1 MR. WISSA: Five.

2 THE WITNESS: Five. Thank you.

3 MR. WISSA: Two.

4 THE WITNESS: Type two cement is

5 somewhat sulfate-resisting cement. Type

6 five is the true sulfate-resisting cement.

7 BY MR. TRAVIESO-DIAZ:

8 Q But this type, four or five, if

9 you were to specify, it would tend to

10 ameliorate the potential problems with

11 sulfates?

12 A Yes.

13 Q Now, you talk about two other

14 things that you were saying also that could

15 be done: Increase the -- increase what?

16 A Just the treatment level.

17 Q What do you mean by that?

18 That's what I didn't understand.

19 A Instead of using five percent

20 cement, use seven percent the cement, let's

21 say, something of that sort.

22 Q So the higher the strength with

1 cement, the lower the possibility of attack
2 by sulfates?
3 A Yes.
4 Q Explain to me how that works.
5 A Yeah. I mean, a given amount of
6 sulfate can only interact with a certain
7 amount of cement. So if you have a bigger
8 army by putting in more cement, you might
9 win the war.
10 Q I see. That is again something
11 that could be done, assuming that you are
12 within the specifications of your design; is
13 that right?
14 A Right.
15 Q Now, tell me one more -- because I
16 know you said that it was experimental, but
17 just so that I know -- what are the chemical
18 treatment methods that you mentioned?
19 A Oh, this was in relation to lime
20 treatment of soils, which a whole different
21 subject. But I think using a barium
22 treatment to tie up the -- some of the

1 bad-acting material would work.

2 The details have gotten fuzzy

3 because it's now almost ten years since I

4 was looking at that aspect of it. It's

5 nothing that I think we want to get into in

6 this kind of a project.

7 Q So this would be more experimental

8 in nature?

9 A It's more experimental in nature.

10 It's really aimed more at stabilization

11 using lime rather than Portland cement.

12 MR. TRAVIESO-DIAZ: Can we take a

13 ten-minute break?

14 MS. CURRAN: Yes. Let's take a

15 break and talk a little bit about where

16 we're at.

17 (Recess)

18 BY MR. TRAVIESO-DIAZ:

19 Q Dr. Mitchell, one more question on

20 sulfates that I had failed to ask you before

21 your break. We talked about three different

22 things that you could do, one was, if I

1 remember, use sulfate-resistant cement mix.
2 Another one was to increase the
3 concentration of cement in the mix. The
4 third that we began talking about was do
5 chemical treatment.
6 Now, would you consider using
7 something like a lime or lime ash as another
8 potential way to deal with the sulfate
9 problem if there is one?
10 A That's a possibility, I think,
11 that you could do that. Because I think the
12 lime in the sulfate would go after each
13 other sooner than the cement. But I'm not
14 sure is that it is an attractive problem
15 position for this project. I haven't
16 thought of that as a possibility, to be
17 honest with you.
18 Q Well, have you seen that done in
19 other projects?
20 A No, I know that there have been
21 projects where they have used lime in
22 cement. In fact, it's a technology that's

1 being used more and more now days for what
2 we call deep soil mixing. But that's not
3 really relevant to this.
4 Q The possibility of adding some
5 lime to your cement -- that's what triggered
6 my question -- adding some lime to the
7 cement mix just to sort of neutralize the
8 sulfate?
9 A I don't know if that would do it
10 or not. I haven't even thought of that
11 possibility in this case.
12 Q What I want to do, if you don't
13 mind, is to go back to Exhibit 1 that's the
14 contention itself, QQ.
15 A I have it.
16 Q What I want to do is walk with you
17 through the portions that you said earlier
18 that you might testify about, to figure out
19 to what extent we have covered them already
20 or not. Now, we talked about C-3-B on the
21 testing problem. Will you take a look at
22 subsection C-3-C, in which the contention

1 talks about impact of native soil.

2 Tell me whether what is described

3 in C-3-C is the same type of problem or is

4 the same problem that we have been talking

5 for the last half hour or so with respect to

6 construction impacts and water migration

7 impacts.

8 A That's the same issue as we were

9 talking about in Exhibit 36, paragraph --

10 Q Your declaration?

11 A My declaration, paragraph 14, the

12 end of that.

13 Q So there are two concerns you

14 express in paragraph 14, which is to say

15 construction impacts and moisture migration

16 are the same here on C-3-C?

17 A Yes.

18 Q So let's move then to C-3-D, which

19 is on page 3.

20 Do you have that?

21 A I have that.

22 Q I see that C-3-D raises a number

1 of issues or potential issues with respect
2 to the performance of the soil cement.
3 Do you see those?
4 A I do.
5 Q Did you provide the facts upon
6 which any of the five numbered -- items one,
7 two, three, four, and five on subsection
8 D -- were developed?
9 A I don't understand the question.
10 Q The question is, there are five
11 potential problems.
12 Were you the person who identified
13 any or all of these five problems; and if
14 so, which?
15 A I'm not sure I can be absolutely
16 sure as to how these were first identified.
17 They evolved back in April and May of last
18 year as we discussed the project among
19 Dr. Ostadon, Dr. Bartlett, and myself.
20 Q Why don't we do it this way?
21 Let's just go through each of them. You can
22 tell me as to each of them whether you

1 believe you are the person who is going to
2 testify as to each of these various items at
3 the hearing.
4 For example, D-1 talks about
5 potential concerns about shrinkage and
6 cracking that normally occurs from drying,
7 curing, and moisture content changes.
8 Is that one of the issues that you
9 expect to --
10 A I expect so, yes.
11 Q The reason that I'm asking you is
12 that I didn't identify this particular
13 concern directly on your declaration,
14 Exhibit 36. So I just wanted to --
15 A Again, I don't recall how it came
16 up in the conversation. But we all agreed
17 it's something that we need to talk about.
18 Q Why don't you tell us what the
19 concern is in this item is?
20 A Well, soil cement typically
21 shrinks some. Cracks form. Sometimes they
22 have little or no affect. Sometimes they

1 can be detrimental. That's just the nature
2 of the material. Generally speaking, the
3 finer grains of soil, the closer space to
4 cracks and the more of them you're going to
5 get.
6 Q Would you consider the soils at
7 the PFS site that are being considered for
8 use in the making of soil cement to be fine
9 grain or to be --
10 A They are fine grain, yes.
11 Q Is the formation of cracks due to
12 shrinkage and curing something that is to be
13 expected in the process of placing soil
14 cement?
15 A Not in the process of placing the
16 soil cement, but in the process of the
17 curing and aging of soil cement, yes.
18 Q I stand corrected.
19 Are there measures that the people
20 who specify the curing process can take to
21 minimize the occurrence of cracks?
22 A One is to recognize that it will

1 take place, and includes some joints in the
2 system. They will do that sometimes with
3 pavements. Another, if it's the case let's
4 say of a pavement structure, to recognize
5 that some is likely to occur, and have a
6 surface course over the top that will
7 prevent ingress of moisture, if that's an
8 issue.
9 Another is in the design, if
10 you're carrying like heavy vehicles over the
11 structure, to consider an edge-loading
12 condition when working out the probable
13 stresses and deformations. Those are three
14 I think that come to mind.
15 Q Is there any treatment that can be
16 imparted upon this cement or the soil cement
17 in the process of curing it that will
18 inhibit the formation of cracks?
19 A Well, there is a shrink-resistant
20 cement. I think it's type K. I don't know
21 how much about this. I've heard about this
22 recently, that could inhibit the cracking.

1 I know in the case of sand cement, limiting
2 the cement content helps. Keeping the
3 material from successive cycles of wetting
4 and drying will tend to minimize cracking.
5 Q How are the curing processes done?
6 Is there anything you can do in
7 specifying the curing that will make it less
8 likely that you will get less cracks or
9 fewer cracks?
10 A Don't give it open exposure to the
11 air during the curing period, perhaps put a
12 seal coat on it of petumatous material. Or,
13 I mean, you can do it with a geomembrane now
14 days. It would be things along those lines.
15 Q Now, you were talking a moment ago
16 about finner soils, fine-grain soils, the
17 fact that you're going to potentially get
18 many shrinkage cracks, assuming that you
19 don't have these treatment processes.
20 And let's differentiate here
21 between the two types of soil cement that
22 are considered for use at PFS -- what the

1 nature of the cracks that you will get will
2 be if you are dealing first with the
3 cement-treated soil that will go under the
4 pads?
5 This is low cement content.
6 A My gut feeling here is that the
7 amount of shrinkage might not be too great
8 because there's not as much cement and
9 because this material will be protected from
10 wet/dry, freeze/thaw, by virtue of the
11 reinforced concrete slab that's over the top
12 of it.
13 Q By the same token, you expect to
14 see more cracking in the other higher soil
15 cement?
16 A Potentially more cracks
17 susceptible.
18 Q Now, what kind of cracks?
19 Describe those for me, what you
20 expect those cracks to look like. Give me
21 the material.
22 A I would say in the finer grain

1 material, they will be relatively fine
2 cracks, particularly in the cement-treated
3 soil. I don't know anything at this stage
4 about whether the material has any expansive
5 soil characteristics. I don't know that.
6 Based on the data that I've seen here. If
7 it were a highly expansive soil, it would, I
8 think, exhibit much more cracking than if it
9 weren't.
10 Does that answer your question?
11 Q Now, all I needed you to explain
12 for the record what expansive material is.
13 Then we will be okay.
14 A Well, expansive soils are those
15 that when unloaded and exposed to water,
16 increase their volume substantially. Then
17 when they're allowed to dry, they shrink
18 again.
19 Q So this is what will be materials
20 that will be prone to expansion and
21 contraction, depending on the moisture they
22 have at the time?

1 A The moisture, and the moisture
2 exposure. Expansive soils are very common
3 in the West and Southwest, some areas of the
4 United States.
5 Q Could you get a sense of how
6 expensive the soils are at a particular
7 location by looking at the Atterberg limits?
8 A You can get some idea, yes, when
9 the material has a high plasticity index.
10 Q But you haven't been really
11 looking at those test results? You didn't
12 focused on that at this point?
13 A I have not.
14 Q Do you have if PFS has conducted
15 tests on the soils so far that would
16 eliminate the issues as to how expensive the
17 soils are?
18 A I do not know if they have.
19 Q Tell me again. You were saying
20 that these cracks are likely to be fine.
21 What do you mean by fine? You're
22 talking about width of the crack?

1 A Width of the crack would perhaps
2 be, oh, say well less than a millimeter, or
3 something of that sort, sort of
4 hairline-type cracks, as opposed to open
5 joints.
6 Q I see. Are these going to be your
7 expectation of vertical cracks, or how would
8 the cracks run?
9 A They generally form more or less
10 vertically across the slab.
11 Q How deep do you expect them to be?
12 A I don't honestly know. This is a
13 rather thick section. So I don't know
14 whether they're going to go all the way
15 through to the bottom or not.
16 Q When you say thick section, which
17 particular soil cement are you talking
18 about?
19 A Well, two feet for a base course
20 is thick in a pavement structure. Five
21 feet, which is what we have between the
22 slabs, is correspondingly thicker.

1 Q I don't know if I called all the
2 dimensions.
3 How long would you expect them to
4 be?
5 A They could extend all the way
6 across the -- the pad, what is it, 30 some
7 feet wide?
8 Q I believe that's the case.
9 So they could run the length of
10 the crack?
11 A I think they could. I don't know
12 if they would.
13 Q Now, let me go to the next. We
14 may come back to cracks in a second. But
15 let's go down to subsection C-3-D-2 on
16 Exhibit 1.
17 That also talks about cracks, but
18 it talks about a different mechanism
19 potential cracking due to vehicle loads?
20 A Uh-huh.
21 Q Is that a concern that you expect
22 that you are going to be testifying about?

1 A I think that might depend on what
2 analysis of this has already been done, if
3 any, and how it's been done.
4 Again, some of this goes back to
5 my misunderstanding of the cross-section, as
6 well, that I talked about earlier this
7 morning. Where I was viewing that two-foot
8 thick layer as the sole support for the
9 cast, which was not a good assumption. Now
10 we're looking at more a typical pavement
11 section. It should be possible to analyze
12 what the tensile stresses will be at the
13 bottom of the cement-treated layer, and see
14 how they compare with the design values.
15 Q Do you know whether PFS has
16 performed any calculation to determine how
17 strong, if you will, would have to be the
18 surface material in which the vehicles would
19 travel in order to be able to withstand
20 those loads?
21 A I don't know if they have. It may
22 be somewhere there that I haven't been able

1 to see. I know they did -- they refer to a
2 finite element analysis that was done of
3 some section. There's a drawing cited. In
4 the documentation that I have, that drawing
5 is not there. So I don't know exactly what
6 they examined.
7 Q Have you studied the traffic
8 pattern on that side, what kind of vehicle
9 traffic you're going to have and so on, to
10 assess whether this is a serious concern or
11 not?
12 A No. I don't know. But I would
13 assume that sense the cast weight is 360
14 kips, that the transporter's got to be a
15 pretty hefty piece of equipment traveling on
16 five-foot thick layer. I don't know what
17 the analysis of that has shown.
18 Q Have you seen pictures of what
19 this transporter looks like?
20 A I have in passing, I think it was
21 yesterday, a very quick glance at something
22 as it went by as I was turning pages before

1 I had to leave to come here. So I don't
2 know the details of that.
3 Q Will the shaping, if you will, and
4 the nature of the wheel or the tire or
5 tire-like arrangement for the transporter
6 have a bearing on how much load it imposes?
7 A Yes.
8 Q So, for example, you have a very
9 wide surface contact between the transporter
10 and the surface below, the loading or the
11 pressure would you less; is that right?
12 A Generally, yes, yes.
13 Q You have really not looked into
14 that issue, or you haven't looked either how
15 many trips those transporters will be making
16 in the course of a typical month or year; is
17 that right?
18 A That's correct.
19 Q So as far as you are concerned,
20 this is something to watch out for; but you
21 have no direct indication that this will be
22 a problem at this site; is that correct?

1 A That's correct.

2 Q Let's take a look at the third

3 issue, which is potential cracking resulting

4 for freeze/thaw cycles.

5 Again, this is something you will

6 testify to at the hearing?

7 A I believe so.

8 Q What would be the concern here?

9 A The concern is that the material

10 around the cast transfer building will be

11 subjected to significant wet/dry,

12 freeze/thaw exposure, as will the material

13 between the pads themselves. The question

14 there is if it is not a properly designed

15 soil cement, we don't have assurance that

16 the durability will be sufficient.

17 Q So this potential cracking

18 mechanism applies only if you have not

19 provided a true soil cement; is that right?

20 A It could apply if it is not a true

21 soil cement.

22 Q Oh, could apply?

1 A Yeah.

2 Q But the converse: If it is a true

3 soil cement, it would not apply; is that

4 right?

5 A Experience seems to show that a

6 properly formulated and constructed soil

7 cement will have good durability.

8 Q Now, tell me about what

9 implications in terms of the performance of

10 the soil cement, do you envision potentially

11 happening as a result of these various

12 cracking mechanisms that we've been talking

13 about?

14 A If you have cracking and if it

15 extends through the soil cement, then you

16 have a path for water to gain access through

17 it to the subgrade soil, and depending on

18 their characteristics could adversely impact

19 the properties.

20 If you have cracks and you are

21 currenting on a certain minimal -- minimum

22 tensile strength at the base of the layer

1 and these cracks extends all the way
2 through, you're going to lose it. Because
3 the cracks cannot carry tension. That's the
4 issue there.
5 Q So those are your two concerns:
6 Water infiltration and loss --
7 A Loss of support.
8 Q Let me try the question again.
9 Water infiltration, and loss of
10 tensile strength?
11 A Yeah, water infiltration; and
12 potential adverse consequences in the
13 subgrade; and the loss of tensile strength,
14 which means the loss of coherence of the
15 whole slab. If you are counting on a slab
16 action, you wouldn't have it anymore.
17 Q Now, let's talk about the first
18 one, just to clarify.
19 When you say water infiltration,
20 you don't believe that that mechanism would
21 apply to the cement-treated soil underneath
22 the pad, do you?

1 A No. I don't think that would be a
2 serious issue there.
3 Q Because there's no way for the
4 water to get down to that level; is that
5 right?
6 A Unless the concrete slabs
7 themselves crack.
8 Q But you don't envision that that
9 would happen?
10 A I don't envision that.
11 Q So the concern would be, for
12 potential water infiltration, would be that
13 there would be for the soil cement that is
14 between the pads and the soil cement that is
15 around the canister transfer building, that
16 water might infiltrate through the cracks
17 into the soil cement surface; is that
18 correct?
19 A That is a concern, yes.
20 Q Well, with respect to moisture,
21 that is the concern?
22 A Yeah.

1 Q What would be the effect again be,
2 decreasing the strength of the soil cement
3 mixture, essentially?
4 A Well, no, I don't think it would
5 be the soil cement mixture. It would be the
6 subgrade material itself.
7 Q Oh, I'm sorry. I guess I
8 misunderstood you.
9 You're saying your concern is that
10 that moisture that would infiltrate through
11 the soil cement would eventually reach the
12 clays underneath?
13 A Yes.
14 Q The clays underneath would have
15 the same effect that we were discussing
16 before, with respect to moisture
17 accumulation?
18 A In the sense that it could lead to
19 a degrading of the properties of that
20 material. There is also, in the traffic
21 areas between the pads if you have moisture
22 there and you start getting a differential

1 movement between adjacent sections, then you
2 start what's called a pumping action, which
3 is a result of the water being squished
4 around if you were -- would, between
5 different areas, and softening the
6 subgrades.
7 Q I don't know if you can answer
8 this, but you will tell me in a second.
9 Are you aware whether in the PFS
10 design PFS is taking credit for the strength
11 of the soil cement between the pads as to
12 provide or assist in the seismic loads?
13 A I am not sure of the details here.
14 What I seem to remember is that they're
15 viewing sort of the whole thing going as a
16 unit, the pads and the material in between
17 as sorted of one sliding unit. But I might
18 be incorrect on that.
19 Q Is it your understanding that the
20 design that PFS intends to implement is one
21 in which there will be no sliding whatsoever
22 in an earthquake?

1 A My understanding is that this is
2 designed so that there will not be sliding.
3 Q So what you're referring to is a
4 case in which the assumption was made that
5 there was sliding?
6 A I'm not sure I understand.
7 Q Well, you said a moment ago that
8 in some material that you reviewed, there
9 was a discussion of the pad and the soil
10 cement underneath sliding as a whole. I
11 remember I heard you say that.
12 A Yeah.
13 Q So that is some analysis that
14 assumes that there was sliding; otherwise,
15 it wouldn't slide as a whole; is that right?
16 A I think the analysis was to show
17 that there was adequate resistance to
18 sliding. That was the basis of the design.
19 Q What I'm not understanding is that
20 if the assumption or the calculation is
21 based to demonstrate that there is no
22 sliding, then how does the sliding as a

1 whole play into the picture?

2 A They are assuming a certain

3 sliding resistance that must be developed to

4 prevent the sliding. If the forces causing

5 the sliding would become greater than that

6 design resistance, then it would slide.

7 Q I see. But the design intent and

8 the calculations are based on providing a

9 design that does not lead to sliding?

10 A That's correct.

11 Q Now, the second consequence that

12 you referred to was, if I understood it,

13 that the existence of cracks could reduce

14 the tensile strength of the soil cement

15 material; is that correct?

16 A Yes.

17 Q Now, is this a potential problem,

18 as you see it, both for the cement-treated

19 soil moisture underneath the pads, and for

20 the soil cement moisture around the canister

21 transfer building? Is it important for

22 both, or for only one of them?

1 A It would be more of a problem in
2 the slab areas where your supporting
3 structures or vehicle -- supporting vehicles
4 and casts -- vertical loads. It's my
5 understanding around the cast transfer
6 building is resistance against horizontal
7 loads. So that's different. It's not an
8 issue, from the tensile strength standpoint.
9 Q Is it your understanding that the
10 design that PFS is implementing for the
11 cement-treated soil underneath the pads uses
12 the strength of the soil cement to resist
13 compressive loads?
14 A Could you repeat the question?
15 Q Maybe we should perhaps have you
16 define for the record the difference between
17 compressive loads and tensive loads.
18 Could you do that?
19 A Yes. Compressive loads push from
20 both sides on the material. Tensile loads
21 pull on the material, or they result from
22 trying to bend it.

1 Q Now, with respect to the soil
2 cement that is placed underneath the slab on
3 the cast storage area, why are tensile loads
4 a concern?
5 A Tensile loads are a concern under
6 the casts because you have a loading from
7 the casts onto the slab and into the
8 cement-treated soil that produces bending
9 stresses at the bottom of the layer.
10 Q So is it your expectation that the
11 stresses would tend to bend the layer of
12 soil cement?
13 A There is that possibility.
14 Q So the concern is that those
15 stresses would result in the tendency to
16 bend the cement-treated soil layer? Is that
17 it?
18 A Yes. The whole system of the pad
19 itself and the treated soil beneath tends to
20 deflect downward. That causes a tensile
21 condition at the bottom of the layer.
22 Whether or not that is important depends on

1 the basis of the design for the support of
2 the whole system.
3 Q Have you reviewed the analysis
4 that PFS performed of the performance of
5 these cement-treated soil underneath the pad
6 with respect to the loads that would be
7 applied to such a pad to such soil in an
8 earthquake to determine what tensile loads
9 are computed to be a concern?
10 A I have not looked -- I have not
11 seen that analysis. I have not been
12 thinking of it relative to the earthquake.
13 I'm thinking of it more in terms of the
14 action of this structural layer beneath the
15 loadings that are coming from above. There
16 are two sources. One is the transporter
17 equipment. The other is the cast themselves
18 sitting on top of the slab.
19 Q So you're talking, essentially,
20 what will be non-earthquake conditions, in
21 terms of the loads that are imposed from
22 above by the very fact that you have a

1 transporter moving on top of the soil with a
2 heavy cast on top of it, and the very
3 presence of that cast over a period of time?
4 Is that what you're talking about?
5 A It is.
6 Q Those would be the conditions that
7 would impart the bending moments that you're
8 concerned about?
9 A Yes.
10 Q Do you know whether or not the
11 concrete pad upon which the cast sits help
12 in meting or resisting those loads?
13 A Very differently.
14 Q Have you looked at the structure
15 or design of the concrete pad upon which the
16 cast will sit? Have you reviewed that
17 design calculation?
18 A I have not.
19 Q Would you expect that the ability
20 to meet these loads would be one of the
21 elements that the organization that
22 performed the design of the concrete pad

1 would take into consideration of the design?
2 A I would certainly expect they
3 would or hope they would.
4 Q If they have done so, would that
5 pad provide significant resistance to
6 bending of the type that you're talking
7 about?
8 A It should.
9 MS. CURRAN: Excuse me one moment.
10 (Counsel conferred with witness)
11 BY MR. TRAVIESO-DIAZ:
12 Q Let me ask you a different
13 question.
14 Take for example the
15 cement-treated soil under the building,
16 under the cast -- would the presence of such
17 cracks, were they to exist, have any affect
18 on the ability of that soil to provide
19 resistance to horizontal motion in the event
20 of an earthquake?
21 A If they were large cracks, I
22 suppose that they could, in the sense that

1 there would have to be more deflexion before
2 you could mobilize the resistance to the
3 load, simply because of the gaps caused by
4 the cracks.
5 Q But you don't envision, based on
6 what you told me a moment ago, that these
7 cracks would be large cracks, in that sense,
8 do you?
9 A I do not envision that, no.
10 Q Now, with respect to again to now
11 talking about the canister transfer
12 building, would the existence of such crack,
13 where there to be such cracks, impede the
14 ability of the cement, the soil cement
15 around the building, from providing
16 resistance against the building sliding
17 horizontally?
18 A If the cracks would be wide, then
19 simply to close the space, you would have to
20 have some movements. It would be necessary
21 to close up any spaces before you could
22 mobilize the full resistance of the soil

1 cement to loads in a horizontal direction.
2 Q How wide do you anticipate the
3 cracks that would occur by these various
4 mechanisms that would apply to the canister
5 transfer building to be?
6 A I think we're talking probably
7 fractions of an inch. I don't know. I
8 don't have a good answer for that question.
9 Q Let me ask you this. Just to
10 describe the physical process for whoever
11 has the misfortune of reading this
12 transcript.
13 You are assuming that there will
14 be an earthquake; and because there is a gap
15 in the soil cement in front of the building,
16 the building will move a little until the
17 gap gets closed; is that right?
18 A Yes.
19 Q Then it would resist motion until
20 you hit another crack: Is that how you see
21 it happening.
22 How would it happen?

1 A I don't know what the phasing of
2 everything would be, because we're dealing
3 with traveling waves and all of that. If
4 there is a series of cracks, you can't begin
5 to resist anything until you close that
6 first gap that's right adjacent to the
7 building. Depending on how far it is to the
8 next crack, that may or may not be
9 sufficient to mobilize the full resistance
10 of the material that's around the building.
11 Q I take it that that's a problem
12 that needs to be analyzed and you don't know
13 how much of an impact you have on the
14 passive resistance of the soil cement, the
15 fact that it has cracks; is that correct?
16 A That's correct. You would need to
17 develop a zone that's probably going to have
18 to be 15 or 20 feet or away from the side of
19 the building before you can develop the full
20 resistance.
21 Q Let's turn to paragraph nine of
22 your declaration. Because I think that you

1 may deal somewhat with this issue. I just
2 want to see if I understand it.
3 A Okay.
4 Q As I understand this paragraph, it
5 relates precisely to the potential for the
6 canister transfer of sliding in an
7 earthquake.
8 Do you see that?
9 A Uh-huh.
10 Q Is that what you were focusing on?
11 A We were focusing on, yes.
12 Q Now, the first thing that you say,
13 which I don't believe that I understand
14 entirely, is in the middle of the paragraph.
15 You say, It does not appear that
16 the CTB will slide as a uniform unit.
17 Could you clarify for me what you
18 mean there?
19 A Well, the assumption here seems to
20 be that the building and the mat and
21 everything go all as rigid blocks. But
22 there is a flexibility to the structure.

1 There is a flexibility of the pavement.
2 We're dealing with seismic loadings that are
3 pulsed. Everything doesn't get hit in the
4 same way at the same time.
5 Q Let me see if I understand it.
6 When you say that the CTB will
7 slide as a uniformed unit, you're not
8 saying, are you, that different parts of the
9 building will move different to with respect
10 to each other?
11 A In a way I am saying that, that
12 there's going to be distortions. So this
13 point over here, let's say, will not
14 necessarily move exactly in phase with
15 another point that's a hundred feet away.
16 Because these are not rigid
17 structures. The loading is not exactly the
18 same at one point as it is at another point,
19 let's say a hundred feet away.
20 Q That's what I am trying to get a
21 picture of. Assume that you have a seismic
22 event which imparts forces on the canister

1 transfer building that will be, if you will,
2 horizontal and would tend to make the
3 building slide.
4 Is it your expectation that the
5 building will deform as such in the presence
6 of those forces so that one portion will
7 move at a different rate than another
8 portion of the building, assuming they're
9 sliding?
10 A Yes. I think that there will be
11 somewhat different movements at different
12 points. This is -- you know, this is not an
13 area that I'm any sort of a wiz bang in when
14 it comes to the dynamics and so on. This is
15 Dr. Ostadon. But to automatically assume a
16 rigid block movement, unless you can show
17 that the outer phase differences are very
18 small, may not totally describe what's
19 actually going to happen.
20 Q Let me ask you this other
21 question.
22 Are you aware, of course, that the

1 canister transfer building has a five-foot
2 reinforced concrete mat underneath it?
3 A I believe it does.
4 Q Would the presence of that mat
5 provide, if you will, such rigidity that
6 will prevent the building from performing
7 the way you are describing?
8 A It will certainly make that base
9 support unit a fairly solid block, yes. I
10 don't remember the planned dimensions of
11 that building at this point. Maybe somebody
12 can help me with that.
13 Q Would you believe, subject to
14 check, it's something like 240 feet
15 times 270 feet sometimes 100 feet tall. The
16 last time that I read it, it was at that.
17 Would that seem reasonable to you?
18 A That makes it, that slab, 40 to 50
19 times wider than it is thick. It's five
20 feet thick and, what did you say, 250 feet
21 in dimension.
22 Q What did you infer from that?

1 A Pardon.

2 Q What do you infer from the

3 relative sizes of the building and the --

4 A Well, we can perhaps uncouple the

5 building at this point. Because the concern

6 is stopping that five-foot thick base slab

7 from moving. The building above it may be

8 distorted significantly. That's a separate

9 issue.

10 But, geometrically, what we are

11 looking at is a plate, in a way, that is

12 being located -- loaded on its edges and

13 pushed. It is rather thin compared to its

14 planned dimensions. That's what I'm

15 thinking about. So it is subject to these

16 kinds of deformations, even though it is

17 five feet thick.

18 Q Do you know if that mat is also

19 reinforced with shear walls?

20 A I thought you were telling me that

21 it is a reinforced concrete mat that is five

22 feet thick.

1 Q I believe that's right. Maybe I
2 said two things that are inconsistent.
3 Well, I don't know how far I can carry the
4 question. But I understood also that there
5 are quite a number of shear walls of the
6 building that are connected to the mat.
7 Would that change your assessment?
8 A Now we're into the details of the
9 structural response. But my gut feeling is
10 that it would, in effect, stiffen the mat.
11 MS. CURRAN: Just go back for a
12 minute, Matias. Dr. Mitchell answered a
13 question by moving his hands. I thought we
14 might want to put some words on the record.
15 MR. TRAVIESO-DIAZ: Yes. That's a
16 very good observation.
17 BY MR. TRAVIESO-DIAZ:
18 Q What do you mean when you waived
19 your hands?
20 A Well, what I'm saying is that
21 because of the dimensions of the mat itself,
22 it's going to behave rather like a thin

1 plate on this foundation, which means that
2 it could distort and assume some sort of a
3 waive form itself. It's not going to be a
4 completely rigid plate. It's going to be a
5 flexible plate.
6 But then, as you pointed out, the
7 structure of the building and the shear
8 walls that are above it are going to connect
9 to the mat at various locations across it.
10 My response to that was, yes, that should
11 stiffen it and should reduce any of the
12 distortions that I was trying to describe by
13 the plate analogy.
14 Q Now, would it be fair to say -- so
15 that we can move to something else -- that,
16 sitting here today, you really don't know
17 because you haven't analyzed whether the
18 base mat of the canister transfer building
19 will behave as either rigid or flexible in
20 the presence of a earthquake? Would that be
21 a fair characterization with your current
22 state of knowledge?

1 A That's fair.

2 Q Now, you go on to say that for

3 flexible foundations that will experience

4 high levels of ground motion, a dynamic soil

5 structure interaction analysis is more

6 appropriate.

7 Do you know whether PFS has

8 conducted a soil structure interaction

9 analysis of the canister transfer building?

10 A I do not know.

11 Q If they had, would this

12 observation be no longer applicable?

13 A Well, that statement then would no

14 longer apply. Because they would have --

15 let's see. Dynamic soil structure

16 interaction analysis would have been made.

17 Now, I don't know what the results of it

18 might have been. But that would have been

19 made.

20 Q Well, I understand you cannot pass

21 on whether or not that analysis would be

22 good or bad or adequate, because you haven't

1 seen it.

2 But if they had done it, your

3 concern about not having it done would no

4 longer apply?

5 A That's correct.

6 Q Now, you're saying that the same

7 argument, the same concern that we have been

8 talking about for the last few minutes

9 applies to the cast storage pads, as well.

10 Could you explain to me the same

11 concern, if it's still valid, as it would

12 apply not to the building but to the pads

13 underneath the cast?

14 A Here, again, we have a plate on a

15 foundation. In this case, it's three feet

16 thick by 70 feet.

17 MR. TRUDEAU: 60.

18 THE WITNESS: Sixty to 70 feet

19 long. So it's 20 times longer than it is

20 think. So it can undergo some up-and-down

21 deformations.

22 BY MR. TRAVIESO-DIAZ:

1 Q Based on the same mechanism that
2 we were describing before?
3 A Yes.
4 Q Again, you have not yourself
5 analyzed those concrete pads to determine
6 whether they would be behave as rigid or
7 flexible bodies in an earthquake, have you?
8 A I have not.
9 Q So this is, again, initial concern
10 that would need to be looked at?
11 A Yes.
12 Q Let's look at paragraph number
13 ten, paragraph number ten in your
14 declaration. In there, you talk about
15 overturning of the canister transfer
16 building as if it's were a rigid body.
17 Do you see that?
18 It's in paragraph ten.
19 A I'm reading it.
20 Q When we're talking about
21 overturning, what do you mean?
22 A We're talking about the building

1 itself tipping over.

2 Q If in the presence of an

3 earthquake motion?

4 A Yes.

5 Q First of all, is this event or a

6 potential occurrence that PFS has analyzed?

7 A They have analyzed it assuming

8 that it was behaving as a rigid body.

9 Q When you say it was behaving as a

10 rigid body, are you talking about the

11 building or the foundation?

12 A I'm talking about the building, if

13 I've interpreted correctly.

14 Q So you saw an analysis which you

15 understood that it treated the canister

16 transfer building itself as if it were

17 rigid; and I take it that what it did is

18 computed the safety factor against sliding?

19 A No.

20 Q Against overturning?

21 A Against overturning.

22 Q Do you remember what safety factor

1 they came up with?

2 A No.

3 Q Subject to check, would you

4 believe like 20 percent?

5 A I'd be very, very concerned if it

6 was 20 percent.

7 Q You think its higher?

8 A Well, a safety factor of --

9 usually, we express a safety factor as some

10 number hopefully greater than one.

11 Q With "1" being -- so 1.2?

12 A 1.2?

13 Q Right.

14 A Under seismic loading is a

15 defensible safety factor, if the appropriate

16 condition has been analyzed.

17 Q Now, did you do yourself an

18 analysis to try to figure out how the

19 canister transfer building would behave from

20 the viewpoint of overturning resistance in

21 the event of an earthquake?

22 A I have not done my own analysis.

1 Q All right. Now, apart from the
2 fact that you believe the building to be
3 flexible in the event of an earthquake, is
4 there any other reason why you believe that
5 this building would, in fact, overturn in an
6 earthquake?
7 A I'm not sure I understand that
8 question.
9 Q You said the analysis, as you see
10 it, may incorrectly assume that the building
11 is rigid, whereas you think it will be
12 flexible or may be flexible in an
13 earthquake, and that you find that to be a
14 flaw with the overturning analysis; is that
15 right?
16 A Yes.
17 Q Now, in your evaluation, did you
18 conclude that it is, as a practical matter,
19 likely that this building would overturn in
20 an earthquake?
21 A No.
22 Q What we're talking about is a 98

1 million pound building.

2 It would take a lot of force to

3 make it overturn, right?

4 A I'm talking hypothetically.

5 Q Oh, I see. So what you're

6 referring to here is a flaw or a potential

7 flaw that you saw in the calculation?

8 A Not in the calculation, but in the

9 basic assumption.

10 Q But it doesn't translate, in your

11 mind, into a real concern that this building

12 is going to overturn in an earthquake, does

13 it?

14 A Not at this point.

15 Q I want to take you back again.

16 Because I think we didn't go through the

17 entire list. Go back to page 3 of

18 Exhibit 1.

19 A Okay.

20 Q I believe we were talking about

21 the first three items, the cracks and so on.

22 Would you take a look at item

1 four, and tell me whether the concern raised
2 in item four with respect to potential
3 interference with cement hydration resulting
4 from the presence of salt and sulfates in
5 the native soils is something we were
6 talking about at some length before?
7 A It is.
8 Q It's the same thing that is
9 referred to in paragraph 14 of your
10 declaration?
11 A No. It's --
12 Q I'm sorry. Paragraph 13.
13 A It's paragraph 13.
14 Q I understand. So it's the same
15 thing as in paragraph 13?
16 A Yes.
17 Q So then we can move to subsection
18 five, which is cracking and separation of
19 the cement-treated soil from the foundations
20 resultant from the differential immediate
21 and long-term sediment. Maybe we should
22 talk about this a little more.

1 Is this an area that you're going
2 to testify, potentially, at the hearing?
3 A No.
4 Q So you would expect that somebody
5 else would be talking about this?
6 A I think that's more than likely
7 what Steve Bartlett will be talking about.
8 Q In any event, we talked about
9 settlement somewhat earlier today, I
10 believe?
11 A I did a little bit.
12 Q Let's move then to item E.
13 Would you explain for the record
14 what the certain is with respect to item E
15 on page 3 of Exhibit 1?
16 A This relates to dynamic Youngs
17 modulus of the cement-treated soil. The
18 issue here, as I see it, is that the modulus
19 needs to be needs to be 75,000 PSI or less
20 to give a condition that will keep the
21 impact forces on the storage casts within
22 the allowable limit so that they don't

1 rupture if they tip over in an earthquake.
2 That's my understanding.
3 Could I ask you if what I said
4 there is correct?
5 Q Well, I believe that your
6 understanding is consistent with what is
7 says here in item E?
8 A Yeah.
9 Q Well, let me ask you this
10 question.
11 What portion of this concern do
12 you expect that you will be addressing?
13 A The modulus value for the soil
14 cement.
15 Q Well, let's talk about that. If I
16 understand it -- and correct me if you don't
17 share my understanding -- the 75,000 PSI
18 limit on the modulus was a number that was
19 developed in a calculation that Hotech
20 performed to determine how the cast would
21 behalf in the event it topped over or
22 dropped somehow?

1 A That's my understanding. I know
2 nothing of the calculation that they've
3 made. I've only seen the statement that the
4 modulus should be limited to that value
5 because of the dynamic impact forces if the
6 cast overturns.
7 Q So I take it then you're not going
8 to or prepared to address whether 75,000
9 value is a good or bad number; is that
10 right?
11 A From the dynamic analysis
12 standpoint, that's somebody else's issue.
13 From the standpoint of whether 75,000 PSI is
14 a good or bad number for soil cement, I
15 probably will make some comment.
16 Q That's what I want to get to.
17 A Yeah.
18 Q So your comment will be on the
19 extent to which it is achievable to create a
20 soil cement mixture that has a Youngs
21 modulus not in excess of 75,000 pounds?
22 A Yes.

1 Q What will your comments be on that
2 particular issue?
3 A Well, we have no data to
4 demonstrate what the modulus is at this
5 point. If the material is a soil cement, I
6 would be seriously concerned about whether
7 the modulus could ever be that low. That's
8 a very low value for soil cement.
9 But, also, as I think I understand
10 it now, the rules of the game have changed a
11 little bit since I first did this. The
12 material beneath the pads will not
13 necessarily be a soil cement. It will be a
14 cement-treated soil.
15 I think at this point it's a
16 question of: All right. For the cement
17 treatment that you're now going to use or
18 it's being proposed for use, will the
19 modulus be within that design limit? To
20 that question, I have no answer. Because I
21 don't see any data.
22 Q Let's talk about that question.

1 First, as a technical engineering
2 matter, is it within what is achievable,
3 given the state-of-the-art, to build a
4 cement-treated soil moisture will that have
5 a Youngs modulus of 75,000 PSI or less?
6 A I can only say it potentially is.
7 But it's going to be an issue of how much
8 cement for this soil and what placement
9 condition. Because the placement condition
10 can be tremendously important in determining
11 the strength and stiffness, as well as the
12 cement content. It's at the low end of
13 modulus values for this kind of a material,
14 where we just don't have much data.
15 I was looking at information on
16 this, and trying to see do we have good data
17 points down in that modulus range. That's
18 about where you go off the chart.
19 Q Now, assuming that, in fact, the
20 design intent is carried out to have
21 cement-treated soil with a strength of 40
22 PSI, do you believe that that's in the range

1 of values that, subject to proven by
2 testing, could yield a modulus of 70,000 PSI
3 or less?
4 A I think it is potentially
5 possible. I'm trying to remember a number.
6 I think it might be in that ACI report,
7 about modulus value is a function of cement
8 content for fine grain soils. It's way down
9 in the lower left corner.
10 Q How would you go, first of all,
11 about testing the soil, the cement-treated
12 soil mixture that you intend to use, to
13 determine whether it meets the upper bound
14 limitations of the Youngs modulus? What
15 kind of test would you expected that would
16 be performed?
17 A I think the -- I would test soil
18 from the site over a range of proposed
19 cement and water contents. I would have
20 specimens -- cured specimens, for which I
21 could determine both the strength and the
22 modulus.

1 There are different ways that you
2 can get the modulus: From strength test,
3 from some dynamic tests that are possible.
4 Then you simply -- you have to find a
5 condition that will give you this strength,
6 which is 40 PSI compressor strength; and for
7 those materials, what range of conditions
8 will give you a modulus that is less
9 than 75,000 PSI.
10 Q That would you determine through a
11 testing program under the lines that you
12 talked about?
13 A Testing program, yes.
14 Q Now, as to the second part --
15 which I thought that you mentioned as being
16 pretty important -- what do you mean by
17 placement conditions?
18 What is it that you would like to
19 see in order to assure yourself that even if
20 you have been able to through testing to
21 determine that you have a cement-treated
22 soil mix that emits a 75,000 PSI limit, what

1 do you need to do in the placement process
2 to assure that that's still achieved?
3 A Well, what I was referring to is
4 the preparation or compaction densities and
5 moisture contents that define the boundaries
6 below which or above which your strength and
7 your modulus are within the acceptable
8 range. Then having determined that, you
9 have to come up with a specification to be
10 used in the field to be sure that the
11 contractor achieves moisture density and
12 cement compositions that are in that range.
13 Q As to the testing for the modulus,
14 for the value of the modulus, in your review
15 of Mr. Trudeau's deposition, did you come
16 across any discussion as to whether PFS
17 intends to perform tests to confirm that a
18 particular given cement to the soil mixture
19 will meet the modulus bar limitation?
20 A I honestly don't remember on that
21 whether -- it may be there. But, again,
22 this is all very, very last minute. Because

1 I just received it a couple of days ago.

2 Q Let me ask you a different

3 question.

4 The steps that you mentioned with

5 respect to the placement process itself,

6 would that be the kind of thing that you

7 would expect would be developed in the

8 process of writing the construction

9 specifications what the actual builder of

10 this material could have to meet?

11 A Yes.

12 Q So then that would be something

13 that the design organization would issue to

14 the construction of an organization giving

15 them detailed instructions as to how you are

16 going to place, what moisture content you

17 have to maintain, and so forth; is that

18 right?

19 A That's correct.

20 MR. TRAVIESO-DIAZ: Can we stake a

21 short break again?

22 (Recess)

1 BY MR. TRAVIESO-DIAZ:

2 Q Let me cover a couple of things we

3 were talking about earlier, and ask you a

4 couple questions more.

5 First with respect to this

6 question that we have with respect to

7 rigidity of the canister transfer building

8 first, and then we talked about the labs

9 later.

10 You remember that?

11 A I do.

12 Q One point that I forgot to bring

13 up was the fact that these slabs are going

14 to have a number of very heavy casts sitting

15 on top of them; isn't that right?

16 A That's correct.

17 Q Would the presence of those casts

18 tend to increase the rigidity of the pads

19 beneath them?

20 A I don't think so.

21 Q Why not?

22 A They're free-standing casts that

1 will deform, will deform the pad. I don't
2 see them as an issue in the rigidity of the
3 pad as such, no.
4 Q So the rigidity of the pad, with
5 respect to the forces of the earthquake,
6 would not be affected either way by having
7 the casts sitting on them?
8 A The rigidity probably isn't going
9 to be affected. The response probably
10 would.
11 Q I asked the wrong question.
12 The response may be different
13 because of the fact that you have a rather
14 massive object sitting on the pads, as well?
15 A The inertial response would be
16 quite different.
17 Q Different in what respect?
18 A It's a much heavier mass now. But
19 I don't think I want to go there. That's
20 Farhang Ostadon's area.
21 Q That's fair enough. Go back for a
22 second to Exhibit 1 that you have in front

1 of you, and to subsection E that we are
2 talking about just before the last break, on
3 the Youngs modulus.
4 A Uh-huh.
5 Q Here's my question. Are you aware
6 that Stone & Webster has done some
7 calculations to try to correlate the design
8 of Youngs modulus of less than 75,000 pounds
9 per square foot to a soil cement strength,
10 if you will, that will achieve that limit.
11 Are you aware that such
12 calculations exist?
13 A Calculations that relate the
14 cement strength -- soil cement strength to
15 the modulus?
16 Q Correct.
17 A I'm not aware that they exist or
18 don't exist. But it seems a reasonable
19 thing to do.
20 Q Remembering that this 75,000 PSI
21 limit is imposed as a result of an event in
22 which it is assumed that the cast falls or

1 tips over and strikes the concrete pad and
2 then the force is transmitted underneath to
3 the soil, are you aware of what strain value
4 of the soil underneath the pads has been
5 calculated to take place in the event of the
6 tip over of the cast?
7 A No.
8 Q Again, since you haven't done the
9 representative calculation, and subject to
10 check, assuming that that calculation showed
11 that the strain on the soil underneath the
12 pad and the soil cement was on the order of
13 two percent, would you characterize that as
14 using the terminology that is used for such
15 strains a large strain?
16 A Two percent in the soil?
17 Q Yes.
18 A Not in the soil cement, but in the
19 soil?
20 Q In the soil.
21 A That's a reasonably large
22 deformation.

1 Q Let me give a hypothetical for
2 you.
3 Two percent in the soil cement, as
4 opposed to in the soil, would that still be
5 considered a reasonably large strain on the
6 soil cement?
7 A That, to me, is a large strain on
8 the soil cement, yes.
9 Q Now, for such a large strain,
10 would you expect that the applicable Youngs
11 modulus would be a static or in the range of
12 a static values or a dynamic, the Youngs
13 modulus?
14 A I'm not sure how to answer that
15 question because I'm not really sure of the
16 question.
17 This strain of two percent is
18 under the tip-over case?
19 Q Correct.
20 A So that is a large strain. In the
21 response of the cast, I don't know whether
22 you need a modulus at the instant of impact

1 where the strain is starting from zero, or
2 at the mid point or end of the deformation
3 process. I don't know about the dynamic
4 response of these casts and how fast things
5 happen. So you're into a series of
6 questions that I'm not sure I can answer.
7 Q Let me ask you just one.
8 Assume that the applicable moment
9 in which to compute the strain is that
10 moment in which the strain is the largest,
11 and that that largest strain is two percent?
12 MS. CHANCELLOR: Mat, I would just
13 like to interject an objection. Dr. Ostadon
14 has been put forward as a flow structure
15 interaction expert. Dr. Mitchell has
16 testified that he hasn't reviewed many of
17 these dynamic analyses-type questions that
18 you're asking. You keep on asking him these
19 hypothetical questions.
20 So I think we're straying a bit
21 far from what Dr. Mitchell has been put
22 forward as an expert on. I will let him

1 answer the questions. But they are
2 hypothetical questions. He has not been
3 presented as an expert in that dynamic
4 analysis area.
5 MR. TRAVIESO-DIAZ: Thank you,
6 Denise.
7 BY MR. TRAVIESO-DIAZ:
8 Q Dr. Mitchell, if you can answer,
9 assuming that it is the strain that is
10 applicable to the largest moment in which
11 strain is experienced by the soil cement,
12 would at that point you expect to have a two
13 percent deformation or strain correspond to
14 a static or to a dynamic Youngs modulus?
15 If you know the answer.
16 A That much strain is usually what
17 you would determine in a -- what we would
18 call a static test. But since you've posed
19 the question, I assume that this two percent
20 would be immediately below the point of
21 impact.
22 In the soil cement in all the

1 surrounding field, the strain will be
2 considerably less. So a comprehensive
3 response of all that would have to take all
4 that into account.
5 Q Fair enough. Let me ask you a
6 more general question. We have been talking
7 about the various issues that you have
8 identified in your declaration, and in
9 subsections C and D of Contention QQ,
10 subsection C and D of part C of Contention
11 QQ.
12 Would it be fair to characterize
13 your responses as indicating that many of
14 these issues are in the nature of things
15 that you would like to see proved through
16 testing, as opposed to being unachievable
17 technically?
18 A Yes.
19 MR. TRAVIESO-DIAZ: I have nothing
20 else.
21 MR. TURK: I may have none, or
22 very, very little.

1 EXAMINATION BY COUNSEL FOR USNRC

2 BY MR. TURK:

3 Q Good morning, Dr. Mitchell. My

4 name is Sherwin Turk. I'm an attorney with

5 the NRC staff. I don't have very much that

6 I want to ask you this morning. But I would

7 like to ask you a little bit about the use

8 of soil cement in other applications.

9 A All right.

10 Q You've referred to the placement

11 of soil cement as a means of soil or ground

12 improvement.

13 Can you describe the kinds of uses

14 that this has had in the construction

15 industry?

16 A The original and primary use of

17 soil cement was for pavement bases and sub

18 bases. It goes all the way back to the

19 early 1900s, I believe. From there, it grew

20 in use. Now it's widely used all over the

21 country, all over the world, as a means for

22 constructing strengthened bases for pavement

1 structures: For roads, for air fields, for
2 parking lots, for wherever you need a
3 pavement structure. So there's a great deal
4 of experience with that.
5 In the 1950s or so, they started
6 using a lot of soil cement or cement-treated
7 soil on hydraulic structures. They used it
8 for slope protection on dam faces or
9 reservoirs. They use it for canal linings,
10 that type of thing. Then it's gone from
11 there into structural fills in seismic
12 areas, and for construction of -- now we
13 find it used for -- well, it's a variation
14 on it, called roller-compacted concrete,
15 where they build dikes and dams. It's a
16 higher quality material, as a general rule.
17 The biggest the current excitement
18 in the use of cement mixed with soil is what
19 we call deep soil mixing, where -- actually
20 building columns and walls that extend down
21 as much as a hundred feet below the ground
22 surface where you're mixing the material in

1 large augers, making columns that are
2 typically a meter in diameter or so,
3 sometimes individual columns, sometimes
4 overlapping columns. So there's a
5 tremendous application that goes on there
6 now.
7 Q One of the uses that you mentioned
8 was as a structural fill in seismic areas?
9 A Uh-huh.
10 Q Where has that been done?
11 A It's been done -- I'm trying to
12 think in the U.S. The case I know best is
13 the one in South Africa, for the Coberg
14 nuclear power station, which was done in the
15 late '70s, early '80s, somewhere in there.
16 They removed and replaced a thick layer of
17 potentially liquefiable sand, saturated
18 loose sand. This was in a coastal area in
19 Cape Town. They took material out, mixed it
20 with cement, and put it back. Made a good
21 fill.
22 Q Can you think of any other

1 instances in which it's been used in order
2 to resist seismic forces or seismic loads?
3 A It's been -- the deep soil mixing
4 in particular has been used to construct
5 cells. Jackson Lake dam in Wyoming is a
6 good example. It's the first to be used in
7 the United States of a deep soil mixing,
8 where they treated the whole foundation of a
9 rebuilt Jackson Lake dam to withstand
10 earthquake loadings. It was used with good
11 success there. Well, whether it's good
12 success, we don't know. Because they
13 haven't had the earthquake.
14 But there are a number of
15 instances. In Kobe, in Japan, where they
16 had the big earthquake in 1995, January
17 of 1995, where they had used deep soil
18 mixing to develop improved ground. The
19 performance of that has been excellent, or
20 it was excellent in that earthquake.
21 Q What type of forces was it used to
22 resist there?

1 A The dynamic loadings, I think they
2 were as high as 1.5 g or something like that
3 there in Kobe. Ground shaking.
4 Q How was it used to deal with that
5 kind of a loading?
6 A It was used to reinforce and/or
7 contain potentially liquefiable zones of,
8 you know, saturated, loose sand-type
9 materials by building a barrier wall,
10 essentially, all around the foundations
11 of -- I think it was called the Oriental
12 Hotel there, that sits in the Kobe harbor.
13 It has had been used for support of
14 structures in several building around the
15 Kobe area that were all shaken by the
16 earthquake. The results were uniformly
17 good.
18 Q Would the use of the soil cement
19 in the cases in Japan be similar to the uses
20 being proposed here?
21 A Not really. Because the condition
22 here is one of a finer grain soil that's

1 not, as far as I know, susceptible to
2 liquefaction in the earthquake. It's being
3 used much more in the way originally used
4 for cement-treated soil for support of
5 structures like pavements.
6 Q For instance, you mentioned the
7 Kobe harbor; you were talking about the
8 harbor wall that was built?
9 A Yeah.
10 Q Was that an instance where they
11 were trying to prevent liquefaction of the
12 wall, or were they trying to resist the
13 seismic stress?
14 A No. They were trying to prevent
15 liquefaction of the loose sand material
16 which was in underneath the hotel building
17 itself, which as I recall was on pile
18 foundations in loose soil. They wanted to
19 prevented liquefaction of that sand that was
20 in that foundation area. They went all the
21 way around the building from the harbor
22 bottom down.

1 Q Are you aware of any instances in
2 which soil cement or cement-treated soil has
3 been used as an embedment or as a means of
4 providing compressional strength to assist a
5 building in resisting seismic loads?
6 A I'm not sure of the kind of system
7 you're envisioning here.
8 Q I'm picturing here the canister
9 transfer building with the soil cement being
10 placed around it.
11 A Oh, okay. I see what you're
12 saying. I don't know of any case of that
13 type. It doesn't mean that there hasn't
14 been any, but I don't know of any.
15 Q My last question about the
16 canister transfer building had to do with
17 placement of the soil around the building.
18 Has soil cement been used, to your
19 knowledge, to resist lateral loads?
20 A Yes. In the construction of walls
21 that you can construct using this deep soil
22 mixing technology. You're left then with

1 lateral loads on the wall itself. In fact,
2 I was involved with a test wall where they
3 did that a few years ago, and deliberately
4 built a wall and excavated everything away
5 in front of it. So there it was to support
6 the lateral loads.
7 Q Where was that project?
8 A That was down in Texas. It's on
9 the Texas A&M campus, or their test -- their
10 test site that they have there.
11 Q Was that a structure that they
12 built?
13 A It was a test program to
14 demonstrate a deep soil mixed wall
15 technology. Probably the biggest
16 application for a lateral load resistance is
17 in Boston, the Boston central artery
18 project.
19 Q The Boston?
20 A The Boston central artery project,
21 the big dig.
22 Q What does was done there?

1 A They used two kinds -- they did
2 shallow soil mixing and deep soil mixing.
3 They -- I think the shallow soil was to
4 provide a good working platform, and enables
5 the other structure to proceed more easily.
6 The deeper soil mixing was to provide open
7 excavation support.
8 Q Were these temporary placements or
9 this is a soil that was mixed with cement?
10 A With cement, by this deep soil
11 mixing process, with the large augers going
12 down from above and injecting the cement.
13 Q That was left in place after the
14 conclusion of the construction project?
15 A Yes. There's a project, if you're
16 interested, quite close at hand, going on
17 right now over here at the 95/Route 1
18 interchange by Alexandria for the new
19 Woodrow Wilson Bridge replacement structure.
20 They're doing a lot of deep soil mixing.
21 The contract is underway at the moment.
22 MR. TURK: I have nothing else.

1 Thank you.

2 MS. CURRAN: I think I have a lot

3 to go after the break.

4 MR. TRAVIESO-DIAZ: You got much?

5 MS. CURRAN: A little bit.

6 MR. TRAVIESO-DIAZ: How long

7 should we take for lunch? An hour? Half an

8 hour? So it is 1:25. Like 2:10?

9 (Whereupon, at 1:25 p.m., a

10 luncheon recess was taken.)

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1 A F T E R N O O N S E S S I O N

2 (2:12 p.m.)

3 Whereupon,

4 JAMES K. MITCHELL

5 was recalled as the witness and, having been

6 previously duly sworn, was examined and

7 testified further as follows:

8 EXAMINATION BY COUNSEL FOR THE STATE

9 OF UTAH

10 BY MS. CURRAN:

11 Q I have a few follow-up questions

12 for you, Dr. Mitchell.

13 I think at several points during

14 your deposition you said that it should be

15 possible to design the soil cement and the

16 cement-treated soil in a way that meets the

17 design specifications that PFS has, but that

18 you would like to see the results first.

19 You would like to see them now.

20 I wonder, could you explain your

21 reason for wanting to see them?

22 A Well, my reason is this. The

1 design as being predicated on certain
2 properties of the material that will be
3 obtained in the construction. It seems to
4 me to be good engineering procedure to find
5 out what kinds of mixes you're going to need
6 to prepare, to what density, to what water
7 content you're going to prepare them, to get
8 these properties, to show that you can get
9 the combination of strength and stiffness,
10 for example, that your design is based on.
11 Because if some unforeseen reason
12 at this point you don't get them, then
13 you're thrown back to square one relative to
14 your whole design. To me, it just is a
15 more -- it seems to me to be a more logical
16 and sounder procedure to be sure. When
17 you're dealing with a soil, it's not like
18 ordering a steel that has a certain minimum
19 yield strength, if you know the
20 manufacturers are going to produce for you.
21 Because all these soils are different. They
22 respond in different ways. You can't be

1 sure until you do it.

2 Q If you're trying to achieve one

3 particular design criteria, are there

4 trade-offs involved with respect to other

5 design criteria. For instance, I think we

6 heard that the amount of Portland cement

7 that you put into the soil cement mixture

8 that you may want to vary that to achieve

9 different goals. That they may be

10 conflicting goals.

11 Is that the case?

12 A There could be conflicting

13 responses in the sense -- for example, that

14 if you increase the cement content, it

15 probably will increase the stiffness and

16 vice versa. Here you're calling, in the

17 cement-treated zone are, for a certain

18 minimum strength and a certain maximum

19 modulus.

20 It's useful to know what range of

21 formulations, so to speak, you want to be in

22 to achieve that. It may mean that you have

1 to limit the density to be in a certain
2 range, the water content to be in a certain
3 range, for a given amount of cement.
4 Q So that when you see the test
5 results, they may not automatically give you
6 an answer as to what the composition of the
7 soil cement or the cement-treated soil may
8 be, there may be judgment involved there?
9 A I think, yes, you need to -- you
10 need to look at the range of properties that
11 you're getting over the full range of
12 compaction conditions that you're testing,
13 and then select from the information that
14 you have the range of values for density,
15 water, content, and cement, if those are
16 your variables, that you satisfy all the
17 conditions that need to be satisfied. That,
18 to me, serves as the basis for the design
19 specification.
20 Q Would you say that the selection
21 within those ranges of the values for the
22 different parameters is something that

1 requires considerable expertise?

2 A It requires a knowledge and

3 understanding I think of the properties, how

4 they vary with the different conditions, and

5 the ability to take all the data and look at

6 it in a coherent way so that you can get a

7 picture.

8 Q I think that you testified earlier

9 on the affect of changes in the moisture

10 content in the clay layer underlying the

11 cement-treated soil.

12 Could you just reprise for me what

13 your view is on the affect of increased

14 moisture on that clay?

15 A Yes. I think there was a question

16 about whether there would be increased

17 moisture. I was trying to describe how it

18 might develop because of the changed

19 pressure conditions and confinement and the

20 sealing off of the surface. As I recall, we

21 talked about settlement as being a potential

22 response that could be affected by it, and

1 was pointed out that one could do some
2 compression tests on fully saturated
3 materials and get some idea of whether that
4 would be a factor.
5 I think an additional question
6 that's come up with whether strength could
7 be influenced, as well. I think it's a
8 similar kind of answer, in terms of what to
9 do there.
10 That, of course, is to find out.
11 The way you could find out is to have
12 samples of that material that were then
13 given access to water under the stress
14 conditions that will exist after placement
15 of the cement-treated soil and the pad, and
16 let them come to equilibrium with water, and
17 then measure the strength.
18 Q So just to summarize, I'd like to
19 confirm that you believe that a potential
20 change in the moisture content in the clay
21 could lead to a change in the shear strength
22 of the clay?

1 A It could.

2 Q That should be tested?

3 A It's something that I think could

4 be quite easily determined in a testing

5 program.

6 Q I think you have looked here today

7 at some test procedures for testing whether

8 the soil cement and cement-treated soil

9 meets PFS's design requirements.

10 Do you have any additional

11 critiques of the procedures in addition to

12 items you've mentioned earlier?

13 A There is one aspect of the testing

14 that I think we want to look at and be sure

15 we understand. That relates to the

16 preparation of the tests that are going to

17 be used for the durability, for the

18 compaction, for the strength and all of

19 those things. It has to do with preparing

20 the samples in the first place.

21 What I don't remember is in the

22 prescribed ASTM procedures if it specifies

1 how you handle the soil as it comes from the
2 field, whether it says dry the material out,
3 pulverize it, and begin your test by adding
4 water and cement and so on, or whether it
5 requires that you not dry the material
6 before you measure these properties.
7 I think particularly with a finer
8 grain of soil like you have here, that can
9 be crucially important. Particularly, for
10 example, should it be that those lower
11 densities that were measured in the
12 laboratory tests were caused by
13 compositional issues as the soil itself.
14 For some of these soils, there can
15 be very significant differences, even in the
16 Atterberg limits, if you start from the
17 material in its wet state and never dry it
18 out, as comparing to drying it out and
19 reprocessing it.
20 Q So are you saying there is a
21 preferred method?
22 A Well, there is in my opinion.

1 That is never, if there's any risk of change
2 in properties, dry it out first. Take the
3 material as you will be dealing with it in
4 the field.
5 Because the way you will be
6 dealing with it in the field is going in
7 there and digging it up, and either mixing
8 it and perhaps adding a little water, or it
9 may be in this stuff, because it's fairly
10 wet, that you'll have to dry it some before
11 you start.
12 I don't know what these procedures
13 specify in that regard. But it's an
14 important issue.
15 MS. CURRAN: Denise, do you have
16 any questions?
17 MS. CHANCELLOR: No, Diane. I
18 have no follow-up questions. Thank you.
19 MS. CURRAN: That's the end of my
20 questions.
21 MR. TRAVIESO-DIAZ: I have a
22 couple, based on questions you were asked.

1 FURTHER EXAMINATION BY COUNSEL FOR
2 PRIVATE FUEL STORAGE
3 BY MR. TRAVIESO-DIAZ:
4 Q First, to clarify, I thought you
5 were asked whether the test results give you
6 no answer as to the composition of the soil
7 cement.
8 Do you remember that question and
9 that answer?
10 A I don't know specifically what
11 you're referring to.
12 Q Well, let me see if I can clarify
13 what I heard and what I think you meant.
14 Isn't it true that in the process
15 of trying to come up with a soil cement mix
16 that will meet the design requirements, the
17 typical procedure is to try various mixes of
18 various strengths and see which of them
19 meets the objectives?
20 A Yes.
21 Q So the percentage of cement on any
22 particular set of tests is a given; it's

1 something that you pick; is that correct?
2 A Well, you may wish to do a series
3 of tests with three percent cement in all
4 the samples, a series of five, or ten.
5 You're free to choose that, yes.
6 Q You do a range and when you find
7 one that meets your design requirement, you
8 proceed with that one and discard the
9 others; is that right?
10 A You can do that. Or you can take
11 all the results, when you've done these
12 series of tests, and look at them
13 collectively and find out what range of
14 cement contents, and what range of
15 densities, and what range of water contents
16 give you the satisfactory property.
17 Q Well, what I was trying to get to
18 is: Is it the normal procedure to try
19 varying mixes with varying cement contents,
20 and ultimately determine which is the one
21 that appears to work the best?
22 A Yes. Yes.

1 Q There is nothing unusual with
2 that?
3 A No.
4 Q You were asked also a series of
5 questions as to why it would be preferable
6 to perform the kind of tests we are talking
7 about at this point. I thought you said it
8 was good practice. It seemed to you to be a
9 good, practical thing to do.
10 Is that what you said.
11 A I think it's good.
12 Q I think I asked you this before,
13 earlier this morning. But let me just again
14 ask it to confirm.
15 Apart from the fact that you may
16 be wasting time if you have unsuccessful
17 results, is there any adverse consequence to
18 do them later as opposed to doing them
19 sooner?
20 A Well, if the tests are deferred
21 until later and if you're not able to get
22 what your design is based on, then you

1 either have to find another material that
2 will meet the design, or change the design.
3 Q So, essentially, you deferred then
4 your producing a risk that you may at the
5 end not be able to come up with something
6 that works; is that right?
7 A Seem to me to be the situation,
8 yes.
9 Q Now, you also were asked something
10 about weighing design criteria one against
11 the other. You may potentially conflicting
12 properties or characteristics that you want
13 to attain.
14 Do you remember that?
15 A Uh-huh.
16 Q Isn't that precisely what you're
17 doing with this problem, trying various
18 alternatives to figure out which is the one
19 that meets all the criteria?
20 A Yes.
21 Q That's normally the process,
22 again, by implementing a test program; isn't

1 that right?

2 A That's part of the reason. Well,

3 my answer there is you're doing it

4 certainly -- you're doing it probably for

5 several reasons: To find out the properties

6 that you're going to get, and whether they

7 satisfy the design criteria, and learning

8 how to optimize the influences of the

9 different variables in the system.

10 Here, there are at least three

11 variables for a given soil. There's

12 density, the water content, and the amount

13 of cement.

14 Q It will be a question to be

15 answered by the people designing the tests

16 how to play with those three variables until

17 you achieve a mix that is proved by test to

18 be adequate; is that right?

19 A Yes.

20 Q One last set of questions. When

21 you were talking about this test procedures

22 and activity for Exhibit 14, you said that

1 one important thing to consider when you're
2 doing the durability testing is what do I do
3 with the samples once I take them out of the
4 field. Do I do anything with them? Do I
5 dry them or whatever?
6 Is that what you're referring?
7 A You mean just now?
8 Q Yes. Just now.
9 A What I'm referring to is how you
10 process the samples that are taken in the
11 field for laboratory testing. My concern is
12 that they not be completely dried prior to
13 processing for the tests. Because that can
14 give permanent changes in the material.
15 Q Now, would you turn to the
16 Exhibit 14, which is the test procedure?
17 A I have it.
18 Q You remember you said you had not
19 reviewed the applicable standard that tells
20 you how to do it? Do you remember that,
21 recently?
22 A Right.

1 Q Would you look at the list of
2 standards on page 2?
3 A Yes.
4 Q Tell me, by looking at them,
5 whether the standard you were thinking about
6 is one of those that are referenced in this
7 procedure.
8 In other words, the standard that
9 will give you guidance as to what to do with
10 the sample, is that one standards listed
11 here?
12 A No. I think that each of these
13 procedures will begin with some statements
14 about how to process the samples. But I
15 have not looked at these recently. I can't
16 recall if they are specific as to whether
17 drying is allowed.
18 There are some ASTM procedures
19 that are simply silent on the issue. I
20 think there may be some that tell you either
21 dry it or not dry it. But I don't know in
22 this case.

1 Q Would a procedure that might give
2 you the answer be ASTM 558?
3 A It may. I don't know without
4 looking at it.
5 Q This test program is conducted,
6 among others, under ASTM 558; is that right?
7 A That's one of their tests in the
8 test program.
9 Q You don't know, as you sit here
10 today, what PFS intends to do in terms of
11 dealing with those samples once they take
12 them from the field; is that right?
13 A I don't know.
14 Q But your recommendation would be
15 that whatever they do, that they determine
16 whether they need to dry them or not before
17 they actually test for durability?
18 A That's correct.
19 MR. TRAVIESO-DIAZ: That's all I
20 have.
21 MS. CURRAN: I have another
22 follow-up question.

1 FURTHER EXAMINATION BY COUNSEL FOR
2 THE STATE OF UTAH
3 BY MS. CURRAN:
4 Q Dr. Mitchell, I think you just
5 mentioned three variabilities that are
6 involved in coming up with the optimum
7 formula for soil cement: Density, water
8 content, and amount of cement; is that
9 correct?
10 A I identified those as three
11 variables. There are others that could be
12 thrown into the pot, if anybody's
13 interested.
14 Q They're examples.
15 Would it also be fair to say that
16 in terms of criteria that one is striving to
17 meet with this mixture that there are
18 another three variables that would, at
19 least, include shear strength, elasticity,
20 and resistance to sulfates?
21 A No. Those are not variables.
22 Those are outcomes.

1 Q So if you are testing various
2 combinations of cement and soil, looking at
3 the three variables you mentioned and trying
4 to balance the three outcomes that I just
5 mentioned, is there one right answer?
6 MR. TURK: I don't understand the
7 question. The preface to that, I was
8 confused.
9 BY MS. CURRAN:
10 Q Did you understand the question?
11 A I think what she's asking is if we
12 are examining the influences for the sake of
13 argument of cement content, water content,
14 and density, is there one correct answer
15 that will come from that in terms of your
16 formula, if you wish, for the cement-treated
17 soil. The answer to that is no. There is
18 inevitably a range of values, which is a
19 good thing. Because you can never construct
20 exactly to a very closely defined set of
21 conditions from a laboratory result. You
22 can't do that in the field, as a general

1 rule.

2 Q Is it acceptable to pick any

3 number, any value within that range, or do

4 you strive to optimize the values for each

5 parameter?

6 MR. TURK: Again, I don't

7 understand.

8 MR. TRAVIESO-DIAZ: I object to

9 the form of the question.

10 MR. TURK: I think it's clear that

11 the PFS program has certain parameters that

12 they define as design requirements.

13 Are you asking whether that's a

14 range of items that PFS has identified, or

15 some other range may apply that they did not

16 identify?

17 MS. CURRAN: All right. I'll

18 rephrase the question.

19 BY MS. CURRAN:

20 Q I believe that you were asked

21 earlier that if a variety of formulas for

22 soil cement were tested, would you

1 ultimately hit on the right formula; is that
2 correct?
3 A Well, I think if you test a
4 variety of formulas or combinations, you
5 will hit upon an acceptable range within
6 which the material will have the properties
7 that you need.
8 For example -- maybe this will
9 help -- you might that if the water content
10 is between optimum water content and five
11 percentage points wet of optimum water
12 content and denser than some percentage of
13 the maximum density as indicated by the
14 test, then it will have properties that are
15 in the right range.
16 Q Can you foresee disagreeing with
17 PFS about the appropriate formula for soil
18 cement?
19 MR. TRAVIESO-DIAZ: Objection.
20 There's no foundation for what basis he
21 would disagree.
22 BY MS. CURRAN:

1 Q For example, you earlier I believe
2 testified that the soil in this case has an
3 unusual amount of water in it; is that
4 correct?
5 A No. I wouldn't say it's an
6 unusual amount of water. I just noted that
7 for the surficial soil in that climate, the
8 moisture content seems to be reasonably
9 high. It's twenty or thirty percent. It's
10 not a dried out, desert soil. It retains
11 some moisture from prior precipitation
12 episodes and so on.
13 Q If PFS proposed to make soil
14 cement by taking soil and Portland cement
15 and adding water, could you foresee
16 disagreeing with PFS as to whether that was
17 an appropriate formula for making soil
18 cement?
19 A I'm not sure that it would work
20 that way. You have to get a series of
21 samples that are within a range of certain
22 water contents either by drying or adding

1 water, depending on where the soil is in its
2 present state, to get within this suitable
3 range for compaction sample preparation.
4 That could require drying back from a
5 certain present water content or adding some
6 water and mixing it thoroughly.
7 If they follow the usual
8 acceptable practice and specified
9 procedures, I wouldn't see any basis for
10 disagreement.
11 MS. CURRAN: I don't have any more
12 questions.
13 MR. TRAVIESO-DIAZ: One last set
14 of questions, just to clarify.
15 FURTHER EXAMINATION BY COUNSEL FOR
16 PRIVATE FUEL STORAGE
17 BY MR. TRAVIESO-DIAZ:
18 Q Did I understand you correctly to
19 say that for any design requirement that may
20 be placed, such as for example strength,
21 there may be a range of combinations of
22 properties for the soil cement that would

1 give you that required property; is that
2 correct?
3 A That's correct, but -- let me say
4 if you vary one of these, though, you will
5 not vary only the strength, you will vary
6 also the stiffness or the permeability or
7 whatever property you're interested in. So
8 you have to be careful. You can't always or
9 ever do only one thing.
10 Q Assuming that you come up with a
11 combination that appeared to satisfy the
12 design requirements with respect to
13 strength, would you expect then that you
14 would proceed to test the other parameters
15 such as permeability based on that
16 combination, as opposed to others?
17 A That's one way to proceed, find
18 out if you've got something that will be
19 suitable from a strength the standpoint, and
20 then see if it satisfies other criteria.
21 But very often, with very little expenditure
22 of time and effort, you can get the other

1 properties at the same time.

2 Q So it's a question of how do you

3 design the series of tests, but not whether

4 you can do it; is that right?

5 A Yes.

6 MR. TRAVIESO-DIAZ: That's all.

7 Thank you. We are done.

8 (Whereupon at 2:40 p.m., the

9 deposition of JAMES K. MITCHELL

10 was adjourned.)

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CERTIFICATE OF NOTARY PUBLIC

COMMONWEALTH OF VIRGINIA

I, BARBARA A. HUBER, the officer before whom the foregoing deposition was taken, do hereby certify that the witness whose testimony appears in the foregoing deposition was duly sworn; that the foregoing transcript is true and accurate record of the testimony given by said witness.

I further certify that I am not related to any of the parties to this action by blood or marriage and I am in no way interested in the outcome of this matter.

Barbara A. Huber

My Commission Expires:

May 31, 2005