these stresses will affect the ability of the cement-treated soil buttress to resist these forces without cracking or separation." How do you answer these concerns?

A11. Dr. Bartlett incorrectly refers to the soil cement adjacent to the Canister Transfer Building as cement-treated soils. This material will be designed to pass the wet-dry and freeze-thaw tests and, thus, it will be a durable soil cement of minimum compressive strength of 250 psi.

The design earthquake will only impose about 7 to 11 significant cycles of motion and, even assuming that the Canister Transfer Building is out of phase with the adjacent soil cement for every one of these cycles, the effect of such motions

would be only to alternately open and close existing shrinkage cracks in the soil cement. As discussed above, the presence of narrow vertical cracks does not diminish the ability of the soil cement to provide passive resistance.

Q12. Does this conclude your testimony?

A12. Yes.

1 CHAIRMAN FARRAR: I'm sorry, Mr. Travieso-
2 Diaz, had you marked these other two documents?

3 MR. TRAVIESO-DIAZ: Yes, I believe I
4 marked them for identification as exhibits 231 and
5 232.

6 CHAIRMAN FARRAR: The Reporter will do
7 that.

8 (Whereupon, the above-
9 referenced to documents were
10 marked as PFS Exhibit Nos. 231
11 and 232 for identification.)

12 MR. TRAVIESO-DIAZ: The first document,
13 which is the calculation, will be exhibit 231. And
14 that is referenced for the first time in, I believe,
15 answer 3 on page 2.

16 And the record will be more accurate if in
17 the copies it was inserted on answer 3, where there is
18 a blank, the number 231.

19 And the second exhibit is referenced on
20 page 5 of answer 8, on the sixth line, fifth line.
21 And where there is a blank after exhibit, that should
22 be exhibit 232.

23 And with these corrections I believe that
24 Mr. Trudeau is available for cross examination.

25 CHAIRMAN FARRAR: You have no oral

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 questions?

2 MR. TRAVIESO-DIAZ: No.

3 CHAIRMAN FARRAR: Okay. And did you want
4 to move the admission of these exhibits, or were you
5 saving that?

6 MR. TRAVIESO-DIAZ: I was going to do it
7 at the end, but it doesn't matter, I can move now.

8 CHAIRMAN FARRAR: Any objection to --

9 MS. CHANCELLOR: No objection, Your Honor.

10 CHAIRMAN FARRAR: Staff?

11 MR. O'NEILL: No objection.

12 CHAIRMAN FARRAR: Then 231 and 232 will be
13 admitted.

14 (The document referred to,
15 having been previously marked
16 for identification as PFS
17 Exhibit Nos. 231 and 232 were
18 received in evidence.)

19 CHAIRMAN FARRAR: Staff, cross?

20 MR. TURK: Very limited.

21 CROSS EXAMINATION

22 BY MR. TURK:

23 Q Good afternoon, Mr. Trudeau.

24 A Good afternoon, Mr. Turk.

25 Q Could you explain the difference between

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 the 0.711G figure for horizontal peak acceleration,
2 and the 0.79G peak horizontal force that are referred
3 to in your answer number 1, and answer number 4?

4 A The 0.711G is the ground acceleration in
5 the horizontal direction that I had used in
6 estimating, or calculating the dynamic load, the
7 inertial load in the pad sliding stability analysis.

8 The 0.79G that you mentioned is an
9 estimate that is backed out of some forces that act in
10 the spring, the soil spring under the pad, from Holtec
11 soil structure interaction analysis.

12 It is not, in my estimation, the correct
13 acceleration of the pad, but it provides an estimate
14 of what the pad acceleration, approximate acceleration
15 of the pad might be, based on the forces that we are
16 seeing from Holtec soil structure interaction
17 analysis.

18 Q As I recall the 0.711G is essentially the,
19 is that free field, peak ground acceleration?

20 A That is correct.

21 Q And that is a number that was derived from
22 the Geomatrix Seismic Hazard Assessment?

23 A Yes. Geomatrix developed that number as
24 part of their design earthquake development effort.

25 Q And the 0.711G, that does not reflect soil

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 structure interaction effects once the facility is
2 constructed and loaded with casks, correct?

3 A That is what I understand, yes.

4 Q Now, could you explain how, if that is
5 exhibit 231 fits into this discussion, and that is the
6 calculation that was distributed and just admitted
7 into evidence.

8 A I had mentioned, in my direct testimony,
9 I don't remember what answer it was responding to, but
10 I had mentioned that the radiation damping applicable
11 for this system would be much higher than the five
12 percent damping curves that the State had directed me
13 to in my November 2000 deposition.

14 So this, the purpose of this exhibit is to
15 just provide the backup information for those high
16 damping values that, as a demonstration that for the
17 masses, and the soil properties here, that damping in
18 excess of five percent is certainly appropriate for
19 this structure.

20 Q I'm sorry, that what is appropriate for
21 this structure?

22 A I didn't hear what you said.

23 Q I didn't hear what you had said, you said
24 that this calculation shows that something is
25 appropriate for --

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 A That damping much in excess of the five
2 percent that was applicable for the response spectrum
3 plot that Dr. Ostadan was using as a reference in the
4 questioning of me, at my deposition in November 2000.

5 But that a higher radiation damping is
6 applicable for this structure than that five percent
7 design response spectrum curve was.

8 Q And can you point to the bottom line in
9 the calculation, is it correct that you are predicting
10 something like a 50 percent damping?

11 A That is what the 0.52 refers to, yes.

12 Q And also on the backup pages, for vertical
13 direction damping, I see you come to 0.50, that is 50
14 percent damping?

15 A Yes. These subsequent pages are for the
16 upper and lower bounds soil properties, and the best
17 estimate soil properties. And you can see that the
18 damping values range from 0.48 to 0.52, or right
19 around 50 percent.

20 For such high levels of damping soil
21 structure interaction analysis would not yield much
22 amplification.

23 Q The calculations in exhibit 231, are those
24 based upon a dynamic analysis? Maybe I'm asking my
25 question wrong. Do they reflect the dynamic values?

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 A These are, I would characterize them as
2 dynamic soil properties perhaps, but they are not the
3 result of a dynamic analysis. It is a simple
4 equation, as shown there, referencing Newmark and
5 Rosenbluth for how to calculate critical damping.

6 And the other numbers come from Holtec's
7 soil structure interaction analysis reports, providing
8 the masses and stiffnesses of the structure in this
9 virtual soil mass under the structure, the pad in this
10 case, or the pad and casks.

11 Q In the PFS calculations, and I'm not even
12 sure which calculation I should be asking you about,
13 but which calculations, submitted on behalf of PFS, in
14 support of its license application, are damping values
15 included?

16 A This is gapping between the pad and the
17 soil cement. Is that what you mean? Did you say
18 gapping?

19 Q Damping.

20 A Oh, damping.

21 Q In other words, here you have values on
22 the order of 50 percent damping. How does that
23 compare to damping that has been used in PFS
24 calculations submitted in support of the license
25 application?

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 A I don't know. We would have to look at
2 the Holtec analysis to see what damping values were
3 used there. Maybe Wen Tseng has used some damping
4 values in his soil structure interaction analysis of
5 the casks, of the pad design, I mean.

6 But damping is typically not used in my
7 geotechnical calculations.

8 Q Now, when you say your geotechnical
9 calculation, what are you referring to?

10 A I'm referring to calculation GB-4, which
11 is the stability analysis of the pads. And GB-13,
12 which is the stability analysis of the canister
13 transfer building.

14 Q In those analyses you do not take credit
15 for damping?

16 A That is correct. Well, the GB-13
17 calculation for the canister transfer building uses
18 masses and accelerations for the building that came
19 from Mr. Ebbeson's calculation. And I suspect that
20 there is some damping of the values used in that
21 analysis.

22 But in my analysis I don't input a
23 damping, or otherwise reflect a damping value. The
24 same is true for the cask dynamic loads that are in
25 calculation GB-4. Those dynamic loads came from Wen

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 Tseng's analysis, soil structure and interaction
2 analysis of the pad and his pad design.

3 I'm sure there was -- well, I suspect that
4 there was some damping used in that analysis, but I
5 don't know what it is, or --

6 Q Could you explain the relevance of PFS
7 exhibit 232, which is, I take it, the material drawn
8 from the updated final safety analysis report for the
9 LaSalle County Nuclear Generating Station, is that
10 correct?

11 A That is what the front page is labeled,
12 but it is actually a collection of -- regarding
13 settlements at various nuclear power plants. I put
14 this exhibit together, largely in response to Dr.
15 Ostadan's testimony, that a couple of inches of
16 settlement that was predicted for the pads was a large
17 number.

18 That it indicated that this was -- there
19 was something atypical about a facility having such a
20 large amount of settlement. And the purpose for this,
21 specially a nuclear facility, so the purpose of this
22 was to demonstrate that these are not atypical
23 settlements.

24 That the reason that these settlements are
25 so large is, generally, that we try to be conservative

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 in estimating what the settlements are, because
2 typically larger settlements would cause more problems
3 than smaller settlements.

4 So you tend to overestimate your
5 predictions of settlement.

6 Q The first two pages in this exhibit appear
7 to come from the LaSalle County Nuclear Generating
8 Station?

9 A Yes, they do.

10 Q And then it is followed by two pages on
11 which somebody has written the names of other nuclear
12 plants. The third page of the exhibit is hand marked
13 River Bend Nuclear Power Station. The last page is
14 hand marked Shoreham Nuclear Power Station.

15 A Yes.

16 Q Did you put those markings on?

17 A Yes, I did.

18 Q Okay. What documents do these two sheets
19 of paper come from?

20 A These come from the safety analysis
21 reports of those two nuclear power plants, as do the
22 pages for the LaSalle County Nuclear Generating
23 Station. Those are from UFSAR, as indicated on the
24 top of page 1.

25 Q Okay.

1 A The LaSalle County one is UFSAR, and I
2 believe that stands for updated final safety analysis
3 report.

4 MR. TURK: Could we have just a moment,
5 Your Honor?

6 CHAIRMAN FARRAR: Yes.

7 (Pause.)

8 BY MR. TURK:

9 Q I'd like to ask you something about a
10 statement that appears in your answer number 11, on
11 page 7.

12 In your second paragraph you indicate that
13 the design earthquake will only impose about 7 to 11
14 significant cycles of motion. Could you explain what
15 you mean by that, and also indicate how those 7 to 11
16 significant cycles compare with the total number of
17 cycles that would be experienced in the design
18 earthquake?

19 A Well, I don't know how many total cycles
20 there are in the earthquake. But many of them, as I
21 understand it, the time histories that Dr. Young's
22 generated for the design earthquake, is about a 30
23 second record.

24 It is digitized at a 0.005 second
25 interval. It has numerous zero crossings, which I

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 would understand to mean the cycles that you are
2 referring to. There is a single that represents the
3 maximum acceleration in these records.

4 All the other cycles would have lower
5 accelerations than that value. For this site we have,
6 as I understand it, a magnitude 6.5 to 7 earthquake.
7 And such an earthquake would be expected to have 7 to
8 11 significant cycles of motion.

9 Which means, to me, peaks that would
10 exceed some number that -- I don't know exactly what
11 that number is, but say half of the peak, for
12 instance, or maybe two-thirds of the peak.

13 Does that answer your question?

14 Q It does, in part. First of all, I think,
15 is it correct that Young's time history, that is the
16 Geomatrix time history?

17 A That is correct.

18 Q That was a 40 second earthquake, if I'm
19 not mistaken.

20 A 40 is a new number to me. I seem to
21 recall 30. But I haven't worked directly with that
22 time history, so you may be correct.

23 It is probably more correct to say that
24 the significant cycles are likely to be two-thirds of
25 the peak, in my estimation.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 Q And, again, when we are talking about
2 cycles, we are talking about the amplitudes? This is
3 the -- could you explain what cycle is?

4 A It is a positive to negative acceleration.
5 If we are talking about an acceleration time history,
6 one cycle would be from the peak in the positive
7 direction, to the peak, the next following peak in the
8 negative direction.

9 Q And that is something that is normally
10 described of in terms of amplitude?

11 A The amplitude, correct.

12 MR. TURK: We have nothing further, Your
13 Honor.

14 CHAIRMAN FARRAR: Ms. Chancellor?

15 MS. CHANCELLOR: Yes, Your Honor.

16 CROSS EXAMINATION

17 BY MS. CHANCELLOR:

18 Q Good afternoon, Mr. Trudeau, at last we
19 get to finish Section D.

20 A Good afternoon.

21 Q In answer 3, on page 2, you refer to the
22 48 to 52 percent damping values. In the radiation
23 damping calculation PFS exhibit 231, did you assume
24 that the entire mass of the casks, that is the 8 casks
25 plus the pads, were available to participate during

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 the seismic event?

2 A Yes. That provides the maximum loading.

3 Q And you stated that, in response to Mr.
4 Turk I believe, that damping is not typical in
5 geotechnical engineering?

6 A Well, not --

7 Q In your branch of --

8 A -- in the geotechnical analyses that I've
9 done.

10 Q And you have testified in the past, I
11 believe, that you are not a soil structure interaction
12 expert?

13 A That is correct.

14 Q And you also testified that you did not
15 verify the damping values in PFS exhibit 231 with
16 those used by Holtec, is that correct?

17 A That is correct.

18 Q And you didn't verify those values with
19 the -- against the CTB?

20 A Against the CTB?

21 Q Against the values that were used in the
22 CTB?

23 A I understand. The values that Mr.
24 Ebbeson would have used in his analysis?

25 Q That is correct, thank you.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 A That is correct. I don't know what
2 damping values are in his analysis.

3 Q And you didn't verify your damping values
4 with those used by ICEC for the pads?

5 A That is correct.

6 Q Would it be correct to say that PFS
7 exhibit 231 is more or less a back of the envelope
8 calculation?

9 A Yes, that is correct.

10 MR. TRAVIESO-DIAZ: Objection. I've been
11 overruled by my own witness.

12 (Laughter.)

13 THE WITNESS: Because it is a simple
14 calculation.

15 BY MS. CHANCELLOR:

16 Q And isn't it true that this simple
17 calculation assumes a rigid foundation?

18 A I'm not sure that is correct.

19 Q In A3 you reference Newmark. Isn't it
20 true that the method in Newmark and Rosenblum is
21 appropriate for a rigid foundation?

22 A That may be, I don't know for sure.

23 Q I'd like to hand out a courtesy copy of
24 the Hearing transcript from May 8, pages 530-31, which
25 are referred to in question 2 of your rebuttal

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 testimony.

2 As a preliminary question, Mr. Trudeau, I
3 believe you were present for Dr. Ostadan's many
4 different versions of testimony on the last Saturday
5 in Salt Lake City, is that correct? When he was on
6 and off the stand --

7 A The day I did not get to do this?

8 Q Yes, I thought you would recall that. And
9 do you recall Dr. Ostadan testifying that he did not,
10 that he was referring to acceleration of the pads, and
11 not acceleration of the casks, in questioning by Mr.
12 Travieso-Diaz?

13 A At which point are we talking about?

14 Q At which point of time? If you -- let's
15 get to it this way.

16 If you look at question 2, and take a look
17 at the transcript on page 7530 and 31, and I
18 apologize, I didn't copy the beginning of the
19 question, which is on page 7529, and Dr. Ostadan
20 replies:

21 Okay, this is in response to question 31,
22 and question 31 is, what can -- and then you pick it
23 up on 30, you see in the ICEC calculation that it is
24 not present in the Holtec report.

25 And if you take a moment to review --

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 A I'm sorry, I'm not following you here.
2 I'm looking at this handout that you just gave us?

3 Q I'm looking, yes, if you would look at
4 that handout, and would you look at the transcript on
5 page 7530, and 7531, and would you agree with me that
6 most of this answer, except for one statement, which
7 is the quote, is referring to acceleration of the pad,
8 and not acceleration of the cask?

9 A And we are talking about my rebuttal
10 testimony response 2, or --

11 Q Question two, where you say that in his
12 oral testimony on May 8, Dr. Ostadan asserted that the
13 Stone and Webster calculation for the pads is also
14 deficient in that it failed to include the seismic
15 loading of the casks, e.g., and Stone and Webster, and
16 in quotes:

17 And this is quoting from the transcript:
18 "And Stone and Webster have to guess even the
19 acceleration for the cask for sliding."

20 And that quote is actually on 753 lines 8,
21 9 and 10 of the May 8 transcript that I handed out.

22 A Correct, I see that.

23 Q If you look at the entire answer on 7530
24 and 31, and this is given by Dr. Ostadan, and that is
25 what I was explaining, I didn't give you the first two

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 lines, but I would be happy to share my copy with you.

2 Isn't that correct that this answer is
3 addressing acceleration of the pads, except for that
4 one two-line answer?

5 A That appears to be correct, but my
6 response was to those particular two lines.

7 Q Do you recall Dr. Ostadan testifying about
8 this issue in Salt Lake City, where he took issue
9 with the fact that he was referring to acceleration of
10 the casks, where in fact he said that he was taking
11 issue with acceleration of the pad?

12 A Well, I know he took issue with
13 acceleration of the pads. But here he said that we
14 even had to guess the acceleration of the casks. And
15 that is the point that is not correct in his
16 testimony.

17 So that is why I was rebutting that in my
18 answer, too, because we did not assume, or guess, the
19 acceleration for the casks. We used the maximum cask
20 dynamic forces from CEC's soil structure interaction
21 analysis.

22 Q Is there a possibility that there may be
23 an error in the transcription here?

24 MR. TRAVIESO-DIAZ: Objection, I think
25 that Ms. Chancellor is trying to amend Dr. Ostadan's

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 testimony in retrospect. The transcript is what it
2 is.

3 MS. CHANCELLOR: Okay, I'm just trying to
4 get at that -- it is okay.

5 MR. TRAVIESO-DIAZ: And if, in fact, the
6 transcript is incorrect, and the answer that Mr.
7 Trudeau gave here is a no, never mind, then we are not
8 the worse for wear.

9 MS. CHANCELLOR: That is fine, Mr.
10 Travieso-Diaz, that is just fine, I shall move on.

11 BY MS. CHANCELLOR:

12 Q In answer 4 of your rebuttal testimony,
13 towards the bottom of the, of page 3, you've got ace
14 of H of pads equals a whole bunch of numbers, and then
15 you've got equals 0.83G?

16 A I see that.

17 Q For this calculation did you ask, did you
18 ask from Holtec what the accelerations, what are the
19 accelerations of the pad?

20 A No.

21 Q Why not?

22 A We have the forces from Holtec's soil
23 structure interaction analysis. Why do we need the
24 accelerations of the pad? The forces are what we are
25 trying to resist for sliding.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 There has been a lot of discussion about
2 accelerations of the pad. But the important number
3 here is what the force is at the bottom of this pad,
4 to resist sliding.

5 MS. CHANCELLOR: Your Honor, we are going
6 to address the long term pad settlement, and Mr.
7 Trudeau's rebuttal testimony with written rebuttal by
8 Dr. Bartlett, and I've handed out a copy to NRC and
9 PFS.

10 And so we will address this issue with Dr.
11 Bartlett. I have no further questions.

12 JUDGE KLINE: Well, to question 11, and
13 answer 11, would you just comment, for us, on the
14 testimony given by Dr. Bartlett earlier today,
15 concerning the role that tensile forces play in this
16 seismic analysis?

17 And just give us your views on it.

18 THE WITNESS: I think, you know, my
19 testimony has stated consistently that we don't rely
20 on tensile forces to resist the sliding forces.

21 What I heard Dr. Bartlett say, earlier
22 today, was a reference to Holtec's recent analysis
23 that included a soil spring, or a spring to represent
24 the soil cement plug between the pads in the north-
25 south direction, the five foot soil cement plug.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 And what I think I heard him say was that
2 Holtec did that analysis using tension and compression
3 springs in one case, and got a certain load, had the
4 pad load between those pads, for that tension and
5 compression spring.

6 And then they repeated the analysis using
7 compression only springs, which is what I believe is
8 more appropriate. It is a conservative place to be,
9 rather than relying on the tension.

10 And Dr. Bartlett argued, I believe, that
11 the forces between the pads was actually increased in
12 that case, in that the complaint that he had was that
13 we didn't include those pad to pad forces in our
14 sliding stability analysis.

15 Again, my response to that would be, when
16 we look at what the forces in the spring, underneath
17 the pad in those analyses, we found that those peak
18 forces are less than the forces that I've included in
19 my sliding stability analysis.

20 So in that regard not including tension
21 has not resulted in a higher -- I mean, in my
22 analysis, not including tension, or relying on
23 tension, I've got a higher force to be resisted at the
24 base of the pad, than what Holtec's analysis, that
25 includes the so-called pad to pad spring.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 JUDGE KLINE: In your testimony -- well,
2 let me say it. In Dr. Bartlett's earlier testimony he
3 referred to vertical cracks as being significant
4 relative to the loss of tensile strength.

5 And your testimony seems to indicate
6 virtually no significant to vertical cracks. Can you
7 comment on that, and reconcile it if you could? Or if
8 not, tell us why not.

9 THE WITNESS: Well, I can agree with Dr.
10 Bartlett that the presence of vertical cracks will
11 preclude resisting tensile stresses, because it will
12 interrupt that tensile strength of the soil cement.

13 I believe that if such tensile stresses
14 exist in the soil cement, those stresses will
15 concentrate in areas where we already have cracks due
16 to the shrinkage of the soil cement when it cures.

17 Those cracks are typically vertical so,
18 yes, I agree that in response to tensile stresses that
19 exceed the tensile strength of the soil cement, will
20 have an enlargement, say, of existing shrinkage
21 cracks.

22 But we don't rely on the tensile strength.
23 We only need the soil cement to push, so that if this
24 thin vertical crack exists, and we need some push, or
25 some oomph from the soil cement, the crack will be

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 closed, and then the soil cement will still provide
2 the compressive strength that we need.

3 JUDGE KLINE: Okay, thank you.

4 JUDGE LAM: So is it true, Mr. Trudeau,
5 that your analysis indicates that there will not be
6 any pads sliding, therefore there will not be any pad
7 to pad interaction?

8 THE WITNESS: That is correct.

9 JUDGE LAM: And how much margin did you
10 say there is against sliding?

11 THE WITNESS: That particular, what we
12 have been calling the base case, the one that ignores
13 all the passive resistance of the soil cement
14 surrounding the pad, has a factor safety of 1.27.

15 JUDGE LAM: So there is a 27 percent
16 margin?

17 THE WITNESS: Correct.

18 (Pause.)

19 THE WITNESS: Might I add something to my
20 previous statement?

21 The base case analyzes the sliding
22 stability of the pad in the east-west direction, and
23 it ignores the passive resistance of the soil cement.
24 If we include the passive resistance of the soil
25 cement in the east-west direction, the factor of

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 safety increases from 1.27 to 3.3.

2 If we look at sliding in the north-south
3 direction, which is the direction that we have been
4 discussing with the pad to pad interaction, without
5 the passive resistance, the factor of safety is 1.52,
6 or 50 percent margin.

7 And when we include passive resistance in
8 that direction it increases to 2.35, as shown on page
9 30 of exhibit UU, which is a copy of calculation GB-4,
10 rev 9.

11 JUDGE LAM: Now, realistically you should
12 take some credit for the passive resistance, isn't
13 that true?

14 THE WITNESS: I believe that it is
15 appropriate in this case. In the -- in some cases it
16 is not appropriate to consider passive resistance, but
17 that would be, for instance, for a retaining wall
18 alongside of a roadway, where you can't guarantee that
19 the material at the toe of the retaining wall might
20 never be removed.

21 Because if you were relying on the passive
22 resistance of that material, and you excavated that,
23 the wall is going to come down. It is clear that once
24 this facility is constructed the soil cement will stay
25 in place until the facility is decommissioned.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 CHAIRMAN FARRAR: Mr. Trudeau, at the very
2 beginning of, I think it was the State's cross
3 examination, you said something about, or perhaps I
4 misheard you, about usually not taking credit for
5 damping.

6 THE WITNESS: I think --

7 CHAIRMAN FARRAR: Do you remember what you
8 said?

9 THE WITNESS: I think what I said was that
10 in the geotechnical analysis that I typically do,
11 damping does not enter into them, other than in
12 earlier analysis that may have generated the dynamic
13 forces that go into my analysis.

14 CHAIRMAN FARRAR: And why is that?

15 THE WITNESS: Because other parties do
16 those analysis, the soil structure interaction
17 analysis, which are, or would be based on damping
18 values, perhaps.

19 But that is the only way that damping
20 would enter into my analysis. I don't modify my
21 resisting forces based on damping, I don't increase
22 them based on damping.

23 CHAIRMAN FARRAR: Okay. Any redirect?

24 MR. TRAVIESO-DIAZ: Well, I won't earn my
25 paycheck if I don't ask at least one question.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

REDIRECT EXAMINATION

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

BY MR. TRAVIESO-DIAZ:

Q Mr. Trudeau, earlier in the examination by Ms. Chancellor you agreed that in the event that you have a crack you might lose your tensile strength.

Would that be true only if the crack, in fact, goes through the entire cross section, if you will, of your soil cement?

A Yes, the tensile strength would be lost through the cracked area.

Q So it is only in the cracked area where you lose the tensile strength?

A That is correct.

Q Thank you.

CHAIRMAN FARRAR: Staff?

RE CROSS EXAMINATION

BY MR. TURK:

Q Just to make sure I understand that last question and answer. As I understood the question, there is a hypothesis that there would be a vertically propagating crack, in other words, a crack in the vertical direction, that would extend from one side of the soil cement placement to the other side, in order for you to lose the tensile strength for the entire --

A The length of the crack was not the

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 important issue here. It is wherever the crack is, it
2 won't support tensile stresses across that crack. So
3 if the crack is two feet long, you've got a section
4 two feet long that will not support tension.

5 If it is 100 feet long it won't support
6 it.

7 Q Across that 100 feet?

8 A Correct, because the cracked area, there
9 is no connection between the two sides. So you can't
10 transmit a force, a tensile force across that joint,
11 so to speak.

12 JUDGE LAM: Well, even if there is no
13 crack, there is very little tensile strength, anyway,
14 isn't it true?

15 THE WITNESS: I heard the State's
16 witnesses say that the tensile strength is likely to
17 be in the order of 20 percent of the compressive
18 strength. And I think I even heard them say 25 percent
19 at one point.

20 But 20 percent of 250 PSI is a lot higher
21 than some soils compressive strength. So it is not
22 that it doesn't exist, there is some amount. But it
23 is not reasonable to rely on it, without
24 reinforcement.

25 MR. TURK: I have nothing further.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 CHAIRMAN FARRAR: State?

2 CROSS EXAMINATION

3 BY MS. CHANCELLOR:

4 Q Mr. Trudeau, I understand that you drafted
5 various sections of the SAR, is that correct?

6 A That is correct.

7 Q Especially with respect to the sliding
8 stability analysis of the pad?

9 A Section of the SAR?

10 Q Right.

11 A Yes.

12 Q And isn't it true in the SAR you rely on
13 the base case and a factor of safety on 1.27 for the
14 description in the SAR?

15 A That is correct. We have consistently
16 referred to our base case for sliding of this pad as
17 having a factor of safety that is at least 1.27, which
18 is in excess of the 1.1 that NUREG 0800 refers to as
19 being acceptable for sliding, due to dynamic loads
20 from an earthquake.

21 Q Thank you. I have no further questions,
22 Mr. Trudeau.

23 CHAIRMAN FARRAR: You said done, or none?

24 MR. TRAVIESO-DIAZ: I said both, none and
25 done.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 CHAIRMAN FARRAR: Okay, good.

2 (Laughter.)

3 CHAIRMAN FARRAR: This completes the
4 Applicant's rebuttal on Section D?

5 MR. TRAVIESO-DIAZ: Mr. Chairman, I was
6 handed, just before Mr. Trudeau took the stand, a
7 written surrebuttal by Dr. Bartlett. I would like to
8 request a few minutes just to review it and figure out
9 what questions, if any, I have for him.

10 CHAIRMAN FARRAR: Right. But I mean, as
11 far as your witnesses on rebuttal on D, you are done?

12 MR. TRAVIESO-DIAZ: I will be done with
13 the exception that I might need to bring Mr. Trudeau
14 back for sur surrebuttal if I get to that point.

15 CHAIRMAN FARRAR: Right. But for this
16 point you are finished?

17 MR. TRAVIESO-DIAZ: Yes.

18 CHAIRMAN FARRAR: Okay. Thank you, Mr.
19 Trudeau thank you, you were very patient in Salt Lake,
20 ten days ago. I'm glad you finally got your chance.

21 Then if the Applicant is finished
22 rebuttal, Ms. Chancellor, do you have -- or does the
23 State have -- I'm sorry, the Staff have any rebuttal
24 witnesses?

25 MR. TURK: Not with respect to this

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 testimony. We still have the open part on Dr. Luk's
2 portion of the Contention Part D.

3 CHAIRMAN FARRAR: Right. Then, Ms.
4 Chancellor, Your Honor have surrebuttal?

5 MS. CHANCELLOR: I have written
6 surrebuttal by Dr. Bartlett, and a few questions based
7 on Mr. Trudeau's testimony, and I would be happy to
8 give Mr. Travieso-Diaz time to review it, because I
9 agree, I got it to him very late.

10 CHAIRMAN FARRAR: Have we seen it, do we
11 have it?

12 MS. CHANCELLOR: We will pass it out to
13 you right now.

14 CHAIRMAN FARRAR: All right.

15 MR. TRAVIESO-DIAZ: Perhaps, Mr. Chairman,
16 to expedite this proceeding, we could have the
17 surrebuttal marked and additional questions asked, and
18 then I could take 15 to 20 minutes to figure out what
19 I'm going to ask Dr. Bartlett, if I may.

20 CHAIRMAN FARRAR: Why don't we do that?

21 MS. CHANCELLOR: That would be just fine.

22 Whereupon,

23 STEVEN BARTLETT

24 was called as a witness by Counsel for the State and,
25 having been previously duly sworn, assumed the witness

1 stand, was examined and testified as follows:

2 DIRECT EXAMINATION

3 BY MS. CHANCELLOR:

4 Q Dr. Bartlett, you have in front of you the
5 State of Utah partial surrebuttal testimony of Dr.
6 Steven F. Bartlett, to rebuttal testimony of Paul J.
7 Trudeau, on Unified Contention Utah L/QQ (Dynamic
8 Analyses), dated June 18, 2002?

9 A Yes.

10 Q Was this testimony prepared by you, or
11 under your direction?

12 A Yes.

13 Q Do you accept this as your written partial
14 surrebuttal testimony?

15 A Yes.

16 MS. CHANCELLOR: Your Honor, I would move
17 that Dr. Bartlett's testimony be bound, be entered
18 into the record as if read.

19 CHAIRMAN FARRAR: Any objection?

20 MR. TRAVIESO-DIAZ: No.

21 CHAIRMAN FARRAR: Staff?

22 MR. O'NEILL: No objections, Your Honor.

23 CHAIRMAN FARRAR: All right, then the
24 Reporter will bind this testimony into the record at
25 this point, as if read.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

(Insert prefiled testimony of Dr.

Bartlett)

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:)
) Docket No. 72-22-ISFSI
)
PRIVATE FUEL STORAGE, LLC) ASLBP No. 97-732-02-ISFSI
(Independent Spent Fuel)
Storage Installation) June 18, 2002

**STATE OF UTAH PARTIAL SURREBUTTAL TESTIMONY
OF DR. STEVEN F. BARTLETT
TO REBUTAL TESTIMONY OF PAUL J. TRUDEAU ON UNIFIED
CONTENTION UTAH L/QQ
(Dynamic Analyses)**

Q. 1: After reviewing Mr. Trudeau's response to question 5 in his rebuttal testimony, do you agree that long term settlement of the storage pad will not affect the dynamic response of the pads?

A. 1: (SB) No. PFS's estimate of total settlement of the pads (immediate + primary + secondary) has changed significantly throughout the design of the project. For example, in a Stone and Webster Interoffice Memorandum from S. M. Macie to P. Trudeau / N. T. Georges dated April 2, 1997, the following concern regarding settlement was expressed in paragraph 5 by Mr. Macie:

Settlements are a problem. The total storage pad settlement of 5 inches in one month under full load will certainly cause differential settlements. Differential settlements are cause for concern in the NRC review and can require extensive additional structural analysis to prove the pad is adequate. Also, gross and differential pad settlements may compromise site drainage at or near the pads. It would appear prudent from SWEC to recommend a preload program to limit gross and differential pad

settlements.

See State's Exhibit 211.

However, in a later calculation, "Estimated Static Settlement of Storage Pads," 05996.02-G(B)-03, Rev.1 , the total settlement of the pads was estimated to be about 3 inches. This calculation was later revised two more times and the current calculation, 05996.02-G(B)-03, Rev. 3 and its companion, *Supplemental to Estimated Static Settlement of Cask Storage Pads* (May 21, 2001) estimates the total settlement to be 1.75 inches. Also, in the current version of its Safety Analysis Report, PFS estimates total pad settlement at 1.7 inches. See State's Exhibit 168 (SAR, Rev. 22 at 2.6-50).

In his rebuttal testimony, Mr. Trudeau proffers his opinion that the actual settlement will now be approximately $\frac{1}{2}$ an inch, based on the "conservatisms" that are in the analysis. However, I note that much of the conservatisms in the analysis may have already been removed during the earlier revisions of the settlement calculations.

I understand that during the design of a project as complex as this, the initial estimates of settlement and the supporting calculations are often revised to reflect new test data and information that may not have been available during the time of the original calculations. However, this may be a case of trying to sharpen a pencil too finely. I do not believe that prediction of settlement is a subject that can be predicted with such accuracy. My experience is that settlement predictions can vary by a factor of about 2 from actual field measured values. I believe it is more appropriate to consider a range of potential settlements that may be in the order of a few inches.

Q. 2: Do you agree with Mr. Trudeau's response to question 5, where he opines that "settlement will be much more uniform across the pad than the 'dishing' of the pad that would be expected based on typical elastic theory?"

A. 2: No. Both Dr. Ostadan and I expressed our opinions earlier that non-uniform settlement may occur. *See* Tr. at 7473-7503. Additionally, Mr. Trudeau himself once opined "that settlements at the edge of the pad would be approximately half" the amount of settlement at the center of the pad. *See* State's Exhibit 210 at ¶ 5.

Q. 3: Do you agree with Mr. Trudeau's response to question 6, that long-term static settlement of the pads has no "significance" on the dynamic response of the pads?

A. 3: I maintain that the Applicant has not fully considered the effects of settlement values in the range of a few inches. Importantly, as both Dr. Ostadan and I have previously testified settlement may adversely impact the pads, soil cement and cement treated soil.

Q. 4: If long-term settlements exceeding 2 inches were estimated for some nuclear power plant structures, would this information alter your concern that the effect of settlement on the dynamic response of the pads have not been evaluated at PFS?

A. 4: No. Notwithstanding the settlement at nuclear power plants, in the case of PFS, where unanchored cask are allowed to slide atop the pads and cement treated soil is placed under the pads and soil cement is placed around the pads and the CTB, settlements of a few inches could be important to the seismic performance. It is my experience that

settlements of this magnitude have caused distress and cracking of foundation systems.

Q. 5: In his response to question 9, Mr. Trudeau explains his basis that pad-to-pad interaction due to the separation or gapping of soil cement during a seismic event is unrealistic, do you agree with his response?

A. 5: No. I disagree that all of the load path for horizontal earthquake loads will be downward to the Bonneville clay. The Applicant incorrectly assumes that sliding is a condition necessary to cause pad-to-pad interaction. Pad-to-pad interaction will exist without sliding because the underlying Bonneville clay is relatively deformable body compared to the much stiffer soil cement plug that is placed between the pads. During earthquake cycling, differences in mass and stiffness between the relatively heavily loaded pad/cask system and the adjacent soil cement will cause these two adjacent bodies to oscillate out-of phase due to differences in their kinematic and inertial properties. These effects are collectively know as soil-structure interaction effects. Because a relatively stiff plug of soil cement will be constructed between the pads, earthquake force will also be transmitted horizontally from pad to pad through the soil cement. The potential for pad-to-pad interaction effect was briefly analyzed by the Holtec (PFS Exhibit 225, *Additional Cask Analyses for the PFSF*, HI-2022878, June 3, 2002) for a simple two pad system in the longitudinal direction. This report showed a significant transfer of lateral forces even without sliding being initiated. Certainly, pad-to- pad interaction will become more severe if sliding of the pads is initiated. Pad-to-pad interaction and the horizontal load path that it produces has not been considered in the seismic stability calculations performed by Stone and Webster for the pads and in the design of the soil cement and cement treated soil.

1 CHAIRMAN FARRAR: And you had some
2 questions, Ms. Chancellor?

3 MS. CHANCELLOR: Yes, I have some
4 questions based on the testimony that was just given
5 by Mr. Trudeau.

6 BY MS. CHANCELLOR:

7 Q Dr. Bartlett, did Holtec consider all
8 cases in its rebuttal to the State on pad to pad
9 interaction?

10 A No. My understanding of that calculation
11 it was a simple scoping study, it looked at just a two
12 pad system with 8 casks on one pad, and one cask on
13 another pad, and a soil cement plug in between the two
14 pads.

15 So it didn't really look at all the
16 potential combinations of groups of pads, or end pads,
17 or things that could be going on.

18 Q There was a question and answer with
19 respect to whether you get pad to pad interaction, and
20 pad sliding. How could there be pad to pad
21 interaction if there isn't pad sliding; is that
22 possible?

23 A Yes, because the difference of stiffnesses
24 between the materials. If you look, at least from the
25 foundation perspective, the Bonneville clay is,

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 obviously, the least stiff of all, and will develop
2 fairly significant shear strains under the dynamic
3 load.

4 Shear strains are strains where you are
5 pushing one, and developing strain on this direction.
6 Then overlying the Bonneville clay is the cement
7 treated soil. It is approximately maybe 20 percent
8 the stiffness of the soil cement.

9 So the soil cement itself is the stiffest.
10 When you start to now get potential to out of phase
11 motion due to these different masses wanting to
12 oscillate at different frequencies, what happens is
13 they are beginning now to strain back and forth on the
14 Bonneville clay that as you do this the forces are
15 concentrated, really, in the stiffest part of the
16 system.

17 I guess an example might be is you could
18 think of two columns in the vertical direction, one a
19 very stiff column, one a very soft column. And when
20 you start to load it, it is always the stiffest column
21 that picks up most of the load, because it has a much
22 higher modulus or stiffness.

23 So the fact is that now there is a
24 tendency to want to develop this out of phase motion
25 that the soil cement plug, particularly in the

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 longitudinal direction, will begin to pick up
2 significant load, and it may pick up load and capacity
3 at a rate different than what the Bonneville clays are
4 straining at.

5 Does that help?

6 Q I hope so.

7 MR. TRAVIESO-DIAZ: Who are you asking?

8 THE WITNESS: I don't know, I thought it
9 was an interesting discussion.

10 MS. CHANCELLOR: I think there are three
11 people at the front who --

12 THE WITNESS: I guess going back to the
13 point that, no, you don't have to have sliding going
14 on. There is still straining going on. The
15 Bonneville clay, before it initiates its sliding
16 itself is straining, it is not a rigid body, it is a
17 very deformable body.

18 In comparison I guess you could think of
19 it somewhat as a jello, it is fairly soft, and you've
20 got stiffer materials on top, relatively. So it is
21 deforming considerably without really reaching a
22 failure state, and without necessarily sliding.

23 And it is because you've got differences
24 in stiffnesses, differences in mass, that you tend to
25 concentrate the forces in the stiffer elements. In

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 this case it would be the soil cement, and cause
2 transfer of load between the two, between maybe
3 adjacent pads, or whatever the system is.

4 JUDGE LAM: Ms. Chancellor, if I may
5 interrupt?

6 MS. CHANCELLOR: Certainly, Dr. Lam.

7 JUDGE LAM: Dr. Bartlett, this phenomenon
8 that you are talking about, pad to pad interaction
9 without sliding --

10 THE WITNESS: Right.

11 JUDGE LAM: Has it been observed, at all,
12 in earthquake, like the San Francisco earthquake, the
13 Los Angeles earthquake?

14 THE WITNESS: Pad to pad interaction?

15 JUDGE LAM: No, I don't mean pad to pad,
16 but would an analogous situation, like during an
17 earthquake, you have two houses adjacent to each
18 other, there is concrete driveway, so without any
19 sliding of the house's foundation, has it been
20 observed that this phenomenon you just described, that
21 two houses without sliding towards each other, indeed
22 interact?

23 THE WITNESS: I'm trying to think of maybe
24 two systems that have different masses that are
25 connected by a strut. And if there is transfer of

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 load.

2 Certainly when there is a stiffer element,
3 in this case the soil cement between two masses. I'm
4 having a hard time in foundations, because I'm not
5 sure I could quote you cases where two fairly loaded
6 foundations only five feet apart may have interacted,
7 in this case in a foundation sense.

8 I certainly could quote to you cases where
9 the superstructure, above the foundation, would cause
10 interaction between two adjacent structures, because
11 there is some strut, or some element in between that
12 allow them to go into compression, and into tension.

13 Does that help?

14 JUDGE LAM: Yes, indeed, thank you.

15 THE WITNESS: Okay. The cases of
16 structures actually, if you will, pounding, competing
17 one against another, is a well-known phenomenon, if
18 you get them too close, particularly if you connect
19 them in some way.

20 If you had two structures connected by a
21 bridge, or a walkway, that connecting feature would
22 take severe damage.

23 BY MS. CHANCELLOR:

24 Q Dr. Bartlett, if passive resistance is
25 mobilized, what happens to the force?

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 A The idea of passive earth pressure theory
2 is, as you increase the load you bring the soil to a
3 state of passive failure, which means you bring it to
4 yield, and you develop a passive failure shear plane,
5 if you will.

6 In the case where we have two pads now
7 potentially oscillating, out of phase with each other,
8 the problem we see now is if we begin to bring, to
9 mobilize passive resistance between two pads that are
10 only five feet apart, this potential failure envelope
11 on both parts, actually overlap.

12 So what really happens now is that you can
13 transfer forces between one pad, and an adjacent pad,
14 just from the fact that you've got these pads so close
15 together, and not separated far enough that the
16 passive failure envelopes don't overlap.

17 So, initially, if you strain it, the shear
18 resistance is picked up by the soil, and then it
19 reaches a passive state of failure, and then failure.

20 But, again, even without that, there still
21 is some elastic transfer of forces, just due to
22 differences in stiffness. So I guess you don't have
23 to reach a passive failure state to transfer forces.
24 But if you do reach the passive failure state, and
25 particularly with two pads that are five feet apart,

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealgross.com

1 these failure envelopes actually overlap and there is
2 really only one way now to transfer load.

3 And that would be by potentially beginning
4 to crush the soil cement in between.

5 Q One final question. Do you recall what
6 the tensile stress was, that was developed in the
7 Holtec rebuttal pad to pad interaction report?

8 A The tensile stresses weren't calculated
9 directly. As I recall the tensile stresses that
10 developed in that simple model was about 1.2 million
11 pounds, or 12,000 kips per square foot, excuse me,
12 12,000 kips.

13 If you convert that to tensile stress it
14 is probably on the order of about 75 PSI.

15 Q Thank you, Dr. Bartlett, I have no further
16 questions.

17 MR. TRAVIESO-DIAZ: If I could have
18 approximately 20 minutes to prepare myself?

19 CHAIRMAN FARRAR: Okay. It is almost 20
20 after, let's come back at 20 of. Depending on what
21 happens there you might want to bring another witness
22 back, you said?

23 MR. TRAVIESO-DIAZ: Yes. What I expect
24 will happen, if we need to bring anybody back, it
25 would be Mr. Trudeau. I might bring Mr. Trudeau back

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 for further rebuttal, if necessary.

2 CHAIRMAN FARRAR: Okay, let's come back at
3 20 of.

4 (Whereupon, the above-entitled matter
5 went off the record at 4:18 p.m. and
6 went back on the record at 4:42 p.m.)

7 CHAIRMAN FARRAR: All right, it looks like
8 everybody is here, Mr. Travieso-Diaz. Are you ready
9 to begin?

10 MR. TRAVIESO-DIAZ: Yes.

11 CROSS EXAMINATION

12 BY MR. TRAVIESO-DIAZ:

13 Q Dr. Bartlett, would you turn to your
14 surrebuttal, do you have it in front of you?

15 A Yes, I do.

16 Q Your first question and answer refers to
17 the settlement calculations or estimates by PFS, is
18 that right?

19 A Yes, the various settlement estimates that
20 have been made at the PFS facility.

21 Q And you make the point that those
22 settlement estimates have been revised various times,
23 since 1997, is that right?

24 A Correct.

25 Q It started with five inches, and the last

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 published estimate was 1.75?

2 A Yes, that is the one published for the
3 pads.

4 Q Now, you characterized, in page 2, second
5 full paragraph, that start in his rebuttal testimony,
6 the second sentence that says: However, I note of
7 much of the conservatisms in the analysis may already
8 have been removed during the earlier revisions of the
9 settlement calculations.

10 Is that your understanding of what
11 happened? For example, in the initial estimate of
12 five inches was at the point where there was virtually
13 no design in this area, is that right?

14 A That I'm not sure of, I'm only just
15 referring to an interoffice memo, so I'm not sure how
16 much calculations were supporting the estimates behind
17 that memo.

18 Q Well, what I'm trying to get to, and maybe
19 you can help me here, is wouldn't it be a more correct
20 description of the process be not that the
21 conservatisms were being removed, but that the
22 calculation was made to reflect better, and better,
23 the design as it evolved?

24 A I'm not sure I have the information to
25 make that judgement.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 Q Well, what is the basis for saying that
2 the conservatisms were removed? You don't know that
3 either, do you?

4 A Well, I'm just saying that simply, that as
5 I understand it, at the time the memo was released,
6 back in 1997, that testing had been done, there were
7 soil properties that had been attained at that time.

8 With time we see refinements of
9 calculations. I understand how the process is
10 somewhat refined. But as, I guess, I'm pointing out
11 that in the case of settlement calculations we must
12 always remember they are somewhat estimates.

13 And in the case where we've gone from half
14 inches down to a half an inch, we may have sharpened
15 our pencil a little too finely.

16 Q But what I'm trying to understand is what
17 your basis is for saying that the reductions that went
18 from five to 1.75 were in the nature of removal of
19 conservatisms. What is your basis for that?

20 A Well, I guess what I'm saying is the soil
21 properties really haven't changed at the site. Maybe
22 there were better estimates of the soil properties
23 that led to more refined settlement calculation.

24 I can see that that could possibly happen,
25 because investigations are usually phased. But also

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 sometimes the revisions of settlement calculations
2 aren't because we necessarily have any new data, but
3 we are just changing our analysis techniques, or
4 looking at it in a little different light than we did
5 before.

6 I'm just trying to bring out the point
7 that in cases of settlement we have seen about two
8 inches of estimated settlement at the pads, and that
9 is total settlement. And that is our basis that we
10 see no problem with that calculation, but we might
11 take exception that these total settlements might be
12 approximately as small as a half an inch.

13 I think that may be sharpening the pencil
14 a little too fine.

15 Q Okay. But what I was trying to convey,
16 and maybe you can help me, if not we will move on; is
17 that you don't have any basis for opining that the
18 1.75 calculation was either more or less conservative
19 than the earlier ones, is it?

20 A Well, certainly less conservative in its
21 number that it estimated. But the basis upon which
22 the settlement was revised from 5 inches, to 3, to
23 1.75, I've reviewed the calculation for the 3 inches
24 of settlement.

25 We haven't -- we don't have the

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 calculation for the 1.75 inches of settlement, and the
2 initial 5 inches of settlement that was estimated by
3 PFS, I don't have the basis of that calculation.

4 So I guess I can't fully go through the
5 history and say, okay, here is a conservatism that was
6 removed, and here wasn't removed.

7 Q Let me ask you two things. Do you have
8 any basis for believing that the 1.75 inch settlement
9 calculation, the number was insufficiently
10 conservative?

11 A I have not reviewed the calculation, it
12 hasn't been provided to me.

13 MS. CHANCELLOR: Your Honor, for the
14 record, I would note that the State did not receive
15 the summaries and the calculation of GB-03 revision 3,
16 and I have communicated with Mr. Donnell from PFS, and
17 he is FedExing a copy of that calculation to us,
18 overnight.

19 It was a calculation done in 1999, and for
20 some reason there seemed to be a slipup in the system,
21 but we have not received that calculation.

22 BY MR. TRAVIESO-DIAZ:

23 Q By the same token, when you say that the
24 .5 calculation, our estimate that Mr. Trudeau is
25 providing, may be sharpening the pencil --

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 A Well, again, yes. Then that I don't think
2 is based on a calculation, and so, yes, it may be just
3 trying to sharpen the pencil a little too finely.

4 Q But you don't know how he arrived at that
5 number, do you?

6 A Well, it says he puts it out as his
7 opinion, so I assume that it was an opinion, not a
8 calculation.

9 Q All right. You are Assuming that there is
10 no calculation behind that number?

11 A I have not reviewed a calculation that
12 supports that number.

13 Q Okay. Putting aside what the number is,
14 I think you did testify last time we spoke about this,
15 back in Salt Lake City, that a number in the range of
16 1.75 to 2 inches looked reasonable to you, based on
17 your experience, is that right?

18 A For total settlement that doesn't -- that
19 calculation seems within the range that one expects.
20 And then also when you kind of reflect that against
21 the canister transfer building with 3 inches, that
22 still seemed to be in the right ranges.

23 Q I believe Mr. Trudeau testified, today,
24 that this type of calculations tends to be quite
25 conservative in the prediction of the settlement. Do

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 you remember that?

2 A It can be. But, again, not being able to
3 put the full history together, I don't know if I can
4 agree to that.

5 Q Well, based on your experience with
6 settlement, is it correct for you to expect that the
7 actual settlement that would be experienced by a
8 structure will typically be less than is predicted by
9 the calculation?

10 A No, not necessarily. As a fact, I have
11 seen the converse, where the settlements were
12 predicted to be relatively low, and a foundation ended
13 up being cracked, because the settlements were higher
14 than what it was anticipated.

15 I'm just pointing out, I believe
16 settlement calculations, and this is my philosophy
17 based on experience, also, that they are an estimate,
18 and they are good within a factor of 2.

19 So, for example, if one estimates a total
20 settlement of 1 inch, it might be as high as 2, and it
21 can be as low as a half inch.

22 Q Now, let's go over your answer 3. You
23 talking about the Applicant having not fully
24 considered the effect of settlement values in the
25 range of a few inches.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 Now, we are talking here, of course,
2 settlement means vertical motion, if you will,
3 vertical movement downwards, is that correct?

4 A Correct. .

5 Q And would the effect of such a settlement
6 be to tend to create a gap between the pad and the
7 surrounding soil cement?

8 A If the settlement is distributed such that
9 there is relatively large differential settlement
10 between the pad and the adjacent soil cement, there
11 could be the development of a vertical shear plane in
12 the soil, which would not really open up in this
13 direction, but it would create a shear in this
14 direction.

15 Q In other words, create a --

16 MS. CHANCELLOR: Dr. Bartlett, could you
17 describe the this and that?

18 THE WITNESS: Opening up in the horizontal
19 direction, whereas a shear plane might develop in the
20 vertical direction.

21 BY MR. TRAVIESO-DIAZ:

22 Q Are you saying that it is not that there
23 will be an actual physical gap, or separation, but
24 that -- what do you mean by shear plane?

25 A Well, there is, sometimes, a slight gap at

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 the surface, it manifests itself. But it is not like
2 we are just pulling two things apart and opening up a
3 large gap.

4 There are cracks, quite often manifested
5 at the surface. You will see a little ridge down, and
6 a ridge down, and these are shear planes that have
7 developed as the system settled.

8 So I don't like to call it a gap. I think
9 I just call it a failure plane that has developed. And
10 the soil, or in this case the soil cement, or cement
11 treated soil, would manifest a failure.

12 Q And what -- and the result of the creation
13 of that shear gap would be what, out of phase motion,
14 or?

15 A Well, I guess -- yes, there would be loss
16 of tensile strength along the shear plane, because it
17 has already pre-failed. It would also have higher
18 permeability along that failure plane. So it could be
19 a mechanism for water to infiltrate along the shear
20 plane.

21 Q So let me see if I understand. That shear
22 plane could lead first potential to the filtration of
23 water, akin to what happened if you have a physical
24 gap?

25 A Similar, yes. It is just that you've

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 developed a shear plane, and changed the
2 characteristics such that there is a zone, now, of
3 higher permeability along that plane, and water could
4 infiltrate down along that plane.

5 Q And the consequences of that water
6 potentially filtrating is what we were talking about
7 earlier today, is that right?

8 A It could be one of the consequences, yes.

9 Q Any others?

10 A We've talked already about loss of tensile
11 capacity, and out-of-phase motion. I guess Dr.
12 Ostadan had expressed some concern, earlier on, about
13 whether this potential for differential settlement had
14 been included in the structural design of the pad.

15 That is all I can recall at this point.

16 Q But with respect to, if you will, the
17 dynamic performance of the foundations, the soil
18 cement, and so on, what you are saying is that there
19 could be egress of water, and there could potentially
20 be some out-of-phase motions?

21 A Right, and a slight inclination of the
22 pads.

23 Q And the pads could --

24 A Yes, it depends on how the differential
25 settlement is distributed, whether it is a dishing

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 effect, or do we have one side dropping relative to
2 another, tilting the pad.

3 Q Pardon me if I'm putting words in your
4 mouth incorrectly. But I don't hear you say anything
5 that sounds like a really significant problem.

6 Do you see this as being a real problem?

7 A Well, settlement is real, whether -- how
8 it affects the dynamic system, I think the potential
9 cracking of the soil cement immediately adjacent to
10 the structure, either the pads, or the canister
11 transfer building could potentially reduce some of the
12 passive earth pressure that is available to resist
13 seismic motions.

14 Certainly the cracks that would develop
15 would lead to loss of tensile strength, and increase
16 the tendency for pad to pad interactions.

17 Q Well, I'm asking because a couple of
18 minutes ago you said that you don't necessarily
19 envision this settlement as to leading to gaps or
20 cracks, but to creating a shear plane, a potential
21 shear plane failure.

22 So I'm not understanding how this two
23 pieces of your testimony fit together.

24 A Create potential gaps. Maybe when I was
25 looking at gaps, at the surface sometimes they appear

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 somewhat as gaps. There can be a slight opening, if
2 you will, of the shear plane at the surface, if you
3 were to trace it on deeper down into the soil I think
4 you would find that there may not be a gap, but it
5 would be a shear plane that develops.

6 Q Okay, let's move --

7 A Does that help? At the surface settlement
8 cracks, if you want to call them that, somewhat appear
9 as a gap. But with depth, if you were to trace them
10 down deeper, I think you would find that they are not
11 openings in the horizontal direction, but it is more
12 of a shear along the plane.

13 Q And the gap that you talk about in the
14 surface, how deep do they go? Are you talking a few
15 inches?

16 A The gap at the surface?

17 Q Yes, the one that you said that you could
18 see on the surface.

19 A A few inches may be a little bit large.
20 Some I've seen maybe a half inch, quarter inch.

21 Q A quarter of an inch?

22 A Sure. Somewhat depending on the soil type
23 we are talking about.

24 Q All right. Let's move to answer 4. Here
25 we are talking about the distinction that you see

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 between the potential effects of settlement for this
2 facility, with respect to nuclear power plants, and
3 the question was, that if there was long-term
4 settlement in excess of two inches, for nuclear power
5 plants, would that make any difference, as far as you
6 are concerned, for the PFS, is that right?

7 A My opinion is that what we need to focus
8 on is not the behavior of what other power plants have
9 done, but what would specifically happen at this site
10 if two inches of settlement were to occur near the
11 pads, or three inches of settlement somewhere around
12 the canister transfer building.

13 In my opinion these are beginning to be
14 relatively large settlements, which could cause
15 distress to the foundation systems.

16 Q Dr. Bartlett, I have passed along, giving
17 you, and the Board, and the other parties, a copy of
18 the transcript of a portion of the examination of
19 yourself and Dr. Ostadan by Mr. Turk on May 9.

20 I remember there was a long discussion
21 between Mr. Turk, on the one hand, and Dr. Ostadan on
22 the other --

23 A Correct.

24 Q -- in which I think that the gist that I
25 got, and that I believe this transcript reflects, is

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 that in Dr. Ostadan's mind, a settlement of two inches
2 in a nuclear power plant would be a serious matter.

3 Do you remember that?

4 A Right, and I kind of stayed out of the
5 discussion because I haven't been involved, only in a
6 couple cases at Savannah River, at facilities that are
7 quite the size of nuclear power plants, so I was
8 relying on Dr. Ostadan's expertise.

9 I think there was questions put forth to
10 me of what were considered acceptable total
11 settlements in my practice, and I proffered a few.

12 Q Would it be fair to say that the exhibit
13 232 that was presented by Mr. Trudeau, and discussed
14 in his rebuttal, tends to show that settlements in
15 excess of 2 inches have been estimated or measured at
16 nuclear power plants who are currently in operation?

17 A No, I wouldn't dispute that fact.

18 Q All right. So you say that
19 notwithstanding Dr. Ostadan's testimony, or
20 independently of Dr. Ostadan's testimony, your view is
21 that we should focus on the effect of settlement here
22 at PFS?

23 A Correct. Let's take a look at your answer
24 number 5 on page 4. I believe that is the last answer
25 in your prepared rebuttal testimony.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 Moving, looking towards the end of that
2 answer, in the -- let's see, eight lines from the end,
3 the paragraph that starts, the sentence that starts:
4 With the potential for pad to pad interaction; do you
5 see that?

6 A Yes, I do.

7 Q The potential for pad to pad interaction
8 effect. I was trying to place you in the portion of
9 the answer that I want you to focus on.

10 A Yes, I see it.

11 Q Okay. This ties, again, to your oral
12 testimony in response to questions to Ms. Chancellor
13 with the same analysis. Is that right?

14 A Yes, I believe so.

15 Q Okay. You say here that Holtec analyzed
16 a simple two pad system in the longitudinal direction,
17 is that right?

18 A Yes, there were two pads and a soil cement
19 plug, if you will, between the two pads in the
20 longitudinal direction.

21 Q And in response to Ms. Chancellor's
22 questions you thought that it was -- that was the case
23 of 8 casks on one pad, and one cask in the other pad?

24 A Yes, that is my recollection of the system
25 that was analyzed.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 Q And you said there were many other
2 combinations that were not considered, is that right?

3 A Many other combinations?

4 Q Of cask loadings and so on. I believe
5 that is what you said.

6 A It could be cast loadings, or the
7 potential for multiple pads being involved in the
8 system, yes.

9 Q All right. Considering just two casks, I
10 believe that Dr. Soler testified that the 8 cask in
11 one pad, and the one cask in the other pad,
12 represented the most extreme, if you will, disparity
13 in the loads that you could have.

14 Do you remember that testimony?

15 A Yes, I disagree with that, but, yes.

16 Q How do you disagree that that is the most
17 extreme situation?

18 A What happens if we had, hypothetically, a
19 row of ten pads, and we looked at the end pad, and
20 maybe five or six pads and their casks were moving in
21 concert, and the end pad was moving out of phase?
22 There would be more mass in that system.

23 Q Yes, but just considering two pads.

24 A Well, that is the problem I have with the
25 analysis, it was a simple scoping analysis of a simple

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 system. I don't think it was meant to be a design
2 basis document, and I don't think it meant to consider
3 all the potential interactions there could be.

4 Q All right. If you had a hypothetical PFS
5 that had only two pads in it?

6 A Okay, fine, I can think of a two pad
7 system.

8 Q For a two pad system would an eight cask
9 on one pad, and one cask in the other pad, be the most
10 extreme diversity of potential loadings for pad to pad
11 interaction that you could conceive of?

12 A Maybe not, I'm not sure, and I will tell
13 you why.

14 Q Tell me why.

15 A The thing I think one may want to try to
16 emphasize is this out of phase motion, which is a
17 function of mass and stiffness. And I'm not sure if,
18 maybe there is a combination where the mass of a,
19 let's say three cask pad, for some reason, is at some
20 point more out of phase than a cask with eight pads
21 and one pad.

22 I'm having a hard time thinking of the
23 complete dynamics of what may really occur. It
24 certainly accentuates the extremes in mass. But
25 whether that equates to an extreme in the out of phase

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 motions, I'm not sure.

2 Q Well, I thought that both you and Dr.
3 Ostadan testified several times that what causes the
4 out-of-phase motion between two bodies is the
5 difference in mass. Am I missing something?

6 A It does. But just because you maximize
7 the differences in mass doesn't necessarily mean you
8 maximize the differences in out-of-phase motions. I'm
9 not sure that is explicitly true.

10 Q Are you saying that you could have a
11 situation in which you didn't have -- you could have
12 less of a disparity in mass, and more out-of-phase
13 motion?

14 A You might.

15 Q Can you think of any physical mechanisms
16 that would lead to that?

17 A Well, you have to remember that the
18 frequency of vibration is somewhat of a function of
19 the square root, I think, of the stiffness divided by
20 the mass.

21 And so I'm thinking, in getting things out
22 of phase you need to maybe think in terms of
23 frequency, which is both a function of stiffness and
24 mass, and not simply just think about the mass side of
25 it. That is all I'm saying.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 Q How would the stiffness change? I'm
2 assuming that instead of having the stiffness, it is
3 the property of the soil, right, and the soil cement?

4 A How would the stiffness, you mean, of the
5 soil cement change?

6 Q Well, you said that you could have a
7 situation in which you could have different number of
8 casks, and you will have --

9 A I guess I'm just trying to put out the
10 position that I never try to second-guess dynamic
11 analyses. And it might be wise. Maybe that is the
12 maximum case, I don't really know.

13 But I can't say intuitively I can arrive
14 that that is the extreme case.

15 Q So what you are saying is that Dr. Soler
16 testified that he considered that to be the extreme
17 case. You personally don't know whether that is the
18 case?

19 A For a two pad system, yes, I don't know.
20 He may have tested that out, or he could have derived
21 it himself. I'm not sure I intuitively arrived at
22 that.

23 Q You don't have any basis for disbelieving
24 that that is the case here?

25 A No, no.

1 Q But you did see the results that he
2 obtained for that two pad system?

3 A Yes, I'm aware of that.

4 Q And if I recall those results, and that
5 analysis, by the way, was based on a number of
6 conservative assumptions, wasn't it, like no damping?

7 A No damping in the springs, I do -- I think
8 I recall that.

9 Q And very high Young's modulus for the soil
10 cement?

11 A A reasonably high Young's modulus and
12 upper bound, as I recall.

13 Q And no transmittal of forces downward, no
14 assumption that forces would be dissipated down?

15 A No, I think there were springs underneath
16 these systems.

17 Q I'm reminded, by people who know better
18 than I do, that what I meant to ask was that there
19 were no springs underneath the soil cement to transmit
20 the forces down into the soil?

21 A That is correct, but that is a very small
22 area.

23 Q All right. And you recall, of course,
24 that the results of those analyses that Dr. Soler
25 performed, showed that there was no sliding, and that

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 there was no discernible, or significant impact on the
2 motion of the casks, is that correct?

3 A Showed there was no sliding --

4 Q Of the pad. .

5 A I'm not sure his model sliding, if it were
6 to occur. I don't think the springs allowed sliding.
7 Regarding the movement of the casks I think his
8 conclusions were that there were no tip over, or
9 excursions were acceptable.

10 Q If I remember, and I don't have exhibit
11 225 in front of me, but if I remember the maximum
12 motion of the casks, in that case that he analyzed,
13 was in the order of three inches or so. Is that --

14 A I really don't recall those fine points.
15 I sometimes focus on what the foundations are doing
16 and I don't want to belittle the casks, but I don't
17 pay as much attention to how much they are moving.

18 Q Well, but keeping things in perspective
19 here, what we worry here is about the casks not
20 tipping over, don't we?

21 A Not me. I worry about the foundations.

22 Q Oh, I see, okay. A couple more
23 questions.

24 When you were talking about pad to pad
25 interaction without sliding, you were referring to the

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 differences in properties between the soil and the
2 soil cement. Remember that?

3 Ms. Chancellor asked you this question.

4 A When we were talking about sliding?

5 Q Well, when you were talking about pad to
6 pad interaction without sliding.

7 A Okay.

8 Q You explained that it could happen because
9 of --

10 A Of the difference of deformation
11 characteristics, different materials, yes.

12 Q Right. And you referred to the Bonneville
13 clay as being like jello. Remember that?

14 A Well, it was just an analogy. Would you
15 like me to pick a stiffer material?

16 Q Well, the reality is that this Bonneville
17 clay has been, at least by PFS' testing, tested out at
18 2,000 pounds per square inch, is that right? I'm
19 talking about --

20 A Yes, you just gave me a compressive
21 strength, I prefer to hear modulus, but go ahead.

22 Q What I'm trying to say, this is far, far
23 stronger than gelatin, isn't it? I mean, this --

24 A Well, certainly. But relatively it is not
25 near as stiff as the cement treated soil, or the

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 counsel. The moduluses could be markedly different.

2 In fact, as I recall, the Young's modulus
3 of the Bonneville clay is on the order of maybe 3 to
4 4,000 PSI. The cement treated soil is maybe 75,000
5 PSI, and maybe the soil cement, when designed, will be
6 five to six times stiffer than that.

7 So we are talking about things that vary
8 at least over one order of magnitude, and maybe --
9 well, really, two orders of magnitude.

10 Q You were talking about because of the
11 potential pad to pad interaction, due to this
12 difference in properties between the various
13 materials?

14 A Yes.

15 Q That there could be mobilization of the
16 passive resistance of the soil. Remember that?

17 A If the stresses in the soil cement strut
18 that we have been talking about, reach a certain
19 point, they will begin to mobilize passive earth
20 pressure in the soil cement, yes.

21 Q And you talk about potential soil failure.
22 Could you explain what you meant by soil failure?

23 A Well, the idea of passive earth pressure
24 theory is that to mobilize this resistance to lateral
25 movement, you have to bring the soil to a state of,

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 essentially, plastic equilibrium.

2 And so you mobilize a bunch of -- well,
3 mobilize shear planes within the soil, and that is --
4 it is this mobilization of the shear strength of the
5 soil, along these shear planes, or potential shear
6 planes, that really provides the resistance.

7 Once that is gone, then you've reached a
8 state of passive failure, and you fail.

9 Q What does that mean?

10 A Well, in this case you would see shear
11 planes manifesting themselves at the surface. You
12 would see shear failure.

13 Q Shear failure of what?

14 A Of the soil cement.

15 Q Of the soil cement?

16 A Yes. The shear plane, maybe to help you
17 out a little bit, is -- say this is a pad here, and it
18 goes down here at some depth, as you begin to mobilize
19 that passive earth pressure, depending on the material
20 properties, there is some subhorizontal angle here
21 that develops, and that -- the stresses begin to
22 localize on that failure plane, and you are mobilizing
23 the shear stress of the soil to resist the motion in
24 this direction.

25 And at some point you reach passive

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 failure, and then the shear plane develops and it
2 would manifest itself up to the surface. You would
3 see a little bit of thrust, if you will.

4 Q The Reporter probably didn't get any of
5 the things that you marked with your hands.

6 A I'm sorry.

7 Q So just to recapitulate what I think you
8 said. If you get to the point of shear failure you
9 are going to have what effects on the soil cement?
10 You could have sliding of the soil cement layer, or
11 crushing of the soil cement layer, or what?

12 A The soil cement would begin to slide on
13 that failure plane, yes.

14 Q Okay. So what you are saying is that
15 because of the difference in properties of the
16 materials, once you went past the -- once you engaged
17 the passive resistance of the soil, that could create
18 stresses on the soil cement that might cause it to
19 slide, or to --

20 A I'm not sure I agree with that. Before
21 you reach passive failure in the soil cement, these
22 bodies will behave more in the elastic range, and they
23 will transfer the load according their stiffnesses,
24 with the stiffest materials carrying the greater
25 amount of loads.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 I perchance you had enough lateral force
2 to bring the soil cement to failure, then this failure
3 plane that we are talking about will begin to develop.
4 And if you progressively continue to fail the soil
5 cement, by pitching into it, then you would see a
6 failure plane develop at the surface.

7 But I'm just putting forth the concept
8 that even before you reach passive earth pressure
9 failure, just because of the differences in
10 stiffnesses in material, there is still transfer of
11 load, and that could progress, if you continue to push
12 into the soil cement with large enough forces, to an
13 actual shear failure of the soil cement.

14 But that is not my main concern about
15 worried about failing the soil cement, it is the fact
16 that it is stiff, and it can transfer load, and it
17 transfers load relatively at fairly high rates,
18 compared to the Bonneville clays that are underneath
19 it.

20 Q I'm glad you said that because I thought
21 that was something that I didn't understand before.

22 A No, I'm not implying that I'm worried
23 about passive shear failure in the soil cement. I
24 think if we looked at Dr. Soler's analysis, and looked
25 at the compressive stresses that develop in the soil

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 cement strut between the two pads, as I recall, that
2 was still below the failure stresses of the soil
3 cement.

4 Q Thank you. And, in fact, I thought that
5 the situation that you personally had the most concern
6 with was the opposite, was the situation in which the
7 soil cement would not fail, but would be served to
8 transmit stresses from one pad to the other, is that
9 right?

10 A Well, I'm concerned about how the system
11 really behaves.

12 Q I see.

13 A And if we tend to concentrate forces in a
14 stiffer element, like the soil cement, depending
15 relative -- there is still shear stresses being
16 mobilized underneath the pads, that is true, there are
17 still forces developing there.

18 And we have to look, relatively, where the
19 stresses are being transmitted. I think Dr. Ostadan
20 called these load pass. And relatively what is going
21 on.

22 But there could be, in the extreme case,
23 where if the soil cement strut picks up its capacity
24 at a much, much greater rate than the shear strength
25 is mobilized in the Bonneville clay, I can think of

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 maybe an extreme case, possibly, that you could bring
2 the soil cement strut to failure before you mobilized
3 all of the capacity in the Bonneville clay.

4 So it is what we call the straining
5 incompatibility problem, we have two very dissimilar
6 materials that strain at different --

7 Q But the reason you brought that up in your
8 examination by Ms. Chancellor was to explain what a
9 hypothetical extreme case could be, but not what you
10 expected would happen, is that right?

11 A Well, I'm just trying to explain the fact
12 that these load mechanisms, and how these materials of
13 different stiffnesses, and how they actually transmit
14 loads during a seismic event, I don't believe has been
15 well thought out by the Applicant.

16 Q But in short this is one of the scenarios
17 that you thought that could potentially, in an extreme
18 case, develop?

19 A I can think of pad to pad interaction
20 before shear failure develops in the soil cement. I
21 can think of pad to pad interaction occurring before
22 sliding occurs. Forces have to be transmitted
23 somewhere, and have to be resisted by something.

24 And to ignore the fact that you have a
25 stiffened material in between two pads that is only

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealgross.com

1 separated by five feet, and not -- to ignore what
2 effect it has on the dynamics of the system is just
3 not correct.

4 MR. TRAVIESO-DIAZ: That is all I have.

5 CHAIRMAN FARRAR: Staff have any cross?

6 MR. TURK: Yes, Your Honor.

7 CHAIRMAN FARRAR: Okay.

8 MR. TURK: I recognize that it is about
9 5:20 now. I forecast about 10 to 15 minutes. Should
10 I go ahead and do that?

11 CHAIRMAN FARRAR: Yes, go ahead.

12 MR. TRAVIESO-DIAZ: I will try not to drag
13 this out, I will try to make it short.

14 CHAIRMAN FARRAR: Let me ask the
15 Applicant, based on this, are you going to need to
16 have whatever surrebuttal?

17 MR. TRAVIESO-DIAZ: My current inclination
18 is no, but I would like to reserve that option until
19 the testimony is finished, and I have a minute to
20 confer with my colleagues.

21 CHAIRMAN FARRAR: Fine. Well, let's see
22 if we can't wrap things up, then.

23 CROSS EXAMINATION

24 BY MR. TURK:

25 Q Good afternoon, again, Dr. Bartlett.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 A Good afternoon.

2 Q I want to come back to something that Mr.
3 Travieso-Diaz was asking you about. In answer number
4 1 to your rebuttal testimony, your surrebuttal
5 testimony --

6 A Yes.

7 Q -- you make reference to two documents
8 that have been admitted for their historical value,
9 those are --

10 A Yes, that is true.

11 Q -- this Macie --

12 A Yes.

13 Q -- memo from April of '97, and that is
14 State exhibit 211, and that is where the five inches
15 of settlement that was discussed?

16 A Yes.

17 Q Do you recognize that that was a different
18 design than BFS is proposing here, or are you aware of
19 that?

20 A Different design? My understanding is
21 always that we have pads on top of soil, but maybe I'm
22 mislead.

23 Q All right. Currently you understand that
24 the PFS design contemplates one to two feet of cement
25 treated soil beneath the storage pads?

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 A One to two feet of cement treated soil,
2 correct.

3 Q Do you know if that was the design back in
4 1997?

5 A No, I don't believe that would have been
6 the design in 1997, that is correct.

7 Q In fact, if we look at State exhibit
8 number 211, which you refer to at page 2 of your
9 testimony, and this is a quotation about the five
10 inches of settlement, I'm looking at that, and I
11 notice the very first point made is that there is to
12 be a four inch mud mat beneath the storage pads.

13 Do you see that reference in State exhibit
14 211?

15 A No, I don't have that in front of me.

16 MR. TURK: Do you have a copy to give him,
17 or should I approach with mine? Your Honor, may I?

18 CHAIRMAN FARRAR: Certainly.

19 THE WITNESS: Okay, four inch mud mat. I
20 see now, okay.

21 BY MR. TURK:

22 Q You saw that reference to a four inch mud
23 mat?

24 A Yes, I did.

25 Q And that is, in fact, a different design

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 than PFS is proposing here, correct?

2 A Right, the design no longer has a four
3 inch mud mat, as I recall.

4 Q Do you want to take time look at this, to
5 see if there is any contemplation of cement treated
6 soil, back in April of 1997?

7 A I am reasonably sure that there was not,
8 at that time, in the project, yes.

9 Q You recognize, also, State exhibit 210,
10 which you refer to, also dated April 1997, similarly
11 referred to a four inch mud mat. Would you like to
12 see that document?

13 A Sure.

14 Q For the record, I'm showing the witness
15 State exhibit number 210, and I would ask him to turn
16 to page 2, and to take a look at the numbered
17 paragraph 5.

18 A Yes, I see the paragraph.

19 Q And, in fact, that document also refers to
20 the four inch mud mat, correct? There is a statement
21 that there is a recommendation to raise the storage
22 pad up by the amount of the four inch mud mat?

23 A In place of mud mat, yes, I see that.

24 Q So you would recognize, then, that the
25 five inch of settlement had to do with a different

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 design of the storage pad, and its foundation system,
2 correct?

3 A Yes, it is evident that there was a mud
4 mat that was in the design at the time, yes.

5 Q Are you aware, also, that over time PFS
6 has changed its proposed design of the foundation for
7 the storage pads, whereby they have gone to the use of
8 cement treated soil and have then changed the amount
9 of cement treated soil from one foot to two feet?

10 A Well, again, the requirement is one foot
11 minimum, maximum, so it is somewhere one and two feet.
12 I think I was trying to capture that, that I
13 understand that during design of a project of this
14 complexity, that there are design changes and more
15 data come in that make revisions in settlement.

16 Q Over time, in fact, are you aware that PFS
17 has changed the depth of the cement treated soil that
18 it proposes to use underneath the storage pads,
19 whereby they may currently have a proposal of using
20 one to two feet, but that has not always been the
21 proposal for the amount of cement treated soil under
22 the pads.

23 Are you aware of that?

24 A That level of detail I'm not sure I
25 remember.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 Q In your answer number 1 you seem to be
2 criticizing the amount of settlement that has been
3 calculated by PFS. You indicate that you believe this
4 is essentially a sharpening of the pencil.

5 Would you recognize that, in fact, the
6 design of the pad has changed so that the amount of
7 settlement may have, in fact, been calculated
8 differently, based upon differing designs?

9 A Yes, and I think that is what I'm trying
10 to capture in the first sentence of that paragraph.

11 Q So it is not so much that it is a
12 sharpening of the pencil, but you recognize that the
13 design has changed, and that may have led to different
14 settlements?

15 A Well, somewhat. I think some of the later
16 revisions of the calculations, and certainly this half
17 inch that has been most recently proffered, has been
18 more of a sharpening of the pencil.

19 I don't think the design has changed.

20 Q But you wouldn't state any more, would
21 you, that the change from the five inch of projected
22 settlement to something on the order of 1.75, or 2
23 inches, that that is just a sharpening of the pencil?

24 A No, I think that would be something
25 reflecting the changes in the design, and things. We

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 haven't had to put forth any major issues with this
2 1.75 inches of total settlement that has been
3 calculated.

4 Q On page 2 of your answer, and this is,
5 again, a question that Mr. Travieso-Diaz raised, there
6 is a statement that states: "However, I note that
7 much of the conservativisms in the analysis may have
8 already been removed during the earlier revisions of
9 the settlement calculations."

10 You don't provide any specific
11 quantification of which conservativisms, or how much
12 conservativism has been removed?

13 A No, I think I'm just noticing a process
14 that is going on, and it keeps on diminishing, without
15 any real improvement of the soils with time.

16 Q You have not done any calculations, or
17 analyses, to determine which conservativisms were
18 removed?

19 A No, I don't perform calculations.

20 Q So you can't state how much conservativism
21 has been removed, or which conservativisms have been
22 removed over time?

23 A I have, like I stated before, I don't have
24 the most recent revision of the calculation, so I
25 think between the three inches that was proffered in

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 rev 1 of the settlement calculations of the pads is
2 the last version that I have.

3 I do not have revision 3, and I haven't
4 made a detailed comparison between the two to see why
5 the revisions were made from 3 inches to 1.75 inches.
6 But we haven't chosen to make a big issue of the 1.75
7 inches, and we haven't in this hearing.

8 Q Question and answer number 2, which
9 appears on page 3. Here you talk about potentially
10 non-uniform settlement.

11 As I understand your testimony, this is a
12 reference back to the testimony that we had in Salt
13 Lake City concerning the potential dishing of the pad?

14 A Yes, it deals with that discussion.

15 Q Okay. And that is where, I believe, I
16 asked for a calculation of the angle of inclination,
17 and do you recall we came up with something like a
18 0.64 degree angle?

19 A I can't remember the number, but I think
20 I can remember the drawing that we did on the board.

21 Q But it is with respect to that testimony
22 that this relates?

23 A Yes, how you distribute the differential
24 settlement, and the way you distribute it is always
25 somewhat of a negotiated thing between a structural

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 engineer and a geotechnical engineer.

2 Distributing at the center of the pads to
3 maximize the dishing effect might be reasonable. One
4 could also look at distributing it, maybe, with one
5 side dropping relative to the other.

6 Sometimes in geotechnical engineering we
7 may take half of the total settlement, and call it
8 differential settlement, and distribute it over the
9 minimum footing width. That is somewhat standard
10 practice, but maybe for critical facilities we might
11 try to see what would be the consequences if you
12 distributed the total settlement over the minimum
13 footing width.

14 But there usually -- it is a difficult
15 thing to try to understand exactly how the
16 differential settlement is distributed. It usually
17 requires a finite element model that we don't commonly
18 use.

19 Q My question really just went to whether
20 this is a reference back to that same discussion that
21 I mentioned.

22 A Yes, I think -- again, I'm just saying
23 that one might reasonably consider two, three, or four
24 scenarios, what may happen, and if it is any
25 consequence to you.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 And I think also Dr. Ostadan was worried
2 about whether that effect had been taken in the
3 structural design of the pads.

4 Q In answer number 4, this is just a
5 clarification, at the bottom of page 3, the question
6 asks you about the effect of settlement on the dynamic
7 response of the pads.

8 And in your answer you talk about the fact
9 that soil cement is placed around the pads, and the
10 canister transfer building. Do you see that, two
11 lines from the bottom, on page 3?

12 A Yes, where the statement is --

13 Q The line begins with the word placed under
14 the pads.

15 A Placed under the pads, soil cement is
16 placed around the pads, and the CTB. Yes, I see that
17 line.

18 Q Then you say settlement of a few inches
19 could be important to the seismic performance?

20 A Right, because of the cracking and loss of
21 tensile strength, yes, and shear capacity.

22 Q Now, are you --

23 A We are talking about the soil cement
24 around the CTB and the pads.

25 Q Okay. So your answer is with respect to

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 both the CTB and the pads?

2 A Yes, there is roughly two inches of
3 settlement projected for the pads. I'm simply asking
4 the question what happens, if two inches of settlement,
5 what is the effect to the soil cement around the pads,
6 and likewise the three inches of settlement projected
7 for the canister transfer building, what is the effect
8 on the tensile strength and shear capacity of the
9 buttress.

10 Q Okay, I think I understand that.

11 A Okay.

12 Q When Mr. Travieso-Diaz was asking you some
13 questions about the failure in the soil cement, you
14 were using your hands to explain the shear plane that
15 you thought might develop?

16 A Yes.

17 Q And, for the record, I would like to note,
18 as I watched you, I saw you putting your hand in an
19 angular direction, such that the tip of your hand was
20 pointing down, or up, relative to the base of your
21 hand?

22 A Right.

23 Q You seemed to be indicating a plane that
24 would develop along some angle that is neither
25 horizontal, nor vertical, but somewhere in between?

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 A Yes, that is correct. I can tell you what
2 the angle is, but it depends on the properties of the
3 materials.

4 Q Is there a precise angle?

5 A Well, theoretically there is a precise
6 angle. And, in practice, it may not be quite that
7 precise. But for material that derives all of its
8 strength solely from cohesion, it would be a 45 degree
9 angle.

10 Something that derives its strength from
11 solely frictionably, 45 degrees minus phi, which is a
12 friction angle divided by two. For this material,
13 which derives some of its strength from cohesion, and
14 some of it from friction, it is somewhere in between.

15 At least if I remember my theory right.

16 Q Could you explain the 45 degree angle
17 minus phi?

18 A Phi is the friction angle. Geotechnical
19 engineers don't usually use coefficients of friction,
20 so what we do is take, let's see, the coefficient of
21 friction is equal to the tangent of the phi angle.

22 So a coefficient of friction of one would
23 equate to a 45 degree phi angle. But I think what I'm
24 trying to point out is that those passive failure
25 envelopes actually overlap in the five foot gap

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 between the two pads in the longitudinal direction.

2 Q If you develop a shear plane on 45
3 degrees, in the soil cement, because of this -- I take
4 it that is because of the transfer of forces from --

5 A Well, as you push into the soil has to
6 resist that some way, that lateral pushing. So it
7 mobilizes its shear capacity to resist your pushing
8 the pad into the soil.

9 Q And then you said that angle would be
10 expressed at the surface of the soil cement?

11 A Once failure is reached, yes.

12 Q Wouldn't that tend to reduce the amount of
13 force that is then being exerted on the adjacent pad?

14 A No doubt if we brought the soil cement
15 plug into passive failure between the two pads, there
16 would certainly be a reduction once it reached the
17 failure state, I wouldn't dispute that.

18 But it takes a lot of force to bring it to
19 ultimately to failure. Short of it is not precracked
20 from settlement, or something else.

21 Q Is there a standard means of calculating
22 the amount of force that would be necessary to bring
23 it to failure?

24 A Yes, if you use the passive earth pressure
25 theory you can calculate it.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 Q Can you provide that calculation now, or
2 that formula?

3 A Just go to standard textbook on, probably,
4 Colum theory, and the passive earth pressure theory.
5 It is in all the technically books.

6 MS. CHANCELLOR: Your Honor, is this
7 within the scope of Dr. Bartlett's rebuttal? I'm just
8 wondering where we are going.

9 MR. TRAVIESO-DIAZ: I think he is
10 exploring the answer that Dr. Bartlett gave me, that
11 started with his motion of his hands describing the
12 shear failure plane, and so on.

13 THE WITNESS: I think it is fair enough.

14 MR. TURK: I think that it is relevant to
15 the testimony that has been given, and if the
16 testimony wasn't relevant, then I don't know why we
17 had it. But I will proceed --

18 THE WITNESS: I think there is a
19 possibility, again, if the soil cement picks up a
20 significant amount of load, very early on as out-of-
21 phase motions beginning, there could be a potential
22 shear failure, crushing of the soil cement.

23 BY MR. TURK:

24 Q Would it be your belief that that failure
25 would occur before the soil cement is crushed, the

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 passive failure of the soil cement plug?

2 A Well, we may be splitting hairs here. The
3 crushing is generally considered a purely axial
4 phenomenon, where we are just axially loading and
5 crushing something.

6 We are now talking about shear failure due
7 to passive resistance. I may have to think about that
8 a little bit. Interesting question. Do we crush it
9 first, or do we bring it to passive failure.

10 Q As you sit here you don't know the answer
11 to that? Which is not a criticism, I just --

12 A No, it is not hard to calculate, I just
13 have to think about it, make sure, make proper
14 assumption.

15 CHAIRMAN FARRAR: Mr. Turk, while you are
16 thinking over your next move, would you also think
17 that you told me 10 to 15 minutes 20 minutes ago?

18 MR. TURK: I don't have very much Your
19 Honor, it is just a question of how to pursue, or
20 whether to pursue certain lines. But I should finish
21 very shortly.

22 CHAIRMAN FARRAR: Okay. The fact that
23 something was mentioned in direct doesn't necessarily
24 mean that you have to pursue it to the end, if it is
25 not terribly significant to the case.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 MR. TURK: I appreciate that. I also have
2 to note, Your Honor, that it is the end of the day,
3 but that is where I find myself, unfortunately, that
4 is where I am, that is the place and time, or the case
5 arrived to me at that point in time.

6 CHAIRMAN FARRAR: To thine own self be
7 true, Mr. Turk.

8 BY MR. TURK:

9 Q You mentioned, also, that you have seen
10 cracks of a quarter inch, or a half inch width, at the
11 surface. Now, what sort of a condition were you
12 describing, what sort of cracking was that, that you
13 were describing?

14 A Usually cracks that are around the
15 foundation due to settlement of the soil. Of course
16 I've also seen cracks right through a foundation, like
17 a slab, or spread footing.

18 Q If a structure has not been placed
19 perfectly horizontally, for instance, if there was
20 some tilt, or perhaps some failure to one side of the
21 structure's foundation, wouldn't that tend to produce
22 a larger crack on the other side of the foundation?

23 In other words, the structure is tilting
24 down on one side, that opens up a crack of a greater
25 extent on the other side.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 A So you are saying we have a rotation of
2 the foundation system like this, and you are asking me
3 if there is a crack bigger on this side, than there is
4 on this side?

5 Q Right.

6 A I guess I would have to ask whether the
7 cracks initiated, really, from shear failure, or from
8 settlement. My experience with settlement is probably
9 not, if there is some kind of shear failure that is
10 causing the rotation, yes, I think you would be
11 correct.

12 Q I guess my puzzlement is, if I picture a
13 building, or a structure that is settling uniformly,
14 I wouldn't expect to see very much of a wide crack at
15 any side, I would expect the whole thing to settle
16 more or less uniformly, which would leave open some
17 small crack, but not a half inch crack on any one
18 side, unless there is some --

19 A I thought the discussion that I was having
20 with Mr. Diaz, was talking about the cracks of the
21 soil cement immediately adjacent to a foundation
22 system. So maybe the foundation system may be
23 settling somewhat uniformly, but the soil cement
24 around the perimeter of a pad, or a canister transfer
25 building wasn't settling as much.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 And we were talking about the nature of
2 cracking there. That is what my discussion, I
3 thought, was about. Cracks usually are accentuated at
4 the surface because simply the material has kind of
5 unraveled down into the crack a little bit, and they
6 look wider at the surface than they really are.

7 Q So deeper down in the foundation there
8 would be less of a width of that crack?

9 A Yes.

10 MR. TURK: I have nothing further.

11 CHAIRMAN FARRAR: Okay, thank you. The
12 Board has no questions.

13 MS. CHANCELLOR: I think I can help you
14 out.

15 CHAIRMAN FARRAR: Okay.

16 MS. CHANCELLOR: I have no questions, but
17 I do have one housekeeping item with Dr. Bartlett, and
18 it doesn't necessarily have to be done tonight. And
19 there is an outstanding Utah exhibit 200, which deals
20 with the shake table test that has not yet been
21 entered into evidence.

22 And if there is an objection I would need
23 to ask Dr. Bartlett some questions about it.

24 CHAIRMAN FARRAR: We don't have that
25 exhibit handy.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 MS. CHANCELLOR: It was the one that was
2 part in Japanese, and part in English, and it had the
3 shake table test, I believe there was only one of
4 those.

5 CHAIRMAN FARRAR: Any objection to that?

6 MR. TRAVIESO-DIAZ: I told you, if I
7 remember, that if there is such a thing as a strong
8 objection, I have a strong objection to that exhibit.

9 MS. CHANCELLOR: And, Your Honor, we would
10 stipulate that we are only relying on the English
11 portion, and not the Japanese portion of this exhibit.

12 MR. TRAVIESO-DIAZ: It doesn't help me
13 because I don't know whether the two proportions are
14 the same.

15 CHAIRMAN FARRAR: It looked to us like,
16 and I think I mentioned it at the time, it looks like
17 one of those deals you get up in Canada, where half of
18 it is in French, and half of it is in English, and
19 they are identical.

20 MR. TRAVIESO-DIAZ: It may very well be
21 the case, but we don't know that for a fact. But, Mr.
22 Chairman, may I suggest something? Can we finish with
23 this witness, first, this testimony, and if we need to
24 argue over the exhibit, we may take it up later?

25 Holding up Dr. Bartlett and Mr. Trudeau

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 now might not be fair to them.

2 MS. CHANCELLOR: The reason I need Dr.
3 Bartlett is that Dr. Bartlett acquired this exhibit.
4 So if there is any question about --

5 CHAIRMAN FARRAR: When is he going home?

6 MS. CHANCELLOR: He is going home Friday.

7 CHAIRMAN FARRAR: Okay.

8 MR. TRAVIESO-DIAZ: Can't we take this up
9 later in the week?

10 CHAIRMAN FARRAR: Yes.

11 MS. CHANCELLOR: I just wanted to put a
12 place for it. If we take it up later that is fine.

13 CHAIRMAN FARRAR: Okay. Maybe you all can
14 talk to Dr. Bartlett privately, see where he got it,
15 and come to some accommodation on this.

16 MR. TRAVIESO-DIAZ: We will try to
17 accommodate.

18 CHAIRMAN FARRAR: You have no questions
19 for him otherwise?

20 MS. CHANCELLOR: No, Your Honor.

21 CHAIRMAN FARRAR: Okay, then he is
22 technically, Mr. Travieso-Diaz you have a chance for
23 more cross, based on the Staff's.

24 MR. TRAVIESO-DIAZ: I have no more
25 questions of this witness now.

1 CHAIRMAN FARRAR: Okay, good. Then he is
2 -- what was that exhibit number, Ms. Chancellor?

3 MS. CHANCELLOR: It is 200, Your Honor.

4 CHAIRMAN FARRAR: Then, Dr. Bartlett you
5 are excused for now. If we need to do any --

6 MR. TRAVIESO-DIAZ: Mr. Chairman, I know
7 it is late, but I have to confer with my colleagues to
8 decide whether the law of diminishing returns is
9 catching up with us or not.

10 CHAIRMAN FARRAR: Right.

11 MR. TRAVIESO-DIAZ: So if I can have five
12 minutes?

13 CHAIRMAN FARRAR: If it helps you in that
14 conferring, our impression is that that law is in full
15 force and effect.

16 MR. TRAVIESO-DIAZ: I am trying to confer
17 that with my colleagues. I raised that point a little
18 while ago myself.

19 CHAIRMAN FARRAR: Go and we will sit here
20 and wait to hear from you. Off the record.

21 (Whereupon, the above-entitled matter
22 went off the record at 5:47 p.m. and
23 went back on the record at 5:51 p.m.)

24 CHAIRMAN FARRAR: Counsel, do you have
25 some good news for us?

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 MR. TRAVIESO-DIAZ: Mr. Chairman, I think
2 we all agree that the law of diminishing return, in
3 fact, has caught up with us. We have no further
4 rebuttal on this issue.

5 CHAIRMAN FARRAR: Excellent. Then as
6 planned we have accomplished what we had hoped to
7 accomplish on Monday and Tuesday.

8 All right, tomorrow who will be, refresh
9 us on where we are procedurally, and who will be on
10 the stand.

11 MR. GAULKER: Tomorrow I believe we begin
12 with the cross examination of Dr. Bartlett with
13 respect to the State's rebuttal on the Luk report.

14 And then I think the Staff mentioned that
15 they had some potential surrebuttal from Dr. Luk in
16 that respect.

17 CHAIRMAN FARRAR: And why had we, we had
18 put that off because the State needed time to spend
19 more time with the report, is that the --

20 MR. GAULKER: We put it off because, if
21 you remember, the State needed time -- first of all,
22 the State didn't have its expert when -- excuse me,
23 the Staff didn't have its expert when Dr. Bartlett
24 gave this testimony, initially, in Salt Lake City.

25 We, therefore, decided to put the

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 testimony on the record to allow the Staff the time to
2 look at it, and have their expert with them when they
3 did the cross examination. From my understanding that
4 is what happened.

5 MR. TURK: And backing up, that happened
6 because the State felt that they didn't have time to
7 evaluate the Luk report when we put Dr. Luk on the
8 stand the first time, they came in with the rebuttal.

9 CHAIRMAN FARRAR: And that was Dr.
10 Bartlett as a rebuttal witness, not as a direct
11 witness.

12 MS. CHANCELLOR: Your Honor, it is at
13 transcript page number 10530 is where there is some
14 argument before hand, but where the actual examination
15 of Dr. Bartlett on the Dr. Luk report, it starts on
16 the June 7th, 2000 transcript, at 10530.

17 CHAIRMAN FARRAR: All right, thank you.

18 MR. TURK: And it occurs at several other
19 places that same day.

20 CHAIRMAN FARRAR: Okay.

21 MR. TURK: Now, I personally don't expect
22 that we will take up the entire day with those two
23 pieces. I think we should be prepared to move into
24 soils some time after lunch.

25 My cross examination of Dr. Bartlett will

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 not be very extensive. I can't give you a time yet,
2 but it should be completed within two hours. Our
3 presentation of Dr. Luk should not be too extensive.

4 So I would think by roughly two or three
5 o'clock we should be moving on to something else, if
6 not sooner.

7 MR. TRAVIESO-DIAZ: I would just make the
8 point, we will have some small cross examination for
9 Dr. Bartlett. I wouldn't envision that much, and
10 Staff may very well cover it in their cross
11 examination.

12 CHAIRMAN FARRAR: And the soils witnesses
13 will be whom for the --

14 MR. TRAVIESO-DIAZ: It would be Mr.
15 Trudeau and Dr. Bartlett, and Dr. Ofoegbu. And I will
16 state for the record, and Mr. Trudeau of course will
17 be available, but I have --

18 CHAIRMAN FARRAR: Now, that direct
19 testimony of Mr. Trudeau is found as part of his
20 testimony with Dr. Wissa?

21 MR. TRAVIESO-DIAZ: Yes, both the
22 testimony of Mr. Trudeau on soils, and the testimony
23 of Dr. Ofoegbu on soils, are already evidence, but
24 they have not been examined on them.

25 Dr. Bartlett has a separate piece that

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 needs to come in.

2 CHAIRMAN FARRAR: All right.

3 MR. TRAVIESO-DIAZ: I was going to say
4 that even though Mr. Trudeau will be available
5 tomorrow, I am not as optimistic of the possibility of
6 going to soils tomorrow as the other people are.

7 CHAIRMAN FARRAR: Well, Mr. Trudeau will
8 be here, right?

9 MR. TRAVIESO-DIAZ: I was going to say I'm
10 afraid, but in fact we will all be here.

11 CHAIRMAN FARRAR: All right, then that is
12 good. Then let's -- we will resume at 9 tomorrow
13 morning. Before we go, I think particularly today,
14 with all the different rebuttal witnesses, it is one
15 thing for counsel to prepare their direct
16 presentations when they have some time to work with
17 their witnesses ahead of time, but the Board has been
18 very impressed with your nimbleness and dedication in
19 putting on these witnesses in this fashion.

20 I know it is not an easy thing for you,
21 and we want to complement all parties. And the degree
22 of that compliment, in one sense, it is the same for
23 all of you.

24 But the more resources your client makes
25 available to you, in terms of number of lawyers, and

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 number of people out there, the -- well, let's put it
2 this way, the less your client makes available to you,
3 the more you can take a compliment from this matter.

4 So let it rest at that. But all of you
5 deserve a lot of credit for what you are able to do on
6 a day like this.

7 MR. TURK: I want to just note one travel
8 concern I have. Dr. Luk is traveling here today, I
9 haven't heard from him yet, I was expecting him to be
10 in the hearing room this afternoon by about five. I
11 haven't seen him, so we need to work together tonight.

12 Hopefully tomorrow morning I will be able
13 to start at nine o'clock, but in case he has had
14 trouble getting in, or have trouble connecting with
15 me, I may ask for a slight deferral of starting time,
16 at nine o'clock tomorrow when we come in.

17 I don't expect that to be necessary, but
18 I just don't know what the situation is right now. So
19 my request would be that we start at nine, but I want
20 to note that that is assuming that I don't have a
21 difficulty in contacting Dr. Luk.

22 CHAIRMAN FARRAR: Well, do you have
23 everyone's -- why don't you, if there is any trouble,
24 why don't you call Ms. Chancellor and Mr. Gaukler,
25 give him your numbers. I mean, you know, we will be

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 here, and this is our office, so we have things to do
2 if we can't be here at nine.

3 But if --

4 MS. CHANCELLOR: Well, is there a plan B
5 if Dr. Luk doesn't get in?

6 MR. TURK: I assume he is here, because
7 the weather is good.

8 CHAIRMAN FARRAR: Well, supposing he
9 doesn't get in until midnight, and he can't work with
10 you until 8 to 10 in the morning. Maybe while you are
11 working with him the rest of us can be moving forward
12 on soils. Is that Mr. O'Neill?

13 Fine, then we will be here at nine. Mr.
14 Turk, if you need to use some time to work with Dr.
15 Luk, we will go ahead with soils.

16 MS. CHANCELLOR: But that is plan B,
17 right?

18 CHAIRMAN FARRAR: That is plan B. But why
19 don't you call opposing counsel by 9:30 tonight and
20 let them know whether you are on target or not, so
21 that they know whether they are walking in here to do
22 the Luk report, or to do soils.

23 MR. TURK: I will do that. I won't wait
24 until 9:30 to let them know.

25 CHAIRMAN FARRAR: And we don't need to

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 know, we will be here. Thank you all, and we will
2 adjourn for the evening.

3 (Whereupon, at 5:58 p.m. the above-
4 entitled matter was concluded.)

5

6

7

8

9

10

11

12

13

14

15

16

17

18

19

20

21

22

23

24

25

CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of:

Name of Proceeding: Private Fuel Storage, LLC

Docket Number: Docket No. 72-22-ISFSI

ASLBP No. 97-732-02-ISFSI

Location: Rockville, Maryland

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

151 John Mongoven
John Mongoven
Official Reporter
Neal R. Gross & Co., Inc.

NEAL R. GROSS
COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com