RAS 4922

# Official Transcript of Proceedings

# NUCLEAR REGULATORY COMMISSION



Title: Private Fuel Storage, LLC

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

Location: Rockville, Maryland

Date: Thursday, June 27, 2002

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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

ASLBP Hearing Room
Third Floor
Two White Flint North Building
11545 Rockville Pike
Rockville, Maryland

June 27, 2002

The above-entitled matter came on for hearing, pursuant to notice, at 9:00 a.m. before:

MICHAEL C. FARRAR, CHAIRMAN
Administrative Judge
U. S. Nuclear Regulatory Commission

DR. JERRY R. KLINE
Administrative Judge
U. S. Nuclear Regulatory Commission

DR. PETER S. LAM
Administrative Judge
U. S. Nuclear Regulatory Commission

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C-O-N-T-E-N-T-S

# E X H I B I T S

| NUMBER | DESCRIPTION | MARK | RECD |
|---|---|---|---|
| State | | | |
| 129 | Cornell Declaration | 12777 | 12778 |
| 130 | Cornell Deposition | 12777 | 12778 |
| 131 | Sigh and Soler Depositions | 12777 | 12778 |
| 132 | Natural Phenomena, Hazards Design and Evaluation Criteria for DOE | 12777 | 12778 |
| 133 | (Withdrawn) | | |
| PFS | | | |
| 244 | Bartlett Deposition | 12788 | 12876 |
| Staff | | | |
| 64 | Section 3.8.4 NUREG 0800 | 12902 | 12904 |

P-R-O-C-E-E-D-I-N-G-S

(9:10 a.m.)

CHAIRMAN FARRAR: On the record. It is 10 after 9, we've been waiting for other counsel for the Applicant, who are on their way, they may have gotten caught up in security problems.

So with Mr. Nelson here we will start, get Dr. Bartlett's testimony introduced, and so forth, and by then we hope the Counsel responsible for this aspect of the case will have shown up.

Go ahead, Ms. Chancellor. Ms. Nakahara.

MS. NAKAHARA: Thank you, Your Honor.

DIRECT EXAMINATION

BY MS. NAKAHARA:

Q Good morning, Dr. Bartlett.

A Good morning.

Q Do you have, before you, your testimony entitled State of Utah, Testimony of Dr. Steven Bartlett on Unified Contention Utah L/QQ part E, dated June 5th, 2002?

A I do.

Q And did you make modifications to this testimony reflected as of June 5th, 2002?

A Yes, there are some strike outs.

Q And is this based on the recent

unavailability of Dr. Ostadan?

A That is correct.

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

A Yes.

Q Including the revisions of June 5th, 2002?

A Yes.

MS. NAKAHARA: Your Honor, I would move to bind this into the record as if read.

CHAIRMAN FARRAR: All right.

THE WITNESS: I have a couple of corrections.

CHAIRMAN FARRAR: Before you do that, for some reason our new versions didn't make it from Salt Lake, so we are operating on the April 1st version, which had the Bartlett/Ostadan.

MS. CHANCELLOR: I'll run and make three copies.

CHAIRMAN FARRAR: While you are doing that, let me just ask --

MR. GAUKLER: I have three copies here.

MR. TURK: We will need some for the Reporter, also.

MS. CHANCELLOR: The Reporter has copies.

CHAIRMAN FARRAR: While you are

distributing those, Dr. Bartlett, this is essentially -- what you are offering today is essentially the same as the April 1st, you've just stricken out references?

THE WITNESS: There are some parts that are stricken out, and then some of these paragraphs were jointly authored by myself and Dr. Ostadan.

CHAIRMAN FARRAR: But the substance is still the same, you just, in effect, stricken references to Dr. Ostadan?

THE WITNESS: Yes, there is one question in Answer 29 that was completely stricken.

CHAIRMAN FARRAR: Okay. We now have the new version in front of us. And before you make the additional changes, let the record reflect that Mr. Gaukler, and Mr. Travieso-Diaz have shown up.

And, gentlemen, we weren't going to do anything without you, we were just going to get the testimony into the record, so we would be ready to go.

MR. TRAVIESO-DIAZ: Thank you, Mr. Chairman. I don't want to sound like I'm whining, but security again got the better of us. We were down there, and there was nobody to bring us up, so we waited fruitlessly for about ten minutes.

CHAIRMAN FARRAR: Very well.

MR. GAUKLER: I would add that that is the

first time this happened.

CHAIRMAN FARRAR: Yes, actually it has worked as well as we had hoped, given all the circumstances, this is the only time, I guess we can consider that good news.

Dr. Bartlett, you were going to tell us the additional changes?

THE WITNESS: Yes, there are still a couple of corrections even to the June 5th copy of this document.

CHAIRMAN FARRAR: Okay.

THE WITNESS: On page 5, in the third paragraph, beginning with the DBE, it references DOE standard. That standard is DOE standard 1021-93, not 1020.

CHAIRMAN FARRAR: All right.

THE WITNESS: On page 9, in the first paragraph, second line, it states: For PC3 structure system components, performance goal is 10 the minus 4, that should be 1 times 10 to the minus 4th.

CHAIRMAN FARRAR: Okay.

MR. GAUKLER: What line, again?

THE WITNESS: It is the second line, and it says: For PC3 SSC, the performance goal is 10 to the minus 4th, it should be 1 times 10 to the minus

4th.

And also in that same paragraph, for the second to the last line in that paragraph, that 10 to the minus 4th should be changed to 1 times 10 to the minus 4th.

CHAIRMAN FARRAR: I see some later references to the same DOE standards, so all of those should be --

THE WITNESS: No, most of this document refers to DOE standard 1020, and that is correct.

CHAIRMAN FARRAR: Okay.

THE WITNESS: There is one place where, actually, the structure systems and components are categorized, and the document where you categorize the structure systems and components is DOE standard 1021, not 1020.

But most of the other, all these other references to DOE standard 1020 are correct.

CHAIRMAN FARRAR: All right, fine, thank you. Then with those --

THE WITNESS: That is all.

CHAIRMAN FARRAR: -- changes, is there any objection to the testimony?

MR. GAUKLER: No objection, Your Honor.

MR. TURK: No, Your Honor.

CHAIRMAN FARRAR: All right, then, the proposed testimony entitled State of Utah Testimony of Dr. Steven Bartlett on Unified Contention Utah L/QQ part E, lack of design conservatism dated June 5th, 2002, will be bound into the record at this point, as if read.

(The testimony of Dr. Bartlett is to be bound into the record at this point.)

CHAIRMAN FARRAR: Ms. Nakahara, did you have any other examination?

MS. NAKAHARA: I have four exhibits, Your Honor.

CHAIRMAN FARRAR: All right.

MS. NAKAHARA: Attached to Dr. Bartlett's testimony. State exhibit 129, which are portions of the declaration of C. Allen Cornell, dated November 9th, 2001, includes the first page, page 11, 12, and 13 through 16, and page 27 and attachment A.

State's exhibit --

CHAIRMAN FARRAR: And that is 4 page attachment with references?

MS. NAKAHARA: Yes.

CHAIRMAN FARRAR: Okay.

MS. NAKAHARA: State exhibit 130, which are portions of Dr. C. Allen Cornell's deposition,

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

| | | |
|---|---|---|
| In the Matter of: | ) | Docket No. 72-22-ISFSI |
| PRIVATE FUEL STORAGE, LLC (Independent Spent Fuel Storage Installation) | ) | ASLBP No. 97-732-02-ISFSI |
| | ) | ~~April 1, 2002~~ June 5, 2002 |

**STATE OF UTAH TESTIMONY OF**
**DR. STEVEN BARTLETT ~~AND R. FARHANG OSTADAN~~**
**ON UNIFIED CONTENTION UTAH L/QQ, PART E**
**(Lack of Design Conservatism)**

**I. Purpose of Testimony.**

**Q. 1: Dr. Bartlett, please state your name for the record.**

**A. 1:** ~~(SFB)~~ My name is Dr. Steven F. Bartlett.

~~**Q. 2: Dr. Ostadan, please state your name for the record.**~~

~~**A. 2:** (FO) My name is Dr. Farhang Ostadan.~~

**Q. 3: What is the issue that you are testifying on?**

**A. 3:** ~~(SFB, FO)~~ PFS's request to the NRC to be exempted from existing regulations relating to selection of the design basis earthquake.

**Q. 4: What is your understanding of the basis for PFS's request?**

**A. 4:** ~~(SFB, FO)~~ PFS has requested an exemption from the seismic requirements put forth in 10 CFR § 72.102(f)(1) that requires the design basis earthquake ("DBE") be equivalent to the deterministic or maximum credible earthquake. Instead, PFS has proposed the adoption of a significantly lower DBE ground motion that has a mean annual probability of exceedance of $5 \times 10^{-4}$ (*i.e.*, 2,000-year return period). Central to PFS's argument for the adoption of the 2,000-year DBE is its position that additional

conservatisms are built into NRC standard review plans ("SRP") and these conservatisms justify the use of a lower DBE ground motion. However, NRC standard review plans do not address seismic design criteria applicable to PFS's unconventional design features (*e.g.*, unanchored casks undergoing "controlled" sliding resting on a shallowly embedded foundations, buttressed by soil cement and subjected to high levels of strong ground motion).

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

A. 5: ~~(SFB, FO) In our t~~Testimony on dynamic analysis, by Dr. Farhang Ostadan and Dr. Steven Bartlett, filed concurrently, ~~we~~ shows that the proposed foundation and unanchored cask designs have many unconservative assumptions, incomplete analysis, which make PFS's claim of "additional conservatisms" baseless. In this testimony ~~we~~ I show that PFS has not demonstrated acceptable performance of the structure/foundation/soil system for the proposed 2,000-year DBE and cannot claim "additional conservatisms" exist in the seismic design.

In this testimony ~~we~~ I will explain the basis for ~~each of our~~ my ~~individual~~ professional ~~opinions~~ opinion that the appropriate design earthquake must be inextricably linked to the performance of structures, systems and components important to safety ("SSCs") at the PFS facility. The key in selecting a design earthquake is to conservatively evaluate the performance of the SSC subjected to the design basis ground motion. This evaluation cannot be made absent consideration of the collective experience gained from previous design and performance of other SSCs subject to similar seismic loading. ~~We~~ I will describe how PFS has failed to conservatively and adequately evaluate the performance of the SSCs under a 2,000-year DBE. In ~~our~~ my opinion, a standard based on a 2,000 year DBE cannot be supported.

~~**Q. 6: Do you consider it necessary to testify together?**~~

~~A. 6: (SFB, FO) Yes. We each have different individual expertise that complements the other's expertise. As a result we each will bring a perspective from our my unique engineering disciplines that we believe will aid the Licensing Board in determining this issue. Although we bring differing expertise to this issue, our my individual opinions are in agreement as to~~

**Q.6: What are the requisite factors in determining a safe design earthquake for the PFS facility?**

A. 6: ~~We both agree that a~~ A design earthquake cannot be designated without considering the seismic performance of specific SSCs at the PFS facility and where

applicable, the appropriate risk reduction factor. ~~Therefore, we are testifying as a panel to make our my testimony more cohesive and easier to understand.~~

~~(SFB)~~ In adequately analyzing the seismic performance and selection of a DBE, my contribution to this hearing is from the perspective of how, based on PFS's design, the capacity of the soil and foundations will withstand a 2,000-year DBE. Also, because I have applied DOE Standard 1020 ("DOE-STD-1020") and am familiar with its philosophy, I will present testimony on the concepts embedded in DOE-STD-1020.

~~(FO) Similarly, the expertise that I bring to this hearing relates to the loads from structures during a 2,000-year DBE that will be transferred to the foundations and soil. I have also applied DOE-STD-1020 in seismic analysis and will also offer some testimony on the application of the DOE standard.~~

## II. Qualifications and Background.

**Q. 7: Dr. Bartlett, have you previously provided your qualifications with respect to pre-filed testimony in support of this contention?**

A. 7: Yes. Please refer to my testimony on Soils Characterization and my curriculum vitae included as State's Exh. 92. In that testimony and also in my testimony on Dynamic Analysis, I discuss my involvement in assisting the State in the PFS proceeding. Especially relevant to this testimony is my professional experience at the Savannah River Site ("SRS"), in which I applied DOE-STD-1020 to seismic performance of DOE Category 3 and Category 4 nuclear facilities. While at SRS, I was part of a multi-disciplinary team responsible for the seismic qualification and upgrade of several facilities, which included: In-Tank Precipitation Facility (ITP), H-Tank Farm (High Level Waste Tank Farm), and the Defense Waste Processing Facility (DWPF) High Level Waste Vitrification Building. The goal of these qualifications was an assessment of each facility to see if it met the seismic performance goals given in DOE Standard 1020. I primarily oversaw the geotechnical assessment and calculations for the foundations of these structures.

~~**Q. 8: Dr. Ostadan, have you previously provided your qualifications with respect to pre-filed testimony in support of this contention?**~~

~~A. 8. Yes. Please refer to testimony I filed on Dynamic Analysis and my curriculum vitae included as State's Exh. 110. I have also applied DOE-STD-1020 standards and guidance to the foundations of nuclear structures, including at the Savannah River Site where I joined Dr. Bartlett on a multi-disciplinary team.~~

## III. The 2,000-Year Design Basis Earthquake is Inconsistent with Other Design and Construction Standards.

**Q. 9: Is the requested standard of a 2,000-year design basis earthquake consistent with nuclear facility design standards established by non-NRC agencies or entities?**

A. 9: ~~(SFB, FO)~~ No. The U. S. Department of Energy ("DOE") published DOE Standard 1020, *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities* ("DOE-STD-1020") in which DOE establishes design standards and guidance for nuclear facilities. In August 2001, DOE released draft DOE-STD-1020-2001, which requires a 2,500-year return period ground motion for performance category 3 ("PC3") SSCs. *See* State's Exh. 126, DOE-STD-1020-01, at C-6.

~~(FO)~~ The current seismic hazard maps, such as those published by U.S. Geological Survey and the National Earthquake Hazard Reduction Program (NEHRP), have also adopted a 2,500-year motion for design use. Also, the most recent design codes such as those adopted or considered by the International Building Code ~~and American Association of State Highway and Transportation Officials,~~ requires a 2,500-year motion for design. Based on the direction of other prominent agencies and organizations in the field of seismic design, it is my opinion that DOE will require a 2,500-year ground motion standard in the final DOE-STD-1020-01.

~~(SFB)~~ The Utah Department of Transportation currently requires all interstate highway bridges to be designed to levels of strong ground motion that exceed the proposed design basis ground motion at the PFS site. The design basis ground motions are based on a uniform hazard spectrum with spectral values that have a 2 percent probability of exceedance in 50 years. This is equivalent to an average return period of 2,500-years.

~~(SFB, FO)~~ In ~~our~~ my opinion, PFS's reliance on a 2,000-year DBE is not consistent with safety and engineering standards established for DOE nuclear facilities, or even the general standard for buildings and highways.

## IV. Factors Affecting Selection of Design Earthquake.

**Q. 10: Does the selection of the design basis earthquake relate at all to the performance of specific SSCs?**

A. 10: ~~(SFB, FO)~~ Yes. When selecting a design basis earthquake, one must

consider the critical nature of the facility, its intended performance during the earthquake and any applicable codes and standards. For example, DOE-STD-1020 applies a graded approach where seismic performance goals are set according to the type of facility. DOE-STD-1021 gives the methods for classifying the facility into specific performance categories. There are ~~five~~ four possible performance categories, PC 1-~~0~~ through PC 4, with PC 4 being the highest category and is reserved for the most critical or sensitive facilities.

For each performance category, seismic performance goals are defined in terms of a permissible annual probability of unacceptable performance $P_F$ (*e.g*, a permissible failure frequency limit). DOE-STD-1020 requires that seismically induced unacceptable performance should have an annual probability less than or approximately equal to these goals. Thus, to meet the requirements of DOE-STD-1020, one must ultimately demonstrate that the facility can meet the seismic performance goal.

The DBE used to evaluate a structure for a given performance category is also set [1021] by DOE-STD-~~1020~~ 1021-93. The DBE is defined at specified seismic hazard exceedance probability $P_H$ and the SSC is designed or evaluated for the prescribed DBE using adequately conservative deterministic acceptance criteria. To be adequately conservative, the acceptance criteria must introduce an additional reduction in the risk of unacceptable performance below the annual risk of exceeding the DBE. This is known as a risk reduction ratio or risk reduction factor.

**Q. 11: What is a risk reduction ratio?**

**A. 11:** ~~(SFB)~~ A risk reduction ratio is a measure of the conservatism incorporated into the design of an SSC. DOE-STD-1020 requires that the risk reduction ratio must be sufficiently large to show that the target performance goals are achieved. The risk reduction ratio, $R_R$, in terms of probability is formally defined as:

$$R_R = \frac{P_H}{P_F}$$

where $P_H$ is the seismic hazard exceedance probability and $P_F$ is permissible annual probability of unacceptable performance. DOE requires minimum risk reduction ratios of 5 and 10 for PC3 and PC4 SSCs, respectively. DOE-1020-94, Table C-3 at C-5.

**Q. 12: Please explain PFS's various estimations of ground motions?**

A. 12: ~~(SFB)~~ At the time PFS requested its exemption, PFS estimated the 84th percentile peak ground accelerations at the site were 0.72 g in the horizontal direction and 0.80 g in the vertical direction. In 2001, PFS's revised 84th percentile peak ground acceleration shows 1.15 g in the horizontal direction and 1.17 g in the vertical direction. *See* Geomatrix, *Update of Deterministic Ground Motion Assessment*, Rev. 1, April 2001 at 3. The 2001 revised peak ground accelerations for a 2,000-year return period are now 0.711 g in the horizontal direction and 0.695 g in the vertical direction. SAR at 2.6-107, Rev. 22.

**Q. 13: What effect does the design basis earthquake seismic exemption request have on the performance and evaluation of PFS's design?**

A. 13: ~~(SFB)~~ Now that the NRC Staff has consented to the seismic exemption request filed by PFS, this constitutes a substantial reduction in the seismic demand used by the design standard. By using a less severe 2,000-year DBE, instead of using a deterministic DBE (maximum credible earthquake) or a 10,000-year DBE, PFS has apparently adopted the design philosophy contained in DOE-STD-1020. Inherent in demonstrating acceptable performance by this standard is the consideration of the conservatisms in the design and if the appropriate risk reduction ratio has been achieved by the design for the DBE.

**Q. 14: How does the unconventional nature of PFS's design and PFS's failure to follow all applicable guidance of DOE-STD-1020 relate to the selection of a design basis earthquake?**

A. 14: ~~(SFB, FO)~~ There is no precedent or direct experience upon which PFS can rely to support its unconventional design using cement treated soil to support the CTB or unanchored storage casks subjected to controlled sliding under high levels of seismic loading.

Furthermore, the seismic analysis becomes more critical now that the design margins or conservatism are substantially reduced. The facility is designed to the 2,000-year DBE ground motion of 0.711 g in the horizontal direction and 0.695 g in the vertical direction. These ground motions are significantly less than the 84th percentile peak ground acceleration of 1.15 g in the horizontal direction and 1.17 g in the vertical direction. Also, it is difficult to determine the seismic performance of SSCs without fragility curves because PFS's design features (*e.g.*, unanchored casks supported by cement treated soil in a high seismic area) are unique and there is no existing data on how the SSCs will perform.

**Q. 15: Briefly describe how PFS supports the notion that a 2,000 year design earthquake is adequate in this case?**

**A. 15:** ~~(SFB)~~ A central theory in PFS's justification for the use of 2,000-year motion is PFS's analogy to the performance goals of SSCs and risk reduction ratios in DOE-STD-1020 and NUREG/CR-6728, *Technical Basis for Revision of Regulatory Guidance on Design Ground Motions: Hazard- and Risk-consistent Ground Motion Spectra Guidelines* (October 2001), and reliance on claimed conservatism built into NRC review plans. Applicant's Motion for Summary Disposition of Part B of Contention Utah L (November 2001) ("PFS SD Motion"), Declaration of Dr. C. Allin Cornell[1] at ¶¶ 20-25. PFS generally surmises that a 2,000-year DBE is warranted because "[t]ypical SSCs in nuclear facilities, such as the PFSF, that are designed to satisfy the US NRC Standard Review Plan structural and mechanical criteria have been found to have a mean component failure return period 5 to 20 times or more greater than the mean return period of the design-basis ground motion" and that the "storage-casks and safety-related structures" could withstand "the loadings resulting from an even more severe earthquake without failure." Applicant's Objections and Response to State of Utah's Eleventh Set of Discovery Requests Directed to the Applicant dated October 2, 2001 at 15. PFS's response to Utah's discovery in October 2001 is the first mention that PFS has made to its theory relating performance goals of SSCs to risk reduction ratios in DOE Standard 1020. *See* id.

The only other apparent justification is PFS's incorporation by reference and adoption of the bases asserted by the NRC Staff in its Safety Evaluation Report ("SER") issued September 29, 2000. Applicant's Response to Eleventh Set at 13. One of NRC Staff's five bases to justify the 2,000-year DBE is DOE-STD-1020-94 which established a 2,000-year DBE. SER (September 29, 2000) at 2-42. The NRC Staff's consent to a 2,000-year DBE in the SER did not consider the substantially greater PFS site ground motions determined in April 2001. In December 2001, the Staff issued a Supplemental SER (December 2001) in which it retained the DOE justification. *See* Supplemental SER at 2-51; Consolidated SER dated March 2002, at 2-51.

I am unaware of any other justification. In PFS's original request for an exemption from the regulations to allow a 1,000-year DBE, PFS principally relied upon the Staff's proposed rulemaking plan, SECY-98-126. PFS Exemption Request at 4-5. *See Request for Exemption to 10 CFR 72.102(f)(1) Seismic Design Requirement* dated April 2, 1999. PFS later revised its seismic analyses from considering a 1,000-year to a 2,000-year DBE,

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[1] Excerpts from Declaration of Dr. C. Allin Cornell (Nov. 9, 2001) included as State's Exhibit 129.

apparently in response to a request by Staff that PFS "should consider" a 2,000-year DBE. *See* PFS Commitment Resolution Letter #14 dated August 6, 1999.

**Q. 16: In this case, is DOE Standard 1020 an appropriate standard to use in the selection of a safe design earthquake?**

A. 16: ~~(SFB, FO)~~ Yes. DOE-STD-1020 establishes design and engineering standards for nuclear facilities, including dry spent fuel storage facilities. DOE-STD-1020 and its companion documents have a carefully ~~proscribed~~ prescribed methodology to safely design nuclear facilities. Moreover, prior to adoption, DOE-STD-1020 was subject to extensive peer review from an array of technical experts such as seismologist, geotechnical experts, engineers, and risk experts. Thus, DOE-STD-1020 would provide appropriate guidance. The important point is: all applicable design and analysis aspects established in DOE-STD-1020 must be considered together. It is highly inappropriate to refer to a design basis earthquake without considering the probability of failure of the SSCs and the appropriate risk reduction ratio. The way in which PFS selectively relies on some aspects of DOE-STD-1020 and ignores other aspects does not constitute a rational approach.

**Q. 17: Please describe how the design earthquake, and probability of failure of SSCs, and the risk reduction ratio are intertwined in the design and analysis philosophy encompassed in DOE Standard 1020.**

A.17: ~~(SFB)~~ DOE-STD-1020 first requires that the SSC be categorized according to DOE-STD-1021, and performance goals are established based on the hazard classification. DOE-STD-1020 gives the design and evaluation criteria that control the level of conservatism introduced in the design/evaluation process. These criteria ensure that the level of conservatism and rigor in the design/ evaluation process is appropriate for the category of the facility. DOE-STD-1020 requires the selection of a target performance goal for the SSC and sufficient evaluations that document the SSC will indeed meet the performance goal for the DBE. The performance goals used in DOE-STD-1020 are probabilistic thresholds, where the probability of unacceptable performance or failure of an SSC is expressed in terms of a mean annual probability of exceedance. Unacceptable performance is considered to be damage to the SCC beyond which hazardous material confinement and **safety-related functions are impaired.** Design considerations for these categories are to limit SSC damage so that hazardous materials can be controlled and confined, occupants are protected, and functioning of the SSC is not interrupted. Thus, the selection of the DBE ground motion is explicitly coupled with a thorough evaluation of the fragility of or damage to the SSC.

In selecting the performance goals for an SSC, DOE-STD-1020 adopted a graded

approach for SSCs. Based on this approach, the performance goal of the SSC is selected. For PC3 SSCs, the performance goal is $10^{-4}$. The key for this selection is the fragility curve for the SSCs. By evaluating the fragility curve for the SSCs and recognizing the detail design and ductility of the SSC under earthquake loading and using data from other experiences, a risk reduction factor of 4 has been adopted for PC3 SSCs. Therefore, to meet the performance goal of $10^{-4}$, the DOE-STD-1020-2001 recommends a 2,500-year return earthquake for PC3 SSCs.

A probabilistic method to determine if a performance goal has been met for a particular SSC is to develop a fragility curve for each SSC. A fragility curve expresses the expected damage or unacceptable performance of an SSC as a function of the amplitude of strong ground motion. Once a fragility curve has been established for a particular SSC, the probability of unacceptable performance can be calculated for all levels of strong ground motion, even for levels beyond those incurred by the DBE.

The determination of fragility as expressed as a fragility curve allows the assessment of the conservatism of the design for multiple levels of ground motion. The calculation and application of a fragility curve are necessary to determine if an SSC has met a desired performance goal for all levels of strong ground motion. A fragility curve in combination with the seismic hazard curve yields the probability of failure of the SSC and this probability is compared with the probabilistic target performance goal for the SSC to determine if the performance is adequate.

DOE-STD-1020 also discusses the use of risk reduction ratios based on deterministic criteria to determine if the SSC performance goal has been met. Sometimes SSCs are evaluated according to deterministic methods, which are found in applicable codes and standards. When deterministic criteria are used, the basic principle embedded in DOE-STD-1020 is to ensure that the target performance goals are met when the minimum ten percent probability of failure corresponds to 1.5 times the seismic scale factor times the DBE.

**Q. 18: To determine the appropriate design earthquake, what primary SSCs at the PFS facility must undergo an adequate seismic analysis?**

**A. 18:** ~~(SFB, FO)~~ The SSCs of concern for seismic analysis at the proposed PFS facility, are the CTB and certain components therein, the storage pads, and the HI-STORM 100 cask system. In its request for the seismic exemption, PFS has not discussed the fragility and seismic performance of the foundation of the CTB and the foundation of the storage pads. This is a glaring omission. For example, an evaluation of whether the crane in the CTB will perform under seismic loads is pointless if the CTB foundation fails under those seismic loads.

~~Our~~ My ~~individual~~ opinion is that PFS still has not adequately addressed all necessary factors in determining the seismic performance of the SSCs.

## V. PFS Fails to Demonstrate the Seismic Performance of the SSCs Are Adequate to Accommodate a 2,000-year Design Basis Earthquake.

**Q. 19: In your opinion, has PFS demonstrated that the probability of failure of SSCs ~~are~~ is appropriate for PFS's desired design basis earthquake?**

A. 19: ~~(SFB, FO)~~ No. In accordance with DOE-STD-1020, the design and evaluation criteria for a critical facility, such as an ISFSI, must consider the level of conservatism or lack of conservatism introduced in the design/evaluation process by the DBE. Such an evaluation must be based on the performance of the facility under the proposed earthquake loading. For the reasons previously discussed, in ~~our~~ my opinion, PFS's choice of a DBE cannot be segregated from the critical issues throughout the unified contention, including sections C and D. The assumptions underlying the design of the PFS facility and quantitative analyses thereof are central to whether there is conservatism in PFS's design. In ~~our~~ my opinion, PFS's attempt to justify a 2,000-year DBE by claiming conservatism in its design cannot be judged without evaluating these claims against the unconservatism of PFS's design, such as the use of unrealistic assumptions, omissions and gross generalizations to show that certain SSCs at PFS will adequately perform given a 2,000-year DBE.

**Q. 20: ~~Is~~ Are PFS's seismic design and analysis conservative?**

A. 20: ~~(SFB)~~ No. The PFS design and analysis are not conservative. It is unprecedented to design unanchored dry storage casks for a seismically active area with such intense strong ground motions similar to those at the PFS facility. PFS's claim that the casks will only slide in a "controlled" manner atop the pads may not be correct. ~~contradicts general engineering principles~~. The lack of conservatism in its analysis is further compounded when PFS uses its claim of "controlled" cask sliding to reduce the seismic loadings to the pad foundations.

~~(SFB, FO)~~ PFS failed to demonstrate that adequate conservatism has been applied in the seismic design of foundations for the storage pads and CTB and to the seismic stability of the pads and HI-STORM 100 storage casks for the proposed DE. As ~~we~~ detailed in ~~our~~ the Dynamic Analysis testimony, there are numerous unconservative assumptions, oversights in PFS's design calculations. The lack of conservatism in the design and the inadequacy of the seismic analysis are important in determining the appropriate DBE. Rather than duplicate ~~our~~ those opinions here, ~~we~~ I refer the Licensing Board to ~~our~~ the Dynamic Analysis testimony and to the Cask Stability testimony, which

are being filed concurrently.

**Q. 21: Please restate the purpose of a fragility curve and whether PFS has developed any?**

**A. 21:** ~~(SFB, FO)~~ A fragility curve expressed the expected damage or unacceptable performance of an SSC as a function of the amplitude of strong ground motion. PFS has not produced any fragility curve for the casks, the storage pads, or the CTB foundation.

~~(SFB)~~ In addition, PFS has not developed fragility curves for the HI-STORM 100 cask system relating to excessive movement and collision of the casks, tipover of the casks, excessive uplift and separation of the casks from the pad, or the consequence of such unstable cask and pad conditions. PFS's DBE witness, Dr. Cornell, had no knowledge of any fragility curves for the HI-STORM 100 cask system, the storage pad, or the CTB at the PFS facility. State's Exhibit 130,Cornell Tr. at 49. In fact, PFS's witness responsible for the seismic stability evaluations of the storage casks was unfamiliar with a fragility curve or its purpose. *See* State's Exhibit 131, Singh/Soler 2001 Tr. at 63.

**Q. 22: Has PFS used SSC specific analysis other than a fragility curve to demonstrate performance goals have been satifisfied?**

**A. 22:** ~~(STB, FO)~~ No. PFS has not demonstrated that the storage pad and CTB foundation meet the performance goals required in DOE-STD-1020. PFS has failed to show that the SSCs can meet a target performance goal of $1 \times 10^{-4}$ for the associated 2,000-year annual return period under DOE-STD-1020-94.

**Q. 23: Is it possible to select the DBE without evaluating the probability of seismic failure of each SSC at the PFS facility?**

**A. 23:** ~~(STB)~~ No. As ~~we~~ I testified, a DBE is meaningless when selected without considering the probability of seismic failure and applicable risk reduction ratios.

**Q. 24: What is a "failure" of an SSC?**

**A. 24:** ~~(SFB)~~ ~~We~~ I agree with PFS's definition of a failure "as exceeding a behavior limit state that may preclude the SSC from fulfilling its intended function." State's Exhibit 129, Cornell Dec. at 14. Based on this definition, a reduction of a storage cask's ability to shield radiation, thereby causing an increase in dosage, would be a failure of the HI-STORM 100 cask. Dr. Marvin Resnikoff calculated an increase in radiation dose in the event of cask tipover. *See* Resnikoff Testimony at A. 23. In addition, Dr.

Mohsin Khan and Dr. Ostadan concluded that the Holtec seismic analysis is not conservative and the results are inconclusive without analysis, test data, and other validation. *See* Khan and Ostadan Cask Stability Testimony at Answers 26-36, 38. Dr. Khan also determined that the HI-STORM 100 may in fact tipover when subject to 2,000-year DBE at the PFS site. These issues are detailed in the Joint Testimony of Dr. Mohsin Khan and Dr. Farhang Ostadan with Respect to Contention Utah L/QQ - Cask Stability. Again to eliminate duplication, ~~we~~ I refer the Licensing Board to that testimony here which demonstrates that PFS has failed to demonstrate that the HI-STORM 100 cask will not tip over when subject to a 2,000-year DBE.

**Q. 25: Does DOE-STD-1020 address acceptance performance criteria for foundations?**

**A. 25:** ~~(SFB)~~ DOE-STD-1020 recognizes that specific acceptance criteria for foundations have not been developed. It states that the intent of DOE-STD-1020 must still be met for some system components for overturning or sliding of foundations. State's Exhibit 132, DOE-STD-1020-94 at 2-24. This intent is that "there should be less than 10 percent probability of unacceptable performance at input ground motion defined by a scale factor [SF] of 1.5SF times the DE." Id. PFS has not made this calculation nor demonstrated that the intent of DOE-STD-1020 has been met for the foundation systems of the storage pads and CTB.

**Q. 26: When analyzing seismic performance, how do you account for nonlinear behavior?**

**A. 26:** ~~(SFB)~~ For soil sites, like the PFS site, because the slope of the hazard curve can be impacted by the soil nonlinear behavior, NUREG/CR-6728 recommends to establish the slope of the hazard curve by including the nonlinear soil effects for determination of the seismic scale factor. This concept is applicable to any nonlinear behavior such as cask sliding on the pads since the response is nonlinear and is effectively based on performance design and cannot be extrapolated from the response at lower level ground motions. PFS has not considered these nonlinear effects, nor has it calculated the seismic scale factor, SF, based on considerations of the slope of the hazard curve.

## VI. Performance Goals Are Not Clearly Inherent in ISFSI and Cask Standard Review Plans.

**Q. 27: Do you agree with PFS that performance goals are "inherent" in the NRC Standard Review Plan design standards?**

**A. 27:** ~~(SFB)~~ No. In an attempt to demonstrate that performance goals are

unnecessary, PFS claims that NRC SRPs have equivalent or greater risk reduction ratios as those stated in DOE-STD-1020-94 for performance category 3 and 4 facilities. State's Exh. 129, Cornell Dec. ¶ 25. Thus, surmises PFS, risk reduction factors of approximately 5 to 20 can then be claimed for the PFS SSCs. Id.

PFS's asserted risk reduction ratios of 5 to 20 for PFS SSCs are unsubstantiated. NRC SRP requirements do not address the seismic performance requirements of unanchored casks supported by shallowly embedded pad foundations which are buttressed by cement-treated soil and subject to high levels of strong ground motion. The proposed PFS design has unique seismic interface and foundation issues and must be analyzed accordingly.

PFS itself only claims that the SRPs for nuclear power plants ("NPP") are equivalent or greater than DOE-STD-1020 design criteria. State's Exh. 129, Cornell Dec. ¶ 25. The HI–STORM 100 cask system is not designed to SRPs governing NPPs but to NUREG-1536, Standard Review Plan for Dry Cask Storage Systems. The CTB must be designed according to NUREG-1567, Standard Review Plan for Spent Fuel Dry Storage Facilities. PFS has not shown that the SRPs for dry cask storage systems and ISFSIs provide an equivalent or greater level of conservatism than that claimed for the NPP SRPs.

NRC Staff and PFS claim that the potential consequences of seismic failure of ISFSIs are much less severe than those of NPPs. *See, e.g.* State's Exh. 129, Cornell Dec. ¶ 16. PFS and the Staff further claim that ISFSI facilities are less vulnerable to earthquake-initiated accidents than NPP. *See* Id. ¶ 17. Thus, the SRPs in NUREG 1536 and 1567 may already incorporate less conservatism than NPP SRPs. Additionally, the dry cask storage system SRP design standards are based on the assumption that the design earthquake is equivalent to the safe shutdown or deterministic earthquake used for nuclear facilities, under 10 CFR Part 50. NUREG 1536 at 2-10, NUREG-1567 at 7-20, 7-54. In sum, SRPs for dry storage cask systems and ISFSIs may already incorporate less design conservatism than NPP SRPs. It is not good engineering practice to rely on presumed conservatism or risk reduction ratios to account for unanalyzed conditions and to assume, without any attempt to validate, that design criteria set for ISFSIs and casks will be encompassed by those standards developed for NPPs. This type of process is particularly troubling in this specific case given the substantially lower standard of a 2,000-year DBE and the unconventional plan to store unanchored casks in a highly seismic area supported by cement treated soil.

NUREG 1536 requires the applicant to demonstrate that the dry cask system will not tipover or drop as a result of a credible natural phenomenon event, such as an earthquake. NUREG 1536 at 3-6. As discussed in detail in the Joint Testimony of Dr.

Mohsin Khan and Dr. Farhang Ostadan Regarding Contention Utah L/QQ, Part D - (Cask Stability), the HI-STORM 100 cask may tipover if subject to the ground accelerations for a 2,000-year earthquake. Thus, even if the SRPs for NUREG-1536 result in design criteria that are equal or more conservative than posed in DOE-STD-1020, PFS has not shown that the HI-STORM 100 cask system even meets the NUREG-1536 SRPs under the ground motions for a 2,000-year DBE at the PFS site.

**Q. 28: Are you familiar with Dr. Cornell's statement supporting PFS's Motion for Summary Disposition that Chapter 7 of the recently released NUREG/CR-6728, generally supports that NRC standard review plans provide equal or greater levels of conservatism than DOE-STD-1020.**

A. 28: ~~(SFO)~~ Yes.

~~**Q. 29: Do the fragility curves presented in NUREG/CR-6728 include an analysis of unanchored casks in a high seismic area with equivalent or greater ground motions than the 2,000-year DBE at the PFS site?**~~

~~A. 29: (SFO) No. PFS witness, Dr. Cornell, claims that NUREG/CR-6728, *Technical Basis for Revision of Regulatory Guidance on Design Ground Motions: Hazard and Risk-consistent Ground Motion Spectra Guidelines* (October 2001), provides a "quantitative finding that the [risk reduction ratio] levels for typical systems, structures, and components designed to NRC SRPs are in the range 5 to 20 or greater" (or in the range of the DOE-STD-1020-94 risk reduction ratios). *See* State's Exh. 129, Cornell Dec. at ¶ 25. To support his claim, Dr. Cornell compares the risk reduction factors for NPP SSCs using both the NRC SRPs and DOE-STD-1020-94. *See* in general id., Attachment A, State's Exh. 129. However, in Attachment A, Dr. Cornell relies upon "numerous engineering evaluations of safety margins and 'fragility curves' of SSCs." Id. at 3. NUREG/CR-6728, Chapter 7 contains fragility curves for a variety of NPP sites. *See* NUREG/CR-6728 at 7-10 to 7-15. The fragility curves used in NUREG/CR-6728 are obtained from *Basis for Seismic Provisions of DOE-STD-1020*, R.P Kennedy and S.A. Short (1994). NUREG/CR-6728 at 7-5. It is important to note that the only site with similar peak ground accelerations to the PFS site is the California site located near Santa Maria, *i.e.*, Diablo Canyon. Id. at 7-11, 7-22. In 1994, when Kennedy and Short published the fragility curves, Diablo Canyon did not have any dry storage casks, let alone unanchored dry storage casks. *See* State's Exhibit 133, portions of the letter accompanying the Diablo Canyon Independent Spent Fuel Storage Installation License Application dated December 21, 2001. The Kennedy and Short fragility curves relied upon in NUREG/CR-6728 could not have included unanchored dry storage casks, and Dr. Cornell's attempt to correlate NUREG/CR-6728 to DOE-STD-1020-94 risk reduction ratios in his Declaration, Attachment A, fails with respect to HI-STORM 100 casks at the~~

~~PFS facility.~~

~~In general, the Kennedy and Short fragility curves do not apply to SSCs such as storage casks sliding on the pads to maintain stability and control for excessive movement and tipping. The fragility curve pertains to inherent strength and ductility of the member and the design code upon which the component was designed. The fragility curve as it pertains to controlled and stable movement of the casks on the pads has not been developed by PFS, nor any appropriate design code.~~

~~In our opinion, it is inappropriate to apply generalized risk reduction ratios deemed appropriate for NPPs to the proposed storage pad, unanchored HI-STORM 100 cask, and the CTB. The basis for selecting appropriate risk reduction factors can only adequately be conducted by evaluating a thorough uncertainty analysis of the fragility of each SSC at the PFS site, as outlined in DOE-STD-1020.~~

**Q. 30: Please summarize your opinion.**

**A. 30:** ~~(SFB, FO)~~ In summary, PFS has not met the intent and requirements of DOE-STD-1020. It is impossible to assess the fragility for the storage pads, storage casks, and the CTB and their foundations because of many errors, omissions and unconservative assumptions in PFS's evaluations. PFS has not demonstrated that the performance goal for the PFS facility has been met. Without this demonstration, the selection of the proposed 2,000-year DBE is not founded on a proper technical basis and is basically arbitrary.

**Q. 31: Does this conclude your testimony?**

**A. 31:** Yes.

taken November 1st, 2001. The cover page, and page 49.

State's exhibit 131, which are portions of Dr. Krishna P. Singh, and Dr. Alan Soler's deposition, taken November 15, 2001, which includes the cover page, and page 63.

State's exhibit 132, which are portions, one page of the Natural Phenomena, Hazards Design and Evaluation Criteria for the Department of Energy Facilities, January -- I think that is our stamp on it, but the date. Number DE96006649, and page 2-24.

And we are withdrawing pre-filed exhibit, State's exhibit 133, which was cited in the paragraph that was deleted.

CHAIRMAN FARRAR: All right.

(Whereupon, the above-referenced to documents were marked as State Exhibit Nos. 129-132 for identification.)

MS. NAKAHARA: And I offer these into the record, Your Honor.

CHAIRMAN FARRAR: Any objections to any of them?

MR. GAUKLER: No objection, Your Honor.

CHAIRMAN FARRAR: Mr. Turk?

MR. TURK: These are State's Exhibits 129-132?

CHAIRMAN FARRAR: Right.

MR. TURK: I have no objection to them.

CHAIRMAN FARRAR: Then those four exhibits will be admitted, and the record will reflect that pre-numbered exhibit 133 is not being officially marked for identification, or offered.

MS. NAKAHARA: And Dr. Bartlett is available for cross examination, Your Honor.

CROSS EXAMINATION

BY MR. GAUKLER:

Q Good morning, Dr. Bartlett.

A Good morning, Mr. Gaukler.

Q How are you doing this morning?

A Fine. Well rested.

Q You've had a long haul, but we are close to the end.

A We are close to the end.

Q I think everybody is happy for that.

CHAIRMAN FARRAR: Thank you, Mr. Gaukler, for making the Board's first speech that we are, in fact, close to the end. I hope everyone will bear that in mind.

BY MR. GAUKLER:

Q Now, you've been here for much of the Proceeding, and you've read all the pre-filed testimony that goes to the concerns discussed in your pre-filed direct testimony?

A Yes, I've read those of Dr. Cornell's.

Q And you've -- I take it you've reviewed the Hearing transcripts as well, of the relevant portions, or you were at the hearing?

A I was through parts of, I believe, for most of Dr. Cornell's testimony. I wasn't present for all of Dr. Arabasz' testimony.

Q Okay. I notice that you made some substantive changes in your testimony that was just introduced, from the prefiled testimony.

And I was wondering if there are any additional changes that you think should be made to your pre-filed testimony, given the evidence put into the record so far in this Hearing?

A Well, we struck, completely, question and answer 29.

Q And other than that are there any other changes you believe that are warranted, based on the evidence that you've heard in this Proceeding to date?

A No, not that I can recall.

Q So you are comfortable with the

correctness of your testimony as it currently stands?

A Yes.

Q In question and answer 4 of your testimony, you make reference to what you consider beyond conventional design features of the PSF facility?

A Yes.

Q And there are some other places in your testimony, this testimony that you similarly make references to what you consider to be unconventional design features of the PFS, correct?

A That is correct.

Q Now, we've sat through a lot of testimony on Section D, I don't want to repeat anything. But all this stuff we previously covered with respect to section D, is that correct?

A D and C, because we discussed soil cement as a buttressing in C.

Q So there is nothing else, in addition, that we need to cover here, to address those points, I take it then?

A No, they are encompassed in C and D.

Q I will not go into those areas again. In question and answer 5, you refer to your and Dr. Osadan's testimony on dynamic analysis with respect to

Section D, correct?

A Yes, I think when we refer to dynamic analysis that would encompass pretty much D.

Q And I take it, again, it would be fair to say that the substantive concerns that you have regarding the PFS site, are laid out in your and Dr. Osadan's testimony on section D, that is identified in answer 5, is that correct?

A Yes. I would add that also Dr. Kahn, I think talked about some of those potential unconservatisms also.

Q And, again, I take it you don't raise any new substantive concerns with respect to the design of the PFS in this testimony here?

A No.

Q So, again, that is something we don't need to go into, we've covered that at length before, correct? Substantive concerns.

A Yes. At least the concerns about the unconservatisms in the design, and the assumptions that were made.

Q Okay. And that includes the assumptions in the dynamic analysis as well, correct?

A Correct.

Q Now, in this testimony you are looking at

issue of conservatism in the design, correct?

A That is correct. Whether there is additional conservatism in the design beyond the 2000 year design basis earthquake.

Q And I recognize, I could draw a distinction, your understanding of conservatism in the context of your testimony on section E, versus the statements you made in the context on section D, on conservative assumptions and analysis.

Would it be fair to say that in section D your testimony on conservative assumptions and analysis is related to the NRC's design basis regulatory framework?

A I'm not sure I quite understand the question.

Q Is it fair to say that in section D your testimony, to the extent you reference the unconservative nature of PFS' design, is in relationship to the, what you understand the NRC requirements to be for design for a design basis earthquake?

A Our review in section D was looking at the methods, and the methodologies in the specific calculations that were supporting the factors of safety that the Applicant were trying to achieve,

outlined in NUREG 0800, section 3.8.5.

And we felt that there were omissions, unconservative assumptions, and errors found in those calculations that the Applicant had not demonstrated adequate factors of safety against sliding, overturning, and bearing capacity.

Q And the factors of safety that you are referring to, in that instance, were the factors of safety, recommended factors of safety set forth in the Nuclear Regulatory Commission Staff review plan of 1.1, correct, for example?

A That I'm -- not being completely familiar with that standard review, then I can't say to the section. But it was the design acceptance criteria put forth by the Applicant.

Q And you didn't consider, in the context of your testimony in section D, you didn't talk about conservatisms that may be imbedded in the standards, or acceptance criteria themselves, did you?

A Well, it was my understanding there is only very few design acceptance criteria for foundations. Most of the codes and standards, I think you may be referring to, are more structural mechanical codes, not codes for foundation design.

CHAIRMAN FARRAR: Mr. Gaukler, hold on a

second. At the beginning you asked Dr. Bartlett whether he was offering anything new in this testimony on section D.

MR. GAUKLER: Right.

CHAIRMAN FARRAR: And he said no. And now the last several questions you are talking to him about section D, and so we are wondering what we are doing here?

MR. GAUKLER: Let me ask a more direct question, I think that might be better.

CHAIRMAN FARRAR: Okay.

BY MR. GAUKLER:

Q Isn't it true that the conservatisms that Dr. Cornell is discussing in his testimony on section E, these conservatisms built into the acceptance criteria themselves --

A For nuclear power plants I question whether some of those codes and standards exactly apply to this specific facility.

Q But just in concept, okay?

A Yes, I understand in concept that if one would design according to those acceptance criteria, that there is extra margins built in design conservatisms that give you a higher margin than just by meeting the bare minimum acceptance, if that is

what you are saying.

Q And that is, really, the subject of your testimony here, at least in theory?

A Well, I guess the main point I'm trying to make out, because this is a unique facility, with an anchored cask sitting atop pads, buttressed by soil cement, and subject to hydro motions, that those codes and standards that are used in the design of nuclear power plants aren't specifically applicable to this system, and that the only really acceptance criterion that one can find in the regulatory guidance for design of foundations is a minimum acceptable factor of safety.

Q Now, first of all, how familiar are you with the acceptance criteria in the nuclear power plants, in the Staff'S review plan for the nuclear power plants?

A Those are, generally, structural mechanical codes, so I'm not very familiar with those.

Q And you are not a structural mechanic?

A No, I'm not a structural mechanical engineer.

Q And your expertise is limited to geotechnical soils issues?

A And foundations.

Q And foundations. But would it be fair to say that opinions that you render in this testimony would be limited to conservatisms for foundations?

A In the foundation design, yes, and how that may affect the cask sliding.

Q And so you are not, you don't have any -- you are not opining any opinion with respect to the conservatisms that may be inherent in the structural design of the canister transfer building, or the struts, or the cranes, inside the canister transfer building, is that correct?

A That is correct.

Q And you are also not opining on any conservatism that may exist with respect to the design of the casks and struts?

A Just this cask, because the structural design, no.

Q Such as, for example, whether the cask will tip over?

A Well, again, whether the cask tips over or not, I don't consider that a structural issue. I wouldn't opine upon what is the consequences of tip over to the structural integrity of the cask..

But I do have some opinions about how the foundation may affect the cask sliding and tipover

analysis.

Q So you wouldn't have any opinion about the conservatisms embodied into the cask, and the canister, in a tipover event, correct? Assuming the casks were to tip over, you would have no opinion about the conservatisms?

A Well, there is one area that we have discussed at length, and it has to do with the modulus that was used in the cask tipover analysis for the cement treated soil. I think I would opine on that, because that is where the foundation issues do impact an accident scenario, and the calculations done for that accident scenario.

Q With respect to the actual conservatisms built into the structures themselves, in terms of --

A I would not.

Q So another way to look at it, you can't opine on the consequences of a cask tipping over, correct?

A The structural response of the casks, and the potential, or lack of confinement due to a tipover scenario, no, I wouldn't opine on that.

MR. GAUKLER: I'd like to hand out a document and have it marked as PSF Exhibit 244.

CHAIRMAN FARRAR: Did you say 244?

MR. GAUKLER: I believe that's correct, Your Honor.

(Whereupon, PSF Exhibit 244 marked for identification.)

MR. GAUKLER: I'm handing this out now, Dr. Bartlett. These are excerpts from the deposition that you and I had, if you recall, November 2nd, 2001 with respect to what was then Section B of Utah L. Do you remember that deposition?

DR. BARTLETT: Not all the details, but I remember the deposition.

MR. GAUKLER: You remember there was one deposition.

DR. BARTLETT: I do remember a deposition.

MR. GAUKLER: Okay. Just keep this handy, because I'm going to be referring to this as we talk about your experience at the deposition.

DR. BARTLETT: Yes.

MR. GAUKLER: Now your testimony focuses on the application of DOE Standard 1020 in the context of the PFS proceeding. Correct?

DR. BARTLETT: The application of, I think the concepts in PFS, I mean in DOE Standard 1020.

MR. GAUKLER: Right. The application --

DR. BARTLETT: Not the strict application

of DOE Standard 1020 to this facility, because it's not an applicable standard.

MR. GAUKLER: And thus, for example, Dr. Cornell refers to DOE Standard 1020 as an analogy in his testimony.

DR. BARTLETT: Right. So we can use it as an analogy and look at some of its philosophy, and some of --

MR. GAUKLER: The same way you're referring to it in your testimony.

DR. BARTLETT: I think that's the general intent, yes. I didn't mean to impose a requirement that PFS must meet this document, because it's not an applicable standard.

MR. GAUKLER: Very good. In your testimony, you're claiming to have some experience relating to the application of DOE 1020?

DR. BARTLETT: Yes, that's correct.

MR. GAUKLER: And I take it the -- your experience was related to evaluating risk reduction factors and the application of DOE 1020 in so far as soil-design issues were involved?

DR. BARTLETT: Soil and foundation issues, yes.

MR. GAUKLER: Soil and foundation issues?

DR. BARTLETT: Yes.

MR. GAUKLER: It was limited to those type of issues, the application of DOE --

DR. BARTLETT: Yes, the specific projects that I worked on. One of the main mechanisms of failure of the structure system component was potential failure of the foundation systems.

MR. GAUKLER: And if I understand your testimony, you worked on -- you utilized DOE 1020 in your work for the Department of Energy at Savannah River.

DR. BARTLETT: That's correct.

MR. GAUKLER: And that was approximately 1991 through 1995?

DR. BARTLETT: That's correct.

MR. GAUKLER: And did you do any work with DOE 1020 prior to your employment with the Department of Energy?

DR. BARTLETT: No, I had not.

MR. GAUKLER: And I take it that subsequent to your employment with the Department of Energy, you have not worked with DOE 1020, except in the context of this case here.

DR. BARTLETT: That's correct.

MR. GAUKLER: And would it be fair to say

that you do not consider yourself an expert in the application of the DOE 1020 concepts or philosophies. Is that --

DR. BARTLETT: I wouldn't characterize myself as an expert. I was just a practicing engineer trying to meet its intent.

MR. GAUKLER: And, in fact, if you recall when I asked you at your deposition in 2001, whether you intended to testify -- give testimony with respect to DOE 1020, you responded that you did not expect to give testimony with respect to DOE 1020?

DR. BARTLETT: I can't remember the context of the question.

MR. GAUKLER: Well, look on page 74 of the --

DR. BARTLETT: Page 74?

MR. GAUKLER: That's where it is. You looked at question and answer that begins on line 7.

DR. BARTLETT: Oh, I think at the time, Dr. Ostadan was present on the team. Dr. Ostadan has even more extensive uses of DOE Standard 1020 than I do because of his more involvement with DOE facilities. I have limited to two or three facilities where he's done several, so I was deferring to him and his opinion.

MR. GAUKLER: So in other words, you're something like a second string quarterback --

DR. BARTLETT: I --

MR. GAUKLER: That's fair enough.

DR. BARTLETT: I would much prefer if Dr. Ostadan would be here today than myself.

MR. GAUKLER: Now to discuss further your testimony at Savannah River, in your experience at Savannah River, you were not designing an ISFSI or another existing facility, or another facility. Correct?

DR. BARTLETT: They were not ISFSIs. These were waste storage and handling facilities, but they were not ISFSIs.

MR. GAUKLER: And also, these were facilities already constructed?

DR. BARTLETT: All right. Back up. We did a little bit of design for spent fuel pool one time, but most of them were either facilities associated with the Defense Waste Processing Facility in some of the tanks that were upstream of that facility.

MR. GAUKLER: And these were by and large already constructed facilities?

DR. BARTLETT: Yes. At least the storage tanks and the Defense Waste Processing Facility had

already been constructed, so it was a review of the design and seismic qualification of existing facilities. Though we did once in a while review new facilities also.

MR. GAUKLER: What version of DOE 1020 were you using at Savannah River? Do you recall?

DR. BARTLETT: I have it right here. Let me check it. I think it's dated. It's the 1994 version, DOE Standard 1020-94.

MR. GAUKLER: And when did that standard first come out? Do you know? 1994, or did it come out earlier?

DR. BARTLETT: I don't know when its drafts were released, frankly. The final publication was obviously 1994.

MR. GAUKLER: Okay. That's okay. It's not a big deal.

DR. BARTLETT: But we were using the concepts in it before then, as I recall. We had this risk-graded approach and target performance goals already established for certain facilities that we were meeting.

MR. GAUKLER: And in your testimony today, you discussed the concept of fragility curves in the concept -- in the context of DOE 1020.

DR. BARTLETT: Yes.

MR. GAUKLER: All right. And is it your understanding that fragility curve is a curve that shows failure of a structure or component as a function of earthquake strength or design-basis ground motion strength?

DR. BARTLETT: Yes. My understand of fragility curves, it could be a probability of failure or expected damage to a structure, or facility as a function of some earthquake measure, generally amplitude of motion is quite often used.

MR. GAUKLER: So it shows --

DR. BARTLETT: Amplitude or intensity.

MR. GAUKLER: So it shows the likelihood or probability of failure at different earthquake strengths.

DR. BARTLETT: Correct. Yes, that's a gross characterization of it, but it's approximately correct.

MR. GAUKLER: Very simple for us here.

DR. BARTLETT: I think that's fine for our purposes.

MR. GAUKLER: Okay. Now at Savannah River, if I understand it correctly, you never developed or calculated any fragility curves. Is that

correct?

DR. BARTLETT: Yes, we did.

MR. GAUKLER: You did?

DR. BARTLETT: Yes, we did.

MR. GAUKLER: Were you responsible for determining whether the performance goal thresholds were met at Savannah River?

DR. BARTLETT: Yes, we were.

CHAIRMAN FARRAR: You were?

DR. BARTLETT: When I say yes, I -- remember the team at Savannah River was a multi-disciplinary team, and I want to not be too bold to say that I did. It was a group of people involved in these calculations.

MR. GAUKLER: Did you, yourself, develop any fragility curves?

DR. BARTLETT: I did for one facility. I developed a settlement hazard fragility curve, liquefaction settlement hazard fragility curve.

MR. GAUKLER: And that was with respect to then foundations, I take it?

DR. BARTLETT: Yeah. As I recall, it was probably for the H-Tank Farm area, the high level tank farm area.

MR. GAUKLER: And is that the only

fragility curve that you developed, that you recall?

DR. BARTLETT: There was another one, and I'm not sure if it went all the way to a fragility curve, but I do recall calculating a probability of failure for a suite of different earthquakes for a spent fuel pool. And I think the postulated mechanism was liquefaction, settlement and potential cracking of the spent fuel pool, and how long would it take for the water to essentially leave the pool.

I've also done some fragility curve calculations for the Department -- for the Utah Department of Transportation for seismic retrofitting of bridges.

MR. GAUKLER: That's outside the context of --

DR. BARTLETT: That's outside of DOE context, yes.

MR. GAUKLER: And these all were related to foundation designs?

DR. BARTLETT: No. Actually, the one for the -- well, at Savannah River, that's correct. Most of these were postulated foundation or soil failure mechanisms, and how they would impact the facility. For the case of the Utah Department of Transportation, no, these were structural fragility curves for the

response of the structure, not the foundations. I didn't actually calculate the fragility curves. I just used fragility curves that had been published.

MR. GAUKLER: That's with respect to --

DR. BARTLETT: For the Department of Transportation for Utah.

MR. GAUKLER: Okay. So you used existing fragility --

DR. BARTLETT: We used existing fragility curves. We had a couple of experts modify them for what would be the expected performance for a bridge retrofit, and we ran curves, we ran analyses with retrofitted and non-retrofitted bridges. They were risk assessments.

MR. GAUKLER: So it would be fair to say you haven't developed fragility curves yourself for structures.

DR. BARTLETT: For structures, no, I would not do that.

MR. GAUKLER: Now you were here, well not here, but you were at the hearing in Salt Lake City when I was asking questions of Dr. Arabasz. I believe you were there at that point in time, at least part of the time. Let me rephrase the question to ask it --

DR. BARTLETT: Yeah, because I did miss

much of his testimony. I only was there for about a half a day of Dr. Arabasz' testimony, and I'm trying to remember at what stage I came in. I believe it was right at the end. It was mostly with Mr. Turk and his testimony that I heard Dr. Arabasz.

MR. GAUKLER: Were you at the beginning of Dr. Arabasz' testimony back on May 17th? Yes, May 17th is the date. Do you recall that?

DR. BARTLETT: No, I don't believe I was there that day.

MR. GAUKLER: Did you review the -- have you reviewed the testimony of Dr. Arabasz that he provided in this proceeding?

DR. BARTLETT: No, not in its entirety.

MR. GAUKLER: Are you aware that Dr. Arabasz in his testimony agreed that DOE Category PC-3 is the appropriate category for ISFSIs, such as the PFSF?

DR. BARTLETT: I believe State Counsel informed me of that, that he had said that in his deposition, or his testimony. Excuse me.

MR. GAUKLER: And you don't have -- you have no reason to disagree with that judgment, I take it.

DR. BARTLETT: I have no reason to agree

or disagree.

MR. GAUKLER: I take it you are aware from your work with DOE 1020 that the performance goal using DOE concepts for PC Category 3 facility would be one times ten to the minus four?

DR. BARTLETT: Yes, that's my understanding.

MR. GAUKLER: And the one times ten to the minus four represents the probability of unsatisfactory performance under earthquake conditions. Correct?

DR. BARTLETT: Of a structure, system and component. That's correct.

MR. GAUKLER: And what actually constitutes failure of the structure, system or component would depend upon that structure, system or component. Right?

DR. BARTLETT: What constitutes failure is a function of what its safety related function is.

MR. GAUKLER: And would it be fair to say that the ultimate theory that we're talking about here with respect to the PFSF is to protect public health and safety from radiation that might emanate from the PFS site in the event of an earthquake?

DR. BARTLETT: I think -- at least my

understanding of what constitutes failure at the PFS facility is in my testimony.

MR. GAUKLER: Do you want to take a look at that?

DR. BARTLETT: Let me see if I can find that.

MR. GAUKLER: I think it was towards the end of your testimony.

DR. BARTLETT: I think there's two places that --

JUDGE LAM: Try question 24.

DR. BARTLETT: That may help. Thank you, Judge Lam. Yes. In this case, I guess the ultimate consequence would be the loss of the cask from performance safety intent and function, and that's of containment, so any loss of containment.

MR. GAUKLER: Are you referring to question and answer 24?

DR. BARTLETT: Yes, that's --

MR. GAUKLER: Okay. And, therefore, I take it you would agree that whether failure exists or doesn't exist comes down to really whether the radiation dose limits for the NRC would be exceeded in earthquake -- under earthquake conditions. Would that be a fair understanding of your concept of failure as

it would apply here?

DR. BARTLETT: Frankly, I guess I can't fully agree with that. My experience with DOE Standard 1020 was one of loss of containment. I don't recall when we were planning at Savannah River going through dose calculations and its consequences. To us, loss of containment was the ultimate governing scenario, not a dose calculation that followed. That's my recollection of how we were using it at Savannah River.

MR. GAUKLER: And loss of containment, you're referring the escape of radioactivity.

DR. BARTLETT: Correct. The cases as we were looking at were mainly tanks, and it would be any breach or damage to the tank due to settlement and the loss of containment. And we were trying to show that there was an acceptable -- well, the probability of that event of actually breaching the tanks where they could loss containment was one times ten to the minus four or less, and that's my recollection, so I don't recall dose calculations and consequences, and trying to show that we had met some acceptable dose limits with one times ten to the minus four. That's my recollections of how we were using it at that time.

MR. GAUKLER: But it would be true if you

showed no breach of containment, you would --

DR. BARTLETT: By de facto, you wouldn't do the dose calculations.

MR. GAUKLER: You wouldn't need it by de facto.

DR. BARTLETT: Yeah, that's -- by de facto you wouldn't do those calculations, so I'm not sure I can say that my experience goes to a place where the ultimate goal is showing an acceptable dose.

MR. GAUKLER: That's --

DR. BARTLETT: Right. And I can actually read you one sentence in DOE Standard 1020 that talks about this. Unfortunately, it doesn't elaborate too much, but it doesn't imply that you have to actually go to the dose calculations, that once a structure system component has lost its safety -- cannot perform its safety related function, then that's determined to be the terminal event that we're looking at.

MR. GAUKLER: In any event, just to go back to your definition of failure as set forth in 24, failure to meet, for example, a factor of 1.1 against sliding would not be failure as you define it in question and answer 24.

DR. BARTLETT: No, it would not be failure, but it would be part of a chain of events

that one would have to analyze to determine whether the ultimate failure mechanism had been -- or the ultimate performance goal had been met. But I'm not implying that they have to have a one times ten to the minus four probability against foundation failure.

MR. GAUKLER: Okay. And so, that --

DR. BARTLETT: It would be part of the chain one would go through if you're doing probabalistic calculations. It would be an extra probability of failure of the foundations, what is it? And then one would complete the probability chain with what would be the extra prob -- what would be the probability of failure given that the foundations were now sliding or overturning, or whatever the mechanism we're postulating.

MR. GAUKLER: Next step, given the fact that the foundations were sliding -- what's the chance of probability of the cask having some --

DR. BARTLETT: Tip-over. Right.

MR. GAUKLER: Tip-over.

DR. BARTLETT: And the loss of confinement, yes. Those calculations, by the way, are difficult to do, and a lot of DOE Standard 1020 is based more on deterministic techniques, not probabalistic techniques.

MR. GAUKLER: Now if I understand your testimony, you would generally agree that DOE 1020 gives appropriate guidance or insights in terms --

DR. BARTLETT: It's a good framework. It's a regulatory framework. It's been peer reviewed, and it's being applied by the Department of Energy, so I consider it a reasonable framework to try this risk rated approach.

MR. GAUKLER: Now the -- under this DOE 1020 approach, it basically comprises two factors, if you will. There's the design-basis earthquake, and then there's the conservatisms inherent in the acceptance criteria.

DR. BARTLETT: Right. There's the mean annual probability of exceedance of the design-basis earthquake, and then there's additional conservatism or probabilities of failure that their margin is beyond the design-basis earthquake.

MR. GAUKLER: And this is formally referred to in the DOE Standard 1020 as risk reduction factors. Correct?

DR. BARTLETT: That is correct.

MR. GAUKLER: And this is what Dr. Cornell and Dr. Arabasz have referred to as the two-handed approach? I don't know if you've heard that or not.

DR. BARTLETT: I wasn't present at that testimony, but I think I understand the analogy. We have to consider the earthquake and what it's probability is. And then we also have to consider given the earthquake, what is the probability of failure from that event, so you need to consider the conservatisms in the design that are inherent there, plus the conservatisms in the earthquake. So if that's the two-handed approach that we've been discussing, I think I'm familiar with it.

MR. GAUKLER: Okay. And so basically you need to take into account both in terms of determining whether a particular design-basis earthquake is acceptable.

DR. BARTLETT: You must take into consideration both to see if the target performance goal has been met. That is correct.

MR. GAUKLER: And I'd like to have you turn to question and answer number 9 of your testimony. Now based on what you just said, that you need to consider both the design-basis earthquake and risk reduction factor of conservatism of design, how do you square your answer in number 9 to that, because there it looks to me like you're just saying just because the PFS design-basis earthquake is 2000 in

this -- 2000 and 2,500 used in other contexts, PFS' design-basis earthquake is inadequate?

DR. BARTLETT: Well, I'm not sure if that's what I'm trying to say.

MR. GAUKLER: That's why I was asking. Could you tell me that -- did I read that wrong?

DR. BARTLETT: So we're looking at the answer 17.

MR. GAUKLER: Answer number 9.

DR. BARTLETT: Answer number 9. Excuse me. I went to page 9. Maybe that's why I wasn't quite understanding you.

MR. GAUKLER: That's okay. Same question with respect to answer number 9.

DR. BARTLETT: I think the first paragraph is just pointing out that DOE looks like they're revising their design-basis earthquake to a 2500 year return period, instead of a 2000 year return period. I don't see any really great news in that, other than a slightly more conservative earthquake. It's my understanding the intent maybe there is to be more consistent with the National Hazard Maps that are coming out.

MR. GAUKLER: And, in fact, when they modified DOE 1020 to go to the 2500 --

DR. BARTLETT: Right.

MR. GAUKLER: -- design-basis earthquakes, they changed the risk reduction factor?

DR. BARTLETT: My understanding is it's gone from five to four, so the terminal probability of performance goal really doesn't change, so I don't --

MR. GAUKLER: Basically, no never mind then, as far as we're concerned.

DR. BARTLETT: So I don't see any news there. Now let me see what I'm saying in the second paragraph. It's just a recognition that a lot of the building codes are now going to a 2500 year motion as a basis of their design. And in the third paragraph, I'm pointing out that in Utah, the Department of Transportation has selected a design-basis earthquake that's more conservative than the AASHTO, which is the American Association of State Highways and Transportation Officials' guidance or requirements. I guess I shouldn't say guidance, they're actual requirements. And they've gone to a 2500 year return period event for design of their interstate bridges. So I'm just pointing out several agencies are seeming to settle on this 2500 year return period event. And when we first saw some of the Applicant's justifications of going to a 2000 year return period

event, there wasn't this two-handed approach. It was just kind of a one-handed approach talking about the design-basis earthquake, but neglecting to discuss the inherent conservatisms that must be there to meet a performance goal. Later on when Dr. Cornell joined the team, we saw that the discussion now being more fleshed out.

MR. GAUKLER: Now at this point in time when you -- well, focusing on the last paragraph.

DR. BARTLETT: Okay.

MR. GAUKLER: Just the last paragraph, now isn't that last paragraph stating that PFS' reliance on a 2000 year design-basis earthquake is not consistent with standards established for -- general standards for buildings and highways?

DR. BARTLETT: Right. I'm just trying to point out that these different organizations and agencies have adopted a higher design-basis earthquake than the 2000 year event.

MR. GAUKLER: Well, it's not appropriate to say solely on that basis that --

COURT REPORTER: Excuse me, Mr. Gaukler. You're breaking up.

MR. GAUKLER: It's not appropriate to say on that basis that PFS' -- solely on that basis, that

PFS' use of a 2000 year design-basis earthquake is inappropriate. Right?

DR. BARTLETT: No. We have to use a two-handed approach. My concern when this was written, and somewhat before I think Dr. Cornell joined the team, that there was too much of a one-handed approach just looking at the earthquake without considering the conservatisms that were required.

MR. GAUKLER: Now this testimony was initially written and filed April 1st. Correct?

DR. BARTLETT: Correct.

MR. GAUKLER: Of 2002. Correct?

DR. BARTLETT: Right.

MR. GAUKLER: And Dr. Cornell had provided a lengthy declaration in November, 2001, had he not, setting forth, essentially, the two-handed approach. Correct?

DR. BARTLETT: I do recall in his testimony discussion of risk reduction factors in the beginning of a suggestion that facilities designed to nuclear power plant standards had inherent in them risk reduction factors. I believe from 5 to 20 was stated. I think we took a little bit of exception, saying that this isn't a standard design, and this isn't a nuclear power plant. And it was, in our

opinion, a little bit of a leap to use standards and codes for nuclear power plants specifically for this ISFSI, and that it should be based on site-specific evaluations, and not relying on general codes and standards, because this facility has a lot of foundation issues, and how the foundation performs affects cask stability. Is that fair?

MR. GAUKLER: I will get to that in a second.

DR. BARTLETT: Okay.

MR. GAUKLER: But Dr. Cornell has set forth the two-handed approach in the November, 2001 declaration. And, in fact, you referred various places in your testimony --

DR. BARTLETT: He began to introduce it. It was more fleshed out in his pre-filed testimony for this hearing, but it was beginning to be introduced. Yes.

MR. GAUKLER: Now would it be fair to say that this last paragraph just slipped through the cracks inadvertently, and really shouldn't be there. It's not appropriate to be there?

DR. BARTLETT: I think if -- once we recognize that we do need this two-handed approach, that this paragraph is more historical. There was

concerns earlier on in the process where we didn't see a discussion by the Applicant about this two-handed approach, but I think certainly now recognized with Dr. Cornell's testimony, that there is an attempt to discuss this two-handed approach, and justify the design basis, not only just on the design-basis earthquake, but also on the conservatisms in the design.

MR. GAUKLER: I'd like to turn now to question and answer number 11, which gets into this idea of the risk reduction factor, and the margins, beyond design-basis margins and body, and codes and standards. First of all, have you ever calculated or determined a risk reduction factor?

DR. BARTLETT: I guess indirectly, sure, through fragility curves.

MR. GAUKLER: And that's for --

DR. BARTLETT: Fragility curve could be viewed as a suite of risk reduction factors for various levels of earthquake motion.

MR. GAUKLER: Now I'd like to have you turn to what's been marked as PFS Exhibit 244. Look at the question and the answer on pages 15 and 16. First of all, on page 15, middle of the page, there you say you have not done any fragility curves in the

sense of a structural fragility.

DR. BARTLETT: That's correct.

MR. GAUKLER: Which you would readily agree with. Correct?

DR. BARTLETT: Yes, I have not calculated structural fragility curves. Our fragility curves were for liquefaction and settlement.

MR. GAUKLER: And then you go down and talk about -- the bottom of -- in question and answer on the bottom of page 15, top of page 16, about getting into risk reduction factors for soils, and soil-type of issues.

DR. BARTLETT: Yes.

MR. GAUKLER: And you basically, if I understand correctly, you basically say that -- there that you really don't know how one would apply risk reduction factor with respect to soil.

DR. BARTLETT: Yeah. It's a little bit difficult for soils and foundation issues, because we don't have -- risk reduction factors are really deterministically done, and there are extra conservatisms and margins inherent in structural mechanical codes, which generally don't apply to foundation systems. And just to help you with this maybe a little bit, why I'm making these statements is

-- if I may turn to DOE Standard 1020-94, here's what it says about foundations. And it's on page 2-24. And it refers to equation 2-7, which is on the previous page. 2-7 would be on page 2-23, and we could talk about that if you want, but it says:

"Equation 2-7 is useful in developing alternative evaluation acceptance criteria, which are also based on target performance goals, such as in elastic seismic response analysis. To evaluate items for which specific acceptance are not yet developed, such as overturning or sliding of foundations, or some systems and components, this basic intention must be met."

And it's the intention outlined in Equation 2-7. So quite often, we find ourselves, at least for foundations and geotechnical engineers, we can't really rely solely on risk reduction factors because we don't have that body of code. Much of our discipline is more judgment-based. And, in fact, at Savannah River, because we didn't have really risk reduction factors calculated for foundations, we went to a purely probabalistic technique, and developed fragility curves, so I hope that explains what I'm trying to say. General structure -- general acceptance criteria are sometimes not available for

foundations, and the appropriate risk reduction factors.

MR. GAUKLER: Let's just focus briefly on risk reduction factors in a general concept. If you understand Dr. Cornell's testimony, for typical nuclear power plant components, there's a -- for typical nuclear power plant components designed to the NRC Standard Review Plan, there is a risk reduction factor of a range of 5 to 20. Is that your understanding?

DR. BARTLETT: That's my understanding for structural mechanical design. That's correct.

MR. GAUKLER: And you have no basis to take issue with that.

DR. BARTLETT: I do not.

MR. GAUKLER: And you further understand, do you not, that the determination of those risk reduction factors has evolved over time through numerous seismic probability risk assessments of existing nuclear power plants.

DR. BARTLETT: I'm sure it's evolved through probabalistic seismic risk assessments, and probably also evaluation of facilities and design under real earthquake conditions, so I imagine there's quite a lengthy process that has gone through to

derive those risk reduction factors for structural mechanical design. Yes.

MR. GAUKLER: And you would also agree, would you not, that there are foundations in nuclear power plant, and foundation issues that would be related and evaluated with evaluating the seismic performance of nuclear power plants --

DR. BARTLETT: Well, the only --

MR. GAUKLER: -- in seismic probability risk assessments?

DR. BARTLETT: They're really not applicable codes and standards in that sense for foundation design. Mainly, there is one criterion which is a factor of safety, that a facility must demonstrate against the safe-shutdown earthquake for that facility, so there's not really in the same sense that you're talking about, there's only an acceptance criterion, but not codes and standards, at least that look at the foundation issues for sliding and overturning.

MR. GAUKLER: But I was looking at -- I was going to the question of conservatisms in the acceptance criteria, whether they be acceptance criteria in codes or standards, or the Acceptance Criteria 1.1 with respect to sliding and overturning

that you just referred to.

Wouldn't -- do you know whether or not the seismic probability risk assessments for nuclear power plants would include evaluations of foundation safety with respect to acceptance criteria of that sort?

DR. BARTLETT: I wouldn't believe they do it for sliding and overturning mechanisms. No.

MR. GAUKLER: You don't think that --

DR. BARTLETT: It's generally thought that at least if you meet the requirements for nuclear power plants of a factor of safety 1.1 against the safe-shutdown earthquake, that sliding and overturning issues don't enter into the evaluation. But I would -- I have not seen any calculations looking at sliding and overturning as mechanisms, and still trying to demonstrate adequate performance for a presumed sliding condition. We just don't try to reach that condition. It's a limiting condition to us.

MR. GAUKLER: So are you saying that the seismic probability risk assessments for nuclear power plants were not have considered foundation issues, such as sliding and overturning, things of that sort?

DR. BARTLETT: I'd be surprised that, you know, that they looked at those failure mechanisms.

MR. GAUKLER: I take it you don't know

yourself whether they did or not. Is that --

DR. BARTLETT: Well, my experience in DOE is that we had no acceptance -- well, we had no codes and standards. We -- as I just read you, there was no acceptance criteria for those, so one would have to develop your own acceptance criteria for the foundations and their performance.

MR. GAUKLER: But you, yourself, don't know what was looked at with respect to the seismic PRAs done for nuclear power plants --

DR. BARTLETT: No, I --

MR. GAUKLER: -- from which the 5 to 20 factor was developed by Dr. Cornell, do you?

DR. BARTLETT: Whether it included mechanisms of sliding, and overturning, and bearing capacity in those evaluations, no, I can't explicitly say that it did or did not, because I wasn't part of those evaluations.

MR. GAUKLER: You also raised -- well, first of all, do you understand that the risk reduction factors of 5 to -- strike that.

Do you understand that the conservatisms embodied in the Nuclear Regulatory Standard Review Plan for typical nuclear power plant components is the same or greater than the risk reduction factor applied

by DOE with respect to Pc-4 categories?

DR. BARTLETT: I cannot really comment on that. I'm not sure.

MR. GAUKLER: You have no opinion one way or the other, or knowledge.

DR. BARTLETT: No.

MR. GAUKLER: Okay. Now you have referred to, in several of your answers this morning, and you also discussed in, I believe, question and answer 27 of your testimony, this concept of whether the 5 to 20 factor, risk reduction factor that exists for typical nuclear power plant components can be applied to ISFSIs. Is that correct? If you'd look at --

DR. BARTLETT: Yes. It's particularly the -- I believe the next to the last paragraph that begins to discuss whether the same level of conservatism is in the NUREGS that govern ISFSI design, versus those of nuclear power plants.

MR. GAUKLER: And I believe at the end of the third paragraph, specifically state that, "PFS has not shown that the Standard Review Plans for dry cask storage systems and ISFSIs provided an equivalent or greater level of conservatism than that claimed for nuclear power plant SRPs." Right?

DR. BARTLETT: Yes, I recall that

statement.

MR. GAUKLER: And then you will say down a little bit further in the middle of the next paragraph. "In sum, SRPs for dry cask storage system and ISFSIs may already incorporate less design conservatism than NPP SRPs." Correct?

DR. BARTLETT: That's correct.

MR. GAUKLER: Now what struck me in that particular sentence was your use of the word "may". I take it you don't know, as a fact of the matter, whether they do or don't.

DR. BARTLETT: Well, I only have one specific example, maybe to give you about that "may" that's being referred to there. For example, if we go to the acceptance criteria for foundation systems for nuclear power plants, which is in NUREG 0800, Section 3.8.4 and 3.8.5.

MR. GAUKLER: Mention those again, please.

DR. BARTLETT: They are in NUREG 0800. I think the structural acceptance criteria are found in Section 3.8.5, and I think to look at the design loadings and cases, you need to refer to 3.8.4. But the -- that document spells out acceptable factors of safety against sliding and overturning for the design-basis earthquake as 1.1.

We've also -- it doesn't mention bearing capacity, but the Applicant has accepted also 1.1 as a factor of safety against bearing capacity, and we have not taken any issue with that. But just recall that if one was designing according to NUREG 0800, Section 3.8.5, that the design-basis earthquake that one would use in evaluating the factors of safety against sliding and overturning would be the safe-shutdown earthquake for a nuclear power plant. ISFSIs are not governed by -- are not designed, at least my understanding of the seismic exemption is that they're not going to be designed to a safe-shutdown earthquake for a nuclear power plant. They're being designed for an earthquake that has a 2000 year return period event, so already, even if you meet the factor of safety of 1.1 for a 2000 year return period event doesn't imply that you're going to meet it for safe-shutdown earthquake for a nuclear power plant. So there's already some unconservatism introduced just in the simple factor of safety.

MR. GAUKLER: Aren't you really confusing the concept of risk reduction factor with respect to the performance objective, interrelating the --

DR. BARTLETT: No, I don't think so. A nuclear power plant, if one was to apply the risk

reduction factors of 5 to 20 and say that they are valid, you would have to recognize that the factor of safety against sliding and overturning done for a nuclear power plant would meet a factor of safety against sliding and overturning of 1.1 for the safe-shutdown earthquake for a nuclear power plant.

MR. GAUKLER: And the safe-shutdown earthquake for a nuclear power plant is the design-basis earthquake for the nuclear power plant. Correct?

DR. BARTLETT: That is correct.

MR. GAUKLER: And here we're just applying the 1.1?

DR. BARTLETT: To a different earthquake.

MR. GAUKLER: To a different earthquake. That is the design-basis earthquake.

DR. BARTLETT: But the margins against failure are different because we're using a lower standard earthquake.

MR. GAUKLER: But isn't that the whole issue here in terms of what earthquake should be used? And in that context, you've already said that it was a two-handed approach. One, you would look at the earthquake itself. And the second, you look at the conservatisms inherent in the codes and standards.

And you -- right now, I thought we were talking about the risk reduction factor, or the conservatisms in the codes and standards. And my sense is, in your last couple of answers, you've gone back to say it's less conservative because the design-basis earthquake is less conservative. Is that what I understand you to say?

DR. BARTLETT: I'm saying if one is to infer that the risk reduction factors that have been developed for nuclear power plants are directly applicable to ISFSI, I would have to take exception with that, because the risk reduction factors for nuclear power plants are based on meeting and acceptable factor of safety against sliding and overturning for a safe-shutdown earthquake for the design of a nuclear power plant.

The Applicant here, in this case, is trying to use that same factor of safety for a less severe earthquake, so I'm not sure those risk reduction factors strictly apply here.

MR. GAUKLER: And I guess my point is, aren't you interchanging the two -- in the two-handed approach, aren't you now mixing the two together, because --

DR. BARTLETT: I don't believe I'm mixing

them. I'm telling you that the factor of safety that one chooses is a function of the design-basis earthquake. When you use a less severe design-basis earthquake, even if you meet the same factor of safety, you have less margin in your design. It's just that simple, because factor of safety is based on both the capacity and demand. And if you reduce the demand, but keep the factor of safety the same, you don't have the same margin.

MR. GAUKLER: But that -- don't those things go to the performance, ultimate performance that you reach. Correct? And it's a reachable performance objective for ISFSIs than nuclear power plants, is what it comes down to. And that, at least according to Dr. Arabasz, is acceptable.

DR. BARTLETT: I'm not sure I understood what that was being discussed there, but the fact is that when you look at those risk reduction factors for nuclear power plants, they've based on a certain design-basis earthquake. And the factor of safety is a function of the design-basis earthquake. And even for an ISFSI, if you meet the same factor of safety, but you're doing it for a lower design-basis earthquake, there's already some inherent margin in the design that has left, because you're using a less

severe event, so I can't see how we can say, at least for foundation design, that these risk reduction factors developed for nuclear power plants are strictly applicable to ISFSIs, at least from the foundation perspective.

MR. GAUKLER: And as I hear it, all your discussion right now has been limited to foundations. Correct? Even your previous --

DR. BARTLETT: That is correct. I will not say those statements about structural mechanical design.

MR. GAUKLER: Okay. And you -- now in terms of the comparison of the SRPs for ISFSIs versus the SRPs in nuclear power plants, you make reference that the ISFSIs SRPs may differ in terms of conservatisms than the nuclear power plants SRPs. You have not made an evaluation of the two, have you?

DR. BARTLETT: No, it was just a concern. Whether -- not knowing those codes completely, had we already removed some of the conservatism in design to the ISFSIs and their appropriate reg guides, versus nuclear power plants, because I just expressed one concern in terms of factor of safety in design. And so, I -- you know, it was a concern whether we had already removed some conservatisms with the ISFSI

NUREGs.

MR. GAUKLER: Now you've read Dr. Cornell's --

DR. BARTLETT: I have.

MR. GAUKLER: And you've read in there, I take it, that he looked at the SRPs for ISFSIs, and compared it to the SRPs for nuclear power plants. Do you remember that?

DR. BARTLETT: Yes, I do.

MR. GAUKLER: And do you recall that he concluded based upon that evaluation that the levels of conservatisms are the same with respect to the SRPs for nuclear power plants, and those for ISFSIs?

DR. BARTLETT: I do recall that, yes.

MR. GAUKLER: And you have no basis to disagree with that, I take it?

DR. BARTLETT: I do on the foundations issues that we've just discussed. I'm not sure that they're the same levels of conservatism based on the foundation design.

MR. GAUKLER: And on the foundation design, you have no basis to disagree with Dr. Cornell concludes in his testimony. Is that a fair statement?

DR. BARTLETT: Yes, because I'm not a structural or mechanical engineer.

MR. GAUKLER: This might be a good time to take a break, Your Honor.

CHAIRMAN FARRAR: Before we do that, let me ask you how you're doing in terms of time.

MR. GAUKLER: I expect to be done this morning.

CHAIRMAN FARRAR: This morning means noon.

MR. GAUKLER: I think that's correct.

CHAIRMAN FARRAR: Okay.

MR. GAUKLER: I have something -- maybe I may have to review my things over noon. I may have a few follow-up after lunch, but I'm more than halfway through.

CHAIRMAN FARRAR: Mr. Turk, is some of your plan being covered by the Company?

MR. TURK: Yes. My own estimate would be two hours with bounded, probably more going to be on the order of an hour and a half, or less.

CHAIRMAN FARRAR: All right. So if --

MR. TURK: I'll know more as the morning progresses.

CHAIRMAN FARRAR: If we finish -- Ms. Chancellor or Ms. Nakahara, you were hoping to finish by what time tomorrow?

MS. NAKAHARA: Noon. With Dr. Cornell's

rebuttal testimony also.

CHAIRMAN FARRAR: Right. Do we have to finish Dr. Bartlett before -- how much progress do we have to make on Dr. Cornell today to finish by noon tomorrow?

MR. GAUKLER: I'm going to hand out now rebuttal testimony for Dr. Cornell with respect to the testimony of DR. Arabasz. I've already given the State a draft yesterday so they could start talking with DR. Arabasz.

In addition, we will probably have some rebuttal from Dr. Cornell with respect to Dr. Bartlett, but I can't say that until after I get done with cross examination. It depends upon the answers I get in cross.

CHAIRMAN FARRAR: Well, do we need --

MR. GAUKLER: But whatever rebuttal I have with respect to Dr. Cornell and Dr. Bartlett will not be very long. It would be -- the oral questions and answers would be less than a half hour, I'm sure.

CHAIRMAN FARRAR: If the State received Dr. Cornell's rebuttal yesterday, have you had time to do enough analysis of it to predict how long you need on cross examination?

MS. CHANCELLOR: No rebuttal, Your Honor.

We don't -- one thing we can say is that we don't expect to call Dr. Arabasz back to rebut the surrebuttal of Dr. Cornell's rebuttal.

CHAIRMAN FARRAR: Well, then if we started Dr. Cornell tomorrow, would we finish him by noon, or do we have to get him on the stand this afternoon?

MR. GAUKLER: I think we could easily finish by noon.

MS. NAKAHARA: That's assuming that there's only a half an hour rebuttal testimony.

MR. GAUKLER: And I say that's a -- I view that as a maximum. I think it would be less than that.

CHAIRMAN FARRAR: Maybe what we should do is plan to have Dr. Cornell deliver his rebuttal today. That gives the State overnight to think about -- have him do all his rebuttal.

MR. GAUKLER: One thing I would want to review and think about what Dr. Bartlett has said in terms of developing -- to what extent I need rebuttal. I could -- I wouldn't mind giving what I have ready to go, but it's conceivable I may have several questions more in the morning. I don't expect much, if anything.

MS. CHANCELLOR: Are you going to do any

written rebuttal with respect to Dr. Bartlett?

MR. GAUKLER: I thought about that, but when I looked through what Dr. Bartlett has stated, I didn't have anything that I wanted to rebut based upon the written testimony, so in terms of his written testimony as of right now, there was no really written rebuttal, and therefore, I didn't prepare any, because it really depends on cross examination.

MS. CHANCELLOR: So your rebuttal would just be to the questions that come out during testimony.

MR. GAUKLER: Basically, yes.

MS. CHANCELLOR: Okay.

MS. NAKAHARA: This presumes the Staff is not putting on any rebuttal to Dr. Bartlett.

MR. TURK: We haven't discussed that among ourselves yet, but at this point, I don't personally anticipate putting on rebuttal to Dr. Bartlett.

CHAIRMAN FARRAR: Why don't we see if we can't get Dr. Cornell on the stand by 4:00 today, and that way the State gets -- we have to decide who gets overnight to prepare. And given the relative resources and the home court advantage which the State enjoyed out there, but you all enjoy here, I'd like to get Dr. Cornell on, both as a matter of timing, and to

make sure the State had a chance to prepare its cross, which would make that go faster.

MR. GAUKLER: And I'm sure that just taking a 15, 20 minute break, or some appropriate break would be sufficient for us. Yes, Your Honor.

CHAIRMAN FARRAR: Okay.

MR. GAUKLER: We'll get done with Dr. Bartlett about that time.

MR. TRAVIESO-DIAZ: I would also note that Dr. Cornell's written rebuttal is very short.

CHAIRMAN FARRAR: Right. Five pages. Yeah. A little over four. All right.

(Off the record 10:32:21 - 10:52:41 a.m.)

CHAIRMAN FARRAR: We're reminded that today is the day the cafeteria breaks down, I think for an awards ceremony. It shuts at 1:00, but they start breaking it down at 12:30, so we will adjourn at noon, so everyone can get lunch without having to go out of the building.

Go ahead, Mr. Gaukler. How much time do you think you will need?

MR. GAUKLER: I would say less than an hour.

CHAIRMAN FARRAR: Oh, good.

MR. GAUKLER: I may need to take a break

to talk with Dr. Cornell on a couple of subjects yet in that time.

CHAIRMAN FARRAR: All right, that would be excellent.

MR. TURK: And if he does that, would he qualify for one of the awards today.

CHAIRMAN FARRAR: We will put his name in and see what happens.

(Laughter.)

MR. TRAVIESO-DIAZ: Please have mine.

(Laughter.)

MS. NAKAHARA: Is it a monetary award?

(Laughter.)

MR. GAUKLER: Dr. Bartlett, I would like to go back to what we were talking about, briefly about the effect of margins with respect to foundations for SRPs for nuclear power plants and for ISFSIs, okay?

DR. BARTLETT: Yes.

MR. GAUKLER: Now, first of all, isn't it true that the overall risk that you're trying to achieve with an ISFSI is lower -- higher than that for a nuclear power plant using the risk-rated approach?

DR. BARTLETT: One would allow a higher probability of failure for an ISFSI versus a nuclear

power plant.

MR. GAUKLER: So you would agree --

DR. BARTLETT: If you would consider DOE as a framework, yes, there are different performance goals for PC Category 4 versus PC Category 3.

MR. GAUKLER: Using the risk-rated approach?

DR. BARTLETT: Yes.

MR. GAUKLER: Now when using this two-handed approach, and for ISFSIs you can have a higher level of risk than for nuclear power plants, when you reduce or lower the design basis earthquake, you will come out with some, assuming you keep the conservatisms the same, you will come out with some higher risks than you would have for a nuclear power plant?

DR. BARTLETT: Could you define what you mean "keeping the conservatisms the same," the factor of safety --

MR. GAUKLER: The factor of safety the same, yes, the risk reduction factor.

DR. BARTLETT: Now, excuse me, please ask the question again.

MR. GAUKLER: Okay. Assuming you hold the risk reduction factor the same you have for nuclear

power plants, but you reduce the design basis earthquake, you are, in effect, allowing or providing for a higher risk at that point in time, assuming that would be the basis for your ISFSI design, correct?

DR. BARTLETT: If we talk about a risk reduction factor related to factor of safety, I'm not sure we can make a fair comparison because risk reduction factors are inherent margins in the design -- a factor safety expresses a margin in a design.

MR. GAUKLER: Well, let's assume at this point we keep the risk reduction factor the same.

DR. BARTLETT: To me, that just said I kept the factor of safety, the margin in the factor of a safety the same. I'm just having a hard time relating risk reduction factors to factors of safety.

MR. GAUKLER: Now let's go back, just using the two-handed approach --

DR. BARTLETT: Okay.

MR. GAUKLER: -- you can increase the allowable risk by two methods. Either you could allow a lower design basis earthquake or you could reduce the risk reduction factor. Either way, using this two-handed approach, you would be allowing a higher risk for ISFSIs compared to nuclear power plants?

DR. BARTLETT: Sure. We talked about an

example of maybe the DOE Standard 1020-94 which uses a 2,000-year design basis earthquake and risk reduction factor of five versus a 2,500-year return period that's now in the new DOE standard and a risk reduction factor of four, but you achieve the same target performance goal.

MR. GAUKLER: Right.

DR. BARTLETT: I understand that.

MR. GAUKLER: Okay. So I guess my basic question that I was asking about before, which I was having a problem understanding is, assuming that I just take and change my design basis earthquake --

DR. BARTLETT: Okay, your factor of safety will change. Okay.

MR. GAUKLER: And factor of safety will stay the same, assuming --

DR. BARTLETT: No, it won't. It will change. Factor of safety is a function demand divided -- capacity divided by demand. So by changing the demand, you change the factor of safety.

CHAIRMAN FARRAR: Mr. Gaukler, let me ask a question over here. It seems at this stage of the proceeding what you're talking about is a truism. I mean I don't that your asking the witness about it -- in other words, we understand at this point the

relationships you're talking about. I don't know what this question -- everyone's struggling with the way this is framed, and I don't know that we're --

JUDGE LAM: Where are you going, Mr. Gaukler?

CHAIRMAN FARRAR: Yes, where is this going?

MR. GAUKLER: Yes, my understanding is that if you decrease the design basis earthquake, you can adjust the overall risk performance two ways, either by adjusting the design basis earthquake or the risk reduction factor.

CHAIRMAN FARRAR: I would think everyone in the room has that understanding So I don't know why we need to belabor it through a witness.

MR. GAUKLER: The only reason I was getting to it was he was claiming that the risk reduction factors in SRPs for ISFSIs are less than the risk reduction factors for nuclear power plants with respect to foundation. That's what I was driving at.

DR. BARTLETT: May I help?

CHAIRMAN FARRAR: Yes.

MR. GAUKLER: Yes.

DR. BARTLETT: The factor of safety is just simply a ratio of capacity divided by demand. If

you keep your capacity the same but change the demand, change the earthquake, the design basis earthquake, the factor safety changes. It's just a simple ratio. I'm not sure I can relate this back to risk reduction factors, but I'm just pointing that when one designs for a nuclear power plant, and looking at it from a factor of safety viewpoint, one would determine the capacity of the system and divide it by the demand, which would be the design basis earthquake for a nuclear power plant, and calculate a factor of safety.

However, if one goes to design of an ISFSI, let's select maybe a 2,000-year return period, the demand is less, and the factor of safety that one would calculate would be higher. It's simple capacity demand concepts.

MR. GAUKLER: On this concept that you're talking about, if you reduce the design basis earthquake capacity, and you kept the same capacity, the factor of safety would increase.

DR. BARTLETT: If you decrease the demand, the factor of safety would increase. A nuclear power plant is designed to have a factor of safety of 1.1 against a design basis earthquake or, say, a shutdown earthquake for a nuclear power plant.

MR. GAUKLER: If I understand what you're

saying, it is that --

DR. BARTLETT: Here's the important point. The Applicant has done all its design basis calculations not using a design basis earthquake for a nuclear power plant. It has used a 2,000-year return period event and tried to demonstrate that they have a factor of safety of 1.1, but the margins in that philosophy is different and less than if we were to design it for a nuclear power plant, because of the fact that you've accepted a lower design basis earthquake, kept the factor of safety the same, and let's say you were at 1.2; you don't have the same margins as you would if you were designing for a safe shutdown earthquake. It's because you've changed -- you're designing to a less severe event.

It's very clear to me, if you accept 1.1 and say an Applicant met 1.1 for a 2,000-year return period event and demonstrated they had 1.1 with a little bit of margin, they certainly couldn't claim that they had a 1.1 margin against failure for, say, a 10,000-year return period event because the demand is much higher.

So factor of safety expresses the capacity demand ratios, but it's dependent on both sides. You have to consider the two-handed approach. But nuclear

power plants are designed for a factor of safety of 1.1 for a safe shutdown earthquake for a nuclear power plant. This ISFSI we're talking about is not being designed for a safe shutdown earthquake. It's being designed to a lesser event, but still trying to demonstrate a minimum factor of safety of 1.1.

MR. GAUKLER: I guess my simple point is that, would you agree with me, then, that with respect to the margins, and with respect to the ISFSI earthquake, using the same margin 1.1 --

DR. BARTLETT: Doesn't --

MR. GAUKLER: -- results in the same factor of safety --

DR. BARTLETT: No, it doesn't give the same -- it doesn't give you the same conservatism.

MR. GAUKLER: -- insofar as the design basis earthquake -- let me complete my question, okay?

DR. BARTLETT: Sure.

MR. GAUKLER: This will probably be the last one because I think we've probably beat this horse enough after this. If I use the factor of 1.1, and not taking into account the other conservatisms, just the 1.1 --

DR. BARTLETT: Okay, for an ISFSI now?

MR. GAUKLER: ISFSI, yes.

DR. BARTLETT: Okay.

MR. GAUKLER: Uh-hum, with my lower design basis earthquake, okay?

DR. BARTLETT: Okay.

MR. GAUKLER: And so my demand is lower than for a nuclear power plant.

DR. BARTLETT: Correct.

MR. GAUKLER: And I design my ISFSI for a factor of safety, using the same factor of safety, 1.1 --

DR. BARTLETT: Okay.

MR. GAUKLER: Don't I have the same factor of safety in both instances with respect to the nuclear power plant and the -- let me complete my question -- the nuclear power plant and the ISFSI with respect to the respective earthquakes? In other words, the ISFSI has a factor of safety with respect to its earthquake in this example of .1, and the reactor has a factor of safety with respect to its design basis earthquake of .1.

DR. BARTLETT: Right.

MR. GAUKLER: Therefore, the factor of safety, by adjusting both the capacity and the demand, basically remains the same, correct?

DR. BARTLETT: No, they don't have the

same margins. One is designed to a less conservative earthquake, so it has lesser margins actually, real margins.

MR. GAUKLER: But in terms of proportional margins they're the same, correct?

DR. BARTLETT: Well, I don't understand why we want to talk about proportional margins. I mean --

MR. GAUKLER: We're talking about proportional risk as well. Would you agree with me that the proportional margins are the same?

DR. BARTLETT: Yes, but I don't understand how it's germane -- go ahead.

MR. GAUKLER: Okay, we can argue the germaneness then.

Since we're talking about margins in the context of foundations, I would just like to hand out courtesy copies of Mr. Trudeau's rebuttal testimony with respect to falls.

In this testimony Mr. Trudeau sets forth what he believes are various conservatisms in his calculation of the safety factor, factor of safety, with respect to sliding and bearing capacity back to the design of the pads, correct?

DR. BARTLETT: Yes.

MR. GAUKLER: Now I know you don't agree necessarily with all the conservatisms that are referred to by Mr. Trudeau here. You've agreed with some, disagreed with others?

DR. BARTLETT: That's correct.

MR. GAUKLER: But would you agree that, assuming that Mr. Trudeau is correct, that he, in effect, has shown sufficient conservatism such that ISFSI or the pad would be protected, say, for example, against sliding in a 10,000-year earthquake?

DR. BARTLETT: No, he has not.

MR. GAUKLER: You don't think he has?

DR. BARTLETT: No, he's not evaluated a 10,000-year return period earthquake. He's only evaluated a 2,000-year return period.

MR. GAUKLER: You're claiming that the margins here do not?

DR. BARTLETT: No, I don't think any justification -- it's hard to linearly interpolate a design that's based on a 2,000-year return period and try to figure out what it would do for a 10,000-year return period event. We have not seen any calculations for a 10,000-year return period event. So I just cannot really comment.

The Applicant's calculations for the

sliding, overturning, and bearing capacity of the pads in the canister transfer building have been based on a 2,000-year period event. It's quite a leap of faith to try to extrapolate that to a 10,000-year period, return period.

MR. GAUKLER: Now with respect to the cask stability analysis done by Holtec, they've used a 10,000-year event with respect to that, correct?

DR. BARTLETT: I'm familiar that they have done calculations for that, yes.

MR. GAUKLER: Assuming, hypothetically, that Holtec's simulations were correct, that would show the capability to meet, survive a 10,000-year earthquake, isn't that correct? We have no basis to disagree with that conclusion?

DR. BARTLETT: I have a lot of basis to disagree with Holtec's calculations but I don't know if we want to get into them.

MR. GAUKLER: Assuming, hypothetically, that the calculation is correct -- it's a hypothetical.

DR. BARTLETT: Well, a lot of our concerns with Holtec's calculations are not so much what they did, but what they didn't do and what they didn't analyze for.

MR. GAUKLER: Assuming the results of Holtec's calculations are correct --

DR. BARTLETT: I can't assume about omissions.

MR. GAUKLER: You can't assume about what?

DR. BARTLETT: I can't assume about omissions. A lot of our points that we make about Holtec's calculations are conditions and things that they didn't analyze for.

MR. GAUKLER: Assuming that the results of Holtec's calculations are correct, hypothetically --

DR. BARTLETT: How do I assume about an admission that has never been calculated?

MR. GAUKLER: I'm asking you a hypothetical question.

CHAIRMAN FARRAR: Dr. Bartlett, he's entitled to ask a hypothetical. No matter how out of keeping with reality you think the hypothetical may be, this is a legitimate technique in the legal field.

DR. BARTLETT: Sure.

CHAIRMAN FARRAR: If he says, "Assume this. What's the conclusion?", you can give an answer that gives away the conclusion, but if your other evidence shows you don't agree with the hypothesis, then your answer doesn't harm your client's interest.

So listen to his hypothetical, if you would, and answer it on that basis.

DR. BARTLETT: Sure.

CHAIRMAN FARRAR: Go ahead and ask it again, Mr. Gaukler.

MR. GAUKLER: Assuming that the results of Holtec's evaluation of the 10,000-year earthquake are correct, will show no tipover of the casks, doesn't that show the capability of meeting a performance objective and meeting the goal of surviving a 10,000-year earthquake?

DR. BARTLETT: No, because Holtec's calculations they put thus far to us have not looked at sliding, overturning, and bearing capacity failure of the foundations, the results of those failures on the stability of the casks for a 10,000-year return period event. So that I can't make assumptions about calculations that haven't been performed.

MR. GAUKLER: Well, assume that there is no overturning, assume that there is no sliding of the pad, and assuming the results of Holtec's calculations are correct, what is your answer then?

DR. BARTLETT: If there is no failure of the foundation systems in those modes, I'm not sure I can fully render an opinion then. I know Dr. Kahn

raised other issues that deal more with the analyses themselves, but if Holtec had done those analyses correctly and all of Dr. Kahn's concerns are resolved, then I guess in your hypothetical sense then I would have to -- I don't know what I'm supposed to agree to, but --

MR. GAUKLER: In the hypothetical sense that the cask would survive a 10,000-year earthquake without tipping over.

DR. BARTLETT: If Dr. Kahn's issues are resolved and there are no foundation stability issues of how it may impact cask sliding, yes, I would agree.

MR. GAUKLER: Thank you, Dr. Bartlett.

JUDGE LAM: Dr. Bartlett, when you talk about foundation failure, what type of failure do you have in mind?

DR. BARTLETT: Probably the one that's of greatest concern right now is sliding. When we look at potential sliding that now may be on the order of inches, maybe six inches or so, we believe that that large amount of sliding definitely causes severe pad-to-pad interaction. We haven't really seen an evaluation of that severity of sliding. I think most of the calculations that we have seen thus far really don't capture the sliding mechanism, and even Holtec's

most recent calculations, I think they only allowed a .6-inch gap to occur. We would believe that, if sliding does occur, that the gapping could be much larger than that. It's really an uncontrolled condition. I don't think I've seen any models that really capture what sliding could do in relation to cask stability.

JUDGE LAM: So you are not referring to the ground opens up and the pad will collapse?

DR. BARTLETT: No, it's transfer of unaccounted for inertial forces due to the sliding. Now in the case of bearing capacity, it's of lesser concern because it doesn't seem to be quite -- the bearing capacity analysis the Applicant has done for the 2,000-year return period, as I said in my surrebuttal, seems to be adequately conservative. But we haven't looked at design calculations for the 10,000-year return period.

So I'm not saying that there is bearing capacity failure for the 10,000-year return period, but there's a point where it could be possible. That would cause now the beginnings of pad rotation. We haven't seen any analyses that really look at pad rotation issues.

Also, I don't think that there will be

overturning of a pad foundation, even for a 10,000-year return period, but, however, we can now start to get uplift and rocking components, as that tries to overturn but can't completely overturn. So when we look at the 10,000-year -- or beyond design basis events, there's no calculations that really discuss this foundation behavior and how it impacts the cask sliding.

JUDGE LAM: Thank you.

MR. GAUKLER: Just a couple of quick questions. In terms of the soil foundation of the 10,000-year earthquake --

DR. BARTLETT: Yes.

MR. GAUKLER: -- in their analyses Holtec took into account the soil parameters for the 10,000-year earthquake, correct?

DR. BARTLETT: The dynamic properties, I think they're trying to capture the response. They're not looking at failure mechanisms from a strength perspective: What happens if we exceed some yield strength of the soil or soil cement, and what's the consequences of failure on the dynamic response of the system? I don't think that's what Holtec was capturing.

MR. GAUKLER: But they did include the

dynamic properties of the soil --

DR. BARTLETT: The dynamic properties, I believe they probably used strain-compatible properties for the appropriate level of earthquake, which means the strains and damping will be larger for the 10,000-year return period.

MR. GAUKLER: Now you also were mentioning the concern that Holtec hadn't evaluated sliding of the pads. I don't want to go into this greatly, but I thought you were criticizing Dr. Luk because he had allowed sliding in the pads, and, in effect, by doing that reduced the dynamic motion of the cask.

DR. BARTLETT: My concern with Dr. Luk's analyses is that the model may tend to allow sliding to occur more early than it may in actuality do. That's as far as I could really go because I think that the amount cohesion at the interfaces had not been properly accounted for in the model. I think that's a fair characterization of my concerns with Dr. Luk's reports, maybe on the properties they used in the model.

MR. GAUKLER: He overemphasized sliding, as far as you saw?

DR. BARTLETT: My tendency was just to think that that could happen, just because the

cohesion hadn't been taken into account.

MR. GAUKLER: Let's go back to the subject of this testimony. With respect to -- you talked about the pads now foundation, what you consider to be potential foundation failures of the past. I take it you really don't have any concerns with respect to catastrophic potential failures of the foundations for the canister transfer building, isn't that correct?

DR. BARTLETT: Well, we've talked about sliding. We still think sliding is a potential problem with the canister transfer building.

MR. GAUKLER: But there's really no potential health and safety consequence from sliding that you could determine, correct? I believe you covered this at length in the Section D testimony?

DR. BARTLETT: Yes, and I can't remember what I said in D. I guess we'll refer back to what we said. I think we expressed the concern that the canister transfer building may slide. I've heard Dr. Ostadan worried about how that sliding may crack the foundation, crack maybe the walls, maybe they would have to be jacked back up to be plumb. I'm not sure what we opined on regarding radiological consequences.

MR. GAUKLER: Whatever you opined back then would --

DR. BARTLETT: I still opine back to what I said --

(Laughter.)

MR. GAUKLER: Whatever you opined then you'll opine the same here then, roughly?

DR. BARTLETT: It's been three weeks; it's getting very distant in my memory.

MR. GAUKLER: Very good. Then we won't go over that more then.

I would like to turn to your Question and Answer 15 very quickly.

DR. BARTLETT: Excuse me. Which question was that again?

MR. GAUKLER: Question and Answer 15.

DR. BARTLETT: Okay.

MR. GAUKLER: There you claim that the only justification set forth for the use of the design basis earthquake of 2,000 is that typical nuclear power plants components would have a factor of safety of 5 to 20?

DR. BARTLETT: No, not a factor of safety; a risk reduction --

MR. GAUKLER: Excuse me. Risk reduction factor.

DR. BARTLETT: That's true.

MR. GAUKLER: Now you read Dr. Cornell's testimony in this proceeding, correct?

DR. BARTLETT: Yes, I have.

MR. GAUKLER: You would acknowledge that he includes as well during his testimony analyses that Holtec has done with respect to the 10,000-year earthquake which go beyond just relying upon the five to twenty factor of typical nuclear power plant components?

DR. BARTLETT: Well, my understanding of Dr. Cornell's testimony is that he's not basing his opinion on the risk reduction factors for nuclear power plants, but he's now basing it more on the site-specific analyses that have been done by Holtec and others, Mr. Ebbeson and Mr. Trudeau.

MR. GAUKLER: So his testimony is based upon both the five to twenty factor, as he discusses, as well as site-specific analysis, correct?

DR. BARTLETT: Yes, and I express my concern about applying risk reduction factors for nuclear power plants that have safe shutdown earthquake for an ISFSI. I think we have just discussed that at length. I would take exception that the site-specific calculations performed by the Applicant demonstrate that there's risk reduction

factors of five to twenty for this facility.

MR. GAUKLER: But, in any event, your statement that there's no other justification, other than the five to twenty, is no longer correct?

DR. BARTLETT: It's been modified by Dr. Cornell's most recent testimony, that's correct.

MR. GAUKLER: You also claim, I think, in Question and Answer 27 that PFS needs to develop fragility curves, is that correct?

DR. BARTLETT: Well, fragility curves would be a probablistic method of doing it, or demonstrating that there is an adequate risk reduction factor for the design basis earthquake I guess would be an alternative approach.

MR. GAUKLER: So, for example, assuming again that Holtec's analysis hypothetically is correct that we just went through, that would establish what you're trying -- that would establish the performance objective, and there would be no need at that point to develop a fragility curve, going back to that hypothetical that we discussed, is that correct?

DR. BARTLETT: Since it's one point on a fragility curve, and I guess short of the system having some kind of brittle behavior where it changes dramatically its response someplace in between, I

guess you could just be satisfied in showing that you met the performance goal for one design basis earthquake. But, again, my issues with Holtec is not so much what they did, but what they didn't do.

MR. GAUKLER: I understand. It's just a hypothetical we're talking about.

DR. BARTLETT: Okay.

MR. GAUKLER: I was just trying to focus on the need for, or the potential need for, a fragility curve --

DR. BARTLETT: No, and I think even Dr. Cornell talks about this in his testimony, that short of any brittle behavior in the system, if you could show that you met the performance goal at a certain design basis earthquake, and the risk reduction factors you had were adequate, there's not necessarily a need to develop a full fragility curve.

I'm not sure I can preclude brittle behavior in this case with the soil cement, but it's hard to say. There might be some place in between where the soil cement bonds break and we do have a market change in response of the system dynamically. So there is a potential for at least brittle failure of the foundation system.

MR. GAUKLER: But you don't have any idea

about --

DR. BARTLETT: I don't know where that begins, no. I know the Applicant's calculations have tried to demonstrate that there will not be any brittle failure of the soil cement and the cement-treated soil for the design basis earthquake. They have not done any evaluations of potential brittle failure of the soil cement and cement-treated soil for beyond design basis earthquake events.

MR. GAUKLER: May I take a few minutes, say five minutes, to review my notes and talk to people?

CHAIRMAN FARRAR: Is five enough or should we --

MR. GAUKLER: Make it 10. I think I'm basically done. I just want to make sure.

CHAIRMAN FARRAR: All right, it's 26 after; we'll be back at 25 of.

(Whereupon, the foregoing matter went off the record at 11:25 a.m. and went back on the record at 11:38 a.m.)

MR. GAUKLER: I have a few short questions.

CHAIRMAN FARRAR: All right.

MR. GAUKLER: I would like to have you

look at Question and Answer 26 of your prefiled testimony. There you say, because the scope of the hazard curve can be impacted by soil non-linear behavior, NUREG /CR 6728 recommends to establish the scope of the hazard curve by including the non-linear soil effects for determination of the seismic scale factor?

DR. BARTLETT: Yes.

MR. GAUKLER: I take it, based on our previous discussion, that Holtec, when it took the 10,000-year point off the hazard curve and used the soil properties for the 10,000-year situation -- just a second. Because Holtec used the 10,000-year earthquake and you had soil properties, this concern here would not relate to Holtec's analysis with respect to the 10,000-year earthquake, isn't that correct?

Just, again, putting aside all your other --

DR. BARTLETT: Yes, I can't because that's Dr. Ostadan's area of expertise in soil dynamics and non-linearity effects, and I can't really say whether it is this concern has disappeared in those analyses done by Holtec for the 10,000-year return period.

MR. GAUKLER: But the hazard curve again

refers to whether -- the way I interpret that question, you had a concern, in terms of what you expressed with respect to soils, that you had taken a point at 2,000 years and then you have some margins, and you're trying to extrapolate up the hazard curve to the 10,000-year point to see whether or not you have sufficient --

DR. BARTLETT: And I think it is just bringing in the point that when you do that extrapolation that it has to take into consideration the effect of soil non-linearity on the slope of the hazard curve.

MR. GAUKLER: And, therefore, when Holtec, in fact, goes in, it doesn't do the extrapolation from 2,000 to 10,000; it goes and uses the actual design basis ground motions as developed by Geomatrix, using the shaped analysis, et cetera --

DR. BARTLETT: Right, and then, again, tries to incorporate the non-linearity effects for the 10,000-year event in the soils. Again, not being completely familiar with that analysis, I can't say whether this has completely disappeared.

MR. GAUKLER: Your best belief is that --

DR. BARTLETT: I just don't really don't know exactly how the non-linear effects of the soils

were incorporated in that 10,000-year return period.

MR. GAUKLER: You have no basis to say that would be a problem with respect to the Holtec analysis? What basis would you have to say that would be a problem with respect to Holtec's analysis of the 10,000-year earthquake, using the soil properties for the 10,000-year earthquake?

DR. BARTLETT: I guess I could put it this way: If Holtec properly accounted for the non-linear effects of the soils for the 10,000-year return period event, then I think this would disappear. But, again, not being intimately familiar with those calculations, I can't say whether I believe they have or haven't.

MR. GAUKLER: Okay. So you have no basis to say that they have not --

CHAIRMAN FARRAR: Well, you asked that and he answered it.

DR. BARTLETT: That's the best I can do, Mr. Gaukler.

MR. GAUKLER: Going on to one other question in terms of the conservatisms that may or may not exist at 2,000-year earthquake, which is a 10,000-year earthquake --

DR. BARTLETT: Okay.

MR. GAUKLER: -- isn't it true that, with

respect to the -- one of the conservatisms that I think both you and Mr. Trudeau have agreed upon that exist with respect to the sliding analysis and the bearing capacity analysis is that the dynamic shear strength of the soil be greater than the static shear strength of the soil, which was used by Mr. Trudeau in his --

DR. BARTLETT: Yes, we agree upon the effect; we disagree on the magnitude.

MR. GAUKLER: Right, you disagree upon the magnitude.

DR. BARTLETT: Yes.

MR. GAUKLER: My question here -- I don't want to get into disagreement on the magnitude -- I guess my point, my question is, doesn't that same conservatism exist with respect, would exist with respect to analysis, stability analysis, at the 10,000-year earthquake level?

DR. BARTLETT: The effect would still be there.

MR. GAUKLER: Okay. Might it be more?

DR. BARTLETT: No. The strain rate effects between the two events are probably not that different.

MR. GAUKLER: Okay, so basically the same

then?

DR. BARTLETT: Yes, that's correct, it would be the same.

MR. GAUKLER: I have no further questions.

DR. BARTLETT: It would not increase.

MR. GAUKLER: I have no further questions.

CHAIRMAN FARRAR: Thank you, Mr. Gaukler.

Let's use the remaining time before lunch to ask a few of the Board's questions. I have one, Dr. Bartlett.

In reading your testimony, it's clear to me you don't like the 2,000-year earthquake. You reason by analogy that it ought to be at least 2,500, but I'm not sure that you are urging the 10,000-year earthquake on us as opposed to something that's 2,500 or greater.

If you were writing our decision, what return period earthquake would you put in? Or did I miss something in your testimony where --

DR. BARTLETT: No, I think the bulk of the testimony was saying that the ultimate goal -- and I think this is where you see agreement -- is that we should set a performance goal, a risk-based performance goal, and then through this two-handed approach, demonstrate that the performance goal has

been met. At least that's the way I have done it in the Department of Energy.

Setting the level of earthquake, we believe at least for the 2,000-year return period event, that even the design, particularly for sliding, is still marginal, if not that the Applicant hasn't demonstrated an adequate factor of safety. So certainly I would like to see a design basis earthquake above 2,000. Whether 2,500 years is really adequately conservative or not I don't know. I would suspect that the 2,500-year return period would be somewhat higher, but not significantly higher.

I do understand that in a risk-rated approach that the 10,000-year event may be somewhat extreme. I guess my best guess is somewhere between 2,500 and 10,000 years, but it's difficult to put a number on it.

I believe that if a higher design basis earthquake was used, that there would be some significant redesign of the facility to meet those demands placed on it.

CHAIRMAN FARRAR: Okay. Dr. Kline has some questions.

JUDGE KLINE: Yes, I would like to back up now and take a more global view of the case as it sort

of unfolded before us. So I'm not going to be interested in a lot of empirical ratios or comparisons to nuclear power plants and safety factors, and all that material, not because it's unimportant, but because we've gone over it.

If I am looking just -- I'm going to base some of my questions on your Question and Answer. 16 and 17. It has to do with your view that it's inappropriate to refer the design basis earthquake without considering the probability of failure of components and all. Is it fair -- I mean, the impression of a novice in this business is that there really is no purpose for even selecting or even considering a design basis earthquake other than to guide the design and construction of the components, is there?

DR. BARTLETT: That's its primary purpose.

JUDGE KLINE: Yes, of course.

DR. BARTLETT: It becomes the design basis so that everything -- it becomes a standard essentially in the design.

JUDGE KLINE: So the design, the so-called two-handed approach is not really a dichotomy. It's, in fact, linked. On the one hand, we get some sort of rough idea of what the earthquake is likely to be, and

then, on the other hand, we design against it.

DR. BARTLETT: Correct.

JUDGE KLINE: Isn't it true we could get all the seismic safety we wanted without even thinking about design basis earthquakes? We could just design everything to the standards of Ft. Knox?

DR. BARTLETT: That would be correct.

JUDGE KLINE: Yes. Okay. So that really a large part of this analysis is not even safety-related, in my view. The fact is that Applicants and the regulated community are simply resistant economically to overdesigning or designing too much conservatism into their facilities? Isn't that a fair assessment?

DR. BARTLETT: Well, certainly designing to a higher design basis ground motion does impose economic penalties. So when you consider economics, there's obviously some thing that you go behind, do that you -- for example, for a building, you don't want to design it as Ft. Knox; you just don't want it to collapse and kill occupants.

JUDGE KLINE: Yes.

DR. BARTLETT: So there's an economic tradeoff, yes.

JUDGE KLINE: So there is, in a sense, a

tension. On the one hand, we don't want to get too low --

DR. BARTLETT: Right.

JUDGE KLINE: -- for safety reasons. On the other hand, we don't want to get too high --

DR. BARTLETT: Correct.

JUDGE KLINE: -- to just drive up the cost?

DR. BARTLETT: Those are usually social, political, economic decisions that are sometimes even --

JUDGE KLINE: Right, but they're embedded in this case, too, aren't they?

DR. BARTLETT: Yes.

JUDGE KLINE: All right. Now it appears to me, having taken account of the record generated here, that this is a very uncertain business, that this is not precise science. Do I have a wrong impression?

DR. BARTLETT: No, you have a very correct impression.

JUDGE KLINE: All right. So what good does it do, and why should we agonize over selecting a design basis earthquake in the first place, other than to get it into the ball park? I mean, why should

we worry about the nuances of it? Because, you know, if we get it into the ball park and we're roughly 2,000 years, and then overdesign to that standard anyway, why haven't we done all we really can do respecting safety?

DR. BARTLETT: Well, again, I think the general sense of your question is correct. I think the concern we're evaluating is not only just the margins, but the basic design philosophy of unanchored casks setting on pads.

JUDGE KLINE: Yes, I understand that.

DR. BARTLETT: That's troublesome to me as an engineer, when I could design redundancy in a system, and I wouldn't say design it as Ft. Knox, but at least put in some reasonable measures that would give it quite large capacity.

JUDGE KLINE: Well, it appears to me that we have strained mightily here and haven't improved our resolution any. It's like zooming in on a digital picture; all it does is pixelize, and you don't get any added resolution. It just seems to me that having gone beyond the first approximations here, we haven't gotten any more out of it, that we deal with imprecise analyses. Straining harder doesn't improve the resolution. We're still dealing with subjective

materials. We are dealing with comparisons, say, with nuclear power plants, which themselves were licensed under a subjective standard. It doesn't seem to me that we make any progress.

I am saying the issue of what design basis earthquake you use really isn't embedded in the laws of nature anywhere. It is just eventually somebody is going to make a subjective decision. Is there any other way to go about this?

DR. BARTLETT: Well, I think the one of design precedence.

JUDGE KLINE: Okay.

DR. BARTLETT: When we have structures that we've actually designed and we've actually seen them perform through earthquakes, and we've seen them perform satisfactorily, we feel confident in the design. A lot of the issues that we are doing really do become minute because we have a design. We've seen it perform, and we know it's adequate.

I think the reason we're going through all these gyrations is because of the somewhat unconventional design that's put in front of us. We're now faced with having to rely on analyses and judgments that are imprecise.

JUDGE KLINE: But here's where we need

some help in how you get by that hurdle because every structure was at one point in its lifetime novel.

DR. BARTLETT: That's correct.

JUDGE KLINE: So somehow designers and engineers and all these people face these problems earlier, and somehow they get over it, and eventually authorize building a building or building a bridge. or building a nuclear power plant. They all got over these dilemmas somehow.

DR. BARTLETT: Yes, through their experience.

JUDGE KLINE: And they were all uncertain and at the time they did it, they didn't have any precedent either, or they had less than we do now. So is there any objective process we can apply here that says, yes, we understand that we don't have a facility just like this, but, nevertheless, we have to find a way to get over that hurdle? If we're not going to build to the standards of Ft. Knox, what do you suggest we do?

DR. BARTLETT: We can do some simple things.

JUDGE KLINE: All right.

DR. BARTLETT: Anchorage doesn't seem to be too far out of the realm of our knowledge and

understanding, and certainly we've discussed that anchorage has some penalties. It transfers more inertial forces to the foundations, and one would have to account for the foundation design. There's designs that will work at this facility.

JUDGE KLINE: Yes, okay.

DR. BARTLETT: My general concern here is that we may be trying to do a design that's somewhat economical, but less safe.

JUDGE KLINE: Yes, okay. Then let's broaden the concept of the two-handed approach again --

DR. BARTLETT: Okay.

JUDGE KLINE: -- and coin another phrase, which I would call, "the overall system performance." It appears now from the record we have here that at least the PFS case is that this system could have localized failures in it and still work, in the sense that the overall objective is not to get a release of radionuclides. So we could have, we could tolerate foundation failure. We can tolerate casks moving and sliding. We can tolerate casks bumping into one another. We can tolerate casks tipping. Overall, the system, still nobody has shown us anything that suggests that the system performance overall, taking

that global look, no one shows us that we have a failure.

So the issue is, if you want to put these casks on pilings, we have to show some flaw as to why this system is likely to fail without them overall, I mean as a system. I need your comment on that.

DR. BARTLETT: Well, from the foundations, we think that foundation stability can lead to cask collisions and tipover.

JUDGE KLINE: Well, we understand. Let us assume that that's true.

DR. BARTLETT: I'll assume that's true.

JUDGE KLINE: Is a possibility of failure defined as breach of containment? You know, we have a fair amount of redundancy in the plan as it is provided to us.

DR. BARTLETT: Right. By this, I recall Mr. Guttmann talking about this, and it seemed to me that at this point the NRC staff had taken the position that what they wanted to achieve from the design, as spelled out in the NUREGs, was to not have collision and tipover, and they hadn't yet evaluated a design that really allowed tipover.

JUDGE KLINE: Look --

DR. BARTLETT: I guess I'm struggling,

too, because I don't know, not knowing how these casks perform in a tipover analysis, it doesn't to me that, if they do tip over, that there isn't going to be some kind of release.

JUDGE KLINE: Well, we understand that no competent engineer is going to go out and design these things to tip over.

DR. BARTLETT: That's correct.

JUDGE KLINE: The issue is contingency. All of the analysis that's been provided to us says they're not going to tip over. The Board has a legitimate interest in asking, okay, what if it's wrong? What if, in spite of our best analysis, what if it does tip over? Then we find, well, there's still more redundancy or there's alleged to be more redundancy. We're giving you an opportunity now to rebut it, when it says, well, if it tips over, the multipurpose cask doesn't breach. Well, we don't have any -- so even though we don't design these things to fail, we don't design these things to go wrong, and if continue the inquiry, what happens, in spite of our best efforts, they do go wrong; we still have redundancy.

So we have to know where the weak point is that undermines this application. Here we speak now

-- you know, we're late in the game. We have a record. We have judicial knowledge of seismicity that we didn't have six weeks ago. So now we have to be more sophisticated, I think, than we were when we were innocent, when we started out.

So we really want to pin you down now and say, "What's wrong with this in terms of the overall likelihood of system failure, looking at that endpoint," and not intermediate failures and not comparisons to power plants, and any of the other stuff that tries to capture empirical experience. But just tell us where there is a breach in redundancy or something to give us a handle here.

DR. BARTLETT: I have not been involved in any calculations to show, upon tipover, what would be the results to structural integrity of the casks.

JUDGE KLINE: All right.

DR. BARTLETT: However, we have discussed at length that in the drop tipover analysis that's been performed by Holtec it made some assumptions: First, that the cement-treated soil had a certain modulus. Also, that upon -- the tipover event postulated that it would be, the cask would be perched on its edge with zero angular velocity. During an earthquake that's not true. If we go to tipover, we

have some angular velocity.

So some of the assumptions made in the drop tipover analysis could be invalidated, first, of the soil cement or soils are too stiff, and those analyses have been performed properly, we could exceed this 45 G minimum -- or maximum, the acceleration posed by that analysis, and also an earthquake tipover event certainly would violate this starting at zero angular velocity at the point of impinging tipover.

So if an earthquake causes a cask to tip over, it seems to me that we could violate this 45 G maximum de-acceleration. The effects to the structural integrity and the loss of containment and increased dosage releases, I just can't really comment on. I think it's a possibility that could happen, but whether we have a factor of two or a redundancy of two against that or five, I don't know.

JUDGE KLINE: But what you can do then is raise the issue of perhaps uncertainty --

DR. BARTLETT: Tipover seems a possibility.

JUDGE KLINE: I mean that there's some still remaining some unresolved uncertainty in the overall analysis.

DR. BARTLETT: Right, and from my

philosophy, why do we go through all this difficulty chain with all of its uncertainties in that? Why don't we just do some simple things to preclude it from happening?

JUDGE KLINE: All right. All right. Thank you.

JUDGE LAM: Well, after Judge Kline's exhaustive questioning, there ain't much left here.

(Laughter.)

I only have one or two questions for you, Dr. Bartlett. In response to Judge Kline's questions, you had offered some ideas as to how these designs could be improved.

DR. BARTLETT: That's correct.

JUDGE LAM: But let me ask you a related question.

CHAIRMAN FARRAR: Hold on. Off the record.

(Whereupon, the foregoing matter went off the record briefly and went back on the record.)

CHAIRMAN FARRAR: Okay, back on the record.

JUDGE LAM: The question is, what is wrong with the Applicant's design? Can you summarize for us?

MR. TURK: May I ask for just a moment to let the announcement finish? It's hard to hear.

(Pause.)

DR. BARTLETT: The use of sliding as an energy dissipation mechanism to reduce the inertial forces to the foundations, and the assumption that that sliding will be relatively limited and controlled is quite a novel approach. Generally, when one approaches these situations, anchorage is suggested. Then the use of cement-treated soil and soil cement for shallow embedded foundation to try to also prevent sliding of the foundation system and the consequences from its foundation.

Those are quite novel, and there are other systems that would take a more robust approach to the problem and give you much more capacity than what's being used in this design. Frankly, this seems like a very economical design, but maybe not a safe design.

JUDGE LAM: And?

DR. BARTLETT: Certainly if the casks were anchored and the foundation systems were designed to be more robust, I wouldn't be here before you today.

JUDGE LAM: Uh-huh, so anchoring of the casks would solve --

DR. BARTLETT: It would solve the issues

of sliding of the casks. Obviously, it would be much more -- they can't tip over or slide if the anchorage system is designed properly. There's a penalty we've talked about before, that that increases the forces now that the foundation has to resist because it is a more complete transfer of earthquake energy now to the foundations because sliding is precluded. Overturning now can occur because we have a firm connection between the casks and the pads. So it does now involve a somewhat redesign of the foundation system beyond what the Applicant's proposed.

JUDGE LAM: Okay. In your prefiled testimony, you indicate the lack of fragility curve is a glaring omission. In response to Mr. Gaukler's question, you further indicated perhaps the performance of risk reduction ratios and performance goals would be an acceptable alternative. Do I understand that correctly?

DR. BARTLETT: I think where I would like to put my position is, if one, for example, designed for a 10,000-year return period event and showed that the foundations had an adequate factor safety of 1.1 against sliding, then you don't need to develop a fragility curve. You have one point on the fragility curve. You've shown that you have selected a very

conservative design basis earthquake, and your potential for failure is at least one or less. So that defines one point on the fragility curve.

If that has, indeed, been met for this facility, you do not need to develop a fragility curve for a suite of different earthquakes and a different response. But the point that I am trying to make is I don't think that particular point on the fragility curve has been defined because the applicant has not put forth foundations to do any calculations for a 10,000-year return period event or a deterministic 84th percentile event. We only have design calculations for the foundations for the design basis earthquakes. So I don't know how we get from a 2,000-year return period to a 10,000-year return period and say that the foundations are still stable.

JUDGE LAM: Thank you for the clarification, Dr. Bartlett.

CHAIRMAN FARRAR: Okay, it's a little after five after. I encourage all to get to the cafeteria promptly.

Mr. Turk, would it help you to have a little longer lunch, given the Board's questions and these answers, to sharpen up your cross?

MR. TURK: 1:15?

CHAIRMAN FARRAR: Yes, let's be back at 1:15.

(Whereupon, the foregoing matter went off the record for lunch at 12:06 p.m. and went back on the record at 1:19 p.m.)

CHAIRMAN FARRAR: Mr. Gaukler?

MR. GAUKLER: One housekeeping matter, I would like to move for the admission of PFS Exhibit 244, the excerpts from the deposition of Dr. Bartlett.

CHAIRMAN FARRAR: Okay, any objection? As I remember, that was a several-page deposition, excerpts, and did you only ask him about one question?

MR. GAUKLER: There was two or three questions I referred to in there.

MS. NAKAHARA: No objection, Your Honor.

CHAIRMAN FARRAR: Staff?

MR. TURK: No objection.

CHAIRMAN FARRAR: All right, then PFS Exhibit 244 will be admitted.

[Whereupon, the above-referred-to document marked as PFS Exhibit 244 for identification was received in evidence.]

CHAIRMAN FARRAR: Mr. Turk?

MR. TURK: Yes?

CHAIRMAN FARRAR: What time are we going to get Dr. Cornell on the stand?

MR. TURK: I will have a better feel after the first hour. There will be more than about an hour.

CHAIRMAN FARRAR: Okay.

MR. TURK: My estimate is roughly an hour and a half to two, as I stated before. If I can get done quicker, I will.

CHAIRMAN FARRAR: Okay, thank you. Go ahead.

MR. TURK: So that would mean that we could get to Dr. Cornell roughly 3:30, 4:00.

CHAIRMAN FARRAR: Okay.

MR. TURK: Well, I should say I don't know how much redirect there is.

MS. NAKAHARA: We have very little right now.

CHAIRMAN FARRAR: Okay, let's get started.

CROSS EXAMINATION BY MR. TURK

MR. TURK: Dr. Bartlett, a large part of your testimony on Subpart E of this contention references the DOE Standard 1020. Is it fair to say that is one of the principal issues that you raise in your testimony on Part E?

DR. BARTLETT: The issue I think we're trying to raise in using DOE Standard 1020 as an analogy is that there is this two-handed approach that is required, that it is not adequate simply to consider design basis earthquake without considering the conservatisms in the design.

MR. TURK: Okay, and my question to you is, in fact, that's one of the major themes of your testimony. For example, if you look at your testimony with me, I will show you how it is mentioned repeatedly. It is mentioned at the top of page 3, as part of Answer 6. It is mentioned in Answer 7. It is mentioned in Answer 9.

MS. NAKAHARA: Could you go just a little slower so he can look it up, please?

MR. TURK: Sure. Do you want me to start back at the beginning?

With respect to DOE 1020 --

DR. BARTLETT: That's correct.

MR. TURK: Let me see if I can just go through the different references that I noted. I see it at the top of page 3, as part of Answer 6. Do you see it there?

DR. BARTLETT: Yes.

MR. TURK: And then again in Answer 7 it

is mentioned?

DR. BARTLETT: Yes.

MR. TURK: Answer 8 has been stricken, but it was there, but it's out and now it's still in Answer 9? Do you see it there?

DR. BARTLETT: Yes.

MR. TURK: Do you see it in Answer 10 on page 5?

DR. BARTLETT: Yes.

MR. TURK: Again, Answer 11?

DR. BARTLETT: Excuse me. We are in --

MR. TURK: I'm sorry?

DR. BARTLETT: Yes, it is in Answer 10, that's correct.

MR. TURK: It's in Answer 10; it's also in Answer 11?

DR. BARTLETT: That's correct.

MR. TURK: I see it as well in Answer 13.

DR. BARTLETT: That's correct.

MR. TURK: I don't notice it in Answer 14 specifically, but then, again, I see it in Answer 15.

DR. BARTLETT: That's correct.

MR. TURK: It's in Answer 16?

DR. BARTLETT: That's correct.

MR. TURK: Answer 17?

DR. BARTLETT: That's correct.

MR. TURK: I don't see it specifically in Answer 18, but the concepts are mentioned. For instance, you indicate, "PFS has not discussed the fragility and seismic performance of the foundation of the CTB and the foundation of the storage pads," and you describe that as a glaring omission.

DR. BARTLETT: Yes, fragility concepts are not unique to DOE Standard 1020, however.

MR. TURK: Okay, but you do reference fragility standard with respect to 1020 as well in your testimony? In Answer 17, for example? At the top of page 9, you talk about the DOE 1020 Standard for PC-3 facilities --

DR. BARTLETT: Correct.

MR. TURK: -- and use of fragility curves? See it where you're talking about 1020, and then you state, "By evaluating the fragility curve for the SSCs and recognizing the detailed design and ductility," et cetera --

DR. BARTLETT: Correct.

MR. TURK: You say that the risk reduction factor of four has been adopted for PC-3 SSCs?

DR. BARTLETT: Correct.

MR. TURK: That's a reference to the DOE

Standard 1020?

DR. BARTLETT: That's correct.

MR. TURK: Okay. Again, Answer 19 mentions 1020?

DR. BARTLETT: That's correct.

MR. TURK: I see it as well in Answer -- well, again, 21 mentions fragility curves, and then Question 22 specifically references 1020. Do you see it there?

DR. BARTLETT: I see 21. I see the mention of fragility curves, and then what --

MR. TURK: I don't see it specifically mentioned in 21.

DR. BARTLETT: Right.

MR. TURK: I only see a reference to fragility curves.

DR. BARTLETT: Yes. I'm just pointing out that fragility curves is not a concept unique to 1020. It's a general concept.

MR. TURK: Okay. Also, Question 22, your response to that mentions the 1020 Standard?

DR. BARTLETT: Correct.

MR. TURK: I see it also in Answer 25.

DR. BARTLETT: That's correct.

MR. TURK: I see it in Answer 27.

DR. BARTLETT: That's correct.

MR. TURK: The top of page 13 and then later on there's some further discussion of it?

DR. BARTLETT: That's correct.

MR. TURK: For instance, at the bottom of the answer on page 14 it appears. Then again I see it in Answer 30.

DR. BARTLETT: The bottom of page 14, Answer 29 has been stricken.

MR. TURK: I'm sorry, I was talking about the bottom of Answer 27 that appears at the top of page 14.

DR. BARTLETT: Oh, okay.

MR. TURK: That's the second place I saw it in that answer.

DR. BARTLETT: Okay.

MR. TURK: Actually, Question 28 asks you if you're familiar with various statements, including the relevance of DOE Standard 1020, and you answered yes. So, again, in 28 the DOE Standard 1020 is referred to.

DR. BARTLETT: In the question, yes.

MR. TURK: And your response to that question acknowledges something with respect to that standard?

DR. BARTLETT: Yes.

MR. TURK: And then, again, Answer 30?

DR. BARTLETT: Yes.

MR. TURK: So it's fair to say that the DOE Standard 1020 is a significant factor underlying your testimony on Part E of the contention?

DR. BARTLETT: It's the framework.

MR. TURK: In discussing the DOE Standard 1020, I notice that you referred to it specifically in two places as DOE Standard 1020-01. For instance, Answer 9 --

DR. BARTLETT: Un-hum.

MR. TURK: -- refers to the 2001 edition of that standard, correct?

DR. BARTLETT: Yes.

MR. TURK: And, again, that's in the first paragraph. In the second paragraph you indicate, quote, "It's my opinion that DOE will require a 2,500-year ground motion standard in the final DOE Standard 1020-01."

DR. BARTLETT: Yes, that's correct.

MR. TURK: Are you familiar with whether DOE has issued a final standard yet?

DR. BARTLETT: I believe they have, but I'm not sure.

MR. TURK: The last version of the DOE standard, then, that you're familiar with is the 2001 version?

DR. BARTLETT: Yes, I believe I had a draft of that version.

MR. TURK: I would like to show you a document -- I only have one copy. I'll read the title into the record and ask you if this is the document to which you refer in Answer 9.

For the record, it's a document entitled, "DOE Standard - Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities, Issued by the U.S. Department of Energy." In the upper righthand corner it indicates that the numerical designation of the document is, quote, "DOE-STD-1020-Year Proposed." It indicates that it is superseding DOE Standard 1020-94 of April 1994.

I would like to show you this document and ask if this is the document that you are referring to when you refer to DOE Standard 1020-01.

DR. BARTLETT: This is the final of the draft that I'm referring to in paragraph 1 of Answer 9. I had available a draft document of what you just handed me.

MR. TURK: And in Answer 9, where you

indicate that you believe, in your opinion, that DOE will require a 2,500-year ground motion standard, you're not aware of whether they've actually done that yet?

DR. BARTLETT: I believe they have, but I'm not certain. It was in the draft document. My understanding, it hasn't changed.

MR. TURK: Let me show you this document again. You don't have a copy of this with you?

DR. BARTLETT: I do not.

MR. TURK: Okay.

DR. BARTLETT: I have the '94 version.

MR. TURK: You refer specifically in your answer to page C-6.

DR. BARTLETT: Correct, that would be of the draft.

MR. TURK: Okay, I would like to show you the document again, and perhaps the pagination has changed. I would ask you to look at page C-6 and C-7 of this document and indicate to me where you see the proposal of a 2,500-year earthquake ground motion.

Maybe I'll check to see if we brought our copy.

(Pause.)

DR. BARTLETT: I'm finished.

MR. TURK: Could you point to where you see in that document the 2,500-year return period ground motion mentioned?

DR. BARTLETT: It's in Table C-3 under Performance Category 3, the seismic hazard exceedance probability piece of H, listed as four times ten to the minus four. If you take the inverse of that, you will see it's a 2,500-year return period.

MR. TURK: And earlier today you indicated your belief that the establishment of a 2,500-year ground motion for a design earthquake for a PC-3 category would be slightly more conservative, I believe was your term, than the prior standard of a 2,000-year earthquake.

(Pause for interruption by PA announcement.)

MR. TURK: Do you need the question repeated?

DR. BARTLETT: Yes, please.

MR. TURK: Madam Reporter, could you just reread the question?

May we go off the record for a moment?

(Whereupon, the foregoing matter went off the record at 1:35 p.m., during which time the pending question was played back by the court reporter, and

went back on the record at 1:37 p.m.)

CHAIRMAN FARRAR: Back on the record.

MR. TURK: I apologize for that confusion.

DR. BARTLETT: No problem.

The purpose of Answer 9 is to point out, if one uses a one-handed approach and only considers the design basis earthquake and not the inherent conservatisms that are based in that earthquake, then the adoption of a 2,500-year return period earthquake would be slightly more conservative than the 2,000-year return period.

MR. TURK: Incidentally, the 2,000-year earthquake standard, that's what had been contained in the 1994 version of the DOE standard, correct?

DR. BARTLETT: That is correct.

MR. TURK: And that would be found in Table C-3 at page C-5 of the '94 version, revised as of January '96. Do you have that document with you?

DR. BARTLETT: I do.

MR. TURK: And that's correct, that's where the five times ten to the minus four --

DR. BARTLETT: Yes, or 2,000-year return period is found.

MR. TURK: Okay, and that's for PC Category 3, seismic hazard exceedance probability PH

of five times ten to the minus four?

DR. BARTLETT: That's correct.

MR. TURK: Okay. Could I ask you to explain something. If you have that document with you, if you would, please turn to page 2-24 of the 1994 standard, as revised through January 1996.

DR. BARTLETT: Okay.

MR. TURK: And you'll see a Table 2-5.

DR. BARTLETT: I do.

MR. TURK: If you go down the lefthand column to, I believe, the eighth line, which is entitled, "Scale Factors," do you see that?

DR. BARTLETT: Yes.

MR. TURK: And you see that for PC Category 1 and 2 it states, quote, "Not used"?

DR. BARTLETT: Yes, there's no scale factors.

MR. TURK: For PC Category 3 it states, "SF equals 1.0"?

DR. BARTLETT: Yes.

MR. TURK: And then for PC Category 4 it states, "SF equals 1.25"?

DR. BARTLETT: Yes.

MR. TURK: Could you explain your understanding of what the scale factor is?

DR. BARTLETT: They're defined on page 2-23 under the heading 2.4.3. Do you want me to just go ahead and read that?

MR. TURK: Yes, please.

DR. BARTLETT: "The basic contention of the deterministic seismic evaluations and acceptance criteria defined in Section 2.3 is to achieve less than a 10 percent probability of unacceptable performance for a structure system or component subjected to a scale of design evaluation basis earthquake, SDBE, as defined by SDBE equals 1.5 times SF, for the scale factor, times the DBE, where SF is the appropriate seismic scale factor from Equation 2-2. The seismic evaluation acceptance criteria presented in this section have an intentional and controlled conservatism such that the target performance goals are achieved. The amount of intentional conservatism has been evaluated in Reference 2-11 such that there should be less than a 10 percent probability of unacceptable performance at input ground motions, as defined by this scale factor of 1.5 SF times the DBE."

And my understanding, the scale factor for PC-3 is 1.0. The scale factor for PC-4 is 1.25. So the design basis earthquake is scaled up slightly for

PC-4 over P-3.

MR. TURK: Does that essentially mean that, once you define a design basis earthquake or PC-3, that you have no change in scaling factor, that in effect the SDBE, which is the scale design evaluation basis earthquake, it would simply be equal to the design basis earthquake?

DR. BARTLETT: No, that's not correct.

MR. TURK: Okay.

DR. BARTLETT: The scale design basis evaluation earthquake is 1.5 times the scale factor. For PC-3 that is one, but the scale design basis evaluation earthquake for PC-3 would still be 1.5 times the DBE, and you must show that the particular structure system and component for that scaled design basis evaluation earthquake has a less than 10 percent probability of failure for the scale design basis earthquake.

MR. TURK: In using the term "scaled design basis earthquake"--

DR. BARTLETT: Correct.

MR. TURK: -- is what DOE is stating here is that is the design at which you would build a DOE facility, would be equivalent to 1.5 times whatever the scaling factor is, times the design basis

earthquake?

DR. BARTLETT: This section puts forth the intentions, as it's headed, "The Basic Intention of Dynamic Analysis Based on Deterministic Seismic Evaluation and Acceptance Criteria." For cases where you may not have specific acceptance criteria, it says that, to meet the intent of DOE Standard 1020, you must scale the design basis earthquake, and it is termed the SDBE, and that must be scaled by a factor of 1. times an additional scale factor which for PC-4 is 1.25, for PC-3 it's 1.0 times the design basis earthquake, and the design basis earthquake for PC-3 would be a 2,000-year return period event.

MR. TURK: And what's the net effect, then, when --

DR. BARTLETT: Your scale design basis earthquake, if we were doing this for a 2,000-year return period event, the evaluation design earthquake -- the scale design evaluation basis earthquake would be 1.5 times larger than the DBE unscaled.

MR. TURK: And that's in the 1994 standard as revised through January 1996?

DR. BARTLETT: Yes, I'm not sure of the last revision date on the 1994, but I am using a 1994 version of the standard.

MR. TURK: You still have a copy, do you not -- do you have my copy of the proposed revision --

DR. BARTLETT: I do.

MR. TURK: -- the document that's entitled, "DOE Standard 1020-Year-Proposed"?

DR. BARTLETT: I do.

MR. TURK: Incidentally, the document says "Year Proposed." You simply equated that to state that was --

DR. BARTLETT: That was just my guess it was going to be adopted in 2001, but --

MR. TURK: You're not aware of any document that bears the caption, "DOE Standard 1020-2001"?

DR. BARTLETT: No, that's correct.

MR. TURK: Okay. Could you see if that same discussion in Section 2.4.3 appears in your proposed IE, what you're calling the 2001 document?

And may I approach the witness since we only have the one copy?

CHAIRMAN FARRAR: Go ahead.

DR. BARTLETT: Yes, I found it. It's Equation 2-7 on page 2-23.

MR. TURK: And do you see, essentially, the same formula there, the SDBE equals 1.5 times the

scaling factor, times the design basis earthquake?

DR. BARTLETT: That is correct.

MR. TURK: Okay.

DR. BARTLETT: Though I haven't verified to make sure that the scale factors between the two documents are the same.

MR. TURK: Why don't we do that just so there's no confusion?

DR. BARTLETT: We could do that. It should be only a minute.

MR. TURK: And in this regard, I will hand the Year Proposed document again and ask you to turn to page 2-25, where Table 2-5 appears.

DR. BARTLETT: Yes, I see those.

MR. TURK: And are the scaling factors the same in that document?

DR. BARTLETT: They are.

MR. TURK: And that would mean the scaling factor for PC-3 is 1.0?

DR. BARTLETT: That is correct.

MR. TURK: And for PC-4, 1.25?

DR. BARTLETT: That is correct.

MR. TURK: I would like to show you one other document and ask if you've seen this before. For the record, I am going to show you a document

which bears the same textual title as the others, but it now has the designation as DOE Standard-1020-2002, dated January 2002. Have you seen that document before?

DR. BARTLETT: No, I have not.

MR. TURK: Would you accept my representation that that is the final DOE standard that has been issued in January 2002?

DR. BARTLETT: Yes, it shows it superseding DOE Standard 1020-94.

MR. TURK: Thank you.

DR. BARTLETT: So this seems to be a final document.

MR. TURK: Okay. If you would, let's turn to the same discussion that we looked at in the prior documents. First of all, let me ask you to look at page C-6, and do you see there Table C-3, entitled, "Seismic Performance Goals and Specified Seismic Hazard Probabilities"?

DR. BARTLETT: I do.

MR. TURK: And for PC Category 3 it shows that the seismic hazard exceedance probability, or PH, is four times ten to the minus four?

DR. BARTLETT: Yes.

MR. TURK: And that would be consistent

with your understanding that they would be using a 2,500-year return period?

DR. BARTLETT: That's correct.

MR. TURK: I would ask you also now to turn to one other page, and that is page 2-26 on which Table 2-5 appears entitled, "Summary of Earthquake Evaluation Provisions." And is this the comparable -- this is comparable to the tables we discussed in the two prior documents, correct?

DR. BARTLETT: That's correct.

MR. TURK: For the scale factors, it indicates that Performance Category PC-1 and PC-2, again, there's no scale factor used?

DR. BARTLETT: Correct. That's correct.

MR. TURK: And do you see that for PC Category 3 they now use a scale factor of 0.9?

DR. BARTLETT: Yes, because the design basis earthquake went from 2,000- to 2,500-year return period. So they have adjusted the scale factor.

MR. TURK: So, in effect, by shifting to the 2,500-year return period, they have pretty much kept the design standard to be the same?

DR. BARTLETT: That's my understanding.

MR. TURK: Okay. Just I would note, and I think you can confirm, that was not reflected in

your testimony?

DR. BARTLETT: No, I didn't have that document available when I prepared this testimony.

MR. TURK: As I was listening to Mr. Gaukler's cross examination today, I have to admit I was confused, and I wasn't sure what caused my confusion. When he was examining you with respect to whether using the same guidance document, NUREG 0800, Section 3.8.5, whether if PFS uses that same guidance document, wouldn't they, in effect, be maintaining the same level of conservatism, and your response was, no, because the -- as I understand your response, the demand has been reduced because the earthquake is smaller?

DR. BARTLETT: Correct.

MR. TURK: And it seemed to me that what you were assuming is that, after the Applicant performs that analysis and chooses or establishes whatever standard for design that they have established, that there would subsequent to that be a reduction from the 10,000-year earthquake down to the 2,000-year earthquake. Is that your understanding of the process?

DR. BARTLETT: What I'm trying to explain is the Applicant, in its calculations for sliding and

bearing capacity and overturning, adopted the factor safety of 1.1, which is outlined in NUREG 0800, Section 3.8.5. However, the earthquake they used in calculating that factor of safety was the 2,000-year return period event, not a 10,000-year return period event. Hence, the design margins are different.

MR. TURK: But isn't that, in effect, the equivalent of going from the 10,000 or deterministic earthquake down to the 2,000-year earthquake? Isn't that, in effect, what DOE does separately, as let's do this reduction from the one times ten to the minus four earthquake down to either a four or a five times ten to the minus four, that's done by PFS here --

DR. BARTLETT: But I don't think we can equate --

MR. TURK: -- ab initio.

DR. BARTLETT: I understand the line of direction of questioning, but I don't think we can strictly relate factor to safety back to risk reduction ratios, which are really a probablistic concept. We can't, at least in my mind's eye, do that.

MR. TURK: Okay. Let me see if I can explore this a little bit with you. You specifically referenced two regulatory or guidance documents. You

mentioned Section 3.8.5 --

DR. BARTLETT: Correct.

MR. TURK: -- and Section 3.8.4 --

DR. BARTLETT: Correct.

MR. TURK: -- of NUREG 0800. If the Applicant follows Reg. Guide -- I'm sorry -- NUREG 0800, Section 3.8.5 -- I see Mr. Delligatti is confirming I'm saying it correctly -- then, in effect, they would be applying the same regulatory guidance in development of their design and in their analyses as if they were building a nuclear power plant?

DR. BARTLETT: Correct, if they did that for a safe shutdown earthquake for a nuclear power plant.

MR. TURK: Okay. And you recognize that Section 3.8.5 specifically references various codes and standards? Do you want me to show you the document?

DR. BARTLETT: They probably may deal with structural design of the foundations, but --

MR. TURK: I would ask you to look at Staff Exhibit EE. Do you have a copy there? This is Section 3.8.5.

DR. BARTLETT: Okay, I have 3.8.5.

MR. TURK: If you would, for example, turn

to the end of that section, there's a list of references. This is Roman numeral VI entitled, "References," and one of the references, the very first one, is ACI-349, "Code Requirements for Nuclear Safety-Related Concrete Structures" --

DR. BARTLETT: That's correct.

MR. TURK: -- by the American Concrete Institute?

DR. BARTLETT: That's correct.

MR. TURK: And PFS, in effect, by following Reg. Guide 3.8.5, would be following the standards established in the ACI document, correct?

DR. BARTLETT: For the structural design of the foundations, yes.

MR. TURK: All right. And the same thing, just for example, the very last one mentioned is Regulatory Guide 1.142, "Safety-Related Concrete Structures for Nuclear Power Plants."

DR. BARTLETT: Yes.

MR. TURK: That specifically referenced -- so, in effect, to whatever extent those apply to the design of a foundation or to the concrete structure, PFS would be following those standards and codes?

DR. BARTLETT: Yes, for the structural design of the foundations, that's correct.