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NUCLEAR REGULATORY COMMISSION

Title: Private Fuel Storage, LLC

Docket Number: 72-22-ISFSI; ASLBP No. 97-732-02-ISFSI

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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

U. S. Nuclear Regulatory Commission
Sheraton Hotel, Wasatch Room
Salt Lake City, Utah 84114

On June 6, 2002 the above-entitled matter came on for hearing, pursuant to notice, before:

MICHAEL C. FARRAR, CHAIRMAN
Administrative Judge
Atomic Safety & Licensing Board Panel

DR. JERRY R. KLINE
Administrative Judge
Atomic Safety & Licensing Board Panel

DR. PETER S. LAM
Administrative Judge
Atomic Safety & Licensing Board Panel

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I N D E X

E X A M I N A T I O N

E X H I B I T S

June 6, 2002 9:05 a.m.

P R O C E E D I N G S

JUDGE FARRAR: Good morning, everyone. We have a couple of preliminary matters before we get started. First, we had talked some time ago about Friday, June 21st cashing in my one scheduling check to attend my friend's 60th birthday and wedding in Philadelphia. Rather than have Judge Bollwerk sit in for me, I think what we'd like to do is go from eight to two that day, on Friday, the 21st, and then Judge Bollwerk has contacted us and said he would like to do an EIE demonstration at two o'clock.

MR. GAUKLER: Talking about Friday, the 21st?

JUDGE FARRAR: Yeah.

MR. GAUKLER: We had hoped to be done that week by that time, so it wouldn't impinge at all on your Honor's schedule.

JUDGE FARRAR: Thank you.

MS. CHANCELLOR: We were trying to finish by Thursday.

JUDGE FARRAR: Okay, great. I thought

this -- Judge Bollwerk was trying to make sure we didn't lose time there. But then I will tell him that may not work and he'll have to wait and see. So then that would be a long weekend for everybody. Good.

MS. CHANCELLOR: We're still talking about when we're going to start the following week, because from the State's travel it would make a difference if we came in the middle of the week to be able to come back to Salt Lake. But we'll talk about that.

JUDGE FARRAR: Okay, we're at your disposal. But the aircraft is certain on the 1st, 2nd and 3rd?

MR. GAUKLER: Yes, your Honor.

JUDGE FARRAR: Last night we had a lengthy discussion after the record closed about the logistical and security arrangements. Mr. Gaukler, you told me you've contacted Mr. Silberg, and even in his vast experience he's not had a hearing there. So what struck me in terms of working with our security and logistics people is a good analogy would have been the state capitol. Mr. Gaukler, how -- if I recall, you all had a room there?

MR. GAUKLER: We had a separate room which was arranged by I guess Parsons, Behle, our local law firm, with the state.

JUDGE FARRAR: And you brought a copier in?

MR. GAUKLER: We brought a copier in.

JUDGE FARRAR: Rented it, or --

MR. GAUKLER: We rented a copier, I believe, and brought in a printer. So we had the capability right there to copy and print as need be. And it was right next door, so it was very handy.

JUDGE FARRAR: Okay. We're working on the security issues. As I told you, you each have a breakout room, and my colleagues are -- not my colleagues here but my colleagues back home were of the impression that it's bigger than I recall, though I've never spent any time in them, and there certainly would be room for computers and printers. The issue we're wrestling with is access to a large enough copier.

Let me ask you all, in the last few days as we've done rebuttal there have been a lot of extra documents that you suddenly pull out. Mr. Soper had some that he used to cross-examine

the witness. Could you have those ready the night before?

MS. CHANCELLOR: No, not always. Frequently it's, could somebody please go down to the room and make 12 copies immediately.

JUDGE FARRAR: And in a short case or when you're on your direct case, just my observations are you're able to plan a lot better. When we get into the rebuttal it's a lot more shooting from the hip. Well, we'll keep working on our end, and if you go with making it, if not ideal, at least very workable. If anybody has any bright ideas, let us know.

Any other preliminary matters? All right, then, Dr. Arabasz.

THE WITNESS: Good morning, Judge Farrar.

JUDGE FARRAR: Good morning. You're still under oath, consider yourself that way.

THE WITNESS: Yes, I do.

JUDGE FARRAR: And Ms. Chancellor, I believe you were going to proceed.

MS. CHANCELLOR: That's correct.

REDIRECT EXAMINATION (Continued)

BY MS. CHANCELLOR:

Q. Good morning, Dr. Arabasz.

A. Good morning, Ms. Chancellor.

Q. Would you please place in front of you State's Exhibit 207 and State's Exhibit 208. 207 is DOE Standard 1020-2002, and I handed this out yesterday, and the second document is Risk Reduction Ratio Mean Return Period of Design-Basis Earthquake, et cetera. Do you have those two documents?

A. Yes, I do.

MR. TURK: Your Honor, before we have examination on this, I'd like to note that I would object to the introduction of State Exhibit 207. It's a matter that's already in evidence. This is a page from the 2002 DOE standard that the Staff introduced in greater detail, more pages yesterday. I don't have any problem with examination on the Staff's exhibit, but I don't see why we need to introduce the same matter more than once. I have no problem if the State wants to examine based on the Staff's exhibit.

MS. CHANCELLOR: I'd just like to comment, your Honor, in an effort to expedite this,

I did note when I identified these exhibits that this was duplicative of the Staff's exhibit, and I'll go forward and examine Dr. Arabasz on State's Exhibit 207. Whether it's introduced or not is a different matter.

MR. TURK: Well, I have an objection, your Honor.

JUDGE FARRAR: But you can't have an objection to her asking questions about it. You may have an objection if she tries to introduce it.

MR. TURK: Well, after she's done asking the questions she'll move to introduce it based on the fact that she's conducted questioning on it. And I would suggest that instead she state simply take Staff Exhibit QQ and examine on the same page.

MS. CHANCELLOR: I'm pleased to know that Mr. Turk knows what I'm going to do, your Honor.

MR. TURK: I will note my objection, your Honor, and I will strongly voice it again if she tries to introduce the exhibit.

JUDGE FARRAR: Let's do this, Mr. Turk. You had lengthy cross-examination of Dr. Arabasz, and while what you say has some merit, I'm reluctant at the very outset to tell the State how

to handle its case. We'll bear your concerns in mind and deal with them appropriately.

Go ahead, Ms. Chancellor.

MS. CHANCELLOR: Thank you, your Honor.

Q. (By Ms. Chancellor) Dr. Arabasz, would you please turn to State's 207, which is a cover page of DOE Standard 1020-2002, and turn to the second page of that exhibit, C-6. In your testimony, Dr. Arabasz, we have attached to it State's Exhibit 128, which is Table C-3 from DOE Standard 1020-2001, correct?

A. I don't find it under 128.

Q. Okay. I can't read my writing. Just a second.

A. Under --

Q. 126.

A. -- 126 I find it.

Q. Yes. The document in front of you, State's Exhibit 207, is that an update of Table C-3 in State's Exhibit 126?

A. Yes, it is, Ms. Chancellor.

Q. Could you please describe Table C-3 with respect to Performance Category 3?

A. Yes. And you allowed me to have in front of me also State's Exhibit 208 at the same

time?

Q. That's correct.

A. Which provides that a useful visual reference, just to understand the terms and also the relationships between probabilities and their inverse.

On State's Exhibit 208 there are terms that appear in the DOE Standard 1020 Table C-3: a term risk reduction R sub capital R, which is identified as the risk reduction ratio; a term capital P sub capital H, the seismic hazard exceedance probability, and this has also been referred to during the hearings as the MAPE, the Mean Annual Probabilities of Exceedance of the design-basis earthquake ground motions. And for understanding the inverse of the MAPE or the inverse of the term P sub H is the mean return period.

The third term, capital P sub capital F, is the target seismic performance goal, meaning the annual probability of exceeding acceptable behavior limits.

And there's a basic equation that's taken from DOE Standard 1020-2002 at page C-5 where a relationship between R sub R is described, the

equation being R sub R equals P sub H, the hazard probability, over P sub F, the failure probability. So that in the example table at the bottom of State Exhibit 208, for a probability of failure P sub F of 1 times 10 to the minus 4, which is the probability of failure for PC-3, then one can enter the table and see the relationships.

For example, in the third column, note that the probability of failure is entered as 1 times 10 to the minus 4 for all cases. So that if one has a P sub H of 1 times 10 to the minus 4, reading from the second column in the table, one sees as a convenient reference, looking to the left, that its inverse is a 10,000-year return period ground motion. And if one begins with stipulating a P sub F of 1 times 10 to the minus 4, if one sets P sub H at 1 times 10 to the minus 4, then the risk reduction ratio, R sub R, required to achieve that P sub F is 1.

Going to the bottom of the table, if the P sub H is 5 times 10 to the minus 4, in other words, a 2,000-year return period ground motion, to meet that performance goal a risk reduction ratio of 5 is required. And the risk reduction ratio can be viewed as the conservatisms that are achieved on

the design side in the design or evaluation procedures and the acceptance criteria.

I'm moving now to Table C-3 appearing identically in State's Exhibit 207, or, as Mr. Turk noted, the Staff Exhibit QQ, I believe. And I discussed with Mr. Turk yesterday the change in the row for Performance Category 3 where the target seismic performance goal remains the same, 1 times 10 to the minus 4, but for the term P sub H the seismic hazard exceedance probability in the most recent version of DOE Standard 1020, namely, version 2002, the hazard exceedance probability has been changed. Formerly it was 5 times 10 to the minus 4, a 2,000-year return period, now it is 4 times 10 to the minus 4. And the risk reduction ratio to achieve that performance goal would be 4.

Now, at least for me personally, as I navigate through this regulatory maze, this is of particular interest to me in that in searching for a fixed R, a fixed reference point, I think I see some fly paper here that, for example, if one had formerly a 2,000-year return period and wanted to reference the updated DOE standard 2002 and be consistent, in other words, if one stayed pinned to 2,000 years where DOE Standard 1020 had moved on to

a 2,500-year P sub H, one could only do that and be consistent if one accepted that performance goal of 1 times 10 to the minus 4.

And this now begins, at least for me, to give some glimmer of a fixed reference point, whereas before, this performance goal had not been acknowledged. I think here we're beginning to see a logic that says if one is to use the DOE Standard 1020 as a reference point, that one logically needs to accept that probability of failure.

Q. And Dr. Arabasz, did you prepare State's Exhibit 208, the risk reduction ratio, the document you had in front of you?

A. Yes, I did, Ms. Chancellor.

Q. And is the formula the same as appears in Staff's Exhibit QQ on page C-5, which is from DOE Standard 1020-2002, the R sub R equals P sub H over P sub F?

A. That's correct.

Q. And the definitions, do they come from DOE Standard 1020?

A. Yes, they did.

Q. And State's Exhibit 207, which has Table C-3, is that the same as on Staff's Exhibit QQ at page C-6? Is that identical?

A. By my inspection it appears to be identical, yes.

MS. CHANCELLOR: Your Honor, I would move for admission of State's Exhibit 208.

JUDGE FARRAR: Any objection, Mr. Gaukler?

MR. GAUKLER: No objection.

JUDGE FARRAR: Mr. Turk?

MR. TURK: No objection.

JUDGE FARRAR: Then 208 will be admitted.

(STATE'S EXHIBIT 208 WAS ADMITTED.)

Q. (By Ms. Chancellor) Dr. Arabasz, if you would now turn to State's Exhibit 202, and 202 is the Yucca Mountain Topical Report YMP/TR-003-NP, August 1997. And it refers -- the second page and last page of that exhibit is Table C-2. Dr. Arabasz, is Table C-2 the survey of nuclear power plants in the western United States on which there has been considerable testimony?

A. Specifically it's a summary of composite mean exceedance probabilities for nuclear power plants in the western United States, and the result for that -- for this sample of five nuclear power plants, the mean of these mean exceedance

probabilities is greater than 2 times 10 to the minus 4, which, from my cheat sheet on State Exhibit 208, I can readily see that that corresponds to a 5,000-year return period ground motion.

MS. CHANCELLOR: Your Honor, we've had considerable testimony about this table. It has not yet been introduced. I would move for introduction of State's 202.

JUDGE FARRAR: Any objection?

MR. GAUKLER: No objection, your Honor.

JUDGE FARRAR: Mr. Turk?

MR. TURK: Your Honor, I don't object. It may be that we want to introduce more portions of that report, but I don't object to the introduction of this page subject to that qualification.

JUDGE FARRAR: Right, and you'll have that option. Then State 202 will be admitted.

(STATE'S EXHIBIT 202 WAS ADMITTED.)

MS. CHANCELLOR: Ms. Nakahara is going to hand out two documents. One is a copy of a transcript, transcript pages from May 13 and May 17. Second document is taken from Staff's Exhibit JJ, and it is from Dr. Stamatakos's notebook,

comparison of western U.S. hazard curves. I'll be asking him some questions about this.

JUDGE FARRAR: These are just courtesy copies?

JUDGE FARRAR: These are just courtesy copies, that's correct, your Honor.

MR. TURK: Your Honor, while this paper is being passed out, may I note that the State Exhibit 202 is a page from Appendix C to Topical Report YMP/TR-003. That appendix discusses each of the various plants mentioned in the table, and perhaps during the next break I can talk with the other counsel about whether we should just introduce the entire appendix. I'm sorry to interrupt.

JUDGE FARRAR: That's all right.

Q. (By Ms. Chancellor) Dr. Arabasz, you were here for Dr. McCann's testimony on May 13, correct?

A. Correct.

Q. On transcript page 8326, Dr. McCann testifies that on line -- beginning on line 8 that a 5,000-year mean return period is not --

A. Are you paraphrasing this, Ms. Chancellor?

Q. Yes, I'm paraphrasing. Is not reasonable either because that would be equivalent to the design basis for a nuclear power plant in the west; and Dr. McCann goes on to say that the Staff bracketed the return periods between 5,000 and 1,000 years. Is that your understanding of this portion of Dr. McCann's testimony?

A. It is.

Q. And then in your testimony --

MR. TURK: I'm sorry. Did you say the Staff bracketed between 5,000 and 1,000?

MS. CHANCELLOR: That's what Dr. McCann testified to.

Q. (By Ms. Chancellor) Now, in determining whether to grant the 2,000 years, Dr. McCann testified that they looked at the upper range of 5,000. Dr. Arabasz, could you explain what your understanding of Dr. McCann's testimony is on page 8326?

A. That what Dr. McCann is offering, in my understanding, was a rationale for justifying the 2,000 years with respect to two end points: a 1,000-year ground motion which the Staff had earlier rejected because there did not appear to be sufficient regulatory or technical basis for

accepting it, and on the upper end, a reference probability for a nuclear power plant.

And he states -- I'm reading beginning on line 12 of page 8326, "And in our consideration we now need to be away from 5,000 years and considerably away from 1,000 years." And he goes on to explain -- well, let me just continue reading. Perhaps that's easiest.

Continuing on line 14, "And if you begin to look at that, 10 percent, 20 percent not being much of a difference at all, factors of one and a half to two being a reasonable change in probability of exceedance, so being a factor of two away from 10 to the minus 3 brings us to 5 times 10 to the minus 4, and being a factor of two away from 2 times 10 to the minus 4 brings us 4 times 10 to the minus 4, and thus we concluded that 2,000 years was appropriate."

And I guess I'm cursed or blessed, depending on point of view, with needing to sort of see the big picture. And to my understanding coming into this hearing, I was aware, for example, of an item that the Applicant had outlined as one of its key determinations for Section E. And it's in item 5 and it reads, "The average mean safe

shutdown earthquake ('SSE') for a typical NPP of approximately 1 times 10 to the minus 4 is the appropriate NPP benchmark on which to determine the higher probability of seismic failure allowed for ISFSIs." And I was also aware that fairly consistently its rationale put forward for justifying the 2,000-year return period that the Staff in the various versions of the SER had basically said that the design-basis motion for an ISFSI relative to a nuclear power plant could be less than 1 times 10 to the minus 4.

And I was also aware -- excuse me. As documented in Staff Exhibit S, and this is SECY-98-071, where on the second page of the document, which is a, I assume a memorandum or a letter from L. Joseph Callan to the Commission dated April 8th, 1998 regarding the TMI-2 ISFSI exemption, on the second page of Staff Exhibit S in the bottom-most paragraph and in the middle of the paragraph there's text that states, "Based on 10 CFR 100.23 requirements as described in Regulatory Guide 1.165, 'identification and characterization of seismic sources and determination of safe shutdown earthquake ground motion,' a future nuclear power plant in the western United States

can use as a safe shutdown earthquake the 10,000-year return period mean ground motion."

And given this context, this is where the reference point for the nuclear power plant appeared to be an important element of consideration before the Board.

Q. And you testified on May 17 that you thought that the Staff were on shaky ground if they associated a 5,000-year with a design-basis earthquake for a nuclear power plant that may be sited in the -- certainly the Intermountain Area of the western United States; is that correct?

A. That was my opinion and it is still my opinion.

Q. And that appears in the transcript at 9116 -- 9169. With that in mind, Dr. Arabasz, where the 5,000-year mean annual probability of exceedance should be defined, maybe we can do a tour of some nuclear power plant sites. Is it your -- could you explain once again the epiphany you had with plate boundaries, just so that we can frame the issue?

A. The awareness I came to was that when faced with Table C-2, which had been compiled by the Department of Energy here, and this is in

State's Exhibit 202, and produced in an appendix, in Appendix C of Yucca Mountain Topical Report 2, the Department of Energy at the time was attempting to justify a design-basis motion of 1 times 10 to the minus 4 at Yucca Mountain, in effect equating it to the reference probability for a nuclear power plant. And they looked at information available to them for five nuclear power plants identified in Table C-2, and that information led them to determining a composite mean exceedance probability where it says the probability of exceeding the design-basis motions or the design-basis response spectrum for those plants, the average of the exceedance probability at spectral ordinants 5 Hz and 10 Hz, and then taking the arithmetic average with the result that for these existing plants in the United States -- excuse me -- in the, quote, western United States, end quote, those quotes are mine, the bottom line, the mean exceedance probability was greater than 2 times 10 to the minus 4, or let's say on the order of a 5,000-year return period.

Q. And was it your testimony that there is a dearth of information for sites in the non-coastal areas of the western United States?

A. Correct. And as I explained relating to the use of my word "epiphany" was that we had a sample of nuclear power plants, at least three of which, in my mind, clearly were along the western coast of the United States or in an area where under the DOE framework they would be identified as -- see if I can remember the wording -- near a tectonic plate boundary. And then I recognized that the Palo Verde plant west of Phoenix in Arizona was away from the plate boundary, and we had heard earlier in testimony that its return period or its exceedance probability of 3.8 times 10 to the minus 5 per year corresponded to something in the order of a 26,000-year ground motion, making that particular plant an outlier.

I then made a generalization about the remaining plants appearing to be influenced by their proximity to the plate boundary. We went through a long walk-about through the western United States with Mr. Turk, and what he correctly prodded me to was to examine Washington Nuclear Plant 2 and whether that in fact was near a plate boundary. And on further reflection, or actually an awareness which had escaped me before, that the Washington Nuclear Plant 2, which was sited on the

Hanford reservation, a major DOE facility, was away from the plate boundary.

Q. And in State's Exhibits 203 through 206, did you use these -- this information to try and fill in some of the gaps with respect to information in the non-coastal areas of the western United States?

A. Correct. And in my examination by Mr. Gaukler, for example, I was asked to estimate whether the reference probabilities should be approximately 1 times 10 to the minus 4. And in that context, if I remember correctly, or in replying to Mr. Turk, I explained at some point that I had information from coastal western United States, I had information from the central and eastern United States, and what was missing was information elsewhere eastward of the plate boundary and into the intermountain area.

Q. Let's turn to State's Exhibit 203, which is the cover page Basis for Seismic Provisions of DOE Standard 1020 prepared by Kennedy and Short in April of 1994. And the second page which goes to the last page of the exhibit, No. A, page No. A-4 has a Table A-2, and then there's some annotations at the bottom of Table A-2. Dr. Arabasz, did you

prepare the annotations on this table?

A. I did, Ms. Chancellor.

Q. And I don't know whether it would be preferable for you to describe A-2 first and then describe the annotations. I'll let you choose which way to -- which would be easier to describe that.

A. I'm pausing for a moment to refer to the source, a report prepared by Robert C. Kennedy and Stephen A. Short which is referenced in DOE Standard 1020-2002 and earlier versions. The report is titled "Basis for Seismic Provisions of DOE-STD-1020."

Q. Maybe just to start with, Dr. Arabasz, could you tell us in general, what is Table A-2? Can you give us an overview of this table?

A. Yes. It gives an overview of the slopes of seismic hazard curves and how they vary across the country. And I just wanted to be able to state more -- I wanted to be able to state precisely what the term A sub R means or how it's defined. And I'm reading from page 2-1 in the Kennedy and Short paper. And there is an equation 4 which reads, "K sub H equals 1 over log (A sub R)." And to guide the Board, let's consider the hazard curves -- is

this Staff's Exhibit JJ? Is that correct?

Q. Yes. It's a page from Dr. Stamatakos's notebook, comparison of western U.S. hazard curves. And yes, it was Staff's Exhibit JJ.

A. The first thing to observe on the graph of hazard curves is the Y axis is logarithmic and the X axis is normal. So that when we view a hazard curve in this form, generally we're looking at a ski slope kind of configuration. Most of it the curves concave up with the exception for the San Francisco Bay Bridge.

And the term "A sub R," now I'll return to Kennedy and Short, page 2-1 beginning right after the equation 4, again K sub H equals 1 over log A sub R. It reads, "In which A sub R is the ratio of ground motions corresponding to a tenfold reduction in exceedance probability." And one recognizes in looking at a hazard curve such as displayed on Staff's Exhibit JJ that the slope of the hazard curve changes depending on the probability interval that one's examining. And in the Table A-2 in Kennedy and Short there's a term A5/A4, and what that is is a ratio of the ground motions corresponding to a change from 10 to the minus 5 to 10 to the minus 4. So that if one

measured the ratio of the change in ground motions over that interval, in Kennedy and Short format it would be designated A5/A4.

And this part of the hazard curve, this particular slope would be relevant to looking at PC 4 facilities or where one is looking at a factor of safety beginning at 10 times -- excuse me -- 1 times 10 to the minus 4 where in effect you're standing on the ski slope at the point of 10 to the minus 4 and you know that you want to go down slope to consider a margin of safety, and so the appropriate part of the slope to be referring to is this A5/A4 slope.

Correspondingly, if one measured the ratio between 10 to the minus 3 and 10 to the minus 4, you'd end up with a measurement that would be designated A4/A3, and this would be appropriate if you were considering the slope of a hazard curve for PC 3 where now you're standing on the ski slope at 1 times 10 to the minus 3, you know that you want to go down the ski slope to the right, and the part of the slope that you're concerned with is the interval between 10 to the minus 3 and 10 to the minus 4.

Q. That's very helpful. Thank you,

Dr. Arabasz. And with respect to the annotations --

JUDGE FARRAR: Ms. Chancellor, let me interrupt. It's very helpful, but I'm missing one piece. I think I understand everything you just said, but what does the ratio represent? I mean, I understand it represents a change in the slope, but what -- and there are no units to the number, but take the top number there, 2.26. Is that transformed into the slope of the line at that point? Or are we doing, comparing these ratios, that the ratios only mean something in relation to each other? Or ask -- or if I'm not asking the right question, ask the right question and give me the answer.

THE WITNESS: If you want to think of it in terms of a slope term, then if we look in log-log space, one may encounter a hazard curve which doesn't look like a ski slope but which it's convexed upward. And there, if you take the log of A sub R and its inverse, then you get the negative slope of the hazard curve in log-log space.

But in either depiction the important thing is the relative change in ground motion for a decade change in probability. And this becomes

extremely important in the rationale as described, for example, revisiting Dr. Cornell's testimony of what happens with a margin when you are at a point in the hazard curve and you move to the right, depending on how the ground motion changes as you move to the right, you can end up with differing degrees of conservatism as it relates to the probability of failure.

JUDGE FARRAR: Hold a second, Ms. Chancellor.

(The Board confers off the record.)

JUDGE LAM: Dr. Arabasz, now, the ratio A5/A4, could you just walk us through just picking some value of this to show us how that ratio is determined?

THE WITNESS: Yes. Okay, let me take the curve for Hanford A on Staff Exhibit JJ. And I will pick the point along the hazard curve at the intersection with 10 times -- excuse me, 1 times 10 to the minus 5, and I enter the curve on the Y axis at 10 to the minus 5, and then I read on the X axis a ground motion value of 700 --

JUDGE LAM: Okay.

THE WITNESS: -- units. Now I will enter the curve at 1 times 10 to the minus 4 on the

same curve and intersect the curve for Hanford A and read approximately 400 units.

JUDGE LAM: Okay.

THE WITNESS: So that for my parameter A5/A4, I would have 700 divided by 400, giving me a slope of 1.75.

JUDGE LAM: So the ratio A5/A4 is the slope? A5/A4 is the slope between 10 to the minus 4 and 10 to the minus 5?

THE WITNESS: I don't think quite true, because if we had -- well, let's see. Okay, Delta X over Delta Y, here our Delta X is 300. So that to go to the slope, we take the log and then its inverse.

JUDGE FARRAR: The number is not the slope. I think that's where I was confused before.

THE WITNESS: It is a slope if you're in log-log space and use the K sub H term.

JUDGE LAM: Okay, thanks.

Q. (By Ms. Chancellor) Dr. Arabasz, with respect to Staff's Exhibit JJ, would it be correct to say that the change is the inverse of the slope?

MR. TURK: I would object. I don't understand the question when you say "the change."

JUDGE FARRAR: Can you --

Q. (By Ms. Chancellor) The A sub R, the A sub R would be the inverse of the slope; is that correct?

A. Let's see. It would be the inverse log of the inverse of the slope. Just to track it safely, I would just follow their definition. The A sub R term understood as a change, a ratio of the change in ground motion. If you want to look at slope in log-log space, go to the K sub H term.

Q. So the change in ground motion and a decade change in probability, this ratio that we're talking about, that's the important point?

A. That's the important point, yes, Ms. Chancellor.

Q. And so as A sub R increases, the slope decreases. Is that correct?

A. That is correct. Higher A sub R -- let me see if I've got this -- higher A sub R, lower K sub H.

Q. And P sub H is --

A. Let me try this one. Okay, the -- let's take, okay, the Skull Valley soil site, for example. The curve -- on Staff Exhibit JJ, the curve for Skull Valley soil that one would intuitively recognize as having a lower slope

compared let's say to the San Francisco Bay Bridge which intuitively appears to have a steeper slope, the -- okay. Let me untangle myself. The A sub R value would be greater for Skull Valley than the San Francisco Bay Bridge by comparison.

Q. Thank you. And you annotated State's Exhibit 203 with San Onofre Washington Nuclear Power Plant 3, Washington Nuclear Power Plant 2, Palo Verde and Yucca Mountain. Is that correct?

A. That's correct. Basically what I did is I went to information in the topical report to Appendix C and used hazard curves or tables available there, for my purpose, to flesh out the information needed to see what the slopes were at the other nuclear power plants and at some other sites in the western United States. And I wasn't attempting to definitively solve this problem here, and so I represent two significant figures here.

Q. And the overall information you can obtain from both your annotations in Table A-2 with respect to whether a nuclear power plant sited, a new nuclear power plant sited at any one of these sites, what does that tell you?

A. Within the context of the DOE Table C-3 -- I refer now to State Exhibit 207. And for PC 4,

which I would assume would be equivalent to a commercial power plant, will be allowed a hazard exceedance probability of 1 times 10 to the minus 4 10,000-year ground motion if a risk reduction ratio of 10 is achieved, for those plants, for those DOE sites that are identified by footnote 1 as, quote, near tectonic plate boundaries, where the risk reduction ratio of 20 or more is achieved and one can justify a lower design-basis ground motion of 2 times 10 to the minus 4, or 5,000 years. So that in effect one needs a steep hazard curve to get your risk reduction ratios with a factor of 20 or more in this DOE guidance to justify the 5,000-year ground motion versus a 10,000-year ground motion.

Now, when I come to the table in State Exhibit 203, I note a segregation in the table that Kennedy and Short had outlined. They had entries first entered under a category of eastern DOE sites, then western DOE sites not near tectonic plate boundaries that they provide information for INEL, LANL, Los Alamos and Hanford. Then -- and incidentally, in that category I infer it because Washington Nuclear Power Plant 2 sited on the Hanford reservation, I'm assuming that it has comparable slope characteristics to its hazard

curve, is that, analyzed here by Kennedy and Short, would not fall into this category of having a slope ratio that would justify a high -- that would have a high risk reduction ratio and hence justifying the 5,000-year return period.

Then continuing on Kennedy and Short's table, high seismic sites near tectonic plate boundaries, so information is provided for LLNL, Lawrence Livermore National Lab in Livermore, Diablo Canyon, and we note that for LLNL the slope, the A5/A4 value is 1.55, for Diablo Canyon 1.36.

Then coming down into my annotated entries, I estimate that for San Onofre the A5/A4 value would be in the order of 1.5, Washington Nuclear Power Plant 3 near Satsop 1.5. And we can see the similarities to the DOE sites LLNL and Diablo Canyon Nuclear Power Plant site that were enclosed in the category of high seismic sites near tectonic plate boundaries.

Then there was not information in Appendix C of Yucca Mountain Topical Report 2 for the Washington Nuclear Power Plant 2 at Hanford, and what I simply -- I put a lined entry and would just look by analogy to the entry farther up in the table for Hanford under western sites not near

tectonic plate boundaries, whether that is 2.01.

Then for Palo Verde my estimate of A5/A4 is in the order of 2.3, and for Yucca Mountain, going to a published PGA hazard curve, I estimated an A5/A4 value of 2.4.

Q. And Palo Verde's in Arizona, correct?

A. That's correct.

Q. So the values are 1.15 range. What would be the return period for a new nuclear power plant planted at soil clay (phonetic)?

A. Under the DOE framework using Table C-3, one would achieve large risk reduction ratios that would justify the use of the 5,000-year P sub H value. When we have slopes of the order of 2 in A5/A4 space, for example, under western DOE sites not near tectonic plate boundaries, INEL, Los Alamos, Hanford, the assumption is that the engineering judgment was made as part of the DOE design approach that these A5/A4 slopes did not justify the 5,000-year return period motion.

Q. And for INEL, is there information in either State's Exhibit 127 or Staff's Exhibit S that would help you flesh out whether any nuclear power plant sited there should be 10,000 or 5,000?

A. There I can begin to consider some other

information, and I can go back to the line of reasoning that considers the exceedance probability of the design-basis motion. And for the nuclear power plants, the design-basis response spectrum is clearly available and was established as part of licensing.

Elsewhere I might consider the proposition of the design-basis motion being equivalent to the 84th percentile deterministic motion. And this in effect is the proposition of using as a proxy for the design-basis motion where one does not have a nuclear power plant the Appendix A guidance or regulation which would give you the 84th percentile deterministic motion as the anchor, if you will, for setting the level of the response spectrum. And we have on the record, I believe it's included in my prefiled testimony under Exhibit 127, and I'm looking at the third page of the exhibit, which is an excerpt from a report prepared by Chen and Chowdhury.

MR. TURK: I'm sorry. Which exhibit are you looking at?

THE WITNESS: I'm looking at 127.

Q. (By Ms. Chancellor) And this is page 4-1 of State's Exhibit 127?

A. That's correct, a report prepared for the Nuclear Regulatory Commission titled "Seismic Ground Motion at Three Mile Island Unit 2, Independent Spent Fuel Storage Installation site in Idaho National Engineering and Environmental Laboratory--Final Report."

MR. TURK: Could we pause for a moment while we get the documents out?

THE WITNESS: Certainly.

MR. TURK: Which page of State Exhibit 127 are you pointing to?

THE WITNESS: Correct.

MR. TURK: Which page?

THE WITNESS: The third page labeled 4-1.

MS. CHANCELLOR: Do you have it, Mr. Turk?

MR. TURK: I do now. Thank you.

THE WITNESS: The last sentence in the third paragraph reads, "The resulting 50th- and 84th-percentile deterministic values of PHAs at the proposed TMI-2 ISFSI site are 0.34 g and 0.56 g, respectively." So we have a .56 g 84th percentile deterministic value.

If we wanted to compare that to PSHA

results, we would then go to the last sentence in the following paragraph that reads, "Based on this study, the PHAs for the proposed TMI-2 ISFSI site are 0.23, 0.30, and 0.47 g for return periods of 1,000, 2,000, and 10,000 years, respectively." So qualitatively one would recognize that the 84th percentile ground motion to .56 g would be higher than a 10,000-year motion. So this is giving me a sense of calibrating, if you will, what the exceedance probability of a hypothetical design-basis motion might be at the INEEL site.

Q. So if a nuclear power plant were to be sited at INEL, is it your opinion -- what is your opinion of what the mean annual return -- mean annual probability of exceedance would be?

A. First I'd say clearly yet to be established by regulatory decision making, but we do have the Staff informing the commissioners in the INEL exemption that if a new power plant were built at that site that it could use the 10,000-year ground motion. But please don't confuse -- okay, what we're dealing with is uncertainties in regulatory guidance. If it were a done deal, what the reference probability of an NPP in the western United States was, we would have

eliminated lots and lots of discussion in this hearing. So there's clearly -- there is evolution in thinking, benchmarks yet to be clearly established, and so when we go back to Dr. McCann benchmark, we just have to take into account these considerations, whether that is a judgment or whether indeed that's the benchmark that the NRC would use.

Q. So the exercise we're going through now is your effort to show through hazard curves what the ground motion should be in the western United States for sites that are not near tectonic plate boundaries?

A. What I'm suggesting is that going to the Yucca Mountain Topical Report 2, taking the statistics from that Table C-2 and then extrapolating that beyond the plate boundary to the rest of the western United States to 105 degrees, I think it is not a given proposition. That is certainly one subject to challenge.

Q. And let's look at the PFS site. Would you turn to State's Exhibit 204. State's Exhibit 204 is Updated Deterministic Ground Motion Assessment, Revision 1, by Geomatrix, April 2002. Has Figure 2 and Figure 3.

A. Mercifully, I found it and have it in front of me.

Q. There's too much paper over there.

A. Here, these are --

MR. TURK: I'm sorry; is there a question pending?

MS. CHANCELLOR: Yes. I'm asking Dr. Arabasz to explain based on the Geomatrix updated ground motions in State's Exhibit 204, looking at the Figure 2 and Figure 3 of the exhibit, what the curves here would tell him with respect to siting a hypothetical nuclear power plant at Skull Valley site.

A. The curves that are shown here are -- this would be the composite graphs, and in each graph there is a solid line curve which is the 84th percentile deterministic ground motion for the east fault which governs the DSHA.

Now, here you have to set aside the issue of the validity of this DSHA and what its level of conservatism was with respect to Appendix A requirements. But just to continue my qualitative examination of the western United States, I look at this graph and I see that the deterministic 84th percentile ground motions, which

I would use again as a proxy for the SSE ground motions at the site, they're compared with the horizontal response spectra for default normal component on Figure 2 and then with respect to default parallel component on Figure 3. And if I were to look at the spectral ordinants for 5 Hz, namely .2-second period, and 10 Hz for .1-second period, I would observe qualitatively that the deterministic 84th percentile ground motion were closer to the 10,000-year equal hazard spectrum in each case, closer to the 10,000-year compared to the underlying 5,000-year spectrum.

In other words, as both the Staff and the Applicant have represented, the deterministic ground motion falls between the five and ten thousand-year equal hazard spectra values, but as I go on to observe again qualitatively I infer a value approaching 10,000 years, perhaps something in the order of 8,000 plus years, eight to nine thousand years.

Q. And continuing a qualitative examination of the western United States, would you turn to State's Exhibit 205, which first page is an e-mail communication, and then there are a total of five pages. From the information -- what information

contained in 205 did you obtain with respect to your qualitative examination of the western United States and what the ground motion should be for a hypothetical nuclear power plant at the Yucca Mountain site?

MR. TURK: Before a question is given, may I ask the witness first to identify, what is this exhibit? So we understand what we're looking at. And then I would -- if the State would permit, I would just ask the reporter to read back the question the State asked.

MS. CHANCELLOR: I have no objection to that, your Honor.

JUDGE FARRAR: Go ahead.

THE WITNESS: The first page of the exhibit has an e-mail correspondence between myself and Ivan Wong, the project manager for the Yucca Mountain PSHA. Ivan Wong is a seismic hazard expert at US Corporation in Oakland, California, as identified or as apparent in his e-mail address.

MR. TURK: And the cover page appears to have several different messages. Could you identify which one is from which person?

THE WITNESS: Yes. The context is that DSHA results, to my awareness, had not been

published for Yucca Mountain, so I sent an e-mail message to the project manager asking if such information were available, and he responded. And these -- his response is identified by the right point -- all of the lines that have to their left the right-pointing arrow.

And he responds to me, "Walter, a DSHA done by the USGS using the experts seismic source characterization and attenuation relationships results in the following values for a M," meaning magnitude, "6.7 on the Solitario Canyon-Fatigue Wash-Windy Wash fault system for the reference rock outcrop." And here the reference rock outcrop is the base of the repository level.

MR. TURK: And is that -- may I ask, is that the controlling fault or the deterministic seismic hazard analysis for Yucca Mountain?

THE WITNESS: The controlling fault -- I'll take care. I'm not certain.

MS. CHANCELLOR: Your Honor, if I just may interject. I didn't realize that Mr. Turk was asking to voir dire a witness. The purpose of the information is for Dr. Arabasz, as he has testified, to do a qualitative examination in the western United States. And Dr. Arabasz has -- is

not claiming that this is -- this is an analytical study of western United States sites. It is a way in which he is trying to satisfy himself with respect to the 5,000 versus 10,000 years.

I won't object to some questioning about -- I don't want to get -- I don't think it serves any purpose for us to get bogged down in controlling faults and et cetera when we're looking at a qualitative rough count, if you will.

JUDGE FARRAR: Okay. Well, the question was simply from Mr. Turk to help explain what this document is. I think you were going through the e-mail, and I take it when you got this reply you responded to Mr. Wong to detect an error in his calculation; he said, thanks, you're right, and did that correction make it into the final report? In other words, is the report as published an error, or did your suggested correction catch it before it was published?

THE WITNESS: I don't know. To my awareness, this is not published information. What I was seeking was companion DSHA information to relate to published PSHA information.

I can answer Mr. Turk's question this way, that I am aware that the Solitario fault

system has the highest slip rate of the Yucca Mountain group. Its slip rate is, for example, in the order of .03 to .04 millimeters a year order of magnitude larger than the other Yucca Mountain faults in the near vicinity of the repository, and the controlling earthquake for 5 to 10 Hz range is approximately a magnitude 6.5 or less event within 15 kilometers of the site.

JUDGE FARRAR: Mr. Turk, is this a sufficient answer for now?

MR. TURK: I appreciate the answer from Dr. Arabasz, but I would have a problem with the exhibit's admission or questioning of the exhibit, because, to my knowledge, DOE has not yet submitted to the NRC a deterministic seismic hazard analysis which would indicate what is the controlling fault and what is the magnitude of the seismic event or the slip rates.

JUDGE FARRAR: But if the witness knows, he can talk about that.

MR. TURK: But the witness stated he doesn't know if this is a controlling fault. And that's why I asked the question. I'm not sure what we establish with this exhibit. I have no problem if the State wants to examine Dr. Arabasz on his

own work. But I don't know what this exhibit establishes. I don't see what it's relevant to. I don't see how reliable it is without going --

JUDGE FARRAR: Let's see if the question -- why don't you keep your objection at hand and we'll see where the questioning goes, and you can state the objection at the appropriate time.

Q. (By Ms. Chancellor) Dr. Arabasz, do you personally know Dr. Ivan Wong?

A. Yes, I do.

Q. And is he the project manager for -- what is his position?

A. He was the project manager for the probabilistic analysis undertaken for the Department of Energy by the USGS and by URS Corporation in a management role for overseeing the expert elicitation for vibratory fault -- excuse me -- for vibratory seismic hazard analysis and fault displacement hazard analysis at Yucca Mountain.

Q. And was the purpose of your communication with Dr. Wong, was the purpose to obtain information that was not available to you elsewhere?

A. Correct.

Q. And could you explain your confidence in the information that you obtained from Dr. Wong?

A. I'm smiling because Dr. Wong as of late happens to be a Ph.D. student in our department for whom I'm an advisor.

Q. He's not in the room, Dr. Wong.

A. I can I think deal with the Yucca Mountain information in another way without relying on these hazard curves. As represented, the answer would be that the exceedance probabilities would be in the order of 2 times 10 to the minus 5.

If I go back to two things. If I were to return to State's Exhibit 203, the Kennedy and Short table, with my annotation of curve for -- excuse me -- my annotation of the A sub R values for Yucca Mountain and compare the slope of 2.40 at Yucca Mountain with 2.29 for Palo Verde which has an exceedance probability of approximately 26,000 years, the bottom line is that one would get an exceedance probability greater than 10,000 years, of the order of tens of thousands of years.

And I believe that with earlier PSHA results, DOE may have been aware of this when it undertook the Yucca Mountain topical report to

exercise, had the statistics in front of them for, quote, these nuclear power plants in the western United States but chose not to use as a benchmark 5,000 years but 10,000 years.

Q. And finally, to fill in the details of the western United States, if you would turn to State's Exhibit 206, Seismic Hazards Evaluation of the Los Alamos National Laboratory dated 24 February 1995, the cover page with second page Figure 8-9 and Figure 9-98.

Are you familiar with this report, Dr. Arabasz?

A. Yes, I am.

Q. And what was the purpose of going to or looking -- did you need Figure 8-9 and Figure 9-98 and State's Exhibit 206 to do your qualitative fill-in, if you will, of sites in the western United States with respect to hazards?

A. First, I would have observed, as I did earlier in my May 17 testimony, that in the -- in DOE Standard 1020-2002, Table C-3, that Los Alamos was clearly a Department of Energy site and did not, to appearances, have characteristics that would achieve a risk reduction ratio that would put it into that special class of facilities such as

LLNL, SNL-Livermore, SLAC and so on, the DOE facilities near the tectonic plate boundaries.

I'm missing a piece of paper. Excuse me.

Q. Should I send Ms. Braxton over there to keep you organized, Mr. Arabasz?

MR. TURK: See if she can stop at my desk on the way over.

A. Okay, then I would have noted in the Kennedy and Short Table A2, State's Exhibit 203, that the LANL site was in the category of western DOE sites not near the tectonic plate boundary, again consistent with not assigning it a 5,000-year P sub H value but maintain the 10,000-year hazard exceedance value.

I happened to have available to me this Los Alamos report as a member of the Seismic Laboratory Review Committee, so I went to the report and excerpted two representative figures, the first one labeled TA-55, meeting empirical acceleration response spectra for Pajarito Fault, P-a-j-a-r-i-t-o, and M sub W 7 earthquake. And the M, magnitude 7 earthquake on the Pajarito Fault is the controlling deterministic motion.

Note that the solid curve is the average

P GA. At .5 g, and this is an average for empirical motions using the attenuation relations described below, in the report it's clear that these empirical ground motions are lower than the theoretical response motions, and so I knew that these results were conservative.

And further, the values plotted here are median deterministic motions, not 84th percentile. And so I was aware of that. And TA-55 being one of the representative technical areas on the Los Alamos compound.

If I enter the curve on -- the solid curve on Figure 8-9 at .1 seconds for 10 Hz and .2 seconds for 5 Hz and then compare with the median equal hazard spectra in Figure 9-98 from the PSHA results, I observe qualitatively that those values are approaching 10,000 years, let me say in general of the order of several thousand years.

Q. So for the Yucca Mountain site, the INEL site, the PFS site and the Los Alamos site, the tour that we have just done, do you feel that this gives you sufficient information to say that 5,000-year ground motions from a mean return period earthquake for 5,000 years should not be used if a nuclear power plant were to be cited at any of

these sites?

MR. TURK: Any of which sites?

MS. CHANCELLOR: Yucca Mountain, INEL, PFS, Los Alamos.

A. I will try to answer this way, that I would not believe that the reference probability for a hypothetical new nuclear power plant in the western United States would appropriately be pegged at 5,000-year return period ground motion. And from my walk-about through the western United States, once I've left the plate boundary, when I've moved eastward to Hanford, when I've moved eastward to Palo Verde, farther eastward to Yucca Mountain, to INEL to the PFS site and to Los Alamos, from the aggregate information before me I guess I finally have information to respond to Mr. Gaukler's questioning, which would be my judgment that the benchmark for nuclear power plant against which to compare relatively a ground motion value for an ISFSI, the benchmark would be in the order of 1 times 10 to the minus 4.

MS. CHANCELLOR: Your Honor, I would move for admission of State's Exhibit 203, which is the Kennedy and Short paper; 205, the Geomatrix -- the exhibit that comes from Geomatrix; and 206, the

information with respect to Los Alamos Laboratory. And I will not move for entry of 205 which Mr. Turk opposed to.

JUDGE FARRAR: I must have misheard you. You said you're moving --

MS. CHANCELLOR: 203, 204, and 206 but not 205.

JUDGE FARRAR: Any objection to 203?

MR. GAUKLER: No objection.

MR. TURK: None from the Staff, your Honor.

JUDGE FARRAR: Okay, then 203 will be admitted.

(STATE'S EXHIBIT 203 WAS ADMITTED.)

JUDGE FARRAR: 204?

MR. GAUKLER: None.

MR. TURK: I have no objection on 204.

JUDGE FARRAR: All right, then 204 will be admitted.

(STATE'S EXHIBIT 204 WAS ADMITTED.)

MR. TURK: If I'm correct, that's -- yes, Geomatrix.

JUDGE FARRAR: Stone & Webster, Geomatrix. And then 206, the Los Alamos document.

MR. TURK: I object to this one, your

Honor. Should I wait for the Applicant?

JUDGE FARRAR: No, go ahead. On what ground?

MR. TURK: On grounds of relevance. Dr. Arabasz indicated in his statement that he was aware that these are -- may I have a moment?

JUDGE FARRAR: Yes.

Mr. Gaukler, while they're thinking, what's your position?

MR. GAUKLER: No objection.

JUDGE FARRAR: No objection.

MR. TURK: Your Honor, based on the fact that this is a document that Dr. Arabasz referred to in attempting to establish a pertinent value for the Los Alamos site, I do not object to the introduction of the exhibit. I will, however, have questions for him.

JUDGE FARRAR: All right, then 206 will be admitted.

(STATE'S EXHIBIT 206 WAS ADMITTED.)

JUDGE FARRAR: And Ms. Chancellor, you said you were not offering 205?

MS. CHANCELLOR: It's not worth going through the argument, your Honor. We won't move for entry of 205.

MR. TURK: May we go off the record?

JUDGE FARRAR: No, because I'm debating what to say about Ms. Chancellor's answer, because if the evidence is valuable then it is worth going through the argument, because --

MS. CHANCELLOR: Your Honor, rather than belabor the hearings, Dr. Arabasz moved to a different set of information, and let me just ask Dr. Arabasz a question.

Q. (By Ms. Chancellor) Dr. Arabasz, did the information that you relied on in the Kennedy and Short paper, did that inform you with respect to the Yucca Mountain site as to the reference probability for a --

A. Yes, it did. And similarly I would add for the Los Alamos site that using the Kennedy and Short paper I can arrive at my conclusion that the hazard curves at those sites do not result in risk reduction ratios that warrant, in the DOE frame work, a reduction from a 10,000-year to a 5,000-year value.

MS. CHANCELLOR: On that basis, your Honor, there's no need for the State to move for admission of 206.

JUDGE FARRAR: All right. Then thank

you for that.

MR. TURK: 205.

MS. CHANCELLOR: 205. Thank you.

JUDGE FARRAR: Thank you for that additional clarification. Mr. Turk, I think you wanted to go off the record.

MR. TURK: If I can, your Honor, just for a few minutes.

(Discussion off the record.)

JUDGE FARRAR: Back on the record.

Q. (By Ms. Chancellor) Dr. Arabasz, you may recall a discussion yesterday with respect to the Martinez paper, and Mr. Turk had you refer to NRC Exhibit PP on page 18 in which there was a discussion about the Martinez paper used by the Staff to support a slip rate of nearly ten times larger -- that the Wasatch fault has a slip rate nearly ten times larger than the Stansbury fault. Do you recall that line of questioning?

A. Yes, I do.

Q. What problem do you have with the Staff using the Martinez paper to argue that the PSHA at the PFS site is conservative?

A. With more time referring to the paper, I returned to it and I have my own copy. I don't

have the exhibit number identified.

Q. That's fine.

A. I would like to read from the paper, but presumably you need the exhibit reference.

MR. TURK: May we have just a moment?

MS. CHANCELLOR: State's Exhibit 184.

MR. TURK: Yes.

A. Referring to the abstract, the left column on page 567, and approximately two thirds of the way down through the abstract there's a sentence that begins, "While we do not yet know the source of this unexpected contemporary deformation," namely the increased deformation observed by GPS, the text continues, "loading of the" -- excuse me. I guess I've confounded the recorder, probably, by not reading verbatim. Let me begin again and I'll read it verbatim.

"While we do not yet know the source of this unexpected contemporary deformation, possible mechanisms include homogeneous crustal extension, loading of the Wasatch and adjacent faults, and pressure solution creep." In other words, the interpretation of the observation was uncertain. One possible modeling interpretation is that the deformation was reflecting higher slip on the

Wasatch fault, but there were other interpretations that the authors were considering.

On page 569, right-hand column in the section Implications of High Strain Rates, the second paragraph reads, "To examine possible sources of the GPS measured horizontal deformation field, Martinez [1996] constructed simple dislocation models for plausible geometries of the Wasatch and nearby faults similar to those of Savage et al. [1992]. Within the observed measurement uncertainties the results were found to be consistent with 1) approximately 4 to 5 millimeters per year of localized slip on a varied fault plane tipping 60 degrees west, or 2) uniform east-west straight of a homogeneous crustal block. It is not yet possible to distinguish between these two end member models because of a lack of broader GPS coverage and the limitations of the current resolution of the GPS measurements."

In other words, the interpretation remains uncertain as to what the cause of those observed high strain rates are.

Q. And in the Martinez paper, did they use the same methodology in comparing slip rates on the Wasatch and Stansbury faults?

A. No. We visited this earlier in my testimony that one had information on geodetic deformation rates from GPS measurements in the vicinity of the Wasatch fault. One had geological slip rate information, namely, information on displaced geological horizons of known or estimated age where one estimated the slip rate from the displacement divided by the time interval. And so we have a comparison of geological slip rate information on the Wasatch, geological slip rate information on the Stansbury fault, GPS information in the vicinity of the Wasatch fault, no comparable GPS information in the vicinity of the Stansbury fault.

Q. And do you consider it acceptable to do a comparison using different methodologies?

A. If this were a rigorous PSH exercise with let's say a multiteam approach, it might be attempted. It would be subject to lots of criticism and, in my view, it probably would be beaten down.

Q. Thank you. Finally, Dr. Arabasz, I'd like you to turn to State's Exhibit 209. This is first page Safety Evaluation Report for systems not directly associated with storage pads of Private

Fuel Storage facility, December 15, 1999. Do you have that document?

A. I have it in front of me. Thank you.

Q. If you'd take a moment to review --

MR. TURK: May we take just a moment, please? This is State Exhibit --

MS. CHANCELLOR: 209. It was handed out yesterday, Mr. Turk.

MR. TURK: We've located it.

MS. CHANCELLOR: Do you need some more time, Mr. Turk?

MR. TURK: Turk 207?

MS. CHANCELLOR: 209.

MR. TURK: Just a minute. Okay.

Q. (By Ms. Chancellor) Dr. Arabasz, are you familiar with this document?

A. Yes, I am.

Q. And does this document, State's Exhibit 209, contain bullets from -- the first three pages, does that contain bullets from various versions of the Staff's Safety Evaluation Reports?

A. Correct, with the observation that the fifth and fourth page includes bullets from the Modified Rulemaking Plan SECY-01-078.

Q. You anticipated may my next question.

Thank you. And with respect to Utah Contention L Part B, which is now Utah L/QQ part E, you testified yesterday, I believe it was, that if we are to track your testimony or your involvement in this, you need to track the staff. Do these five -- by that testimony do you mean that you track the bullets in the SER that the Staff has given for the rationale at various stages for considering and determining the use of a 2,000-year return value at the PFS site?

A. Basically, yes, that the process has been evolutionary. We've heard that the Staff's thinking has been evolutionary, and I explained earlier that I'm either cursed or blessed with a need to see the big picture, and this provided a convenient road map for me and I believe for others to put side by side the bases for justifying the 2,000-year return period and to examine them.

Q. Now, I don't want to beat that horse too much, but could you just briefly review the Safety Evaluation Report for December of the excerpts from December 15, 1999 and then proceed on to the September 2000 and March 2000 consolidated SER and explain how certain items have been carried through and others may not have?

JUDGE FARRAR: Before you do that, Dr. Arabasz, everyone may be able to focus better on what I think will be a lengthy answer if we take a break first.

MS. CHANCELLOR: That's fine, your Honor. This -- I would just note that this is the last portion of my redirect.

JUDGE FARRAR: But this will be a fairly long answer, I assume?

MS. CHANCELLOR: I assume it will.

MR. TURK: And your Honor, when you hear the answer, before you do that I'd like to object to the exhibit and to the examination on it and the question, and I'll wait until after the break if you'd like.

MS. CHANCELLOR: Then we definitely need a break, your Honor.

JUDGE FARRAR: I think we're going to change reporters at the same time. Let's come back at five after.

(A recess was taken.)

JUDGE FARRAR: I think we're ready to resume. When we left off, Ms. Chancellor, I think you were about to ask the witness -- did you already ask him about Exhibit 209?

MS. CHANCELLOR: I believe I was starting there, your Honor, and because the response may be a little lengthy you decided to take a break.

JUDGE FARRAR: Had you asked the question --

MS. CHANCELLOR: I can -- we can start from scratch, your Honor.

JUDGE FARRAR: Yes, go ahead.

Q. (By Ms. Chancellor) Dr. Arabasz, you have spoken about a logic train. And would it help us take an excursion on that logic train if you had the various bullets of the Staff's evolving and changing -- well, I won't characterize it -- the Staff's various rationale as described in the SAR version that came out on December 15, '99, the SAR --

MR. GAUKLER: You mean SER?

MS. CHANCELLOR: I beg your pardon, Mr. Gaukler. I didn't mean to ascribe that to PFS.

Q. (By Ms. Chancellor) Start again. The first page, the SER from December 15, 1999, the SER from September 29, 2000, the Consolidated SER of March 2002, and the Modified Rulemaking Plan of September 2001. Having the excerpts from these

four documents in front of you, would that help succinctly describe the logic train that you have been talking about with respect to the big picture overview of your concerns with the State's -- with the Staff's logic?

A. Yes, it would.

Q. And could you succinctly go through the four pages that form State's Exhibit 209 and help us with this logic train?

MR. TURK: Objection.

JUDGE FARRAR: On what ground?

MR. TURK: The staff has already introduced into evidence each of the documents which contain the bullets. We have examined Dr. Arabasz on each of those documents. If you'll recall, Staff Exhibit A was the preliminary SER of 1999, Staff Exhibit NN is the September 2000 SER, Staff Exhibit OO and PP contain the SER Supplement No. 2 either in unbracketed or bracketed form showing the differences between that document and the September 2000 document. That is already in the record. Dr. Arabasz's testimony explains the logic train that he followed and his concern about the moving target presented by the Staff and PFS. The information is already on the record.

My objection as to examination on Exhibit 209 and on the introduction of 209, because if it's correct that it is a recitation of what is in the other documents then it's duplicative. And, frankly, I would have to look at it to assure myself that it is, in fact, a correct replication of what is in those documents. That's my first objection.

My second objection is that the bullets are out of context. They appeared in Section 2.1.6.2 of the various SERs and the context is the entire section of the SER. What we're presented with here, assuming that Mr. Chancellor has accurately replicated them, is something taken out of those documents which are in the record already and it's out of context.

And finally with respect to the fourth page of this proposed Exhibit, that document is also in evidence. Ms. Chancellor represents or Dr. Arabasz represents that this is a portion of SECY-01-178, which is the Modified Rulemaking Plan. That is in evidence as a Staff Exhibit also.

JUDGE FARRAR: Mr. Gaukler?

MR. GAUKLER: I have no objection.

MR. TURK: For the record, let me note

that the last page is, if it is a correct replication, it's a portion of Staff Exhibit U.

MS. CHANCELLOR: Your Honor, I would request that I be permitted to examine the witness on this Exhibit. It has not yet been offered. It has been marked, but it has not yet been offered to be introduced. I would request that I be permitted to examine the witness.

JUDGE FARRAR: Give us a moment here.

(The Board confers off the record.)

JUDGE FARRAR: Recognizing that State 209 for identification does not appear to be a photocopy of the SERs, nonetheless, Mr. Turk, we allowed you to cross-examine the witness and track his chain of logic as he took into account or didn't take into account changes in the Staff thinking, and there is no reason not to allow the State to, in response to your examination, to take him through the Staff's thinking which, after all, is at the heart of this case in whatever way they see fit.

You, of course, will be welcome, if it turns out this is not an accurate copy or recitation of what's in the document, or if there's context in the four documents that needs to be

brought to bear, you'll have your opportunity to do so. So the objection is overruled. Go ahead, Ms. Chancellor.

MS. CHANCELLOR: Thank you, your Honor.

Q. (By Ms. Chancellor) Dr. Arabasz, is the train ready to leave the station?

A. Almost. One moment, Ms. Chancellor.

MR. TURK: May we ask, then, for representation from counsel for the State that this is, in fact, a correct replication of the portions of those Exhibits that I mentioned?

JUDGE FARRAR: This was keystroked in by your people from the documents? How was it prepared?

MS. CHANCELLOR: I had a discussion with Mr. Turk during the break to see if I could satisfy him. It was electronically copied from the SER and pasted onto a separate page and each page is a electronic representation of what appears in what was given to us for the various SERs and Modified Rulemaking Plan.

JUDGE FARRAR: So there's not the danger of keystroke error?

MS. CHANCELLOR: To the best of my knowledge, no, your Honor.

MR. LAM: Also, there was no modification to this bullet by you?

MS. CHANCELLOR: Absolutely no modification. It was just basically copy/paste from an electronic version to get everything in a succinct format in one place. But no, it was electronically done.

JUDGE FARRAR: Then in response to Mr. Turk's request for a proper representation of the legitimacy of this version, you can make that, you can make that representation?

MS. CHANCELLOR: I certainly can, your Honor.

JUDGE FARRAR: Then let's go ahead.

Q. (By Ms. Chancellor) Dr. Arabasz, I believe you testified that you reviewed the various versions of the SER, but you focused on the bullets with respect to analyzing the Staff's logic for considering and recommending the 2,000-year return period for the exemption proposed; is that correct?

A. Correct.

Q. And with the documents -- with the various pages side by side, could you take us through the overline rationale that the staff used and how that changed?

A. Yes. This can simply be done I think with some pattern recognition, just standing back from these documents and being able to view the bullets side by side.

On the first page, and I believe I've put my ripped up pages in order here, I'm looking at the Safety Evaluation Report, or an excerpt from it dated December 15, 1999. In the first bullet, generally we see the reference to DOE-STD-1020 as a point of reference, namely, the 2,000-year return period for a performance Category-3 facility.

In the second bullet we see reference to the Uniform Building Code and a total probability of exceedance, which we've learned has fallen by the wayside in the Staff's thinking, except to the extent that it reappears in the Modified Rulemaking Plan.

In the third bullet we see the reference to the TMI ISFSI, and I've explained in my view that what was approved was a design basis ground motion in fact higher than a 2,000-year value. But I think the key point in this bullet is to recognize that what was central to the -- one of the things that was central to the request was that it was a DOE facility, which had DOE standards to

consider or to enter into consideration and, namely, the DOE 1020 Standard of a 2,000-year ground motion for a PC-3 facility.

The fourth bullet, ancient history. What was challenged to be circular reasoning, referring to what Geomatrix thought was appropriate and examination of the Geomatrix reasoning, referring back to Staff reasoning, and that fell by the wayside and became ancient history.

As we advance in time to the second page, September 29, 2000, what I see in terms of pattern recognition is the first three bullets are part of establishing a proposition, namely, that the radiological hazard of a dry cask ISFSI less than a nuclear power plant. The second bullet getting into the median versus mean issue, and then ending up with the third bullet which is the statement that, "On the basis of the foregoing, the mean annual probability of exceedance for the PFS Facility may be less than 10 to the minus 4 per year."

From my testimony earlier this morning, one can fairly say that even though I disagree with how the Staff may have gotten there, namely, that median versus mean issue, on the third bullet we're

basically of the same view.

Then the two bottom bullets, again the reference to the DOE-STD-1020 for PC-3 and the TMI-2. I'll note that on each of these pages, perhaps I should have done so at the beginning, I think the introductory sentence is the same in all cases, and it reads, "However, the staff has determined that a 2,000-return value with the PSHA methodology can be acceptable for the following reasons."

So so far what we see tracking consistently in time is the reliance on the DOE-STD-1020 and the reliance on the precedent of the TMI to ISFSI exemption. Then when we come to the most recent Consolidated SER, the third page of this Exhibit, an excerpt from the March 2002 Safety Evaluation Report, we again see the first three bullets developing that proposition that on the basis of the foregoing, the mean annual probability of exceedance for the PFS facility may be defined greater than 10 to the minus 4 per year, and we see continuing to appear consistently the reference to the DOE-STD-1020, and the TMI-2 precedent.

The fourth page, the Modified Rulemaking Plan, I don't need to concern myself with greatly

at this point. I'll simply observe that the first bullet is the TMI-2 precedent; the second one, this issue of consideration of the total probability of exceedance as a measure of acceptable risk, and we heard from Mr. Turk that the staff may re-examine whether it chooses to maintain that argument.

And then the bullet at the bottom, the reference again to the DOE-STD-1020 and the mean annual probability of exceedance of 5 E to the minus 4 for the 2,000-year ground motion. So that as the train arrives at this hearing in its most updated version, namely, the Consolidated Safety Evaluation Report, what I understand to be the key underpinnings of the Staff's justification for the 2,000-year return value comes down to the first three bullets that developed the proposition, again, that relative to a benchmark of 10 to the minus 4 per year for a nuclear power plant, a PFS facility could have a hazard probability that were higher, a mean return period ground motion that were lower.

And then in the last two bullets it seems to me that ultimately the Staff comes down to reliance on the DOE-STD-1020, either explicitly in the third bullet or implicitly in the TMI-2

exemption precedent.

Now, if that's the case, we come back to what I think is good news, that the Staff, if it chooses to stay pinned on the 2,000-year value, while 2002 -- excuse me, while DOE-STD-1020 has moved on to a exceedance probability of 2500 years for PC-3, it can only stay pinned on that 2,000-year value if it accepts the target size and performance goal of 1 times 10 to the minus 4.

And I think that's good news because I believe that this logic is forcing finally some kind of fixed star to navigate by, that the Staff, I've been told, need not accept the DOE-STD-1020, but it's such a key point that one has to somewhere accept a seismic performance goal to move on to the rest of the logic to consider a hazard probability and risk consistency.

This equation that I showed you this morning about R sub R equals PH over P of F, this appears in that reference B4 in the Reg Guide 1.165 as to how to consider a reference probability different than 1 times 10 to the minus 5 median. The design approach and philosophy was developed in the reference document in DOE-STD-1020 and its various versions. Again, a standard design

approach and philosophy was developed. It was developed in the Kennedy and Short paper as a basis for DOE-STD-1020 and I'm greatly impressed by looking at NUREG 6728 or NUREG/CR 6728, and if I could just pick that up for a moment, Section 7, the NUREG is titled Technical Basis for Revision of Regulatory Guidance on Design Ground Motions: Hazard and Risk Consistent Ground Motion Spectra Guidelines. And Section 7 specifically is titled Procedure for the Development of Risk Consistent Spectra.

Let me read a sentence from the beginning of the introduction section of Section 7 of the cited NUREG. "For the purposes of this project we mean by consistency that the ground motion recommendations result in facilities at different sites having about the same level of safety from earthquake caused failures no matter where there (sic) are located in the country."

So I guess as I try to figure out how to get off the train and when I can, I think that the discussion put forward by Professor Cornell in Attachment A of his prefiled testimony basically lays out a rational framework for deciding how to deal with the reference probability.

He, I think, is constrained to some extent by needing to argue within the DOE, what I call the DOE paradigm or the DOE framework. In other words, considering a seismic performance goal, a hazard probability and then with the risk reduction ratio consider the conservatisms that are achieved in the design procedures and the acceptance criteria.

I have made it plain in my prefiled testimony that I agree with this need to fundamentally couple the hazard exceedance probability with the design side and that if one accepts this proposition that sufficient protection depends on that fundamental coupling, then I've gone as far as I can on the train and have to pass off to the engineers and for the Board to consider whether, as Dr. Cornell argues, those conservatisms, indeed, have been achieved on the design side to justify the 2,000-year return period.

And if a judgment is made that they have not or there's uncertainty whether they have then one would come back to something like State's Exhibit 208 where I have the graph at the bottom of the table and we have the famous left-hand and

right-hand, if that sufficient protection isn't achieved on the design side, then necessarily it requires that left-hand side to come up with the return period of the ground motion.

MS. CHANCELLOR: Thank you, Dr. Arabasz. I have no further questions.

Oh, your Honor, I do have one thing. I would like to move for entry of State's Exhibit 209.

JUDGE FARRAR: Mr. Gaukler?

MR. GAUKLER: No objection.

JUDGE FARRAR: Mr. Turk?

MR. TURK: Your Honor, I noted my objection previously. I would restate it, but expect your ruling to be adverse.

JUDGE FARRAR: Unless you have something additional to add, you're correct.

MR. TURK: I think the only thing I would make clear, your Honor, is that the bullets are taken out of context. In each case the State left off the concluding paragraph as well as all the preceding discussion that led up to those bullets. This may be significant and I think that any time one looks at this Exhibit one must keep in mind that more was said by the Staff than the State

is representing here because they have taken the bullets out of context. And, for example, if I may just note what I mean by that --

JUDGE FARRAR: Rather than have you note it, number one, your complete version of the document will indicate that, and you, of course, would be free to put on a Staff witness who could, I assume, fairly briefly point out that something has been omitted that would be appropriate to put the matters in context. So on that basis we will admit State Exhibit 209.

MS. CHANCELLOR: Thank you, your Honor.

(STATE'S EXHIBIT-209 ADMITTED.)

JUDGE FARRAR: Mr. Gaukler, do you have some -- I think you had indicated yesterday you had some cross.

MR. GAUKLER: Yes. Should I start?

JUDGE FARRAR: Yes, go ahead.

CROSS-EXAMINATION

BY MR. GAUKLER:

Q. Good morning, Dr. Arabasz.

A. Good morning, Mr. Gaukler.

Q. I will agree with you, it has been a long train ride.

If you recall back to May 17 when you were testifying here before, Judge Lam and Judge Farrar asked you to arrive at what you would consider an appropriate earthquake level assuming you disregarded any conservatism in the design. Do you remember that?

A. Yes, I do.

Q. And you were very reluctant to go that route because, as you've stated in your testimony and have just reiterated, you believe you should consider both the mean annual probability of exceedance of an earthquake as well as whatever conservatisms may be inherent in the design procedures and criteria for the structure, correct?

A. Correct.

Q. And, in fact, that is the whole purpose of your State Exhibit 208, to show the relationship as far as you see it being an appropriate relationship as far as you see it, correct?

A. Correct.

Q. Now, in response to Judge Lam's or Judge Farrar's question, I forget whose it was at the specific point in time, to disregard any conservatism you considered the possibility of an earthquake longer than a 2,000-year earthquake and

you concluded perhaps that a figure of 4,000, excluding any conservatism, might be an appropriate figure.

A. I recall that, yes.

Q. Now, that was just a number that did not take into account any conservatism in the design of the structure or anything like that, correct?

A. Correct.

Q. And assuming, hypothetically, one were comfortable with a three or 4,000-year earthquake which would equate in that situation to really the performance goal, correct?

A. Let's see. Let me use my cheat sheet, if I may. The performance goal is 1 times 10 to the minus 4.

Q. What?

A. The performance goal for a PC-3 is 1 times 10 to the minus 4.

Q. I guess I was assuming hypothetically if one took 4,000 years with no conservatism, being satisfied with that, with an R sub R of 1, your 4,000 years was?

A. That would be an R sub R between 2 and 3.

Q. Okay. I have --

A. Referring, if you choose to, to keep either of us from tripping up, if you choose to refer to State Exhibit 208, and so that in the left-hand column, looking at where a 4,000-year ground motion would fall, and you would see that would fall between the 2 and the 3 R sub R.

Q. So if you were to take conservatism into account, then you would come up with a 4,000-year with the conservatism of R factor of 2.5 to come up to a performance goal of 10,000 is what you just stated right now, correct? Is that correct?

A. I'm sorry, I'm getting confused.

Q. I am too. I guess I was trying to go back to hypothetically where you didn't consider any conservatism, okay? And you just picked the figure of 4,000.

A. Would it help you if I explained or tried to justify how I honed in on that 4,000-year number?

Q. That might help focus us, yeah.

A. If I were in a situation where the engineers were in another room discussing the conservatism and I either didn't know what their outcome would be or someone exited the room and said, "We don't know," what I would turn to is a

different framework for judging acceptable risk, and that framework would be a probability of exceedance.

And in my mind this might be comparable to how the NRC thinks about on a capacity curve, as I understand it, the high confidence low probability of failure point, the 1 percent probability of exceedance. And I would look at -- I would consider the 40-year lifetime of the facility a 1 percent probability of exceedance, which was a value of 3980 years, or approximately 4,000 years. So forced into that question, that's how I come back and respond.

Q. So basically you were looking at the life of the facility in that context then?

A. That, and as I discussed -- or I believe I described to Judge Lam, the relative return period for large earthquakes on the Stansbury fault to get me closer to a level of comfort about adequately conservative, sufficient and protective.

Q. So, again, that testimony was all tied into the assumption of the hypothetical you were working with excluding any consideration of conservatism in the design in picking the level of earthquake, design basis earthquake, correct?

A. That's correct.

Q. And then going back to what you believe is the appropriate method, you would go back to your table which is Exhibit 208, correct?

A. Within the context here as appropriate. If you asked me -- well, I guess it would be an either here nor there because I would have in front of me the DOE paradigm and I would also have in front of me the NUREG 6728 framework. And I think it's evident that there are directions to be considered in regulatory decision making in 6728 that might be better, but here I think in this hearing the DOE 1020 framework is where we are.

Q. So just going back to this DOE 1020 framework, if Dr. Cornell is hypothetically correct that we have a risk reduction factor in the order of 5, then that would justify in your mind the 2,000-year return basis earthquake, correct?

A. I've stated that, yes. That's where the logic train takes me and I have committed to that.

Q. Also, just on the logic train --

A. I'm sorry, there's one qualifier, and that's the acceptance of the performance goal, the 1 times 10 to the minus 4.

Q. But the risk if you had a 2,000-year --

and you would agree that's an appropriate performance goal for an ISFSI of this sort?

A. Yes. We discussed this issue last October in my deposition and I agreed that 1 times 10 to the minus 4 performance goal I considered appropriate for the PFS facility.

Q. Going back to the logic, do you have the letters that Mr. Turk went over with you? These were your reports to the State's Attorney General Office with respect to the --

A. Yes, I do.

Q. -- with respect to the PSHA and the exemption? And you recall that both Mr. Turk questioned you and then Ms. Chancellor followed up. I would like to have you look at the third page from the back, which is page 2, it's in the second document we were talking about, which is Issues and Perspectives Relating to Hazard Assessment of Earthquake Ground Shaking and Surface Fault Displacement for Licensing the Private Fuel Storage Facility in Skull Valley Utah.

A. On the third page?

Q. It's page 2.

A. It's labeled page 2, correct.

Q. And that's where we're talking about --

where we have stated here that, "If, indeed, the dry storage cask and canisters, even under the conditions of a major seismic event, are as safe as asserted by PFS and believed by NRC staff, then we can think of no compelling argument to put forward against awarding the exemption." Do you see that?

A. Yes, I do.

Q. And basically, I take it, what you're referring to in terms of the cask and canisters being as safe as asserted by PFS was the assertion by PFS that the, number one, that the cask would not tip over and, number 2, even assuming they would tip over there would be no release of radioactivity which was discussed in the exemption request. Is that what you're referring to?

A. Yes. That's the hypothetical situation I was considering at that early stage.

Q. And you would still agree if those hypothetical conditions were true that, A, the cask doesn't tip over and even if it does tip over there would be no release of radioactivity, there would be no compelling reason not to grant the exemption, correct?

A. If I can phrase this as a hypothetical, it would be a restatement of your question that a

risk reduction ratio of 5 or greater had in fact been achieved, and I have conceded that if that were established with assurance, that that's where my logic takes me.

Q. So in other words, that would be the same as achieving the risk reduction of 5 or more --

MS. CHANCELLOR: Objection.

MR. GAUKLER: -- Hypothetically.

MS. CHANCELLOR: Dr. Arabasz has answered.

MR. TURK: I'm sorry, your Honor, I didn't hear an answer to the question. I think it's worth putting it on the record.

Q. (By Mr. Gaukler) Let me ask one question and I'll try to rephrase it. So if I understand your last answer, the showing that, number one, the dry storage cask would not tip over and, two, even if they did tip over with no release of radioactivity would be the equivalent, assuming that we're hypothetically correct, okay, that would be the equivalent of showing a risk reduction factor of 5 or more in the context of your Exhibit 208?

A. I answered yes earlier and I'm -- I have

to take care here in what I'm interpreting on the design side because I understand that it does become complex on the engineering side what elements enter into the factors of safety. But if I allow you to ask me the question, if a risk reduction ratio of 5 or more were established with engineering correctness and assurance, would I then agree that the 2,000-year return period were justifiable, to that question I would say yes. If that doesn't help you'll need to ask another question.

Q. Let me rephrase it just slightly. If, therefore, we show that the casks, assuming hypothetically as Holtec has done analyses, and assuming those analyses are correct, that at the 10,000-year earthquake the cask doesn't tip over; and then further, that even assuming if it did tip over there would be no release, that would be a reduction factor of 5 or more then, as you understood it, assuming that those were correct statements hypothetically?

A. Yes. And I would add that it would require more than if we showed, it would require the judges on the Board to conclude.

Q. Right.

A. Or to accept that.

Q. If the Board were to conclude that, you would agree then that there was a reduction factor of 5?

A. I stand ready to adhere to whatever the Board concludes.

Q. Enough of that. Thank you, Dr. Arabasz.

On this same point, you remember that you had a discussion with Mr. Turk on Friday afternoon, May 17th, going back again to approximately three weeks ago already, about your deferral to the State witnesses on the technical questions of conservatism. Do you recall that?

A. Correct.

Q. And he was asking you about why you deferred to the State as opposed to Dr. Cornell and things of that nature. But let me just kind of break up the issue. Isn't there really two issues in terms of conservatism? One, there is kind of the conservatisms that you normally find in design codes and standards. That's one type of conservatism, correct?

A. Correct.

Q. And then the other type of conservatism, there might be a conservatism that you would show

by analyses, specific analyses? For example, so we're all talking the same wavelength, the analyses that Holtec has done showing the casks don't tip over at 10,000 years, assuming hypothetically that were correct, that would be a conservatism that would be shown by technical engineering analysis, correct?

A. Yes. If I -- I said that I listened to Dr. Cornell, and I continue to be educated, and my understanding of seismic margins is a product of the conservatism between the seismic loading and the design procedures -- or excuse me, between what would be called a demand analysis and a capacity analysis.

Q. Right, right.

A. And if I understand correctly, the equation that he puts forward, he actually brings forward from NUREG 6728 and then goes through a quantitative analysis, on the right-hand side of that equation is a factor of safety. Part of that factor of safety, as I understand that, is established a priori as a matter of code or as a matter of regulatory target. And the other part of that margin, in terms of the margin as it relates to a reference capacity, basically has to be

validated by testing.

So in other words, one starts with a desired factor of safety and another element on the engineering side is somehow establishing that that factor of safety, in fact, has been achieved.

Q. And it's recognized that various codes and standards have various conservatisms imbued and embodied in the codes and standards, correct?

A. That's correct. And Dr. Cornell explained this in his attachment in referring to the deterministic acceptance criteria in terms of a factor that enters into that factor of safety term, the difference between the DOE and the NRC policy making, and in NUREG/CR 6728 there's a reference to a 1.63 factor between, I believe, the seismic loading and the so-called HCLPF point, high confidence low probability of failure point.

Q. And you agree that Dr. Cornell is a recognized expert in this area of evaluating conservatisms that exist in codes and standards as one of his areas of expertise?

MS. CHANCELLOR: Your Honor, I'm going to object to this line of questioning. Dr. Arabasz has not been put forward for the conservatisms or lack thereof in PFS's design. He has testified

that he hands that off to the State engineers and I believe is beyond the scope of what we have offered Dr. Arabasz for. And it doesn't relate to any direct testimony that Mr. Gaukler is crossing on or any follow-up to my redirect.

MR. GAUKLER: Your Honor, on Mr. Turk's cross, he discussed this area. And this is my last question and I'm going to move on.

JUDGE FARRAR: We'll allow it.

DR. ARABASZ: I'll need the question to be repeated, please.

(Pending question read back as follows:)

"Q And you agree that Dr. Cornell is a recognized expert in this area of evaluating conservatisms that exist in codes and standards as one of his areas of expertise?"

THE WITNESS: As the question is phrased, I agree.

Q. (By Mr. Gaukler) I would like to -- let's see. With Mr. Turk you were also discussing the Geomatrix PSHA. Again, I'm going back, taking you back to Friday afternoon, May 17th, and you were discussing, I think, one of the initial concerns you had with the initial site evaluation

going back to 1997 before Geomatrix did its 1999 report was whether or not they had taken into account a potential earthquake that could occur along a fault that had not been previously identified, correct?

A. I recall that, yes.

Q. And then I believe, if I understood you correctly, Geomatrix did their evaluation, identified the East fault and the West fault in very close proximity to the site, correct?

A. Correct.

Q. And this was approximately the magnitude or the approximate magnitude of earthquake you might expect along the East fault was analogous to what you might expect on a random earthquake on a fault that had not been previously identified?

A. Correct.

Q. And therefore, by Geomatrix having done this evaluation and having identified a fault that had not been previously identified in close proximity to the site, that would have reduced, in your mind, one of the major uncertainties in terms of correctly characterizing the seismicity of the site and the appropriate ground motion for the site; is that correct?

A. The vibratory ground motion hazard, if I can characterize it that way, correct.

Q. Okay. So if I understood your last answer to my question, finding this fault close to the site would have reduced -- reduces one of the major uncertainties in terms of the appropriate vibratory ground motion that would be experienced at the site? Did I phrase it correctly or did I not?

A. Maybe I messed you up a little bit in terms of the seismic source characterization. Yes, it removes the uncertainty in the seismic, whether the seismic source characterization is adequate, and that relates to the issue of the random earthquake in the vicinity of the site, and in the absence of good information whether there's a potential that that random earthquake may occur beneath or very close to the site.

Q. So that reduced or eliminated that uncertainty then?

A. In my mind, correct.

Q. I would like just to go back, I have one last topic I have a few questions on, and this is the issue of annual risk versus lifetime risk and to what extent one should take into account the

duration of a facility in determining the appropriate ground motion.

Assuming hypothetically one were to say that because we intend to operate for 40 years, one ought to maybe increase the 2,000 year to a higher level, which is what you were following up on the Staff's logic of their initial statement, I take it the same logic, if you were to apply that logic, the same thing would work in the opposite direction; assuming that somebody came in and said you were only going to use a 10-year facility then you would only need to have a design basis earthquake of 1000 years if you were to refocus on lifetime, correct?

A. Please don't lead me, Mr. Gaukler, with your head nodding.

Q. I'm just trying to say -- I'm sorry. I know you're independent enough you're not influenced by my head nodding, Dr. Arabasz.

A. I'm considering this carefully because I've reviewed a monograph by Dr. McGuire dealing with this issue and describing the illogic of the very short lifetime in terms of a total exceedance of probability. And I guess what I would come down to is some baseline below which I would not

increase the allowed probability of exceedance. At bottom, Dr. Cornell has given you a very clever question to put to me. And if you came up with this question on your own, I'm greatly impressed with your --

Q. No.

A. You're learning from Dr. Cornell's side.

Q. I have to attribute this, in truth, to Dr. Cornell.

A. I'm sorry, I don't mean to take this lightly, I'll need to have the question restated.

(Pending question read back as follows:)

"Q Assuming hypothetically one were to say that because we intend to operate for 40 years, one ought to maybe increase the 2,000 year to a higher level, which is what you were following up on the Staff's logic of their initial statement, I take it the same logic, if you were to apply that logic, the same thing would work in the opposite direction; assuming that somebody came in and said you were only going to use a 10-year facility then you would only need to have a design basis earthquake

of 1000 years if you were to refocus on lifetime, correct?"

THE WITNESS: I've committed myself to logic and so I'll follow it with the qualification, again, that there would be some baseline stipulated by code or regulatory policy below which I would not go.

Q. (By Mr. Gaukler) So the answer would be yes, if I understood your answer?

A. Yes.

Q. Two other questions to follow-up just on this same line. Basically we've kind of arrived at a consensus, at least on a national basis, that the design basis earthquake for nuclear power plants is approximately 1 times 10 to the minus 4 or 10,000-year mean return period earthquake?

A. The first part of your question again?

Q. Assuming that we've discussed -- just assume for purposes here that the 10,000-year design basis earthquake is a earthquake that would approximate the design basis earthquakes for nuclear power plants in the United States, which we've discussed generally.

A. Generally, yes, absent other regulatory decision making.

Q. So let's assume for purposes of this question that that is hypothetically correct. Nuclear power plants are licensed initially for 40 years and had this design basis earthquake established at the time of their licensing. We are now going through a process where most nuclear power plants are going through relicensing and they're getting a new license, extending their license for another 20 years.

Does the fact at this point, assume you were using an annual lifetime risk consideration in establishing an appropriate earthquake design level initially, does the fact that you are now having these licenses extended somehow invalidate that initial determination of the appropriate design basis earthquake for the nuclear power plants, in your mind?

MS. CHANCELLOR: Could I just ask a question? Is this a hypothetical that previous nuclear power plants were designed to a 10,000-year mean return period earthquake as opposed to a deterministic?

MR. GAUKLER: Yes. I think it's hypothetical. We've discussed this and I think we've agreed this is an approximation that may well

be correct, but for purposes of this question it's just hypothetical.

MS. CHANCELLOR: But the approximation was for a new nuclear power plant, not for an old nuclear power plant.

MR. GAUKLER: We won't discuss that, just hypothetically.

MS. CHANCELLOR: Okay.

DR. ARABASZ: Okay. The mixed elements here are knowing in advance what your exposure period realistically will be as opposed to guessing what it will be. In the case of the nuclear power plants, guessing 40 years and having to revisit the extended lifetime later.

Q. (By Mr. Gaukler) Yes. Nuclear power plants were initially licensed for 40 years. I don't know to what extent people thought about licensing back then, but they were licensed for 40 years. And now at this point in time, most power plants are coming in for relicensing to extend their license for another 20 years.

And does the fact that now all of a sudden we're increasing their total life from what we had expected initially from 40 years to 60 years, does that somehow invalidate in your mind

the original determination as to the appropriateness of my hypothetical 10,000-year design basis earthquake?

A. I don't know.

Q. And given these uncertainties in terms of lifetime, isn't really the best way just to focus on the annual or some frequency of probability of exceedance as the appropriate basis for determining the appropriate design basis earthquake for a facility such as the PFS?

A. Somewhere in your train was "best" and also "appropriate." And I'll answer, it all depends on the context, what the pertaining regulatory guidance is to be and whether there is a clearly established framework for the decision making. If the established -- if the DOE framework is established then that would lead me in one direction. If not, then I have to go to another arena for considering acceptable risk.

Q. And in the DOE framework it would be the mean annual frequency that would be the basis for determining the appropriate design basis earthquake, right?

A. Correct.

MR. GAUKLER: I have no further

questions.

JUDGE FARRAR: Mr. Turk, I assume you'll have some questions. In terms of planning the break, how long do you think you'll need?

MR. TURK: I'll need to talk to Dr. Stamatakos to resolve that. In fact, it may be that in order to expedite I'll ask permission to have Dr. Stamatakos ask a few questions after I'm done with the ones that I have planned to ask. I would estimate 20 minutes. One of the areas that we were going to explore is quite technical so it may go into 30 minutes.

JUDGE FARRAR: If I recall correctly, there's a provision in the rules that specifically authorizes questioning by a non-lawyer person?

MR. TURK: I believe that's correct, as long as the Licensing Board determines that it's permissible.

JUDGE FARRAR: The reason I'm looking at my watch, it has nothing to do with you, but I have an appointment to make a call back to our office on logistical things, which I need to do before 1:00. Do you think you can finish well before then? Or why don't you get started and we'll take it a few minutes and see what happens. What's Dr.

Bartlett's situation, Ms. Chancellor?

MS. CHANCELLOR: Here for the duration, your Honor.

JUDGE FARRAR: Oh, okay. I thought there was some limitation on his --

MS. CHANCELLOR: It's Dr. Ostadan. And we'll need to start Dr. Ostadan and Dr. Bartlett first thing tomorrow on a different set of testimony on the Part D portion. Dr. Bartlett, with respect to seismic exemption, doesn't have any scheduling constraints.

JUDGE FARRAR: Fine.

MR. TURK: May I suggest, your Honor, so that Dr. Stamatakos and I can talk, perhaps take the lunch break now and come back?

JUDGE FARRAR: Okay. I thought that might make sense. I should note that Dr. Stamatakos may decide he would rather sit in the back row, in which case I will do it myself.

JUDGE FARRAR: I was rereading a transcript the other day of the one witness we kept calling on who decided he was going to leave the hotel and be out of our reach.

Let's take a slightly longer break than usual because my call may take a good amount of

time. It's 12 after, let's come back at 20 after 1:00.

(Noon recess taken.)

JUDGE FARRAR: When we broke we were going to begin the Staff's second round of cross-examination, and Mr. Turk, you had suggested you wanted to proceed with Dr. Stamatakos conducting the questioning?

MR. TURK: What I'd like to do, your Honor, is conduct the cross-examination for the Staff, and at some point when we get to a technical area that I think would be more expeditious for Dr. Stamatakos to inquire about, I would ask at the time.

JUDGE FARRAR: And that would be under Section 2.733 of part 2 which allows you to ask us to do this, and according to that we'd have to make three findings which I'll paraphrase: that he's qualified by scientific training to contribute, which one would think would be the case. If he's read any written testimony on which he intends to examine or cross-examine on any new documents, I assume that's the case. And that he's prepared himself to conduct a meaningful and expeditious examination or cross-examination.

MR. TURK: I can attest to all three of those, your Honor.

JUDGE FARRAR: To save time, when we get to that point will there be any objection to us proceeding that way?

MS. CHANCELLOR: Provided there isn't tag teaming, your Honor, I wouldn't have any objection. So in other words, if Dr. Stamatakos asks a question and then Mr. Turk jumps in with a follow-up, it would get very confusing. So if he's going to pass the baton to Dr. Stamatakos, it should stay passed until it's passed back definitively.

JUDGE FARRAR: Well, we've tried to avoid tag teaming in this proceeding, not always successfully, so we'll deal with that when we come to it. Mr. Gaukler, will you expect to have any objection?

MR. GAUKLER: I have no objection.

JUDGE FARRAR: All right, then Mr. Turk, go ahead.

MR. TURK: Your Honor, before we begin the examination I'd like to introduce a Staff exhibit which we discussed previously. The parties and the licensing Board may recall we examined on

the TMI-2 ISFSI license on March 19th, 1999. And I'd like to have marked for identification at this time Staff Exhibit SS.

(STAFF EXHIBIT SS MARKED.)

MR. TURK: For the record, let me identify this document as follows. It consists of a cover letter from E. William Brach, director of the spent fuel project office, to Warren Bergholz, acting manager of the Idaho Operations Office, U.S. Department of Energy, dated March 19, 1999.

Attached to the cover letter is a two-page document which bears the title TMI-2 Independent Spent Fuel Storage Installation Materials License No. SNM-2508, and it includes the docket number and the name of the licensee. For brevity's sake I won't state the whole thing.

Behind those two pages are found three pages which are the license for independent storage of spent nuclear fuel and high-level radioactive waste, license No. SNM-2508. Behind that is a cover page of the Safety Evaluation Report for the TMI-2 spent fuel storage installation.

And behind that cover page is Section 2.5.6.2 entitled Vibratory Ground Motion. This is pages 2-17 through 2-26 of the Staff's SER for that

facility.

Q. And by way of identification, I would ask the witness if in fact this is the document that we inquired about previously which I showed to him which contained the TMI-2 ISFSI license including the exemption from the provisions of 72.102(f)(1), which appears on page 2, paragraph 12a of the license in this exhibit.

A. Yes, I recall this document.

MR. TURK: Your Honor, I would offer this into evidence and ask that it be admitted at this time.

JUDGE FARRAR: Any objection?

MS. CHANCELLOR: No objection, your Honor.

MR. GAUKLER: No objection.

JUDGE FARRAR: Then it will be admitted.

(STAFF'S EXHIBIT SS WAS ADMITTED.)

RECROSS-EXAMINATION

BY MR. TURK:

Q. Dr. Arabasz, starting with this subject pertaining to which the Staff Exhibit SS pertains, that is, the Three Mile Island 2 ISFSI license and exemption, I believe you had testified yesterday

that you presumed or assumed that DOE performed an analysis of demonstrating performance goals consistent with the DOE 1020 standard for that ISFSI. Do you recall that part of your testimony?

A. No, I do not.

Q. Is it your belief that DOE did perform a 1020 type analysis with respect to the exemption request for the TMI-2 ISFSI?

A. No, that's not my understanding.

Q. In your testimony today and also yesterday, you referred to a bullet, and this is in State Exhibit 209. On the first page of that exhibit, the last bullet states, "In its Fault Evaluation Study and Seismic Hazard Assessment Study--Final Report for the site, Geomatrix consultants, Inc. (1999a) concluded that an appropriate design probability level for both vibratory ground motion and fault displacement for the site is 5 times 10 to the minus 4 (or a 2,000-year return period)." And that bullet is taken from Staff Exhibit A, the Preliminary Safety Evaluation Report dated December 15, 1999?

A. Correct. I have that in front of me.

Q. I believe you indicated this was circular reasoning or circular logic in that in

your view the Geomatrix report had simply referred to the Staff paper before.

A. The argument was developed in a prior state filed document. I can't recall the exact document. I do recall going back to the Geomatrix report and discovering that the arguments that were put forward by Geomatrix, to the best of my memory, related to either -- well, they basically related to NRC and/or Staff decisions or positions.

Q. Which Geomatrix document are you referring to now? Is it the one that's referenced here as 1999(a)?

A. Correct, yes.

Q. Do you happen to know the date of that document?

MS. CHANCELLOR: Your Honor, is this a relevant question? 1999(a) --

MR. GAUKLER: I believe it's February 1999.

Q. (By Mr. Turk) Do you recall if that's the document that you're referring to?

A. It's the February 1999 Geomatrix PSHA document.

MR. TURK: Your Honor, I'd like to distribute at this time a copy of a document, and

I'd like to have this marked for identification as Staff Exhibit TT.

(STAFF'S EXHIBIT TT MARKED.)

MS. CHANCELLOR: Just as a point of reference, Dr. Arabasz was looking for a document that the State filed that challenged this Staff's circular reasoning, and I would identify for the record that that was contained in State of Utah's Request for Admission of late filed basis 2 to Contention L on January 26, 2000 at page 18.

MR. TURK: May we go off the record?

JUDGE FARRAR: Yes.

(Discussion off the record.)

JUDGE FARRAR: And before you make the request, I'll make the request. We're at the end of a long -- no, we're not at the end. We're heading toward the end of a long, difficult, complex proceeding. There are documents all over the place that have shown up at different times. It's getting very difficult for everybody to track them. So the simplest way possible that whoever can give a reference when it's needed gives it in non-confrontational tones, and we will move along much better.

MR. TURK: Your Honor, it has been a

long proceeding and it is a difficult area to examine upon, and I would appreciate it if interruptions were kept to a minimum. I don't know understand why that last interruption was necessary at this time.

JUDGE FARRAR: Well, without passing on one interruption or another, let's all try to provide references when we can that will make things easier on the witnesses and counsel and let us move faster.

Q. (By Mr. Turk) Dr. Arabasz, do you have in front of you a document that's been marked for identification as Staff Exhibit TT?

A. I do.

Q. Let us identify this as cover page entitled Final Report--Volume I of III, Fault Evaluation Study and Seismic Hazard Assessment, Private Fuel Storage Facility, Skull Valley, Utah, prepared by Geomatrix Consultants, Inc., February 1999. Behind that cover page are pages 54 to 56 of the document.

Is this the document that you referred to in commenting upon this bullet in State Exhibit 209?

A. Yes, it appears to be.

Q. And do you see in this document a discussion by Geomatrix providing reasons why a 2,000-year return period would be appropriate for the PFS site?

A. Yes, I do.

MR. TURK: Your Honor, at this time may I offer and request that this document be admitted into evidence?

MS. CHANCELLOR: Objection on the relevance of the document, your Honor.

MR. TURK: If it's not relevant, then why are we hearing testimony about this document?

JUDGE FARRAR: I thought it's relevant because it's referred to in the bullets that the witness talked about, in the Staff document that the witness -- critiqued, if that's the right word.

MS. CHANCELLOR: If Mr. Turk is going to connect it up, that's fine, your Honor.

JUDGE FARRAR: Well, objection overruled. We'll admit the document.

(STAFF EXHIBIT TT WAS ADMITTED.)

MR. TURK: Thank you, your Honor.

Q. (By Mr. Turk) In fact, if you turn to page 55 in this document, you see that the first paragraph at the top discusses the NRC

recommendation in SECY-98-126 that probabilistic approaches be taken for dry cask storage system licensing?

A. I see that.

Q. And you see in the next paragraph which starts off with the words, "Until the Part 72 rulemaking is completed, there is only indirect guidance from the Staff regarding the appropriate probability level for seismic design"?

A. I see that.

Q. And in that paragraph do you see where Geomatrix recites the TMI-2 ISFSI exemption in which a 2,000-year return period was approved?

A. I see that.

Q. And do you see also a discussion in that same paragraph of the DOE Standard 1020 which concludes for PC 3 that an appropriate mean ground motion corresponding to a 2,000-year return period would be appropriate for a PC 3 facility?

A. Yes.

Q. And do you also see in that same paragraph a discussion of the 1020 standard which concludes with in this paragraph the statement "Considering th minor radiological consequences from a canister failure, and the lack of a credible

mechanism to cause a failure, the staff finds that the DOE approach of using the 2,000-year return period mean ground motion as the design earthquake for dry storage facilities is adequately conservative"?

A. I see that, yes.

Q. So in fact, and incidentally, on the next page, page 56, the concluding paragraph in this section states, based on -- "Based on the above arguments for a risk-informed graded approach, we conclude that an appropriate design probability level for the PFSF site is 5 times 10 to the minus 4 (2,000-year return period)." Do you see that statement?

A. Yes, I do.

Q. So in fact, in February 1999 Geomatrix proposed a 2,000-year return period ground motion for the PFS facility, did it not?

A. I don't -- well, I'm pausing because of the distinction between proposed and concluded, Geomatrix concluding the appropriateness of a design level as opposed to proposing the design level.

Q. Well, perhaps you disagree with the word "proposed." Are you saying that their conclusion

that 2,000 years was appropriate?

A. That's what I read, yes.

Q. And you recognize that this document was submitted to the NRC -- I'm sorry -- this document was authored and completed prior to the submission of the PFS exemption request on April 2, 1999?

A. I see that.

Q. And you also recognize, then, that this document was authored and completed prior to the Staff suggesting to PFS that they use a 2,000-year return period in connection with their PSHA request, correct?

A. I follow that timeline, yes.

Q. And you agree that's correct?

A. Correct.

Q. So is it fair to say that your belief that -- I'm sorry, strike that.

In your testimony yesterday you were addressing certain statements that appeared in your April 1999 report to the State of Utah, and you stated that some of the conclusions which are mentioned in your issues and perspective paper are not your views today and that your views fell by the wayside when the Staff issued its rationale for a 2,000-year return period. Do you recall that

part of your testimony?

MS. CHANCELLOR: Objection to the characterization of the testimony, your Honor.

MR. TURK: All right.

Q. Did you find my characterization to be incorrect?

A. I'd need to have it restated. I was distracted.

MS. CHANCELLOR: It was the last part of Mr. Turk's question that Dr. Arabasz changed his mind based on the Staff's question.

JUDGE FARRAR: Let's have it read back.

MR. TURK: Your Honor, I can cut it short. I'll read the testimony into the record.

Q. (By Mr. Turk) At page 10057 continuing on to page 10058 --

JUDGE FARRAR: Of which day?

MR. TURK: Of testimony from yesterday, June 5.

Q. (By Mr. Turk) Do you have that before you?

A. Almost. Yes, I'm there.

Q. Ms. Chancellor asked you in her redirect the following question. Quote, "And the views expressed in this paper of April of 1999, are they

still views you hold today?" Do you see that question?

A. Yes, I do.

Q. And you answered, "No, they're not, and they fell by the wayside pretty quickly with the issuance of the Staff's reasoning for justifying the 2,000-year return period ground motion, and that began the -- I guess the trail of my challenging the reasons that they offered for the 2,000-year return period ground motion," close quote. Have I read that correctly?

A. Correct.

Q. In fact, you recognize now that the rationale contained in the Staff's December 1999 SER, preliminary SER, fairly closely resembled the points made by Geomatrix in its February 1999 document, correct?

A. That's correct. The context of the April 1999 was a review of the exemption request.

Q. And you had not reviewed the Geomatrix report when you commented to the State in April of 1999 on the exemption request?

A. Yes, I had. That was part of the review process.

Q. Thank you. Also in your testimony

yesterday you were commenting upon the concept of risk as discussed in NRC Regulatory Guide 1.165. Do you recall that part of your testimony?

A. Specifically the reference B.4 in Appendix B.

Q. When you mentioned reference B.4, I take it you're referring now to something that appears in Reg Guide 1.165?

A. That's correct. What you pointed me to originally was part of my November 2000 statement or argument supported by my declaration.

MR. TURK: Your Honor, I would like to distribute another document at this time.

MS. CHANCELLOR: Had Dr. Arabasz finished his answer?

Q. (By Mr. Turk) Had you finished your answer?

A. Yes.

MR. TURK: And I would ask that this document be marked for identification as Staff Exhibit UU.

(STAFF'S EXHIBIT UU MARKED.)

For the record, let me identify this document as follows. It is page 1 of Regulatory Guide 1.165 dated March 1997 followed by pages

1.165-12 and 1.65-16.

Q. Do you have that document in front of you, Dr. Arabasz?

A. Yes, I do.

Q. And this is in fact a correct replication of those two pages of the Reg Guide 1.165, is it not?

A. It certainly appears to be, yes.

Q. And at page 1.165-12 -- and by the way, this page, page 12 of the document, is also contained in a Staff -- in a State of Utah exhibit, is it not?

A. I believe that's correct.

MS. CHANCELLOR: State's Exhibit 201, Mr. Turk.

Q. (By Mr. Turk) State Exhibit 201, however, does not contain the following page that I've appended here, which is page 16, which is the reference, correct?

A. Correct.

Q. And in fact, if we look at the bottom of page 12 of Staff Exhibit UU for identification, in the first column the following statement appears, and I believe this is the statement that you discussed yesterday with Ms. Chancellor.

"Reference B.4 includes a procedure to determine an alternate" -- I'm sorry, "an alternative reference probability on the risk-based considerations; its application will also be reviewed on a case-by-case basis." Have I read that correctly?

A. Yes, you did.

Q. And this is the statement which leads you to conclude, if I understand your testimony from yesterday, that Reg Guide 1.165 when it uses the word "risk" was discussing risk as equivalent to a seismic hazard rather than any type of radiological risk. Is that correct?

A. No. If I may explain.

Q. Yes.

A. The reference to risk is specifically within the context of reference B.4, and the full text that began this line of questioning, as I recall, was you were pointing me to text in a November 2000 state submitted document. This is where you began the line of questioning asking me whether I and the State in its contention as one of the subsections of Utah QQ/LL E, part E, were challenging that the Staff had not taken risk into consideration in, to the best of my memory, establishing a 2,000-year return period.

Q. I'd ask you to turn to pages 10064 through pages 10067 of your testimony of yesterday.

A. Yes, I have that.

Q. Ms. Chancellor asked you the following question beginning at the bottom of page 10064. "Dr. Arabasz, in the November 9, 2000 State's request for modification of Utah L, Basis 2, when you referred to risk, are you referring to radiological risk?" Do you see that question?

A. Yes, I do.

Q. And you answered -- it's a pretty long answer. I'll read the first sentence. "No" -- quotes, "No. What I am referring to is the risk as referenced in Appendix B to Reg Guide 1.165." Then you go on with a longer paragraph which is in the record; we don't need to repeat it now. And then -- and you're welcome to take a look at that again as we study your testimony.

A. Yes, yes.

Q. And then Ms. Chancellor asked you the following question. "This is State's Exhibit 201a; is that correct?" And your answer, yes -- I'm sorry -- you answer, quote, "Yes, that's correct," close quote, and then you referred to this reference probability discussion. Can you see that

in your testimony?

A. Yes, I do.

Q. And that discussion that appears starting at the bottom of 10065 and continuing into 10066 is a discussion of that same paragraph that I read into the record a short time ago from Staff Exhibit UU for identification, is it not? In other words, the sentence that begins with the words, quote, "Reference B.4 includes a procedure--"

A. Yes.

Q. "-- to determine an alternative reference probability on the risk-based considerations?

A. Yes.

(A recess was taken.)

JUDGE FARRAR: Let's see how much progress we can make. Go ahead, Mr. Turk.

Q. Dr. Arabasz, before that unexpected break I was asking you about your testimony at page 10066 and the testimony begins at the bottom of 10065 in response to Ms. Chancellor's question whether what you're discussing is State's Exhibit 201. Do you see where we were in the testimony there?

A. Yes, I can.

Q. At the bottom of page 10066 you indicate that the reference to B.4 -- and here when you say the reference to B.4 you're referring to Reg Guide 1.165 where it mentions reference B.4, correct?

A. Correct.

Q. You indicate that's a position paper by the Nuclear Energy Institute which, as you state, quote, "puts forward thinking about what one should do if one wants to achieve risk consistency from site to site across the country." You continue in your testimony to state, "And the elements that enter into that consideration include the relative slopes of hazard curves in different parts of the country, the robustness of the SSC's, or the -- whatever elements are being designed, basically the design conservatisms and so on." I read that correctly?

A. You did.

Q. And then you continue on 10067 by stating, "so in that context the risk is risk consistency for the same probability of failure across the country; it doesn't relate to a radiological risk or a formal PRA as understood." Have I read that correctly?

A. Did you.

Q. So your understanding, then, of Reg Guide 1.165 and its reference in this paragraph to reference B.4 is that this is not a radiological risk consideration. That's your understanding, correct?

A. The part of Reg Guide 1.65 meaning this reference B.4, that's my understanding.

Q. And then reference B.4, that's the document that appears cited at the back of Staff Exhibit TT -- I'm sorry, Staff Exhibit UU as item B.4 on page 16, which is listed as, quote, "Attachment to Letter from D.J. Modeen, Nuclear Energy Institute, to A. J. Murphy, USNRC, Subject: Seismic Siting Decision Process, May 25, 1994," correct? That's the B.4 reference that you were discussing?

A. Yes.

MR. TURK: Your Honor, at this time I'd like to ask for Staff Exhibit UU to be admitted into evidence.

MR. GAUKLER: No objection, your Honor.

MS. CHANCELLOR: No objection.

JUDGE FARRAR: All right, UU will be admitted.

(STAFF EXHIBIT UU WAS ADMITTED.)

MR. TURK: And just so we're clear: this is essentially identical to the state's exhibit except that it includes the page 16 with the references.

MS. CHANCELLOR: Even though it's almost duplicative, I won't object, your Honor.

Q. (By Mr. Turk) Now, had you read that reference B.4 before you testified about it?

A. I have information in front of me that allows me to say yes.

Q. My question is, did you read reference B.4?

A. Before the November --

Q. Before you testified yesterday.

A. Yes.

Q. So you're familiar with that document?

A. Yes, I am.

(A recess was held.)

JUDGE FARRAR: All right. We're back, ready to go.

MR. TURK: Your Honor, at this time I'd like to distribute another document. I'll ask to have this document marked for identification as Staff Exhibit VV, as in Victor.

(STAFF EXHIBIT-VV WAS MARKED.)

MR. TURK: And let me identify this document as follows: It consists of a cover page, a letter from David J. Modeen of the Nuclear Energy Institute to Dr. Andrew J. Murphy of the NRC, Office of Nuclear Regulatory Research, dated May 25, 1994. As part of this exhibit, behind the cover page I've inserted the cover page of the attachment entitled "Seismic Siting Decision Process" prepared by the Nuclear Energy Institute, May 24, 1994 and behind that the cover page to Appendix C of that document entitled "Site-Specific Consideration of the Reference Probability." And then I've attached certain pages from that Appendix C, pages C-1 and C-2 and then pages C-10 through C-14.

Q. Dr. Arabasz, have you seen this letter before?

A. Not the letter itself. I received through a document request the attachment certified to be the attachment to the letter.

Q. And that would be the attachment which begins with the second page entitled "Seismic Siting Decision Process"?

A. Correct.

Q. Does this document on its face appear to

be Reference B.4 in Reg Guide 1.165?

A. Yes.

Q. Would you accept my representation that it is, in fact, Reference B.4?

A. Yes.

MR. TURK: Your Honor, I'd like to offer this exhibit.

MS. CHANCELLOR: No objection, Your Honor.

MR. GAUKLER: No objection, Your Honor.

JUDGE FARRAR: Then VV will be admitted.

(STAFF EXHIBIT-VV WAS ADMITTED.)

Q. (By Mr. Turk) And you mentioned that you've seen the attachment to the letter which is entitled "Seismic Siting Decision Process." Do you recognize that the following page, Appendix C, is also part of that submittal from the NEI to the NRC?

A. I do.

Q. Dr. Arabasz, before I begin examination of this document, are you familiar with the fact that risk has a special regulatory usage and understanding in NRC parlance?

A. No, I'm not.

Q. Have you ever heard the equation that

risk equals probability times consequences?

A. Yes.

Q. And are you aware that that's the usage of the word "risk" in NRC parlance?

A. As you've explained it to me, I understand that.

Q. Before today you did not?

A. I was certainly aware of definitions of risk within the seismic hazard community, but some particular nuance or definition that it might have within NRC policy making or regulations, no, not specifically.

Q. So you weren't aware that that was the way the word "risk" is used in NRC parlance before I mentioned it to you today?

A. Correct.

Q. I'd like you to look at page C-2 of this document, Staff Exhibit VV, and there is a paragraph in the middle of the page which states as follows: "The purpose of this appendix is to describe the conditions for which an adjustment of the PR for a site might be considered by an applicant."

Do you see that statement?

A. Yes, I do.

MR. TURK: I won't read more from the document, Your Honor. It is in evidence, and we can all turn to it as we deem necessary.

Q. If you would, turn to page C-10. Do you see the section entitled "C.7, Evaluation of Seismic Risk"?

A. Yes, I do.

Q. In the first paragraph of that section, the following statement appears -- and please tell me if I read it correctly -- To develop guidance when a site specific modification of the RP may be warranted an evaluation for selected sites located in the SCR, close quote.

I did read that to be evaluation rather than evaluations.

A. You did.

Q. I corrected the typo --

A. Yes.

Q. -- on my own.

And SCR, it stands for stable continental region --

A. Yes.

Q. -- is that correct?

A. In other words, the central -- it means here in the United States.

Q. There will be one SCR, correct, the central and eastern United States --

A. Would be start of the stable continental region.

Q. And what's your understanding of what the stable continental region consists of?

A. The core of a continental region which would have ancient rocks unaffected by relatively young geological deformation.

Q. Would the SCR include the western United States? Would the same SCR that includes the central and eastern United States also include the western United States?

A. No.

Q. The second sentence in that same paragraph read as follows: "The purpose of this assessment is to characterize the hazard at these sites in terms of hazard curve slopes and ground motions that contribute to the risk of seismically initiated core damage at future reactors."

Do you see that statement?

A. Yes, I do.

Q. And do you know what is meant by the term "seismically initiated core damage"?

A. I believe I do.

Q. Would you give me your understanding of that term?

A. This would be core damage, some failure induced by a seismic event.

Q. And when we're speaking of core, is that the reactor core? Do you know?

A. I do not know. I assume that.

Q. Do you know if that's associated with the reactor vessel in any way?

A. I assume it is.

Q. Do you understand -- assuming that your assumption is correct, do you understand, then, that what this sentence discusses is the correlation of seismic hazard with the risk of inducing core damage in a reactor vessel?

A. Yes. That's consistent with the analytical consideration of capacity as part of the -- a seismic risk consideration.

Q. Do you understand that core damage --

MS. CHANCELLOR: Just a moment. I don't believe Dr. Arabasz has finished.

Had you?

THE WITNESS: Perhaps I'm speaking out of turn.

MS. CHANCELLOR: Go ahead if you haven't

completed your answer.

THE WITNESS: I'll stop there.

Q. (By Mr. Turk) In the next paragraph, the paragraph begins by stating, "To assess the risk of a seismically initiated accident at a future commercial nuclear power plant, two approaches are considered," and then two alternatives are mentioned.

Do you understand that a seismically initiated accident refers to the potential for an accident involving the potential release of radiological materials from a nuclear reactor?

A. Yes.

Q. In the first paragraph, numbered paragraph that follows, there's a discussion of future reactors and an assumption that there will be a standard plant design with a certain peak ground acceleration safe shutdown earthquake.

Do you see that?

In fact, let me read it. One, in the first case, it is assumed that a future reactor will be a standard plant design with a 0.30 g peak ground acceleration (PGA) SSC.

Do you see that?

A. Yes, I do.

Q. Do you understand what a safe shutdown earthquake is?

A. Yes, I do.

Q. And could you provide your understanding of an SSE?

A. A safe shutdown earthquake would be an earthquake incident in which the plant would remain functional and able to shut down without some radiological release. That would be my general understanding.

Q. So without going into the precise definition, which I assume you recognize would be stated in the regulations for the NRC --

A. Yes.

Q. -- you understand that an SSE is that earthquake which is related to the potential for systems, structures and components important to safety not being able to perform their intended safety function?

A. Yes. I've seen that general description.

Q. And, therefore, if an earthquake exceeds the SSE, then there's a potential that the safety function of those SSCs may be impaired, correct?

A. Yes.

Q. And therefore, the definition of an SSE is important in order to understand at what level an earthquake should be considered to be the design earthquake in order to prevent the potential release of radiological material or other hazardous condition at the reactor?

A. Yes.

Q. You understand, then, that the SSE is related to radiological risk?

A. Yes.

Q. In the next sentence, in that first bulleted paragraph, it states, "In this case the plant is assumed to have a predefined seismic capacity as represented in terms of a core damage fragility curve."

Do you see that sentence?

A. Yes, I do.

Q. Do you understand what is a core damage fragility curve?

A. I have seen examples of fragility curves included in NUREG 6728, either as a probability density function or a -- more generally a cumulative distribution function.

Q. Are you familiar with the X and Y axes that would be represented in a chart depicting a

fragility curve?

A. The Y axis would be probability, the X axis, capacity.

Q. And probability of what?

A. The probability of failure, however defined. Presumably the failure of the component to perform its function.

Q. And when we're speaking about the ability of a component to perform its function, we're talking about its ability to perform the intended safety function so as to protect the public health and safety and avoid radiological releases?

A. That seems reasonable, yes.

Q. Or possibly, if not a radiological release, at least to prevent damage to the core such that a hazardous condition may ensue?

A. Yes.

MS. CHANCELLOR: Your Honor, may I interject? I've withheld objecting to this line of questioning because I did ask Dr. Arabasz a question about that circular reasoning in the Staff's safety evaluation report dated December 15th, and Dr. Arabasz testified that this was of an historical nature and was no longer valid. And I'm

just wondering if this line of questioning is relevant to anything that is at issue in this contention.

JUDGE FARRAR: Mr. Turk?

MR. TURK: Your Honor, Ms. Chancellor pursued this line of questioning. Dr. Arabasz, in response to her questions, indicated his view that Reg Guide 1.165 was not involved in consideration of radiological risk. I indicated at the time that he discussed the document my belief the document should be excluded because he didn't appear to have a proper understanding, or at least he hadn't expressed a proper understanding. If Ms. Chancellor had not raised the question in her redirect, I would not be pursuing it now. Whether it's relevant or not, I leave to Ms. Chancellor's initial determination to ask the question in the first place.

JUDGE FARRAR: I think he's largely correct, Ms. Chancellor. I'll overrule the objection.

MR. TURK: And I'd note again, Your Honor, it is a difficult area, and I'd appreciate the lack of interruption.

MS. CHANCELLOR: Your Honor, I object to

this characterization on the record.

JUDGE FARRAR: Wait, wait.

I thought, Mr. Turk, you were going to say it's a difficult area and that's why sometimes we're not sure we're within the scope of the prior examination or not. But Ms. Chancellor's objection, although not well founded substantively, was fully appropriate to be lodged.

And so let's just move on.

Q. (By Mr. Turk) Dr. Arabasz, when you provided your testimony yesterday, did you have this Appendix C to the NEI paper in mind?

A. Yes, and I was viewing it in a different context than how you are now parsing it.

Q. You recognize the fact that radiological risk is a part of this reference?

A. It is -- yes, and it's part of the consideration of what is described here as an analytical assessment of seismic risk, which I recognize in its exposition in pages not included in the exhibit that you offer that expands in a very similar way to the exposition of an approach in methodology in the Kennedy and Short paper and in NUREG 6728, Section 7.

MR. TURK: Your Honor, may we go off the

record for a moment?

(A discussion was held off the record.)

Q. (By Mr. Turk) Dr. Arabasz, in your testimony earlier today, I believe you mentioned that -- with respect to the table that appears in the Yucca Mountain Topical Report, State Exhibit 202, I believe you indicated today that you consider now that three of the plants listed in that table --

A. Excuse me, Mr. Turk.

Q. Yes.

A. May I put this document away? Are you --

Q. Yes, I'm completed with it.

A. Yes, I have it.

Q. State Exhibit 202 contains page C-18 of Topical Report TR-003 for Yucca Mountain, correct?

A. Correct.

Q. Incidentally, I believe you referred to this as the TR-2 document. Is that the colloquial way to refer to this?

A. If I did, I may have been mistaken, but I --

Q. Well, you may be correct, in fact. I don't know if there's ever been a TR-1.

A. A Topical Report 1, yes, there is.

Q. There has. All right.

A. Okay. So I'm sorry --

Q. All right. So --

A. -- Topical Report 2.

Q. Well, this -- this table appears in Topical Report TR-003?

A. Correct.

Q. And I believe your testimony today indicated that three of the facilities listed in this table are associated -- or are western U.S. plants associated with the coastal region, the tectonic plate region?

A. In my belief, yes.

Q. And you're excluding from that the Palo Verde and the Washington Nuclear Plant -- which of the nuclear plants? Is it No. 3?

A. 2 is Hanford.

Q. And you're excluding that from your discussion of coastal tectonic plate sites?

A. Yes.

Q. And you indicated your belief that there is -- I believe you stated, quote, a dearth of information for sites in the noncoastal United States, close quote. Maybe I'm quoting you

wrong --

A. Is this from May 17 or from --

Q. This was in this morning's examination. I believe this was Mr. Gaukler's cross.

A. Are you reading from the transcript?

Q. No. I don't have a transcript yet.

A. All right. From your notes?

(A discussion was held off the record.)

MR. TURK: Oh, perhaps that was the question, then.

Strike that, then. I withdraw that question.

Q. In State Exhibit 203, that is the exhibit in which you provide your hand annotation --

A. Correct.

Q. -- for various western U.S. plant sites or facility sites.

A. Correct.

Q. Can you provide us with information as to the frequencies that you used in coming up with the numbers that appear in your annotation on page 84 of that exhibit?

A. Yes. The average of ordinates for 5 hertz and 10 hertz or other information in that

near range provided in Appendix C, if one reads Appendix C carefully, it's evident that full data and information are not provided for every nuclear power plant, so assumptions are made by the authors to get reasonable estimates. For example, there might be data provided for, let's say, the 3- to 8-hertz range for a particular power plant, and if that were the only data available to the authors of the topical report, then they justify it and explain and use that data as a best estimate.

Q. Can you identify for each of the five facilities that you list there what frequencies you realized?

A. Yes. I'll refer to my copy of the topical report.

Q. So when you mentioned Appendix C, that's Appendix C to Topical Report 003, correct?

A. Yes.

For San Onofre data are provided in Table C-1 on page C-11, for spectral acceleration at 10 hertz and 5 hertz for probabilities of 1E to the minus 5, 1E to the minus 4, 1E to the minus 3.

Q. I'm sorry. Did you State Table C-1?

A. In my copy, yes, on page C-11 --

Q. Okay.

A. -- in the table identified as table C-1. This is for the San Onofre site.

Washington Nuclear Plant 2, I have information on page C-12 where hazard spectra are presented for -- excuse me, ordinates can be read for 5 hertz and 10 hertz at the 1,000-year return period and the 10,000-year return period. They're not provided for the 100,000-year return period, hence my simple line entry, my handwritten table.

Q. In other words, you left that as a blank?

A. Correct. And recognizing that, by comparison I could proceed up that column to the Kennedy and Short entry for the Hanford site insofar as WNP-2 was located on the Hanford Reservation with some reasonable equivalents. In other words, I did not -- I was unable to enter a value for A5/A4 for the Washington Nuclear Plant 2 and have referred to the availability of information for Hanford farther up in that column.

Q. That doesn't appear in your annotation?

A. No, it does not.

Q. Okay. By the way, I didn't mention Washington Nuclear 3, Satsop. Is that the next one you want to address?

A. Yes, that and Palo Verde. And for Palo Verde, on pages C-7 and C-8, hazard curves are provided for 5 hertz spectral velocity and 10 hertz spectral velocity. One can measure those ratios of ground motion equivalently insofar as if one went from spectral velocity to spectral acceleration, you would simply multiply by 2 pi times the frequency being used, and because it's a ratio, those terms would cancel out.

And that leaves Washington Nuclear Plant 3, I believe, and for Washington Nuclear Plant 3 I used information on page 16 where it has a curve given for spectral velocity. In this case it's for .15 seconds, which would be a frequency of between 6 to 7 hertz.

Q. When you say approximately between 6 and 7, is it about 6.67? I'm sorry. I don't have my calculator out.

A. Yes, 6.67. And I believe that covers the -- the range of information that comes from the Topical Report 2.

Q. I don't see in this table, State Exhibit 203, any calculation for the PFS site. Did you attempt to determine the A5 over A4 or the A4 over A3 for the PFS site?

A. The A4 over A3 was calculated by Dr. Cornell, or at least reported in Attachment A to his prefiled appendix in terms of the kH value which he reports as 2.8, to the best of my memory, so that if one took 2.8 and its inverse and then its inverse log, one would have an A4/A3 value for the PFS site of 2.28.

Q. And would you accept that as a correct number?

A. Yes.

Q. And what about for an A5 over A4?

A. The A5 over A4, using the same figure in the Geomatrix report from which Dr. Cornell made his measurements, there's some difficulty in that the 10 to the 5th value is slightly off the right-hand side of the graph and it's not clear what the resolution of the data points controlling that graph is. To the best of my memory, I made an approximation of an A5/A4 value that was of the order of 1.8. And, again, this is just from memory.

Q. 1.8?

A. 1.8.

Q. Incidentally, the values that you mentioned for the PFS site, is that the soil

condition or the rock condition? Maybe I'm using the wrong term. Do you recognize from Dr. Stamatakos's chart that he provided two curves, one for the soils and one for the rock?

A. I believe in Dr. Cornell's attachment it's a Figure 6-11, and -- I'm not certain. I believe that it was the PGA hazard curve for the soil conditions, to the best of my memory.

MR. TURK: Your Honor, this is an area that I would turn to Dr. Stamatakos to examine upon, but I'd like to wait at this time and complete my examination so we don't do tag team. I'll complete what I'd like to ask, and then I'll ask Dr. Stamatakos to pursue this line further.

JUDGE FARRAR: All right. We don't mind -- if you're on a line now and you want him to continue, we're happy to do that, and then you come back to another subject.

MR. TURK: As long as that's not going to be objectionable to anybody, that's okay with us.

JUDGE FARRAR: I think the concern is that he would ask a question and you would ask a follow-up on the same subject.

Any objection to the procedure?

MS. CHANCELLOR: No objection, Your Honor.

JUDGE FARRAR: Dr. Stamatakos, I don't know how often this provision of the regulations has been invoked, but give it a try.

DR. STAMATAKOS: This is clearly a first for me.

MR. TURK: We've made a deal. After today, he'll go to law school and I'll try to learn something about geophysics.

RECROSS-EXAMINATION

BY MR. STAMATAKOS:

Q. Good afternoon, Dr. Arabasz.

A. Good afternoon, Dr. Stamatakos. And I assume you're now on lawyer's rates.

Q. I think the only thing I'll get out of it, I might get a free dinner out it.

We had a lot of discussion about the implications of the different slopes of these hazard curves or their AR values, but I wonder if you might venture what your opinion is of the underlying phenomenon which contribute to the slope of the -- the differences in the slopes of these hazard curves that you talked about.

A. Yes. I believe it's basically due to the proximity of a controlling fault in the western, let's say, plate boundary area, which has a relatively short return period, on the order of centuries, as opposed to seismic sources moving farther eastward that have much longer recurrence intervals such that as you advance to the right on the hazard curve to ground motion, in the western U.S., after the controlling faults have produced their maximum motions, the additional ground motion going to the right on a hazard curve is basically coming from a -- I believe a tail on the distribution of ground motion, let's say on an attenuation curve, the log normal distribution of ground motion given a particular distance and magnitude, whereas on the eastern United States, as you move to the right or as you come down a decade in probability or return period that you still are having larger earthquakes from new sources with very long return periods that weren't contributing, as it were, one decade up in probability on the hazard curve, so that if we looked at this ski jump or ski slope that I described, as we're moving down in probability -- excuse me -- correct, as we're moving down on the Y axis in probability, in other

words, as we are encountering time with longer recurrence -- excuse me, longer return periods between events, that we're encountering large earthquakes in the central and eastern United States that have very, very long return periods.

I think that's the general gist of why these curves are flatter at the lower probabilities in the central and eastern United States and, relatively, in the intermountain area compared to the plate boundary.

Q. Do you -- in addition to that, would you agree that some component of the slope reflects uncertainties in the probabilistic seismic hazard assessment itself? You mentioned the ground motion part and when you get to the tails of the distributions, does that uncertainty also play a role, do you think, in the shape of the slope of the hazard curve?

A. Yes, but in some way that I couldn't fully understand. I come back to this comment that you picked up on many mickle makes a muckle, and it really takes a trained analyst to understand all of the aspects of a hazard curve and understanding elements that contribute to level or shape.

Q. Are you aware that in the assessment

that was performed for Diablo Canyon, for example, that there was some specific discussion about how the uncertainty was modeled in the ground motion part with an effort towards achieving some character to the slope in the Diablo Canyon hazard curve?

A. I'm not familiar with that.

Q. You -- you gave us some additional numbers for the PFS site. I wonder if you could go back -- I see a discrepancy or an apparent discrepancy. I wonder if you could check it for me. For the Los Alamos -- you provided in one of the State's exhibits some hazard information for Los Alamos, and I did a quick calculation -- I wonder if you could do the same -- of what the slope value was for Los Alamos. That's State Exhibit 206.

A. Okay. I did not attempt a slope value because Kennedy and Short had entered one for Los Alamos on Table A-2.

Q. Could you do one quickly now, just to check against the values that they reported?

A. Okay. I'll use information from the 1,000-year equal hazard spectrum and the 10,000-year equal hazard spectrum.

Okay. On the -- looking at Figure 9-98, and I will enter on the Y axis at .2 seconds for 5 hertz, and I will read approximately 1.43 for the spectral acceleration for the 10,000-year value. And for the 1,000-year value, which will be the second curve from the bottom, the lowermost one being 500 years and then 1,000 years, I'll read a value of approximately .51. And this will be the A4/A3 value.

Q. A4/A3 or A -- you're right, excuse me, A4/A3. You're correct.

A. So I will have a ratio of 1.53 to .51.

MR. TURK: 1.43.

THE WITNESS: Excuse me. 1.43 divided by .51 and a value of 2.80, and that -- well, yes, that's my estimate for -- for 5 hertz. And, let's see. So we'll enter the X axis for .1 seconds, representing the 10 hertz ordinate. On the uppermost curve for the 10,000-year spectrum, I will read a value of 1.1 g. On the 1,000-year hazard spectral curve, I will read a value of approximately .41. And my ratio will be 1.1 g divided by .41 g, giving me 2.68. And then I will average the 2.8 plus the 2.68 and have a result of 2.74, or approximately 2.7, to two significant

figures.

Q. (By Dr. Stamatakos) And can you compare that to the value that was reported in the Kennedy and Short paper for Los Alamos?

A. Yes. This is an A4/A3 value. Kennedy and Short -- excuse me, Kennedy and Short for the site LANL report a value of 2.14.

Q. So there's some -- some noticed difference between the values we calculated here and the values that are reported in that paper?

A. Yes. And I will remind you of a caveat I made this morning, that I wasn't attempting to definitively solve the problem, but I was seeking qualitative information to try to flesh out my overview of the western U.S. moving eastward from the plate boundary.

Q. I appreciate that.

Given that, which value would you consider to be more representative in your sort of overall assessment, the 2.14 as reported in the Kennedy and Short paper or the calculated value you just performed for us here?

A. The caution presented by Kennedy and Short in their analysis is to take care to use hazard curves in some wording that related to their

pedigree, and so in this case we have a February 1995 report for an updated P-S-H-A done at the Los Alamos site done by Woodward-Clyde, then, and which would be given precedence, in my opinion.

Q. In other words, the 2.7 is a more accurate representation of the A sub R for Los Alamos?

A. A4/A3. That would be the preferred value, in my opinion.

Q. One last one. Did you attempt to calculate an AR ratio for the National -- the USGS, the NEHRP curve that I provided in that scientific notebook exhibit that had the family of hazard curves for the western United States?

A. No, I did not.

Q. Can you just take a quick look at that figure, if you can find it?

MR. TURK: It's Staff Exhibit JJ at page 5 of the scientific notebook.

Q. (By Mr. Stamatakos) Would it be fair to venture an estimate that that slope of that hazard curve is steeper than the hazard curves for Skull Valley, either the rock hazard curve or the --

A. Which curve are you referring to?

Q. The curve in red -- oh, I'm sorry. It's

the one that's labeled Salt Lake City. Of course, you don't have the color version.

MS. CHANCELLOR: Does the exhibit that Dr. Arabasz has have the pedigree of the data?

THE WITNESS: It's a hazard curve that would be more generalized because it would not involve as fine scale seismic source characterization as some of these other curves.

Q. (By Mr. Stamatakos) But just on the shape of that curve, given that figure, it would appear to be slightly steeper than the hazard curves for PFS; is that correct?

MS. CHANCELLOR: Is this a hypothetical question based on the graph on page 5 of Staff's Exhibit JJ?

MR. TURK: Your Honor, may I interject? As an attorney, the question was does the line for Salt Lake City appear to be steeper than the lines for PFS. I don't hear a hypothetical.

MS. CHANCELLOR: And Dr. Arabasz testified that the --

MR. TURK: I don't think the question has a --

MS. CHANCELLOR: Just let me finish.

-- that the value -- that A sub R

value -- that the validity of that value is based on the pedigree of the data, and so my question is is it a hypothetical question because, first of all, you have to -- I don't want to get into technical legal objections with Dr. Stamatakos, but there really is no foundation that the Salt Lake City curve actually represents any particular site in Salt Lake City.

Q. (By Mr. Stamatakos) I would just say on the face value of the curve, just based on the shape of that particular curve as represented. So I don't know if that's hypothetical or not but --

A. Well posed, Dr. Stamatakos.

MR. TURK: I think the lawyers should just leave the room.

THE WITNESS: What I have to accept here, we have a composite plot, whereas with the other plots what I was accessing were -- were detailed hazard curves where the author is -- would be validating with great specificity, you know, the accuracy of the plotting points and so on. Here I have a generalized plot. I would have to accept your representation of the accuracy of this curve, as you've transcribed it from the NEHRP database to this plot. And as you gave me the hypothetical, at

face value, we will compare in the probability interval 10 to the minus 3 to 10 to the minus 4, the red line on the figure that I have with which plot from Skull Valley?

Q. Either the soil curve or the rock curve.

A. And, let's see. In that interval -- I need to be careful with slopes here. Yes, there is an apparently steeper slope in log normal space, and I would have to -- to make a quick calculation to -- well, let's see. Okay. The process, recognize, please, involves a ratio, so to get to that ratio in the -- the A4/A3 value, I need to make a quick calculation.

Q. Okay. Go ahead.

A. Well, I must have made my calculation too quickly because I got 2.23 -- excuse me, 2.3 versus 2.25.

I believe the implication is that the -- what appears to be the shallower dipping slope, in this case the hazard curve for Skull Valley, will end up with a larger AR value than the one for Salt Lake City.

Q. Thanks for on-the-spot calculations.

I wonder if I could ask you to look at DOE-STD-1020, Appendix C, again, and I believe this

is Staff Exhibit QQ. And if you could, turn to page C-9.

A. I have it.

Q. There's a paragraph in the middle of the page that begins with the words, "The Basis of the Seismic Provisions of DOE-1020."

Do you see that?

A. Yes, I do.

Q. Halfway down in that paragraph I believe the authors of this document offer a definition of what they mean by tectonic plate boundaries, beginning with the words, "For California and other high seismic sites near tectonic plate." Would you mind reading that full definition?

A. "For California and other high seismic sites near tectonic plate boundaries with seismicity dominated by close active faults with high recurrence rates, AR typically ranges from 1.5 to 2.25. If other western sites with seismicity not dominated by close active faults with high recurrence rates such as INEL, LANL, and Hanford, AR typically ranges from 1.75 to 3.0. Therefore, seismic design/evaluation criteria should be applicable over the range of A sub R from 1.5 to 6 with emphasis on the range from 2 to 4."

Q. Thank you.

Let's look at that definition with an eye towards the hazard that Geomatrix produced for Skull Valley. Would you agree with me that the site at Skull Valley is close to active faults?

A. Yes, I would.

Q. Would you agree that -- as calculated, that the seismic hazard for the site is high seismicity?

A. No.

Q. And then can you give me a definition of what you would mean by high seismicity?

A. If we look at the regional source areas defined by Geomatrix in their analysis of seismicity in the central Utah region, I recall three source zones. I can't remember how they were depicted, but there basically was a zone which encompassed the PFS site which was westward of a zone of higher background seismicity in the general north central Utah region. And on that basis, just from memory, what I would characterize is that in the vicinity of the PFS site, marginal to the main seismic belt, that the seismicity was less than the seismicity along the central zone which encompassed and was more or less centered on the Wasatch Fault

zone.

Q. So your definition occurs to the rate of occurrence in historic earthquakes and not to the overall level of ground motion you might expect at the site?

A. That was the response that I gave you.

And one thing that -- that concerns me as a seismologist, when I enter this exercise and go to the step or consider the step of calculating the recurrence ratios, in other words, using the kind of equation that Dr. Cornell did in Attachment A of his prefiled testimony, that it's not evident to me, as a nonengineer, when I end up with a -- a risk ratio whether that reflects a relationship to an average capacity, to a critical capacity of some component. And so I take care, assuming that there's some considerable engineering judgment entering in looking at that special segregation of outcomes that are identified by Kennedy and Short as being near the tectonic plate boundaries, in justifying the lower return period, P sub H value.

Q. All right. I think you went way beyond what I was asking you on that --

A. You've been patient. Mr. Turk would not have allowed me.

JUDGE FARRAR: Speaking of patience, we had talked about going to 3:30. If you have more than a couple minutes, Dr. Stamatakos, it might be worth taking a break.

MR. STAMATAKOS: Let's take a break. I have just a couple more question on this and one other --

MR. TURK: I would caution the questioner not to limit the number of questions.

JUDGE FARRAR: Right.

MR. TURK: I've done that.

JUDGE FARRAR: It's quarter of. We've lost some time today due to unforeseen circumstances, so let's just take 10 minutes, be back at 5 of.

(A recess was taken.)

Q. (By Mr. Stamatakos) Dr. Arabasz, a minute ago I asked you about -- we had a little discussion about what you consider high seismicity, and you indicated that you didn't think that the PFS site necessarily lies within an area of that high seismicity. Given that, aren't you at least surprised of the very large ground motions that Geomatrix predicted at this site, given some absence of what you would classify as high

seismicity, especially in comparing those ground motions with some of the ground motions that are calculated for sites that are clearly on the tectonic margin in areas I would assume you would say have high seismicity like Diablo Canyon or the San Francisco Bay Bridge?

A. Recognize that the slope of the hazard curve is different at the PFS site, and what is controlling the ground motion as described in the Geomatrix report are earthquakes of approximately magnitude 6.5 that have been brought very close to the site that are at distances, as I recall, on the order of 5 kilometers. And given the closeness of the controlling earthquake source to that site, the east fault, for example, having a distance of less than 1 kilometer from the measuring point on the site that Geomatrix selected, I reckon that that's the consequence of bringing that source so close to the site.

Q. All right. A little while ago we gave some estimates of the ratios, those A ratios, for the PFS curve. I think you quoted Dr. Cornell having an A4 to A3 curve ratio of 2.28, and you recalled the A5 to A4 ratio to be something around 1.8 --

A. Let me just check that. Let's see, the conversion to -- from 2.8, that sounds right, but let me just check that quickly.

Yes. Okay.

Q. So if you go back and look at that definition in the DOE-STD-1020 on page C-9, with those kinds of AR ratios, you would agree with me that they could fall into the category that are defined here either for the high seismic tectonic plate or the range that are given for other western sites not dominated with close faults with high recurrence rates?

A. Two aspects of this. Numerically I think we may be dealing with the A4/A5 range with a borderline value, something borderline in terms of an implication for a risk reduction ratio considered in the B.4 category in the DOE table. But, in a general setting, let's say on regional scale, from the discussion that Dr. Cornell gave relating to hazard in California along the plate boundary and Salt Lake City in general, the difference in implication for hazard on a regional scale is distinctly different.

Q. But just the values in and of themselves, given the value distinctions that are

provided in the document, the 1.8 or 2.28 could fall within the range of 1.5, 2.25 or 1.7 to 3.0 which are given in the definition in the DOE standard, correct?

A. Correct. There are a spectrum of values, and Kennedy and Short selected, as I recall, what were overlapping ranges for their -- let me return again to page C-9 that you pointed me to. The plate boundary curves 1.5 to 2.25 overlapping with the next range, 1.75 to 3.0 overlapping with the -- let's see the range for the -- I'm searching for the central and eastern U.S. But each of those classes has overlapping bounds.

Q. So perhaps a more refined way of thinking about these different classes of areas, following the logic at least as it's presented based on DOE-1020, might perhaps be that we shouldn't have two distinctions but perhaps three distinctions, the central and eastern United States where the slopes are very shallow and the recurrence intervals are very long, an intermountain west division and a tectonic plate division. Would you agree with that assessment?

A. No, and I'll explain why. This is

something that earth scientists might dream up as a logical way to bend the information, and I think a better, a more refined way to -- to look at the issue is the more complete methodology that's developed in NUREG 6728, particularly in Section 7. That entire NUREG faces the issue of aiming for risk consistency across the whole country and how to deal with that problem. And what that poses is a need for extensive regulatory development to treat all of this information, the earth science input, namely, the hazard curves, notably their slopes and their influence on seismic margin studies and capacities, design or evaluation procedures, acceptance criteria and so on that gets into that engineering domain that I'm reluctant to step into.

Q. But -- so given that criticism, then, you would also be critical of this current division that's just provided in DOE-1020 between the tectonic plate and the rest of the country, following that same logic, correct?

A. I'll take care with the criticism because I would have to stand back. And I have a considerable respect for Dr. Kennedy as he's developed this methodology, and I recognize from

various sources that it appears he's had a very heavy influence in the development of this methodology and particularly in its application. Now, when I consider the DOE facilities to which these results are applied, it's very clear that these are major, major installations, particularly the litany of installations across the western U.S., and my belief would be that very serious considerations and lots of engineering judgment went into the development of that methodology and its application, particularly for the DOE facilities.

Q. So if I understand that correctly -- I make a leap of logic here -- then this whole exercise where we're looking at the AR and the slope values is not as critical as other aspects, in your assessment? In fact, perhaps this slope -- at least the details of the slope calculations don't really matter all that much compared to other parts of your -- your logic.

A. They're very important in an equation that appears in Attachment A of Dr. Cornell's prefiled testimony, and that equation also appears in NUREG 6728 and even going back to this Reference B.4 cited in the Reg Guide 1.165. The slopes of

those hazard curves are a big deal to the engineers insofar as those slopes propagate through considerations of factors of safety into risk consistency. And so what we have going, all the way back to that paper submitted by the Nuclear Energy Institute, is great concern about along the plate boundary having failures of probability lower -- let me see. No, excuse me -- failures of probability, lower -- yes, I believe I have that correct -- compared to nuclear facilities in the eastern and central United States.

Q. Take one more example, and I think I'll be able to wrap up. If you look at the AR value for Washington Nuclear Plant No. 2 that you calculated in State Exhibit 203, that value is 2.72, correct?

A. For the A4/A3, and that would apply to a PC-3 facility.

Q. And we don't know what the value is for A5 to A4?

A. We would have to accept the value entered for Hanford by Kennedy and Short under the A4/A5 column and accept that the -- because the Nuclear Power Plant 2 is on the Hanford Reservation, that the hazard curves might be

similar.

Q. If you look at those slope values -- and I know in the discussion when we were talking about these five particular power plants you sited Palo Verde as being an outlier. I wonder if you might also consider that perhaps Washington Nuclear Power Plant 2 might be an oddity in the sense that it has relatively high slope values but its SSE or its mean probability of exceedance that corresponds to the SSE is about 3,600 years and so, in a sense, it doesn't fit the definition of having an SSE that's closer to 10 to the minus 4 acting like a site that should be in the eastern central U.S. bin as opposed to the tectonic plate bin, correct?

A. Correct, and I applaud you, as a scientist, for honing in on the exception because generally there's information to be gathered there. I believe that at the beginning of your characterization you said that the site -- the Washington Nuclear Plant 2 had a high slope --

Q. I mean a high AR value, excuse me, higher than you might expect.

A. The value of 2.01 --

Q. Or higher up, 2.72.

A. Yes, a higher AR value, correct. Okay.

Now I'm with you.

A real puzzle why that exceedance probability for the Washington Nuclear Power Plant in terms of the return period is so low, and one possibility is that the original design basis earthquake, for whatever reason, may be low, lower than one would expect at that site.

Q. So you at least would want to critically question how that SSE was originally derived?

A. Just so, particularly if I were to go to a table in Yucca Mountain Report 2 and use that as a basis for attempting to justify the 5,000-year return period for the entire western U.S., that point certainly would invite close inspection.

Q. But that's -- that conclusion you draw is based on this whole line of thinking about slopes and locations relative to tectonic margins and where these facilities ought to be compared to the type of exceedance probability you would expect for their SSE?

A. In general, yes. I think I followed your question adequately.

MR. STAMATAKOS: I don't think I have any --

(A discussion was held off the record.)

MR. STAMATAKOS: I thank everybody's indulgence for a non-lawyer being able to ask questions, and I hope I never have to do this again.

JUDGE FARRAR: Thank you, Dr. Stamatakos. We appreciate your contribution.

Mr. Turk, you wanted to go to another line?

MR. TURK: Yes, Your Honor.

JUDGE FARRAR: All right.

MR. TURK: And I would note I would also thank Dr. Stamatakos. I thought it was very helpful and done professionally, as an attorney would do in his best practice.

RECROSS-EXAMINATION (Continued)

BY MR. TURK:

Q. One thing that you mentioned in your testimony earlier today, Dr. Arabasz, was you looked at the set of curves presented by Dr. Stamatakos in Exhibit JJ for the Staff at page 5, you mentioned that this was done with a logarithmic Y axis and an arithmetic X axis, and would you agree that that's a proper way in which to present the information contained in this graph?

A. I think it's an arbitrary presentation. The hazard could either be -- excuse me. The hazard curve could either be presented in log-log space or log normal, and data are presented in either format.

Q. When you say "arbitrary," what you're saying, in essence, is that this is one acceptable means in which to do it?

A. Correct.

Q. And you don't have any problem with the fact that Dr. Stamatakos presented it in this fashion?

A. No, I do not.

Q. Just so I'm clear in my understanding of State Exhibit 204, which is the Update of Deterministic Ground Motion Assessments, Revision 1, for the PFS site --

A. Yes, I have it.

Q. -- these curves do not purport to be, nor are they, probablistic seismic hazard analysis -- seismic hazard curves, are they? These are only deterministic curves.

A. No, that's not correct, Mr. Turk. The solid line is a deterministic response spectrum from the east fault, and that solid line is

superposed (sic) on top of a series of curves identified as equal hazard spectra that come from the P-S-H-A.

Q. Do you understand that the equal hazard spectra curves do not constitute new curves, but, rather, this is a comparison of the deterministic curve calculated by Geomatrix with those equal hazard spectrum that existed previously, or are those new curves?

A. In this -- in this Revision 1 of April 2001, the equal hazard spectra would come from the latest P-S-H-A results at the -- at the PFS site, or for the PFS site.

Q. And do you know when that latest P-S-H-A was conducted? Is that the one we've been discussing already in the proceeding?

A. Yes, in general reported in the March to April 2001 time frame, as I recall, at least in the documents.

Q. So these do not constitute new curves with respect to the P-S-H-A, but, rather, this is just a comparison of this deterministic line with the probabilistic seismic hazard analysis curves that are already -- that already make up part of the PFS application and Staff review of that?

A. In their most recent, most updated version, correct.

Q. And the P-S-H-A curves, or as they're described here, the equal hazard spectra curves, those are not curves for the entire P-S-H-A, but, rather, these are only the curves presented for that particular fault, the east fault, correct?

A. No, that's not correct, Mr. Turk.

Q. So the equal hazard spectra, that represents the entire P-S-H-A --

A. They are representations of the P-S-H-A results.

Q. Including all faults applicable to the site?

A. All seismic sources that enter into the P-S-H-A, correct.

Q. At one point in your testimony earlier today, you indicated that DOE chose not to use a 5,000-year return period but instead chose to use a 10,000-year return period. Do you recall that part of your testimony?

A. Relating to Yucca Mountain?

Q. I believe it was for the -- the Yucca Mountain preclosure facility.

A. Correct.

Q. And in making that statement, were you referring to something that appears explicitly in a DOE document?

A. The -- yes, within the general context of Yucca Mountain Topical Report 2 and DOE's undertaking to identify and justify a probability of exceedance for Frequency Class 2 events.

Q. Did you mean to suggest that DOE was not aware of any intermountain characteristics that might be applicable to the Yucca Mountain preclosure facility?

A. Good Lord, no. What I'm suggesting is that in developing Topical Report 2 that PFS -- excuse me. I've misspoken -- that DOE needed to justify the selection of a hazard exceedance probability for Frequency Class 2 events, selected 1 times 10 to the minus 4 and then, to justify that selection, set out to compare it to a reference probability for a nuclear power reactor and, as part of that exercise, then carried out the hazard exceedance -- excuse me, the -- the calculations which computed the annual probability of exceeding the SSE design basis response spectra motions for existing nuclear power plants in the western United States, at the end of that exercise basically had

that result of a mean annual probability of exceedance of 5 times 10 to the minus 4 and logically would have had the option to either use that as a reason for justifying a different probability of exceedance or to remain with the 1 times 10 to the minus 4. And to my understanding, they did the latter.

Q. And that afforded them additional conservatism in establishing the design basis earthquake for the facility?

A. That's correct.

Q. And, again, the preclosure facility --

MS. CHANCELLOR: Your Honor, I think Dr. Arabasz may have misspoken.

Did you mean 2 times 10 to the minus 4 when you were talking about the western U.S. nuclear power plants? I think you said 5 times 10 to the minus 4.

THE WITNESS: If I said 5, I misspoke. I meant to say 2 times 10 to the minus 4.

MS. CHANCELLOR: Excuse me, Mr. Turk. I didn't mean to interrupt.

THE WITNESS: That's the trouble I get into when I lose my cheat sheet.

Q. (By Mr. Turk) And for clarity, you

mentioned that this is Topical Report 2. In fact, that's TR-003, correct?

A. That's correct.

Q. And your confusion is one that I understand other people make as well because these reports are referred to colloquially differently than they're titled.

A. Yes. And we encountered this is the 2001 depositions.

Q. And just so we're clear on the record, then the preclosure facility includes the removal of spent fuel from within canisters and the transfer of that spent fuel into other storage systems, correct?

A. Correct.

Q. And that's a higher hazard than would be presented by the PFS facility in which -- I'm sorry. There's a higher risk associated with that than there is associated with the PFS facility in which the spent fuel remains within the multipurpose canister at all times, correct?

A. Correct.

Q. Do you have a copy of State Exhibit 203 handy?

A. This is the one with my hand

annotations?

MS. CHANCELLOR: 203, Dr. Arabasz, is the Kennedy and Short paper.

THE WITNESS: Yes, I have that in front of me, Mr. Turk.

MR. TURK: May we have just a moment, Your Honor?

(A discussion was held off the record.)

MR. TURK: I'll move on. I'll skip that.

Q. At many different times in your testimony you were discussing a document which I believe you referred to as NUREG/CR -- is it 5628? I'm sorry. 6 -- 6728?

A. Correct.

Q. Do you have that document with you?

A. Yes, I do. I have Volume 2 with me.

Q. And does that volume that you have with you indicate who the authors of the document are?

A. On the --

Q. Or which organization sponsored it?

A. Yes. At least on the title page of Volume 2, the authors are identified as Risk Engineering Incorporated.

Q. And does it have the date?

A. Excuse me. I also happen to have with me a title page apparently from Volume 1 which has additional information on authorship. Shall I hand it to you to read into the record?

Q. No. If you would do that, it would be more expeditious.

A. The title, Technical Basis for Revision of Regulatory Guidance on Ground Motions: Hazard- and Risk-Consistent Ground Motion Spectra Guidelines. The date that appears, manuscript completed May 2001. Date published, October 2001. Prepared by R.K, McGuire, M-c-G-u-i-r-e, W.J. Silva, C.J. Constantino with the affiliation of Risk Engineering Incorporated being the principal contractor. Subcontractor, Pacific Engineering & Analysis. Consultant, Carl J. Constantino and, identified, R.M. Kenneally, K-e-n-n-e-a-l-l-y, NRC project manager.

Q. May I look at that now, please?

And at the bottom of the title page, do you also see that it --

MS. CHANCELLOR: Mr. Turk, if you're asking questions from Mr. Arabasz's document, could you go and stand next to Dr. Arabasz, please?

MR. TURK: I think that's a fine idea.

Q. At the bottom of the cover page, do you see that it states, Prepared for Division of Engineering Technology, Office of Nuclear Research, U.S. Nuclear Regulatory Commission?

A. Correct.

Q. Is it your understanding that this document constitutes a publication by the NRC?

A. I'm uncertain. No. I infer or believe that a NUREG is a publication which is given this characterization or classification of some recognition by the NRC.

Q. Do you understand if there's a distinction between a document that bears a NUREG designation versus a document that bears a NUREG/CR designation?

A. I'm not familiar with that distinction, Mr. Turk.

Q. Do you know whether the NRC staff or the Commission has ever endorsed this document?

A. I do not.

Q. But as you look at the document, your assumption is that this is an NRC approved document?

A. An NRC sponsored and approved document.

Q. And if, in fact, it was not an NRC

approved document but, rather, represented the views of the authors, including the contractors listed there, then that would be something which those authors or contractors purport to be valid, but we don't know if the NRC agrees with that conclusion, correct?

A. Correct. I understand that this is part of a process of developing regulatory considerations.

Q. And if, in fact, that document represented the views of the authors or contractors to the NRC, the fact that you agree with them, as you've indicated in your testimony, would mean that you like the views they have expressed there, you would agree with the views expressed there and you would believe that those views should be considered by the NRC?

A. What I recognize in this document in the methodology development is what I'll call the fingerprint of Dr. Kennedy. His authorship is not explicit in the Nuclear Energy Institute report, the Reference B.4, but there's clearly a commonality in looking at the Kennedy and Short document, the methodology or the philosophy and design approach in the DOE-STD-1020 documents.

And, indeed, there are basic equations here that are ascribed, for example, to development by Gabriel El Toro and Dr. Cornell, in my understanding and judgment representing the considered opinion of very respectable practitioners in the hazard and risk assessment.

Q. I'd like to move to another document at this time, and that is a document that we've admitted as a Staff exhibit, Staff Exhibit QQ, which are portions of the DOE-1020-2002 standard. And I would ask you to turn to page C-14 --

A. Excuse me. I seem to be missing that one document.

Now I have it. Excuse me. Yes. Which page, please?

Q. Starting at the bottom of page C-14 and continuing on to page C-15, I think -- the paragraph at the bottom of the page C-14, do you see the discussion by DOE in which they indicate that they have calculated the probability level of SSE design spectra between 5 and 10 hertz at the 69 eastern nuclear power plants?

A. I see that.

Q. That's a bit different, isn't it, from the previous discussion by DOE of only 29 nuclear

power plants in the central and eastern United States, correct?

A. Correct.

Q. Actually, there was a discussion in Reg Guide 1.165 about 29 nuclear power plants in the central and eastern United States.

A. Yes. There's a sequence of references. It may have been Lawrence Livermore National Lab, for example, that originally carried out that analysis, and then the citation appears forward in Reg Guide 1.165 and other places.

Q. If you turn to C-15 --

A. Yes.

Q. -- there's a chart. This is Figure C-4. And is it correct that this chart represents a plotting, p-l-o-t-t-i-n-g, of the probability of exceeding safe shutdown earthquake response spectra at those 69 central and eastern United States nuclear power plants as a function of -- well, let me stop there.

MS. CHANCELLOR: Your Honor, I've been very patient. I just can't connect this up with any redirect testimony.

MR. TURK: In his testimony earlier today, Dr. Arabasz indicated he agrees with the 1

times 10 to the minus 4 MAPE for nuclear power plants, and I'm just examining on this document and how that bears on his statement.

JUDGE FARRAR: All right. We'll allow it, but it does seem to me that the recross is going on a relatively long time compared to the redirect. So --

MR. TURK: If it's any help, Your Honor, I don't see very much more that I'm going to be asking of him today.

JUDGE FARRAR: All right.

THE WITNESS: Yes, okay. Referring to the graph, one of the typical differences between graphs documented by engineers and those by scientists, in general, is that the engineers present a very terse title caption so that -- let's see. I just -- I'm going to assume that, indeed, the plot is for the 69 power plants and what we have here is a cumulative distribution function. And, let's see. I'm trying to discern whether we're looking at the median -- I assume from the value 1 times 10 to the minus 4 that these must be mean exceedance values that were plotted, such that the median of the means for the 69 power plants is 1 times 10 to the minus 4.

Q. Just to make sure that there's no confusion, at the bottom of page C-14 in that paragraph that we discussed briefly --

A. Yes.

Q. -- if you would, read the sentence -- or let me read it into the record. Quote, Recent probabilistic hazard studies, e.g. Reference C-6, have indicated that for nuclear plants in the eastern U.S. the design SSE level generally corresponds to an estimated annual frequency of exceedance of between 0.1 times 10 to the minus 4 and 10 times 10 to the minus 4 as is illustrated in Figure C-4. The probability level of SSE design spectra between 5 and 10 hertz at the 69 eastern U.S. nuclear power plants considered by Reference C-6 fall within the above-stated range. Figure C-4 also demonstrates that for two-thirds of these plants that the SSE spectra corresponds to probabilities between about 0.4 times 10 to the minus 4 and 2.5 times 10 to the minus 4. And then it continues, Hence, the specified hazard probability level of 1 times 10 to the minus 4 in is this standard is consistent with SSE levels. See also U.S NRC Regulatory Guide 1.165.

Does that help you with your

understanding of what this figure is?

A. Yes.

Q. And it, in fact, does plot the 69 nuclear power plants in the central eastern United States?

A. Yes.

Q. And could you tell me -- the vertical access indicates or has a bar at the 0.5 level --

A. Yes.

Q. -- for cumulative distribution?

A. The Y axis is probability, so the cumulative distribution as standardly plotted is from 0 to 1. The horizontal line at .5 then would represent the median, that value below which half the entries fall and above which the remaining half fall.

Q. So is it correct, then, that the horizontal line represents a median value for those 69 nuclear power plants?

A. The intersection with the cumulative distribution curve, which is the irregular curve, that intersection -- well, let me look closer at this because the intersection with the -- typically one would intersect the curve and then go down to intersect the X axis. In this case it appears that

what is represented by the cross hairs, in effect, is the value for 1 times 10 to the minus 4 on the X axis, showing that, at least by my inspection, it approximately intersects the cumulative distribution function at the .5 level.

Q. In fact, it's slightly off from that. Would it be more correct to say that the -- the meeting of the means represented by the horizontal line -- that's correct, that's a meeting of the means?

A. Correct.

Q. -- comes out slightly to the right of that 1 times 10 to the minus 4 value?

A. Correct.

Q. And can you take a look at that and give me a rough estimation? Is that approximately a 1.1 times 10 to the minus 4 value?

A. A little less than 1.1. Something between 1.0 and 1.1E to the minus 4.

Q. And that would equate to something of a smaller return period than 10,000 years. That would be more on the order of somewhere between 9,000 to 10,000 years?

A. Let me make a quick calculation.

9500, approximately.

Q. Do you see much difference between stating this value as being a 9500-year return period versus a 10,000-year return period?

A. No. I think a careful practitioner would characterize it as approximately 1 times 10 to the minus 4.

Q. The approximate equivalent?

A. Yes -- excuse me. Would characterize the outcome, namely, the meeting of the means as being approximately 1 times 10 to the minus 4.

MR. TURK: I have nothing further.

JUDGE FARRAR: Ms. Chancellor, do you have some questions?

MS. CHANCELLOR: One, Your Honor.

JUDGE FARRAR: Okay. We'll see.

FURTHER REDIRECT EXAMINATION

BY MS. CHANCELLOR:

Q. Dr. Arabasz, did any of the questions and testimony during Mr. Turk and Dr. Stamatakos's recross-examination cause you to change the opinions that you have given during this proceeding?

A. I'll begin by pointing out that Mr. Turk graciously helped me with a better understanding of

some fine points of NRC parlance and documentation, but at bottom, no, my opinions remain the same.

MS. CHANCELLOR: Thank you, Dr. Arabasz. I have nothing further.

JUDGE FARRAR: Mr. Gaukler?

MR. GAUKLER: Nothing further, Your Honor.

JUDGE FARRAR: Mr. Turk?

MR. TURK: No, Your Honor.

JUDGE FARRAR: All right. Then, Dr. Arabasz, the good news for you is you are excused.

THE WITNESS: Thank you, Your Honor.

JUDGE FARRAR: The record will note that you are smiling, and we can understand why. We thank you for your testimony, which began a couple of weeks ago, if I recall correctly, and you've been in that chair for a long time. We appreciate you sharing your views with us.

THE WITNESS: Thank you very much, Your Honor.

JUDGE FARRAR: It's now a few minutes to 5:00. What can we get accomplished in a few minutes?

MS. CHANCELLOR: I guess we could introduce Dr. Bartlett -- are we on the record? I

guess we could introduce Dr. Bartlett's testimony, but I don't know that we'll get much further.

JUDGE FARRAR: Well, let's put it in the record and -- oh, but, now, wait a minute.

MS. CHANCELLOR: Yeah, we'll probably pick this up in Rockville, Maryland.

MR. GAUKLER: I have no problem going ahead and putting it in. And I'll start some cross-examination, but, obviously, I'm not going to get done today.

MR. TURK: May we go off the record?

JUDGE FARRAR: Yes.

(A discussion was held off the record.)

JUDGE FARRAR: Let's go back on the record.

Having consulted with the parties, we've decided that it would make for an unnecessarily choppy record to introduce Dr. Bartlett's testimony now and not come back for some days or weeks.

And it is now just before 5:00, and this seems like a good time to adhere to nine-to-five rule, particularly since the parties have some discussions that they need to conduct off the record amongst themselves.

So we will adjourn at this time,

reconvene here 9:00 here tomorrow for the Bartlett/Ostadon --

MS. CHANCELLOR: Section D testimony.

JUDGE FARRAR: -- Section D testimony. Thank you.

(The proceeding was concluded for the day at 5:00 p.m.)

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:	Salt Lake City, Utah

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.

/s/ Diana Kent

Diana Kent
Official Reporter
Neal R. Gross & Co., Inc.