State of Utah's Comments
on Proposed 10 CFR Part 72 Rule
Geological and Seismological Characteristics for Siting and Design of Dry Cask Independent Spent Fuel Storage Installations and Monitored Retrievable Storage Installations.

October 22, 2002

The State of Utah ("Utah") submits comments on the above-referenced proposed rule published in 67 Fed. Reg. 47745 on July 22, 2002. Utah acknowledges and appreciates that the Commission extended the comment period 15 days at Utah's request until October 22, 2002, because the date by which public comments were due was also the filing date for Reply Findings of Facts and Conclusions of Law ("Reply Findings") in the Private Fuel Storage, LLC licensing proceeding (docket 72-22) on issues that are the subject of this proposed rulemaking.[1]

Commencing in 1997, Utah became a party to the PFS licensing proceeding. One critical issue in the proceeding is seismicity: the unprecedented nature of PFS's seismic design concept, soils characterization and testing, precedent-setting use of soil cement to resist seismic forces, engineering and cask stability analyses, and the design basis earthquake standard that PFS must meet for a site that has two faults (magnitude 6.4 and 6.5) dipping underneath it and a fault capable of producing a magnitude 7.0 earthquake that is just 5 miles away. In the PFS proceeding, Utah has been able to view first hand the NRC staff's ("staff") performance and its *ad hoc* and indefensible rationale in supporting PFS's exemption to allow use of a PSHA methodology and a 2,000-year return interval design basis earthquake. The staff's faltering position in justifying acceptance of PFS's exemption request necessitated Utah to make numerous filings with the Board before the Board actually decided that the staff had reached a firm decision on the exemption. Also, a

[1]The date on which the Reply Findings were due was later extended to October 16. In essence, Utah had only three working days to draft its comments.

significant portion of the adjudicatory hearings on seismicity was devoted to the issue of PFS's exemption. Attached hereto as Attachment 1 is "Chronology of State of Utah's Involvement in the Private Fuel Storage Licensing Proceeding as it relates to PFS's Request for an Exemption from the Design Basis Earthquake Standard and Seismic Hazard Assessment Methodology." A glance at Attachment 1 is all that is necessary to grasp the burden and resources placed on Utah and the Licensing Board in dealing with the staff's ever-changing rationale. Utah does not believe that the rule as proposed will obviate the muddling procedure that Utah had to endure in the PFS proceeding, partly due to the lack of standards in the rule and also because NRC has no clearly developed philosophy when it comes to seismic performance and seismic standards, especially when compared with the United States Department of Energy's ("DOE's") paradigm for the seismic design of nuclear facilities described in DOE Standard 1020-2002, *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities* (January 2002).

Utah's comments are drawn from its experience in the PFS proceeding. As described in more detail below, as part of its comments Utah submits excerpts from relevant portions of testimony and Findings from the PFS proceeding that are directly on point to the issues in this proposed rule. While this is done, in part, because Utah has only three working days to prepare its comments, it is also done to show the Commission the unacceptable performance by the staff in that proceeding and the need to reign in the unbridled staff discretion the Commission is proposing under this new rule.

A Key Element in the Proposed Rule

According to the rulemaking notice, the Commission believes the following constitute an acceptable approach, review and approval to seismic and geologic siting standards:

a. Conducting site-specific and regional geoscience investigations;
b. Setting the target exceedance probability commensurate with the

level of risk associated with an ISFSI . . . ;

c. Conducting PSHA and determining ground motion level corresponding to the target exceedance probability;
d. Determining if other sources of information change the available probabilistic results or data for the site; and
e. Determining site-specific spectral shape, and scaling this shape to the ground motion level determined above.

67 Fed. Reg. at 47748. Utah in its comments will show that the Commission has put forward an untenable approach. In particular, the staff's incompetency in addressing PFS's seismic exemption request in the PFS proceeding cannot sustain the Commission's reliance on "insights and information [the staff has obtained] from previous licensing experience" in reviewing applications for ISFSIs sited in seismic areas. Id. These are harsh words but Utah is prepared to back up this statement with evidence from the PFS proceeding.

Particularly egregious as a "standard" for the proposed rule is that notion of setting the exceedance probability commensurate with the level of risk. What does this mean? The Commission intends the staff's guidance document to detail these requirements. NRC case law is emphatic that staff regulatory guides are not regulations, do not have the force of regulations, and when challenged, are considered only one way in which an applicant may meet the regulations. *See e.g.,* Vermont Yankee Nuclear Power Corporation (Vermont Yankee Nuclear Power Station), CLI-74-40, 8 AEC 809, 811 (1974) (*stating* guidance documents "do not themselves have the force of regulations"); Louisiana Energy Services, L.P. (Claiborne Enrichment Center), LBP-96-7, 43 NRC 142, 147 (1996) (*stating* a regulatory guide is the staff's "view on how to comply with regulatory requirements" and "is advisory not obligatory"); Gulf States Utilities Co. (River Bend Station, Units 1 & 2), ALAB-444, 6 NRC 760, 772 (1977) (*stating* that regulatory guides are not regulations, need not be followed by applicants, and do not represent the only satisfactory method of meeting a regulatory requirement). The Commission, however, has placed all issues of substance associated

with this rulemaking into a draft guidance document[2] – a document that does not even establish a hard and fast design basis earthquake standard. Draft Reg. Guide DG-3021 recommends a mean annual probability of exceedance of 5.0E-04 (*i.e.*, 2,000-year mean return period event or "MAPE") but an ISFSI license applicant may "demonstrate that the use of higher probability of exceedance value would not impose any undue radiological risk to public health and safety." DG-3021, App. B § B.2 (at 16). Significantly, the draft guidance does not even set a 2,000-year MAPE as a minimum design basis earthquake but leaves open the possibility of an even lower standard for seismic sites. Not only does the rule have no firm standards, the draft guidance is short on firm standards also.

Utah does not object to the use of a PSHA methodology – Utah's criticisms are focused on the lack of standards in "determining ground motion level corresponding to the target exceedance probability" that are obtained from the PSHA. 67 Fed. Reg. at 47748.

B. The Commission Has Not Promulgated an Enforceable Standard

The rule proposed by the Commission does not comply with the Administrative Procedures Act ("APA"). The way in which the Commission has structured the rule and accompanying guidance gives unbridled and unchecked discretion to the staff in determining the seismic design standard for ISFSIs sited in seismic areas. One significant defect is that the rule gives no standards against which a licensing board or intervenors may evaluate whether an applicant has complied with the rule.

The Commission states it is placing "only basic requirements in the rule." Id. In essence, all the proposed rule requires is that the applicant determine the geologic, seismological, and engineering characteristics of the proposed site; establish the design earthquake; and identify

[2]Draft Reg. Guide DG-3021, *Site Evaluations and Determination of Design Earthquake Ground Motion for Seismic Design of Independent Spent Fuel Storage Installations and Monitored Retrievable Storage Installations* (July 2002)

uncertainties associated with these requirements. Id. The reasons offered for not placing substantive requirement in the rule are:

> Geoscience assessments require considerable latitude in judgment because of (a) limitations in data; (b) current state-of-the-art of geologic and seismic analyses; (c) rapid accumulation of knowledge; and (d) evolution in geoscience concepts.

Id. The Commission fleshes this out by noting: "specifying geoscience assessments in detail in a regulation has created difficulty for applicants and the NRC staff by inhibiting needed latitude in judgment ... [and] inhibited the flexibility needed in applying basic principles to new situations..." Id. Utah requests the Commission explain and identify how and when the staff was "inhibited" and needed latitude and flexibility.

In fact, very few ISFSIs are contemplated to be sited in seismic areas. The only ones that come to mind are the proposed PFS ISFSI, and ISFSIs proposed in California (*e.g.*, Diablo Canyon, San Onofre, Humbolt Bay).[3] Even fewer ISFSIs are or will be away-from-reactor facilities, PFS being the pre-eminent exception. NRC has issued only one exemption to the design basis earthquake standard and that was to INEEL sited at the Idaho chemical processing plant ("IPCC") on a vast federal reservation in Idaho. Notably, INEEL's need to obtain an exemption from the design basis earthquake was that an ISFSI designed to comply with current regulations would have been designed to higher ground motions than the higher risk IPCC facility sited nearby. The only other exemption from the design basis earthquake standard relevant to this rulemaking that NRC has received is from Private Fuel Storage, LLC. PFS's need for an exemption is that the design

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[3]Notably, bundles of three horizontal vaults ("casks") will be used at San Onofre and anchored cylindrical casks are planned at Diablo Canyon. Ranch Seco, California also stores dry casks; however, the ground motion at Rancho Seco ranges from 0.05 to 0.1 g which does not render the site a seismic area. Additionally, the Idaho National Environmental and Engineering Laboratory ("INEEL") Three Mile Island 2 ("TMI2") ISFSI licensed in 1999 is located west of the Rocky Mountains. However, the ground motion for a 10,000-year return interval earthquake at the INEEL TMI2 site is only about 0.47 g.

motions in its SAR are greater than those computed under the current regulations. PFS Consolidated SER, dated March 2002, at 2-34. The foregoing brief ISFSI history hardly constitutes an inhibition on needed flexibility.

The rule as written, proposed 10 CFR §72.103(f)(1), does not comply with the notice and comment rule making requirements of Section 553 of the Administrative Procedures Act. "Rule" is defined in the APA as "the whole or part of an agency statement of general or particular applicability and future effect designed to implement, interpret, or prescribe law or policy or describing the organization, procedure, or practice requirements of an agency . . ." 5 USC § 551(4). The APA exempts from the formal rule-making requirements of Section 553, "interpretive rules, general statements of policy, [and] rules of agency organization, procedure, or practice." 5 U.S.C. § 553(b)(3)(A), (d)(2). In contrast, if a rule is "substantive" the exemption is inapplicable, and the requirements of Section 553 must be strictly adhered to. Professionals and Patients for Customized Care v. Shalala, 56 F.3d 592, 595 (5th Cir. 1995). Furthermore, the APA's notice and comment exemptions should be narrowly construed. United States v. Picciotto, 875 F.2d 345, 347 (D.C.Cir. 1989).

The proposed rule is in the guise of a substantive rule, but it is not. Any substantive requirements are found in the draft guidance, *i.e.*, a document that, based on NRC case law, is emphatically not a rule. While the APA itself does not define what would qualify as a "substantive rule," an "interpretive rule" or a "statement of policy" case law establishes that the rule NRC is proposing circumvents substantive rulemaking, thus avoiding compliance with the APA. As the D.C. Circuit opined, "there is, to be sure, an outer limit to that deference imposed by the Administrative Procedure Act. A substantive regulation must have sufficient content and definitiveness to be a meaningful exercise in agency lawmaking. It is certainly not open to an agency

to promulgate mush and then give it concrete form only through subsequent less formal "interpretations. . . That technique would circumvent section 553, the notice and comment procedures of the APA." Paralyzed Veterans of America v. D.C. Arena L.P., 117 F.3d 579, 584 (D. C. Cir. 1997). Here, the Commission attempts to give concrete form to its proposed rule through an interpretative document, DG-3021, and the Commission thereby circumvents section 553 notice and comment rulemaking procedures.

Generally, a substantive rule "establishes a standard of conduct which has the force of law." Professionals and Patients, 56 F.3d at 595. In the proposed rule there are no substantive standards for the design basis earthquake – merely target exceedance probability commensurate with the level of risk. Furthermore, the hallmark of a substantive rule is whether the agency intends to bind itself to a particular legal position. Molycorp, Inc. v. United States E.P.A., 197 F.3d 543, 546 (D.C. Cir. 1999) (*quoting* Syncor Int'l Corp. v. Shalala, 127 F.3d 90, 94 (D.C. Cir. 1997)). In examining the "binding effect" of the rule, the court begins by looking at the agency's characterization of its own rule. Professionals and Patients, 56 F.3d at 596. The Court will give the agency's characterization of its own rule some deference, but will, generally, stay "suspicious of the agency's own characterization." Id. at 595. Further, in examining the "binding nature" of the rule, the court will also look at whether the rule leaves the agency free to exercise its discretion to follow or not to follow that general policy in an individual case. Id. at 596. Here, there is no binding effect in the proposed rule. Moreover, even if DG-3021 were a legitimate method to implement the proposed rule, it does not contain a binding norm. For example, in certain circumstances an applicant may design its facility to a standard lower than a 2,000-year MAPE. "As long as the agency remains free to consider the individual facts in the various cases that arise, then the agency action in question has not established a binding norm." Id. at 596-597. The proposed rulemaking is more akin to a policy

statement, which courts have described as "neither a rule nor a precedent but is merely an announcement to the public of the policy which the agency hopes to implement in future rulemakings or adjudications." Panhandle Eastern Pipe Line Co. v. Federal Energy Regulatory Commission, 198 F.3d 266, 269 (D.C. Cir. 1999) (*quoting* Pacific Gas & Electric Co. v. Federal Power Commission, 506 F.2d 33 (D.C. Cir. 1974)). Furthermore, the D.C. Circuit Court has stated, "It is well-established that an agency may not escape the notice and comment requirements...by labeling a major substantive legal addition to a rule a mere interpretation." Appalachian Power Co. v. E.P.A., 208 F.3d 1015, 1024 (D.C. Cir. 2000) (*citing* Paralyzed Veterans v. D.C. Arena L. P., 117 F.3d 579, 588 (D.C. Cir. 1997)).

The proposed rule has no force of law. For example, if the staff and an applicant agree that a 1,000-year MAPE is the commensurate level of risk for a facility, by what standard does the staff evaluate the application? By what standard does an intervenor challenge that site-specific standard? And by what standard does a licensing board evaluate whether the applicant meets the regulatory requirements? The answer is, there are no standards.

Utah recognizes that the Commission followed a similar approach in amending the rules applicable to seismic evaluation of siting nuclear power plants. However, Utah does not believe the Commission can take comfort from that approach. First, if the approach violates the APA, as Utah argues it does, it should be rejected. Second, as no new nuclear power plant ("NPP") applications have been submitted under the rule, the effect of the rule, therefore, has not been put to the test. Third, there are no data for ISFSIs that establish design basis ground motions. Certainly there are no data comparable to the safe shutdown earthquake ("SSE") for a nuclear power plant, where the reference probability approach to implement the NPP rule has, at least, a scintilla of data to provide guidance to the staff and the public.

Utah strongly urges the Commission to revoke the proposed rule and take an approach that conforms with the APA.

C. Unbridled Staff Discretion and Staff Competence.

If the Commission decides to go forward with the proposed rule, it should be cognizant of the limitations that the staff brings to seismic analysis. A significant portion of the description in the rule announcement in the Federal Register is directly from the staff's position in the PFS proceeding. Therefore, Utah's challenge to the staff's rationale in the PFS proceeding is highly relevant to the issue at hand.

The staff provided rational for PFS's 2,000-year MAPE in its various iterations of the PFS SER. The staff's logic can also be seen in the document accompanying SECY-01-0178, the rulemaking plan that gave birth to the proposed rule. Attachment 2 contains excerpts from the various iterations of the PFS SER and from SECY-01-0178 that show the varying and inconsistent logic the staff has used to justify a 2,000-year MAPE, as well as PFS Hearing Tr. pages 10075-76; 10141-49. It has been Utah's impression that the staff's logic in justifying a 2,000-year MAPE has been to merely cherry-pick from various standards to support that number.

In the PFS proceeding, Utah took particular exception to the staff's ad hoc and flawed rationale. Attachment 3 is the testimony[4] by an internationally recognized expert on seismic hazard analysis, Dr. Walter A. Arabasz, that addresses the staff's rational in the PFS proceeding. Other justifications for the proposed rule include claimed "conservatism" in PSHA results and reference to DOE Standard 1020. These same factors were brought forward by the Staff in hearing testimony in the PFS proceeding. In addition, the staff attempted to bracket the 2,000-year MAPE

[4]Testimony of Dr. Walter J. Arabasz, and excerpts from PFS Hearing Tr. pages 9094-95; 9156-64; 9178-79; 9183-85; 9199-9203; 9306-9312.

by claiming that it is below the safe shutdown earthquake for a hypothetical nuclear power plant sited in the Intermountain west. The staff took the indefensible position that the SSE for such a facility would be 5,000 years. PFS Hearing Tr. (McCann) at 8326, 8337-38; Stamatakos/ Chen/McCann Testimony, Post Tr. 8050 at 26-29; Stamatakos Rebuttal, Post Tr. 12648 at 4-5. This position was not even supported by PFS. Utah's expert, Dr. Walter J. Arabasz, provided extensive testimony in the NRC proceeding. In that proceeding, Dr. Arabasz established that the SSE earthquake for the Intermountain west was close to 10,000-years, not 5,000-years as claimed by the staff. *See* Attachment 4, excerpts from PFS Hearing transcript.[5] These issues are addressed in great detail in Utah Findings of Fact and Conclusion of Law ("Utah Findings") (September 5, 2002) ¶¶ 447-494, enclosed as Attachment 5.

To support the staff's position it pointed to the conclusion in a published paper based on an untested and unvalidated theory that has not been accepted by the seismic professional community. *See* Attachment 6, transcript excerpts from the testimony of Dr. Arabasz.[6]

Attachments 2, 3, 4, 5 and 6 show examples that strongly question the Staff's ability to make informed decisions that are logical and consistent with the seismic community's accepted norms when evaluating and approving seismic standards for high seismic sites.

Moreover, over the past year the staff's qualifications and independence have been publically questioned. Former NRC commissioner, Victor Gilinsky, suggested the Staff's "most experienced and competent top officials" were forced to resign because of NRC's "unwelcomed independence

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[5]PFS Hearing Tr. pages 9094-95; 9166-78; 9201-02; 9220-42; 9817-19; 10065-67.

[6]PFS Hearing Tr. pages 9817-18; 9865-72; 10075; 10128-31.

of mind." *See* Attachment 7[7]. Moreover, former Commissioner Gilinsky and others claim that "NRC has been knocking itself out to please the [nuclear] industry." *See* Attachments 7 and 8.[8]

Additionally, the article in Attachment 8 states that with respect to the February 2000 Indian Point rupture, staff had concerns with some components "[b]ut the NRC didn't pay close attention to the methodology used in an engineering report" and although the methodology was flawed, staff "took the utility at its word." In light of the recent incidents, compounded by staff errors in judgment and acceding to influence from the licensee, it is highly inadvisable to give the staff unbridled discretion in establishing and reviewing a design basis earthquake for a proposed facility.

Furthermore, in the PFS case, the staff vehemently advocated the PFS seismic design and supporting calculations while more aggressively attacking Utah's witnesses and contentions than PFS itself. Post licensing, Utah questions the staff's ability to maintain independence and objectivity in future evaluations and inspections if the staff makes similar efforts to champion a regulated entity and its application during the licensing proceeding. The staff's post licensing objectivity may particularly be influenced when the staff are given such discretion in establishing the seismic design standards as allowed under the proposed rule.

D. Public Participation Is Limited or Eliminated.

If clear seismic standards are not established, the opportunity for interested persons to participate in the licensing proceeding involving the seismic design of an ISFSI will become essentially prohibited because of the lack of resources (financial and necessary expertise). While the

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[7]Washington Post article by Victor Gilinsky, titled *Heard About the Near-Accident at the Ohio Nuclear Plant? I'm Not Surprised,* April 28, 2002, currently located at http://www.washingtonpost.com/wp-dyn/articles/A57994-2002Apr27.html.

[8]The Plain Dealer (Cleveland, Ohio) article, titled *Cracks appear in NRC's new rules,* September 22, 2002, currently located at http://www.cleveland.com/ohio/plaindealer/index.ssf?/xml/story.ssf/html_standard.xsl?/base/news/103268735656630.xml

lack of resources is not a recognized hardship by the NRC, it is a reality. Utah has been extremely fortunate that its seismic experts, many internationally renowned, agreed to assist the State in the interest of sound science, engineering, and safety. Notwithstanding the seismic experts' interests in assuring sound science, engineering, and safety, the financial cost to participate in the PFS licensing proceeding has been substantial, although Utah's resources pale in comparison to the resources of PFS. Smaller organizations and parties are unlikely to be so fortunate.

When extensive discretion is left to the Staff with no definitive standards, a panoply of specific expertise (*e.g.*, seismologists, probabilistic seismic hazard assessment experts, risk analysts, soil-structure interaction engineers, geotechnical engineers, soil engineers, structural engineers, dynamic analysts, dose analysts, etc.) is needed to evaluate the seismic design and participate in the licensing proceedings. Additionally, regardless of the financial burden, the universe of seismic experts is relatively small. As a result, the staff's discretion is left unchecked and parties are denied an opportunity to participate in the licensing proceeding because of the realistic inability of intervenors to obtain the highly specialized expertise necessary to analyze probabilistic seismic risks and design of nuclear facilities.

As shown in the PFS case, while Utah still disagrees with PFS's seismic design, Utah's participation in the licensing proceeding has proved to be beneficial. For example, Utah strongly believes it was responsible, at least in part, for PFS's additional seismic site investigation[9], data from which revealed that the projected site ground motions were actually more than thirty-five percent higher than earlier calculated. PFS conducted this additional site investigation **after** the staff had already approved PFS's probabilistic seismic hazard analysis with substantially lower ground motions

[9] *Development of Design Basis Ground Motions for the Private Fuel Storage Facility*, Rev. 1, March 2001 (Geomatrix); *see also e.g.*, PFS Consolidated SER at 2-48.

in its published Safety Evaluation Report of September 2000. Intervenors can be an important aspect of the licensing proceeding. Utah urges the Commission not to create additional hardships for intervenors by leaving the staff with unbridled discretion.

E. Annual Probability of Exceedance.

The Commission has specifically solicited public comments on the appropriate mean annual probability of exceedance ("MAPE"). For starters, a 2,000-year MAPE is not defensible. There are numerous standards that already use a 2,500-year MAPE. DOE Standard 1020 employs a MAPE of 2,500-years but the important point is that it is inextricably tied to meeting performance and risk goals – a concept the NRC has not adopted. Certain critical buildings, such as hospitals, under the International Building Code must be designed to a 2,500-year MAPE, as must interstate bridges in Utah. At a minimum, the NRC cannot adopt a standard lower than these codes.

During the PFS proceeding, Dr. Arabasz described to the Board the lack of performance standards in the staff's approach:

> What is absent in this regulatory process -- and this is explained in detail in NUREG-6728 that was published or that has an October date -- is, first of all, the lack of agreement on a failure probability which enters importantly into how one looks at those two hands [the MAPE and the performance capability of the SSCs], the hazard probability and the design conservatisms. These are fleshed out more in the DOE framework. But if one sets out to achieve risk consistency across the country, then these elements that [PFS witness] Dr. Cornell has described and that he elaborates on in Attachment A of his prefiled testimony become very important. . . . [U]ltimately, if we do not have a regulatory framework where the performance goal or the probability of failure is established, then we enter into a fluid domain.

PFS Hearing Tr. at 10048-49 (*emphasis added*); *see also* Attachment 9, which contains relevant excerpts of Dr. Arabasz's testimony in the PFS proceeding[10].

[10]PFS Hearing Tr. pages 9094-95; 9179-81; 10075-76; 10128-31.

F. Cask Stability.

NRC has authorized a variety of dry spent fuel storage designs, including unanchored cylindrical designs. The NRC places too much stock in the integrity of the dry storage cask. Over the past decade, NRC has issued 19 ISFSI licenses (9 general licenses and 10 site specific licenses).[11] 67 Fed. Reg. 47749. No ISFSI has been licensed in seismic areas. NRC has not licensed unanchored cylindrical casks in any seismic areas.[12] Additionally, there are no performance data, no test data and no earthquake experience data for dry casks or ISFSIs. Moreover, the proposed rule is based on principles that are antithetical to earthquake engineering practice.

1. Nonlinear Computer Analyses.

As a basis for reducing the design earthquakes for ISFSIs and MRSs, the Commission relies the applicant's computed showing that the casks will not tip over or collide "or that the calculated movements are acceptable." 67 Fed. Reg. at 47749. For unanchored casks, the staff relies solely on the predictions of nonlinear computer models.

While experts generally agree that nonlinear computer models are sensitive to the input parameters, to date the nonlinear computer model projections of the seismic behavior of casks have not been validated with shake table data or actual performance data.

The Commission should be commended for its efforts to study the generic and site specific nonlinear seismic behavior of casks. However, Utah only became aware that the Staff had

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[11]Licenses were issued for only three sites west of the Rocky Mountains. Maximum ground motions at INEEL (Idaho) are approximately 0.46 g; at Rancho Seco (California) are approximately 0.05 to 0.1 g; and at Trojan (Oregon) are approximately 0.15 g.

[12]Other than the PFS site, unanchored cylindrical casks have not been proposed in seismic areas. Bundles of three horizontal casks are proposed at San Onofre and anchored cylindrical casks embedded in bedrock are proposed at Diablo Canyon.

contracted a generic and site specific analysis, including one[13] for the PFS proposal, shortly before the scheduled PFS seismic hearings. Given NRC's mission as a regulatory agency to serve and protect the public, Utah finds disturbing the lack of availability and notice of this important NRC study.[14] While the Staff sought the advice and opinion of four industry representatives in at least three meetings closed to the public, other potentially interested parties were not allowed to participate. Importantly, while the NRC contractor, Dr. Vincent Luk expressed his hope that full scale shake table tests would be conducted to validated the results of his nonlinear analyses, the NRC generic and site specific study of the seismic behavior of casks has not, in fact, been validated with any test or performance data. Thus, Utah urges the Commission not to rely solely on nonlinear analysis to ensure adequate safety in the seismic design of storage casks. *See* Attachment 10, excerpts from Utah's Findings.

2. Radiological Risks.

Furthermore, the radiological risk of exposure from fuel stored in the open in a dry storage cask is likely greater than fuel stored in a reactor building where there are multiple layers of protection, including the containment building. The NRC appears to be relinquishing its long held defense-in-depth philosophy and is now willing to rely entirely on the performance of the dry storage cask. While it may be argued that a dry storage cask has some layers of protection (*e.g.*, the multi-purpose canister and the storage cask shell), without adequate and reliable performance and test data, the NRC does not know whether the casks will actually provide the critical barrier that is

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[13] *Seismic Analysis Report on HI-STORM 100 Casks at Private Fuel Storage Facility*, Rev. 1, dated March 31, 2002 (Vincent K. Luk, et al.).

[14] A Staff witness claimed he sought to include the PFS site in this study to "assist the State in understanding the complexities of the analyses" (PFS Hearing Tr. at 6843), yet Utah was not provided a copy of the 2,000-year earthquake analyses until approximately 4 months after the contractor transmitted its results to the Staff.

espoused and relied upon in the proposed rule.

CONCLUSION

For the reasons discussed above, the State of Utah strongly recommends that the Commission not final the proposed 10 CFR Part 72 Rule *Geological and Seismological Characteristics for Siting and Design of Dry Cask Independent Spent Fuel Storage Installations and Monitored Retrievable Storage Installations.* In the alternative, Utah recommends the Commission establish by rule a definitive design basis earthquake at a return interval greater than 2,000-years which is tied to defined risk and performance goals.

ATTACHMENT 1 TO
STATE OF UTAH'S COMMENTS ON
PROPOSED RULE, 67 FED. REG. 47745 (2002)

Chronology of State of Utah's Involvement in the Private Fuel Storage Licensing Proceeding as it relates to PFS's Request for an Exemption from the Design Basis Earthquake Standard and Seismic Hazard Assessment Methodology

1. June 1997: Existing regulation requires analysis of seismicity for siting ISFSIs west of the Rocky Mountain Front using deterministic methodology techniques in Part 100 App. A, V(a)(1)(i). 10 CFR § 72.102(b). For siting of nuclear power plants § 100.23 allows the option of using probabilistic seismic hazard assessment ("PSHA") methodology.

2. June 1997: PFS submitted ISFSI license application to NRC, which stated 84th percentile ground motions at 0.67 g (horizontal) and 0.69 g (vertical).

3. September 1997: State of Utah filed petition to intervene in licensing proceeding, Docket No. 72-22.

4. November 1997: State filed contentions, including issues relating to seismicity at the PFS site (Contention Utah L).

5. April 1998: State admitted as an intervenor; Board admits all seismicity issues in Contention Utah L. LBP-98-7, 47 NRC 142 (1998).

6. June 1998: Rulemaking Plan, SECY-98-126[1] issued. Preferred option required dry cask ISFSI applicants for sites west of the Rocky Mountains to use PSHA methodology ("conforming to 10 CFR 100.23 in lieu of 10 CFR Part 100 Appendix A" and a "graded approach to seismic design for ISFSI structures, systems, and components" ["SSCs"]); SSCs to be designed to withstand either Frequency-Category-1 design basis ground motion (1,000-year recurrence interval) or Frequency-Category-2 design basis ground motion (10,000-year recurrence interval).

7. February 1999: PFS reports discovering two formerly unknown faults dipping beneath the PFS site; deterministic (84th percentile) ground motions were 0.72 g (horizontal) and 0.8 g (vertical).

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[1] *Rulemaking Plan: Geological and Seismological Characteristics for Siting and Design of Dry Cask Independent Spent Fuel Storage Installations, 10 CFR Part 72,* SECY-98-126.

8. April 1999: PFS requested an exemption from 10 CFR § 72.102 (f)(1) to allow it to conduct a probabilistic seismic hazard analysis using a mean annual return period event of 1,000-years instead of the required deterministic analysis. PFS estimated ground motions for a 1,000-year return period at 0.4 g (horizontal) and 0.39 g (vertical).

9. April 1999: State's motion requiring Applicant to apply for rule waiver under 10 CFR § 2.758(b) or in the alternative amendment to Contention Utah L Part B (seismic exemption).

10. May 1999: The Licensing Board rejected State's Amended Contention (and denied the motion to require PFS to apply for a rule waiver) because the Staff had not actually taken a final position and thus the State's challenges were premature. LBP-99-21, 49 NRC 431 (1999).

11. August 1999: NRC Staff suggested[2] PFS consider using a design earthquake based on a PSHA with a return frequency of 2,000-years.

12. August 1999: PFS exemption request to use a 2,000-year recurrence interval to calculate the design basis ground motion.

13. December 1999: Staff issued its original PFS safety evaluation report ("SER") in which it recognized that Part 72 required a deterministic analysis for sites west of the Rocky Mountain Front and that the June 1998 Rulemaking Plan only allowed a 1,000-year or 10,000-return period event; notwithstanding the directives in the Rulemaking Plan, the Staff determined that a 2,000-year return value with the PSHA methodology can be acceptable.

14. January 2000: State filed another motion to amend Contention Utah L Part B in response to the Staff's SER, which seemed to accept PFS's exemption request to use a 2,000-year return period; the State's motion again asked that NRC require either the use of a probabilistic methodology with a return period of 10,000-years or compliance with the deterministic analysis as currently required by 10 CFR § 72.102 (f)(1).

15. June 2000: Licensing Board rejected State's second amendment to Utah L Part B (seismic exemption), again saying that the Staff had not actually taken

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[2] PFS's Commitment Resolution Letter #14 from John Donnell to NRC dated August 6, 1999).

a final position on the 2,000-year return period issue; consequently, the State's motion was premature. LBP-00-15, 51 NRC 313 (2000).

16. September 2000: Staff issued its second SER, in which it found sufficient basis to find acceptable PFS's use of the PSHA methodology with a 2,000-year return period event.

17. November 2000: State filed a third motion to amend Utah L Part B (seismic exemption) in response to the Staff's acceptance in its September 2000 SER of the use of the PSHA methodology with a 2,000-year return period requested by PFS.

18. December 2000: Letter from PFS to NRC announcing that previously unincorporated geotechnical data will impact the project licensing basis, resulting in a major license amendment affecting PFS facility design basis ground motion and dynamic stability analyses based on new shear and pressure wave velocity profiles.

19. January 2001: The Licensing Board admitted Contention Utah L Part B (seismic exemption) in part, and referred its ruling to the Commission, certifying the question of whether the contention should be further litigated. LBP-01-03, 53 NRC 84 (2001).

20. March 2001: PFS's additional geotechnical site investigations report describing thirty five percent increase in ground motions for the PFS site: *Development of Design Basis Ground Motions for the Private Fuel Storage Facility*, Rev. 1, March 2001 (Geomatrix). PFS estimated ground motions for a 2,000-year return period at approximately 0.7 g and 84th percentile ground motions at 1.15 g (horizontal) and 1.17 g (vertical).

21. March 2001: PFS License Application Amendment No. 22, major license amendment affecting PFS facility design basis ground motion and dynamic stability analyses based on new shear and pressure wave velocity profiles.

22. June 2001: The Commission confirmed the Board's ruling, stating

> . . . what Utah proposes to litigate is whether PFS's ISFSI design, which is dependent on an exemption from otherwise controlling seismic regulations, is adequate to withstand plausible earthquake risks. Viewed this way, Utah's proposed revised Contention L (geotechnical) plainly puts into play

safety issues that are material to licensing and suitable for consideration at an NRC hearing.

CLI-01-12, 53 NRC 459, 466 (2001).

23. September 2001: NRC issued modified rulemaking plan, SECY-01-0178,[3] in which use of a PSHA methodology and a design basis earthquake with a 2,000-year mean return period is proposed for dry-cask ISFSIs.

24. November 2001: PFS filed for summary disposition of Contention Utah L Part B (seismic exemption), arguing in part that the contention was mooted due to SECY-01-0178.

25. January 2002: The Licensing Board denied PFS's motion for summary disposition of Contention Utah L Part B. LBP-02-01, 55 NRC 11 (2002).

26. April 2002: The State, PFS, and the NRC Staff prefiled testimony on the seismic exemption issues involved in Utah L Part B.

27. April-June 2002: Hearings were held in the PFS licensing proceeding, and State's witnesses Dr. Walter J. Arabasz and Dr. Steven F. Bartlett presented evidence on the seismic exemption issues involved in Utah L Part B.

28. July 2002: NRC published its proposed rule, *Geological and Seismological Characteristics for Siting and Design of Dry Cask Independent Spent Fuel Storage Installations and Monitored Retrievable Storage Installations*, 67 Fed. Reg. 47745, and announced its new draft regulatory guide, DG-3021, *Site Evaluations and Determination of Design Earthquake Ground Motion for Seismic Design of Independent Spent Fuel Storage Installations and Monitored Retrievable Storage Installations* (July 2002).

29. September 2002: Parties in PFS proceeding filed simultaneous Findings of Fact and Conclusions of Law on Unified Contention Utah L/QQ, including issues relating the PFS's seismic exemption request.

30. October 2002: Parties in PFS proceeding filed Reply Findings.

31. October 2002: Comments due on proposed rule.

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[3] SECY-01-0178, *Modified Rulemaking Plan: 10 CFR Part 72 – Geological and Seismological Characteristics for Siting and Design of Dry Cask Independent Spent Fuel Storage Installation*, (September 26, 2001).

ATTACHMENT 2a to
STATE OF UTAH'S COMMENTS ON
PROPOSED RULE, 67 FED. REG. 47745 (2002)

Safety Evaluation Report for Systems not Directly Associated With Storage Casks for the Private Fuel Storage Facility, December 15, 1999

PAGES 2-44 to 2-45:

However, the staff has determined that a 2,000-year return value with the PSHA methodology can be acceptable for the following reasons:

- The DOE standard, DOE-STD-1020-94 (U.S. Department of Energy, 1994), defines four performance categories for structures, systems, and components important to safety. The DOE standard requires that performance category-3 facilities be designed for the mean ground motion with a 2,000-year return period. Category-3 facilities in the DOE standard have potential accident consequences similar to a dry spent fuel storage facility.

- The Uniform Building Code and the National Earthquake Hazards Reduction Program (International Conference of Building Officials, 1994; Building Seismic Safety Council, 1995) both recommend using peak ground motion values that have a 90-percent probability of not being exceeded in 50 years for the seismic design of structures. Considering the radiological safety aspects of a dry spent fuel storage facility, conservative peak ground motion values that have a 99 percent likelihood of not being exceeded in the 20-year licensing period of the Facility are considered adequate for its seismic design. This exceedance probability corresponds to a return period of 2,000 years.

- The NRC has accepted a design seismic value that envelops the 50th-percentile deterministic ground motion value and the 2,000-year return period probabilistic ground motion value for the TMI-2 ISFSI facility license.(Nuclear Regulatory Commission, 1998b; Chen and Chowdhury, 1998). The TMI-2 is designed to store spent nuclear fuel in dry storage casks. The applicant's 2,000-year PSHA response spectra generally envelops the 50th-percentile updated DSHA response spectra (Stamatakos et. al., 1999). A lower design value of 50th-percentile design earthquake is adequate because the passive design of the dry cask storage facility is inherently less hazardous and less vulnerable to earthquake-initiated accidents than an operating nuclear power reactor, which requires a 84th-percentile design earthquake (Hossain et al., 1997).

- In its Fault Evaluation Study and Seismic Hazard Assessment Study–Final Report for the site, Geomatrix Consultants, Inc. (1999a) concluded that an appropriate design probability level for both vibratory ground motion and fault displacement for the site is 5×10^{-4} (or a 2,000-year return period).

Safety Evaluation Report for the Private Fuel Storage Facility
September 29, 2000

PAGES 2-41 to 2-42:

However, the staff has determined that a 2,000-year return value with the PSHA methodology can be acceptable for the following reasons:

- The radiological hazard posed by a dry cask storage facility is inherently lower and the Facility is less vulnerable to earthquake-induced accidents than operating commercial nuclear power plants (Hossain et al., 1997). In its Statement of Consideration accompanying the rulemaking for 10 CFR Part 72, the NRC recognized the reduced radiological hazard associated with dry cask storage facilities and stated that the seismic design basis ground motions for these facilities need not be as high as for commercial nuclear power plants (45 FR 74697,11/12/80; SECY-98-071; SECY-98-126).

- Seismic design for commercial nuclear power plants is based on a determination of the Safe Shutdown Earthquake ground motion. This ground motion is determined with respect to a reference probability level of 10^{-5} (median annual probability of exceedance) as estimated in a probabilistic seismic hazard analysis (Reference Reg Guide 1.165). The reference probability, which is defined in terms of the median probability of exceedance, corresponds to a mean annual probability of exceedance of 10^{-4} (Murphy et al., 1997). That is, the same design ground motion (which has a median reference probability of 10^{-5}) has a mean annual probability of exceedance of 10^{-4} .

- On the basis of the foregoing, the mean annual probability of exceedance for the PFS Facility may be less than 10^{-4} per year.

- The DOE standard, DOE-TD-1020-94 (U.S. Department of Energy, 1996), defines four performance categories for structures, systems, and components important to safety. The DOE standard requires that performance Category-3 facilities be designed for the ground motion that has a mean recurrence interval of 2000 yrs (equal to a mean annual probability of exceedance of 5×10^{-4}). Category-3 facilities in the DOE standard have a potential accident consequence similar to a dry spent fuel storage facility.

- The NRC has accepted a design seismic value that envelopes the 2000-yr return period probabilistic ground motion value for the TMI-2 ISFSI license (Nuclear Regulatory Commission, 1998b; Chen and Chowdhury, 1998). The TMI-2 ISFSI was designed to store spent nuclear fuel in dry storage casks similar to the PFS Facility.

PAGES 7-8

The rationale for the proposed mean annual probability of exceedance of 5.0E-04 (return period of 2,000 years) for a design earthquake is based on several points:

- Use of a mean annual probability of exceedance of 5.0E-04 (return period of 2,000 years) for the design earthquake is consistent with the Commission's approval of DOE's request for an exemption from section 72.102(f)(1) for a proposed ISFSI at the INEEL to store spent fuel generated at the Three Mile Island Unit-2 nuclear power plant. Section 72.102(f)(1) requires that for sites that have been evaluated under the criteria of Appendix A of Part 100, the design earthquake must be equivalent to the SSE for an NPP. In its evaluation of the request, NRC staff considered the relative risk posed by the ISFSI. The staff concluded that considering the minor radiological consequences expected from a cask failure resulting from a seismic event, and the lack of a credible mechanism to cause such a failure, the NRC staff believes that the design earthquake using a mean annual probability of exceedance of 5.0E-04 for dry storage facilities at INEEL would be conservative.

- The total probability of exceedance for a design earthquake at an ISFSI facility with an operational period of 20 years (20 years x 5.0E-04 = 1.0E-02) is the same as the total probability of exceedance for an earthquake event at the proposed pre-closure facility at Yucca Mountain with an operational period of 100 years (100 years x 1.0E-04 = 1.0E-02).

- Because SSCs important to safety in an ISFSI are few, relative to those found in an NPP, the use of a graded approach for classifying ISFSI SSCs into one of two different categories for earthquake designs would unnecessarily increase the complexity in applications, without a commensurate improvement to safety. The SSCs important to safety in an ISFSI are associated with the storage cask, and include the canister, the canister handling systems, concrete pad supporting the cask, the transfer building supporting the handling systems, and the transfer cask. Since these SSCs are needed to be functional to prevent the dose limit of 5 rem being exceeded at the controlled area boundary, they would be required to be designed for a Category 2 design basis earthquake. Other SSCs important to safety may include the pressure monitoring system, protective cover, security lock and wire, etc. and can be designed for a lower Category 1 earthquake. However, it would be simpler to design all SSCs for a bounding Category 2 earthquake.

- The critical element for protection against radiation release is the confinement boundary for containing the spent fuel assemblies. Because the casks are rigid and have high natural frequencies, the damage from a drop or tip-over accident is expected to be far greater and more severe than the seismic inertial acceleration loads. Therefore, seismic inertia loads are bounded by other loads. The dry storage cask designs are very rugged and robust, and are expected to have substantial design margins to withstand forces from a seismic event greater than the design earthquake.

- During a seismic event, a cask may slide if lateral seismic forces are greater than friction resistance between the cask and the concrete pad. The sliding and resulting displacements are computed by the applicant to demonstrate that the casks, which are spaced to satisfy thermal requirements, are precluded from impacting other adjacent casks. Furthermore, the staff typically requests, as part of its approval process, that an applicant demonstrate that during a seismic event equal to the proposed design earthquake, the cask will not tip over. However, it follows from the discussion above that even if the casks slide or tip-over and then impact other casks or the pad during a seismic event greater than the proposed design earthquake, the casks have adequate design margins to ensure that they maintain their structural integrity to meet the Part 72 exposure limits for radiological protection.

- The mean annual probability of exceedance of 5.0E-04 for ISFSI facilities is consistent with the design approach used in DOE Standard DOE-STD-1020, "Natural Phenomena Hazards Design Evaluation Criteria for Department of Energy Facilities," for similar type facilities.

Consolidated Safety Evaluation Report
Concerning the Private Fuel Storage Facility, Docket No. 72-22
March 2002

PAGES 2-50 to 2-51:

However, the staff has determined that a 2,000-year return value with the PSHA methodology can be acceptable for the following reasons:

- The radiological hazard posed by a dry cask storage facility is inherently lower and the Facility is less vulnerable to earthquake-induced accidents than operating commercial nuclear power plants (Hossain et al., 1997). In its Statement of Consideration accompanying the rulemaking for 10 CFR Part 72, the NRC recognized the reduced radiological hazard associated with dry cask storage facilities and stated that the seismic design basis ground motions for these facilities need not be as high as for commercial nuclear power plants (45 FR 74697, 11/12/80; SECY-98-071; SECY-98-126).

- Seismic design for commercial nuclear power plants is based on a determination of the Safe Shutdown Earthquake ground motion. This ground motion is determined with respect to a reference probability level of 10^{-5} (median annual probability of exceedance) as estimated in a probabilistic seismic hazard analysis (Reference Reg Guide 1.165). The reference probability, which is defined in terms of the median probability of exceedance, corresponds to a mean annual probability of exceedance of 10^{-4} (Murphy et al., 1997). That is, the same design ground motion (which has a median reference probability of 10^{-5}) has a mean annual probability of exceedance of 10^{-4} . Further, analyses of nuclear power plants in the western United States show that the estimated average mean annual probability of exceeding the safe shutdown earthquake is 2.0×10^{-4} (U.S. Department of Energy, 1997).

- On the basis of the foregoing, the mean annual probability of exceedance for the PFS Facility may be defined as greater than 10^{-4} per year.

- The DOE standard, DOE-TD-1020-94 (U.S. Department of Energy, 1996), defines four performance categories for structures, systems, and components important to safety. The DOE standard requires that performance Category-3 facilities be designed for the ground motion that has a mean recurrence interval of 2000 yrs (equal to a mean annual probability of exceedance of 5×10^{-4}). Category-3 facilities in the DOE standard have a potential accident consequence similar to a dry spent fuel storage facility.

- The NRC has accepted a design seismic value that envelopes the 2000-yr return period probabilistic ground motion value for the TMI-2 ISFSI license (Nuclear Regulatory Commission, 1998b; Chen and Chowdhury, 1998). The TMI-2 ISFSI was designed to store spent nuclear fuel in dry storage casks similar to the PFS Facility.

ATTACHMENT 2b to
STATE OF UTAH'S COMMENTS ON
PROPOSED RULE, 67 FED. REG. 47745 (2002)

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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

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

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

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

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

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

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1 INDEX

2 EXAMINATION

7

EXHIBITS

8

	prepared by Geomatrix Consultants, Inc., February 1999.	
UU	Pages 1, 12, and 16 of Reg Guide 1.165 dated March 1997	10187/10193
VV	Letter from David J. Modeen, May 25, 1994, with attachments	10194/10196

1 A. Yes. This can simply be done I think
2 with some pattern recognition, just standing back
3 from these documents and being able to view the
4 bullets side by side.
5 On the first page, and I believe I've
6 put my ripped up pages in order here, I'm looking
7 at the Safety Evaluation Report, or an excerpt from
8 it dated December 15, 1999. In the first bullet,
9 generally we see the reference to DOE-STD-1020 as a
10 point of reference, namely, the 2,000-year return
11 period for a performance Category-3 facility.
12 In the second bullet we see reference to
13 the Uniform Building Code and a total probability
14 of exceedance, which we've learned has fallen by
15 the wayside in the Staff's thinking, except to the
16 extent that it reappears in the Modified Rulemaking
17 Plan.
18 In the third bullet we see the reference
19 to the TMI ISFSI, and I've explained in my view
20 that what was approved was a design basis ground

21 motion in fact higher than a 2,000-year value. But

22 I think the key point in this bullet is to

23 recognize that what was central to the -- one of

24 the things that was central to the request was that

25 it was a DOE facility, which had DOE standards to

1 consider or to enter into consideration and,
2 namely, the DOE 1020 Standard of a 2,000-year
3 ground motion for a PC-3 facility.
4 The fourth bullet, ancient history.
5 What was challenged to be circular reasoning,
6 referring to what Geomatrix thought was appropriate
7 and examination of the Geomatrix reasoning,
8 referring back to Staff reasoning, and that fell by
9 the wayside and became ancient history.
10 As we advance in time to the second
11 page, September 29, 2000, what I see in terms of
12 pattern recognition is the first three bullets are
13 part of establishing a proposition, namely, that
14 the radiological hazard of a dry cask ISFSI less
15 than a nuclear power plant. The second bullet
16 getting into the median versus mean issue, and then
17 ending up with the third bullet which is the
18 statement that, "On the basis of the foregoing, the
19 mean annual probability of exceedance for the PFS
20 Facility may be less than 10 to the minus 4 per

21 year."

22 From my testimony earlier this morning,

23 one can fairly say that even though I disagree with

24 how the Staff may have gotten there, namely, that

25 median versus mean issue, on the third bullet we're

1 basically of the same view.

2 Then the two bottom bullets, again the

3 reference to the DOE-STD-1020 for PC-3 and the

4 TMI-2. I'll note that on each of these pages,

5 perhaps I should have done so at the beginning, I

6 think the introductory sentence is the same in all

7 cases, and it reads, "However, the staff has

8 determined that a 2,000-return value with the PSHA

9 methodology can be acceptable for the following

10 reasons."

11 So so far what we see tracking

12 consistently in time is the reliance on the

13 DOE-STD-1020 and the reliance on the precedent of

14 the TMI to ISFSI exemption. Then when we come to

15 the most recent Consolidated SER, the third page of

16 this Exhibit, an excerpt from the March 2002 Safety

17 Evaluation Report, we again see the first three

18 bullets developing that proposition that on the

19 basis of the foregoing, the mean annual probability

20 of exceedance for the PFS facility may be defined

21 greater than 10 to the minus 4 per year, and we see

22 continuing to appear consistently the reference to

23 the DOE-STD-1020, and the TMI-2 precedent.

24 The fourth page, the Modified Rulemaking

25 Plan, I don't need to concern myself with greatly

1 at this point. I'll simply observe that the first
2 bullet is the TMI-2 precedent; the second one, this
3 issue of consideration of the total probability of
4 exceedance as a measure of acceptable risk, and we
5 heard from Mr. Turk that the staff may re-examine
6 whether it chooses to maintain that argument.
7 And then the bullet at the bottom, the
8 reference again to the DOE-STD-1020 and the mean
9 annual probability of exceedance of 5 E to the
10 minus 4 for the 2,000-year ground motion. So that
11 as the train arrives at this hearing in its most
12 updated version, namely, the Consolidated Safety
13 Evaluation Report, what I understand to be the key
14 underpinnings of the Staff's justification for the
15 2,000-year return value comes down to the first
16 three bullets that developed the proposition,
17 again, that relative to a benchmark of 10 to the
18 minus 4 per year for a nuclear power plant, a PFS
19 facility could have a hazard probability that were
20 higher, a mean return period ground motion that

21 were lower.

22 And then in the last two bullets it

23 seems to me that ultimately the Staff comes down to

24 reliance on the DOE-STD-1020, either explicitly in

25 the third bullet or implicitly in the TMI-2

1 exemption precedent.

2 Now, if that's the case, we come back to

3 what I think is good news, that the Staff, if it

4 chooses to stay pinned on the 2,000-year value,

5 while 2002 -- excuse me, while DOE-STD-1020 has

6 moved on to a exceedance probability of 2500 years

7 for PC-3, it can only stay pinned on that

8 2,000-year value if it accepts the target size and

9 performance goal of 1 times 10 to the minus 4.

10 And I think that's good news because I

11 believe that this logic is forcing finally some

12 kind of fixed star to navigate by, that the Staff,

13 I've been told, need not accept the DOE-STD-1020,

14 but it's such a key point that one has to somewhere

15 accept a seismic performance goal to move on to the

16 rest of the logic to consider a hazard probability

17 and risk consistency.

18 This equation that I showed you this

19 morning about R sub R equals PH over P of F, this

20 appears in that reference B4 in the Reg Guide 1.165

21 as to how to consider a reference probability

22 different than 1 times 10 to the minus 5 median.

23 The design approach and philosophy was developed in

24 the reference document in DOE-STD-1020 and its

25 various versions. Again, a standard design

1 approach and philosophy was developed. It was
2 developed in the Kennedy and Short paper as a basis
3 for DOE-STD-1020 and I'm greatly impressed by
4 looking at NUREG 6728 or NUREG/CR 6728, and if I
5 could just pick that up for a moment, Section 7,
6 the NUREG is titled Technical Basis for Revision of
7 Regulatory Guidance on Design Ground Motions:
8 Hazard and Risk Consistent Ground Motion Spectra
9 Guidelines. And Section 7 specifically is titled
10 Procedure for the Development of Risk Consistent
11 Spectra.
12 Let me read a sentence from the
13 beginning of the introduction section of Section 7
14 of the cited NUREG. "For the purposes of this
15 project we mean by consistency that the ground
16 motion recommendations result in facilities at
17 different sites having about the same level of
18 safety from earthquake caused failures no matter
19 where there (sic) are located in the country."
20 So I guess as I try to figure out how to

21 get off the train and when I can, I think that the

22 discussion put forward by Professor Cornell in

23 Attachment A of his prefiled testimony basically

24 lays out a rational framework for deciding how to

25 deal with the reference probability.

1 He, I think, is constrained to some
2 extent by needing to argue within the DOE, what I
3 call the DOE paradigm or the DOE framework. In
4 other words, considering a seismic performance
5 goal, a hazard probability and then with the risk
6 reduction ratio consider the conservatisms that are
7 achieved in the design procedures and the
8 acceptance criteria.
9 I have made it plain in my prefiled
10 testimony that I agree with this need to
11 fundamentally couple the hazard exceedance
12 probability with the design side and that if one
13 accepts this proposition that sufficient protection
14 depends on that fundamental coupling, then I've
15 gone as far as I can on the train and have to pass
16 off to the engineers and for the Board to consider
17 whether, as Dr. Cornell argues, those
18 conservatisms, indeed, have been achieved on the
19 design side to justify the 2,000-year return
20 period.

21 And if a judgment is made that they have

22 not or there's uncertainty whether they have then

23 one would come back to something like State's

24 Exhibit 208 where I have the graph at the bottom of

25 the table and we have the famous left-hand and

1 right-hand, if that sufficient protection isn't
2 achieved on the design side, then necessarily it
3 requires that left-hand side to come up with the
4 return period of the ground motion.
5 MS. CHANCELLOR: Thank you, Dr. Arabasz.
6 I have no further questions.
7 Oh, your Honor, I do have one thing. I
8 would like to move for entry of State's Exhibit
9 209.
10 JUDGE FARRAR: Mr. Gaukler?
11 MR. GAUKLER: No objection.
12 JUDGE FARRAR: Mr. Turk?
13 MR. TURK: Your Honor, I noted my
14 objection previously. I would restate it, but
15 expect your ruling to be adverse.
16 JUDGE FARRAR: Unless you have something
17 additional to add, you're correct.
18 MR. TURK: I think the only thing I
19 would make clear, your Honor, is that the bullets
20 are taken out of context. In each case the State

21 left off the concluding paragraph as well as all

22 the preceding discussion that led up to those

23 bullets. This may be significant and I think that

24 any time one looks at this Exhibit one must keep in

25 mind that more was said by the Staff than the State

1 is representing here because they have taken the
2 bullets out of context. And, for example, if I may
3 just note what I mean by that --
4 JUDGE FARRAR: Rather than have you note
5 it, number one, your complete version of the
6 document will indicate that, and you, of course,
7 would be free to put on a Staff witness who could,
8 I assume, fairly briefly point out that something
9 has been omitted that would be appropriate to put
10 the matters in context. So on that basis we will
11 admit State Exhibit 209.
12 MS. CHANCELLOR: Thank you, your Honor.
13 (STATE'S EXHIBIT-209 ADMITTED.)
14 JUDGE FARRAR: Mr. Gaukler, do you have
15 some -- I think you had indicated yesterday you had
16 some cross.
17 MR. GAUKLER: Yes. Should I start?
18 JUDGE FARRAR: Yes, go ahead.
19
20 CROSS-EXAMINATION

21 BY MR. GAUKLER:

22 Q. Good morning, Dr. Arabasz.

23 A. Good morning, Mr. Gaukler.

24 Q. I will agree with you, it has been a

25 long train ride.

ATTACHMENT 3a TO
STATE OF UTAH'S COMMENTS ON
PROPOSED RULE, 67 FED. REG. 47745 (2002)

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

STATE OF UTAH TESTIMONY OF DR. WALTER J. ARABASZ REGARDING UNIFIED CONTENTION UTAH L/QQ (Seismic Exemption)

Q. 1: Please state your name, affiliation, and qualifications.

A. 1: My name is Dr. Walter J. Arabasz. I am a Research Professor of Geology and Geophysics at the University of Utah in Salt Lake City, Utah, and also Director of the University of Utah Seismograph Stations. I have more than 30 years' professional experience in scientific research, consulting, occasional teaching, and publishing articles in observational seismology, seismotectonics, and earthquake hazard analysis with a primary focus on Utah and the Intermountain West.

Since 1977 I have routinely provided professional consulting services on earthquake hazard evaluations for dams, nuclear facilities, and other critical structures and facilities. Since the mid-1980s I have been directly involved in methodology development and applications of probabilistic seismic hazard analysis. During the past decade I have had major involvement in assessing vibratory and fault-displacement hazards for the high-level nuclear waste repository at Yucca Mountain, including serving on a Peer Review Group for Early Site Suitability Evaluation, reviewing technical reports, and serving on expert teams for seismic source characterization for probabilistic hazard analyses.

My service on numerous national and state advisory boards and panels has included – relevant to this filing – serving on the National Research Council's Panel on Seismic Hazard Evaluation (1992-96), the Utah Seismic Safety Commission (1994 to present; chair, 1997-2001), and numerous panels and work groups under the National Earthquake Hazards Reduction Program since the early 1980s. My *curriculum vitae* is included as State's Exhibit 123.

Q. 2: What is the purpose of your testimony?

A. 2: The purpose of my testimony is to explain the basis for my professional opinion that, within my areas of expertise, the NRC Staff has presented a flawed rationale for recommending that Private Fuel Storage, LLC ("PFS") be granted an exemption from existing regulations and to elaborate on the rationale that PFS has recently presented to support its exemption request.

Q. 3: Describe, generally, your role in assisting the State in the PFS proceeding.

A. 3: I was designated one of the State's testifying experts with respect to Contention Utah L, Basis 2. This portion of the original geotechnical contention, Utah L, was incorporated into the unified contention Utah L/QQ as section B and has been resolved by stipulation. I have also been designated as a testifying witness for Section E of the unified contention; this portion of the unified contention is a consolidation of Utah L, Part B and it deals with PFS's request to the NRC to be exempted from basing their seismic design on the results of a deterministic seismic hazard analysis; instead PFS requests that it be allowed to base its seismic design on results from a probabilistic seismic hazard analysis for a 2,000-year return period.

My involvement in the PFS proceeding as a technical expert for the State has included review of the Applicant's SAR sections, and updates thereof, relating to its earthquake hazards investigation of the proposed site and relevant reports and other documents prepared by the Applicant or its contractors and submitted to the NRC or produced to the State in discovery; assisting the State in answering and preparing discovery; review of the NRC Staff's preliminary, final and supplemental Safety Evaluation Report ("SER") for the PFS facility[1] as well as the Staff's Position on Utah L (April 28, 2000).

In response to PFS's request to be exempted from 10 CFR § 72.102(f)(1), I assisted the State in preparing late filed contentions to modify basis 2 of Contention Utah L.[2] I was deposed by Private Fuel Storage, LLC ("PFS") on October 31, 2001 and I was present when, shortly thereafter, the State deposed PFS witness, Dr. C. Allin Cornell, on the appropriateness of using probabilistic seismic hazard methodology with a 2,000-year return period. When PFS filed for Summary Disposition of Utah L, Part B (November 9, 2001), I gave my primary attention to PFS's Motion, its Statement of Material Facts, and the attached declaration of Dr. C. Allin Cornell, and I provided a declaration in support of the State's

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[1] Dated December 15, 1999, September 29, 2000 and December 21, 2001 respectively.

[2] The State filed modification requests on January 26, 2000 and November 9, 2000.

December 7, 2001 Response and Opposition thereto.

Q. 4: Please describe the evolution of the seismic design basis ground motions at the PFS site?

A. 4: I first became involved in providing technical expertise to the State of Utah regarding seismic hazards at the PFS facility in August 1998. Since then, considerations by both the Applicant and the NRC Staff regarding the seismic design basis ground motions – or, for simplified reference, the design basis earthquake ("DBE") – for the PFS facility have continually evolved, providing a "moving target" for critical evaluation. Some of the noteworthy stages in this process include:

1. PFS's submission of its Safety Analysis Report in 1997 in which a "deterministic" approach was used for establishing the DBE aimed at meeting requirements of 10 CFR 72.102(f)(1).

2. PFS's Request for Exemption to CFR 72.102(f)(1) (April 2, 1999) in which PFS requested to calculate the DBE using a probabilistic seismic hazard analysis ("PSHA") and a 1,000-year recurrence interval.

3. The Staff's review of the PFS's request and finding that use of a 1,000-year return-period value was not acceptable – but that use of a PSHA with a 2,000-year return-period value could be acceptable for reasons provided by the Staff (Staff's Preliminary SER ("PSER") (December 15, 1999) at 2-44 to 2-45.

4. The Staff's finding the PSHA with a 2,000-year return period acceptable (Final SER, "FSER", September 29, 2000, at 2-41 to 2- 42);

5. PFS's changes in site-response modeling for the PFS site in March 2001, which resulted in significant changes to the 2,000-year return-period ground motions, including an increase in the peak horizontal acceleration from 0.528 g to 0.711g (*see* SER Supplement No. 2, "SSER", December 21, 2001) at 7 and 21-23).

6. PFS's Motion for Summary Disposition of Utah L Part B (November 9, 2001) in which PFS has presented, for the first time in a documented way, its own case for justifying a DBE with a 2,000-year mean return period ("MRP").

7. The Staff's continued reliance on the same rationale in its SSER as in the FSER to find acceptable a PSHA with a 2,000-year return period – despite many concerns raised by the State regarding non-conservatism in the engineering design of the PFS facility.

Q. 5: Please describe the framework of your testimony.

A. 5: I will frame my testimony as follows. First, I will briefly revisit the original issue of a deterministic seismic hazard analysis ("DSHA"). Then I will address those issues, within my scope of expertise and testimony, associated with unified Contention Utah L/QQ, Section E. In my testimony I will address issues that arose directly from arguments put forward by the Staff to justify a seismic exemption for the PFS facility (allowing a probabilistic DBE with a 2,000-year MRP) as well as new issues, relevant to my area of expertise, raised in PFS's Summary Disposition Motion. I might add that PFS's Motion for Summary Disposition provides the latest rationale offered by PFS for its seismic exemption request.

Q. 6: Do you have any comments about the Deterministic Seismic Hazard Analysis for the PFS site?

A. 6: In previous submissions to the NRC, I stated that PFS had not conducted a fully deterministic seismic hazard analysis ("DSHA") as required by 10 CFR § 72.102(f)(1) and, by reference, 10 CFR 100 Appendix A. The NRC Staff has acknowledged that the DSHA performed by Geomatrix Consultants, Inc. for the PFS facility and reported in the 1997 SAR and the updated DSHA reported in April 1999 "did not meet the deterministic requirements in 10 CFR 100 Appendix A."[3]

A later updated DSHA by Geomatrix Consultants, Inc. reported in April 2001 follows the same methodology as earlier and presumably would also not meet the deterministic requirements of 10 CFR 100 Appendix A.

The relevance of a valid DSHA, other than being required by current NRC regulations, is that it establishes a benchmark to which results of any probabilistic seismic hazard analysis can correctly be compared to evaluate the conservatism of the PSHA results, such as earlier done for the NRC Staff by Stamatakos et al.[4]

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[3] NRC Staff's Objections and Responses to the "State of Utah's Sixth Set of Discovery Requests Directed to the NRC Staff (Utah Contention L)" (February 14, 2000), Response to Requests for Admissions 1 and 2 at 7-8.

[4] *See* Stamatakos, Chen, McCann & Chowdhury, *Seismic Ground Motion and Faulting Hazard at Private Fuel Storage Facility in the Skull Valley Indian Reservation, Tooele County, Utah – Final Report* (September 1999) at 2-46.

Q. 7: Please describe your concerns about Subsection E.1 of the Unified Contention Utah L/QQ.

A. 7: Unified Contention L/QQ, Sub-section E.1 states:

> The requested exemption fails to conform to the SECY-98-126 (June 4, 1998) rulemaking plan scheme, i.e., only 1000-year and 10,000-year return periods are specified for design earthquakes for safety-important systems, structures, and components (SSCs) – SSC Category 1 and SSC Category 2, respectively – and any failure of an SSC that exceeds the radiological requirements of 10 C.F.R. § 72.104(a) must be designed for SSC Category 2, without any explanation regarding PFS SSC compliance with section 72.104(a).

The scope of my testimony with respect to subsection 1 excludes radiological dose consequences. Subsection 2, which also deals with radiological dose limits, is similarly outside the scope of my testimony.

The State has challenged the NRC Staff's proposal to grant an exemption request to PFS that would allow use of a DBE with a 2,000-year return period; the State argued, in part, that the NRC Rulemaking Plan set forth in SECY-98-126 (June 4, 1998) provides only two alternatives for design basis ground motions: a 1,000-year return period or a 10,000-year return period.[5] The Staff has rejected the use of a 1,000-year return period. FSER at 2-41. The Commission has instructed that the State "may not rely solely on the rulemaking plan [SECY-98-126] to prove its contention." CLI-01-12, 53 NRC 416 (June 14, 2001), slip op. at 16. At the same time, the Commission instructed that "PFS is not bound by the rulemaking plan, but it does have the burden to show that the 2000-year design standard is sufficiently protective of public safety and property." Id.

In its Motion for Summary Disposition PFS argued, in part, that non-compliance of a 2,000-year return period with SECY-98-126 is now mooted because the Staff has recommended a Modified Rulemaking Plan in which use of a DBE with a 2,000-year MRP is proposed for dry-cask ISFSIs. Whether the latter indeed moots the issue is questionable in light of the Commission's recent issuance of Staff Requirements Memorandum[6] relating to SECY-01-0178 (September 26, 2001), wherein the Commission writes:

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[5] State of Utah's Request for Admission of Late-filed Modification to Basis 2 of Utah Contention L (November 9, 2000) ("Request for Modification of Utah L") at 6-7.

[6] Staff Requirements Memorandum to William D. Travers dated November 19, 2001, included as State's Exhibit 124.

> Central to this rulemaking is the determination of the mean annual exceedance probability of an earthquake at a proposed ISFSI. The proposed rule should solicit comment on a range of probability of exceedance levels from 5.0E-04 through 1.0E-04. Staff should undertake further analysis to support a specific proposal.

Q. 8: What do you consider to be the key issue in subsection 1?

A. 8: The key contested issue linked to subsection 1 is the validity of PFS's claim that it has met the Commission's requirement to show that "the 2000-year design standard is sufficiently protective of public safety and property."[7] PFS's claim fundamentally rests on the proposition that sufficient protection "depends on both the probability of occurrence of the seismic event (often expressed as the mean annual probability of exceedence or "MAPE" of a given earthquake level) and the level of conservatism incorporated in the design procedures and criteria."[8] I agree with the proposition – but the latter critical part of PFS's claim of sufficient protection is challenged by the State's engineering and dynamic analyses experts, who dispute PFS assertions that it has demonstrated adequate conservatism in design of SSCs at the PFS facility. Here, and ultimately at the end of my testimony, I defer to these experts for more complete discussion of their disputes, which go the heart of "appropriately conservative" and "sufficiently protective" design of the PFS facility. *See* Testimony of Dr. Steven F. Bartlett and Dr. Farhang Ostadan (Dynamic analysis); Dr. Ostadan and Dr. Mohsin R. Khan (Cask stability), and Dr. Ostadan and Dr. Bartlett (Lack of design conservatism) (hereafter "Engineering and Dynamic Analyses Expert Testimony").

Q. 9: Please describe your concerns about Subsection E.3 of the Unified Contention Utah L/QQ.

A. 9: Subsection E.3 of the unified Contention Utah L/QQ, states:

> The staff's reliance on the reduced radiological hazard of stand-alone ISFSIs as compared to commercial power reactors as justification for granting the PFS exemption is based on incorrect factual and technical assumptions about the PFS facility's mean annual probability of exceeding a safe shutdown earthquake (SSE), and the relationship between the median and mean probabilities for exceeding an SSE for central and eastern United States commercial power reactors and the median and mean

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[7] PFS's Motion for Summary Disposition at 10.

[8] Id. at 6.

probabilities for exceeding an SSE for the PFS facility.

In its Request for Modification of Utah L, the State evaluated the rationale put forward by the Staff in its September 2000 SER to justify a DBE with a 2,000-year return period for the PFS facility and characterized the Staff's reasons as *ad hoc* and either flawed or not compelling.[9] Subsection 3 concerns a series of three statements made by the Staff leading to the conclusion: "On the basis of the foregoing, the mean annual probability of exceedance for the PFS Facility may be less than [sic] 10^{-4} per year." FSER at 2-42. The Staff's flawed reasoning, as presented, was to posit that a design ground motion (for an SSE) at the PFS site which had a median reference probability of exceedance of 10^{-5} as defined in Regulatory Guide 1.165 would be the same as a design ground motion with a mean annual probability of exceedance of 10^{-4}.

Q. 10: Do you believe there has been a misperception about the issue the State has raised in Sub-section 3?

A. 10: Yes I do.

In support of PFS' Motion for Summary Disposition, Dr. Cornell challenges Subsection 3 – formerly Utah L, Part B, Basis 3 – on various grounds and concludes that "the argument raised by the State in Basis 3 is inconsequential and irrelevant to the issue whether a 2,000-year earthquake should be used at the PFSF." Declaration of C. Allin Cornell ("Cornell Dec.") at ¶40. What remains relevant is the benchmark for an SSE at the PFS site if the DBE for an ISFSI is to be compared to that benchmark, as was done by the Staff in its September 2000 SER. Absent a determination by the Staff along the lines of Dr. Cornell's beliefs of what the Staff "today would both select and prefer" (Cornell Dec. ¶35), or "can reasonably be expected to revert to" (id. ¶37), or "would likely conclude" (id. ¶38), or "would today not only accept but prefer" (id. ¶39), the State relied on guidance in Regulatory Guide 1.165 and on corresponding commentary by the Staff. Murphy et al., *Revision of Seismic and Geologic Siting Criteria,* Transactions of the 14th International Conference on Structural Mechanics in Reactor Technology (August 17-22, 1997), 1-12, included as State's Exhibit 125.

Dr. Cornell states that "The provision in Regulatory Guide 1.165 that a median value of 10^{-5} could be used is only the result of historical circumstances . . . [involving] a significant discrepancy in the assessment of the mean estimates between the two major CEUS seismic hazard studies then available . . . [which has] since been resolved . . ." (Cornell Dec. ¶36). This assertion is at odds with the following commentary by the Staff in 1997:

> It should be noted that this RP [Reference Probability of 1E-5/yr] is

[9] Request for Modification of Utah L at 7.

> calibrated with the past design bases, it is not derived directly from any quantitative risk or safety goals. In fact, one of the reasons for using the median hazard curve in the regulatory guide approach is that the controlling earthquakes resulting from the de-aggregation of the median hazard curve are very similar to those used in the past licensing from the deterministic procedures.

Murphy et al. (1997) op. cit. at 7.

A similar commentary by the Department of Energy notes the following:

> In developing Regulatory Guide 1.165, NRC staff considered whether to define the reference probability as a mean or median value. The mean value has the advantage of better reflecting the uncertainty in the seismic hazard evaluation (i.e., it is sensitive to the range of interpretations of seismic source zone configurations, earthquake magnitude recurrence relationships, and ground motion attenuation relationships). However, precisely because the median is less sensitive to uncertainties, it provides a more stable regulatory benchmark than does the mean. Another consideration leading to the staff's preference for the median was the finding that, when median hazard curves were disaggregated, the magnitudes and distances of the controlling earthquakes tended to be more sharply defined and to agree better with the safe shutdown earthquakes of the selected plants than when mean hazard curves were disaggregated (Bernreuter et al. 1996).

DOE Topical Report YMP/TR-003-NP, 1997) at §3.1.2.1; *see* Exh. 3 to Cornell's Dec. in PFS's Motion for Summary Disposition at pages 2-3 of 7.

From the above discussion, it is not the State's argument that a median estimate should be used "in lieu of the mean estimate for the design of nuclear power plants, and similarly for ISFSIs . . ." PFS's Statement of Material Facts on Which No Genuine Dispute Exists at ¶19. Rather, the argument rests with the Staff's guidance in Regulatory Guide 1.165. Therein the procedure is specified for determining the reference probability, the annual probability of exceeding the SSE, at future nuclear power plants: "This reference probability [median annual exceedance probability of 1.0E-05] is also to be used in conjunction with sites not in the Central and Eastern United States (CEUS) . . . However, the final SSE at a higher reference probability may be more appropriate and acceptable . . . for some sites . . . Reference B.4 includes a procedure to determine an alternative reference probability on the risk-based considerations; its application will also be reviewed on a case-by-case basis." Regulatory Guide 1.165 at 12.

Q. 11: Please describe your concerns about Subsection E.4 of the Unified Contention Utah L/QQ.

A. 11: Subsection E.4 of the unified contention Utah L/QQ, states:

> In supporting the grant of the exemption based on 2000-year return period, the staff relies upon United States Department of Energy (DOE) standard, DOE-STD-1020-94, and specifically the category-3 facility SSC performance standard that has such a return period, notwithstanding the fact the staff categorically did not adopt the four-tiered DOE category scheme as part of the Part 72 rulemaking plan.

The Staff's reliance on DOE-STD-1020-94 in its December 1999 PSER, its September 2000 FSER and its December 21, 2000 SSER to justify a DBE with a 2,000-year return period for the PFS facility suffers from two circumstances. First, DOE-STD-1020-94 was fully available to, and was referenced by, the Staff when it drafted its 1998 Rulemaking Plan (SECY-98-126). Yet the Staff chose in its 1998 Rulemaking Plan not to propose the use of a 2,000-year return period for ISFSIs. Second, the Staff cited the 2,000-year return period (mean annual probability of exceedance of 5×10^{-4}) for Performance Category-3 ("PC3") SSCs without acknowledging that in the design approach of DOE-STD-1020-94, the MAPE for PC3 is fundamentally coupled to a target seismic performance goal of 1×10^{-4} (the annual probability of exceedance of acceptable behavior limits). DOE-STD-1020-94 at B-7 to B-8.

PFS's Motion for Summary Disposition is replete with acknowledgments that, just as in the overall design approach of DOE-STD-1020-94, there should be a coupling of the hazard exceedance probability and a level of conservatism in design procedures that together ensure a desired performance goal. For example:

> [T]he risk of failure of a facility or structure depends on both the probability of occurrence of the seismic event (often expressed as the mean annual probability of exceedence or "MAPE" of a given earthquake level) and the level of conservatism incorporated in the design procedures and criteria. Cornell Dec. ¶13.

PFS's Motion for Summary Disposition at 6.

> As discussed above, the level of safety achieved depends on both the earthquake threat definition and the design procedures and criteria utilized to protect against that threat; thus, looking only at the earthquake return period is incorrect.

Id. at 15.

> Two factors are relevant to determining the likelihood of seismic failure of a facility or structure due to an earthquake event. These are (1) the seismic design basis earthquake ("DBE") for the facility or structure and (2) the conservatisms embodied in the codes and standards applicable to its seismic design. Cornell Dec. ¶¶18-19; see also Arabasz Dep. at 41-42, 81-84, 115-117.

PFS's Statement of Material Facts on Which No Genuine Dispute Exists, ¶12.

> While the risk-graded approach is implemented in somewhat different ways in the various fields of seismic design, the standards of practice almost invariably utilize a DBE defined at some mean annual probability of exceedance and a set of design procedures and acceptance criteria.

Cornell Dec. ¶18.

> Both the MAPE of the DBE and the level of conservatism incorporated in the design procedures and criteria affect the failure probability of seismically-designed facilities and structures. . . . [I]t is important to understand that both the MAPE and the level of conservatism in the design procedures and criteria must be considered when assessing and comparing the safety implications of various seismic design standards.

Cornell Dec. ¶19.

The discovery and deposition process for Contention Utah L, Part B, has led me to the opinion that determination of the mean annual exceedance probability (or equivalent return period) of a DBE for the proposed PFS facility, and whether it ensures sufficient protection, cannot be made independent of an evaluation of conservatism (or non-conservatism) in design procedures.

Q. 12: Do you have any comment on DOE Standard 1020-01?

A. 12: A final point of particular relevance to Subsection 4 is the recent release of Revised DOE Standard 1020-2001 for review and comment. Memorandum from Richard L. Black to Technical Standards Program Managers dated August 22, 2001. For PC3 the revised standard changes the MAPE from 5×10^{-4} (2,000-year return period) to 4×10^{-4} (2,500-year return period) while retaining the same target seismic performance goal of 1×10^{-4} per year for sites not near tectonic plate boundaries. Revised DOE-STD-1020-2001,

Table C-3 at C-6, included as State's Exhibit 126. The new DOE-STD-1020-2001 was released before the Staff issued the SSER yet the Staff makes no mention of it and still relies on the 1994 version.

Q. 13: Please describe your concerns about Subsection E.5 of the Unified Contention Utah L/QQ.

A. 13: Subsection E.5 of the unified contention Utah L/QQ, states:

> In supporting the grant of the exemption based on 2000-year return period, the staff relies upon the 1998 exemption granted to DOE for the Idaho National Engineering and Environmental Laboratory (INEEL) ISFSI for the Three Mile Island, Unit 2 (TMI-2) facility fuel, which was discussed in SECY-98-071 (Apr. 8, 1998), even though that grant was based on circumstances not present with the PFS ISFSI, including (a) existing INEEL design standards for a higher risk facility at the ISFSI host site; and (b) the use of a peak design basis horizontal acceleration of 0.36 g that was higher than the 2000-year return period value of 0.30 g.

In my opinion, circumstances specific to the seismic exemption awarded to DOE for the TMI-2 ISFSI at INEEL (SECY-98-071, April 8, 1998) do not justify using the exemption as a compelling precedent for the PFS exemption request.

The design basis of an existing higher risk facility, namely the Idaho Chemical Processing Plant ("ICPP"), at the host site for the TMI-2 ISFSI was a definite consideration in DOE's proposal of a DBE for the ISFSI.[10] Under existing DOE design standards at INEEL, based on DSHA results from the 1970s, the peak design basis horizontal acceleration for the ICPP was set at 0.36 g, including effects of soil amplification.[11] DOE proposed to use the same acceleration for the DBE for the TMI-2 ISFSI. In an analysis for the NRC, the regulatory problem was stated this way:

> [T]he DOE-proposed design PHA of 0.36 g does not bound the most recent 84th-percentile deterministic value of 0.56 g and 10,000-yr return period probabilistic value of 0.47 g. Therefore, a judgment

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[10] Chen and Chowdhury, *Seismic Ground Motion at Three Mile Island Unit 2 Independent Spent Fuel Storage Installation Site in Idaho National Engineering and Environmental Laboratory – Final Report* (June 1998), excerpts included as State's Exhibit 127, at 4-1.

[11] Id.

> of whether the DOE-design approach is acceptable depends on whether there are regulatory and technical bases to accept an ISFSI-design value that bounds the 50th-percentile deterministic value and the 2,000-yr return period probabilistic value.[12]

Ultimately, DOE was allowed to use a design earthquake with 0.36 g peak horizontal acceleration (together with an appropriate response spectrum) for the TMI-2 ISFSI. SECY-98-071 at 3. What the NRC approved in terms of a design-basis ground motion was a design value higher than the 2,000-year return period mean ground motion from the PSHA. In their analysis for the NRC, Chen and Chowdhury provided information showing that the 0.36 g horizontal design value for the ISFSI soil site lies between the 2,000-year probabilistic value of 0.30 g and the 10,000-year probabilistic value of 0.47 g. Id. at 3-5 (State's Exh. 127). Although the report by Chen and Chowdhury does not contain sufficient information to identify precisely the return period corresponding to 0.36 g on soil, the bounding probabilistic values for 2,000 years (0.30 g) and 10,000 years (0.47 g) suggest that 0.36 g corresponds to a return-period value on the order of three to four thousand years (the precise return period would have to be determined from the original PSHA data). Thus, a 2,000-year return period for the PFS facility would be significantly lower than what was approved for the INEEL ISFSI.

Another factor that significantly influenced the Staff's approval of the TMI-2 ISFSI exemption was a site-specific radiological risk analysis coupled with "the lack of a credible mechanism to cause a failure." SECY-98-071 at 3.

On April 8, 1998, the NRC informed the DOE, "Since the rulemaking to revise the Part 72 seismic requirement for ISFSIs is unlikely to be completed before issuance of the TMI-2 ISFSI license, the staff intends to grant the exemption as requested if the Environmental Assessment (EA) is favorable." SECY-98-071 at 3. Two months later in June 1998, the Part 72 Rulemaking Plan (SECY-98-126) was released with allowance only for design basis ground motions with mean annual probabilities of exceedance corresponding to return periods of 1,000 years or 10,000 years, depending on risk. This sequence of events, in my opinion, does not support PFS's assertion that "there is no doubt that at the time the INEEL exemption was approved, the NRC Staff and the Commission expected (and intended) that it would serve as a precedent towards the granting of similar exemptions in the future." PFS's Motion for Summary Disposition at 14.

Q. 14: Please describe your concerns about Subsection E.6 of the Unified Contention Utah L/QQ.

A. 14: Subsection E.6 of the unified contention Utah L/QQ, states:

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[12] Id. at 4-2.

> Because (a) design levels for new Utah building construction and highway bridges are more stringent; and (b) the PFS return period is based on the twenty-year initial licensing period rather than the proposed thirty- to forty-year operating period, the 2000-year return period for the PFS facility does not ensure an adequate level of conservatism.

PFS's witness, Dr. Cornell, addresses the relative comparison of a DBE with a 2,000-year mean return period proposed for the PFS facility with the higher return period value of approximately 2,500 years required by the International Building Code 2000. Cornell Dec. ¶46. He states:

> One should not draw the erroneous conclusion, however, that this difference in the definition of the DBE implies a lower probability of failure for SSCs designed to IBC-2000 versus those, such as the PFSF, designed to the 2,000-year MRP and the NRC's SRP design procedures and criteria.

Id. Granting that "the safety achieved depends on *both* the DBE MRP and the design procedures and criteria utilized" (id.), the contested issue once again becomes the conservatism (or non-conservatism) in design of SSCs at the PFS facility. As in Answer No. 8 above, I defer the latter issue to the State's engineering and dynamic analyses experts (including implications for the analogous situation of comparing a 2,000-year MRP DBE for the PFS facility with a 2,500-year MRP DBE for new highway bridges in Utah). *See* Engineering and Dynamic Analyses Expert Testimony.

I might add that the Staff's comparison between probabilistic ground motions used for the design of new Interstate 15 highway bridges in the Salt Lake Valley and those proposed for use at the PFS site is partially erroneous and, in any case, irrelevant due to the many differences between the two sites. *See* SSER at 18.

Part (b) of Subsection 6 (the significance of a 20-year initial licensing period versus a 30- to 40-year total operational period) concerns a metric the Staff put forward for justifying the adequacy of a 2,000-year return period for seismic design of the PFS facility, namely, a 99-percent probability that the DBE not be exceeded in the 20-year licensing period of the facility. The Staff wrote:

> Considering the radiological safety aspects of a dry spent fuel storage facility, conservative peak ground motion values that have a 99 percent likelihood of not being exceeded in the 20-year licensing period of the facility are considered adequate for its seismic design. This exceedance probability corresponds to a return period of 2,000 years.

PSER at 2-45. The Staff again relies on this same metric in its recent Modified Rulemaking Plan as one basis to justify the proposed mean annual probability of 5×10^{-4} (return period of 2,000 years) for a DBE for dry-cask ISFSIs. Attachment to SECY-01-0178 at 7. Therein, the Staff argues:

> The total probability of exceedance for a design earthquake at an ISFSI facility with an operational period of 20 years (20 years x 5.0E-04 = 1.0E-02) is the same as the total probability of exceedance for an earthquake event at the proposed pre-closure facility at Yucca Mountain with an operational period of 100 years (100 years x 1.0E-04 = 1.0E-02).

Id. Using this metric, a facility with an operational life of 40 years would have to have a DBE with a mean return period of 3,980 years. State of Utah's Objections and Responses to Staff's First Set of Formal Discovery Requests to State of Utah (November 5, 2001), Answer to Interrogatory No. 1 at 8-10.

PFS's witness, Dr. Cornell, attacks Subsection 6(b) of Utah L (now E.6(b) of Unified Contention Utah L/QQ) stating:

> This contention is unfounded because in virtually all areas of public safety hazards are measured as annual probabilities (or frequencies) of occurrence, regardless of the length of the activity in question, the exposure time, the estimated facility life, or the licensing duration [Ref. 12 (Paté-Cornell paper)].

Cornell Dec. ¶49. In my deposition, I deferred to probability experts, including Dr. Cornell, when asked, "Do you have an opinion as to whether risks should be expressed on an annual basis or the total life of a facility?" Arabasz Dep. at 51-52. However, I beg to differ with Dr. Cornell's statement above and will elaborate.

Q. 15: Please elaborate on how considerations of seismic hazards in areas of public safety commonly take into account the exposure time and not just the annual probabilities (or frequencies) of occurrence.

A. 15: One of the well-established standards for portraying ground-shaking hazard in the United States is the suite of national seismic hazard maps published by the U.S. Geological Survey. "The hazard maps depict probabilistic ground motions and spectral response with 10%, 5%, and 2% probabilities of exceedance (PE) in 50 years." *National Seismic-Hazard Maps: Documentation June 1996, USGS Open-File Report 96-532* at 1. These maps provide reference ground motions for the International Building Code 2000. Dr. Cornell and I were co-members of a Review Panel for the USGS national maps in 1996.

Another well-established standard linked to building codes is the *NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures, 1997 Edition (FEMA 303)* ("Provisions"). The Commentary to the Provisions states:

> In past editions of the *Provisions*, seismic hazards around the nation were defined at a uniform 10 percent probability of exceedance in 50 years .... While this approach provided for a uniform likelihood throughout the nation that the design ground motion would not be exceeded, it did not provide for a uniform margin of failure for structures designed to that ground motion.... The approach adopted in these *Provisions* is intended to provide for a uniform margin against collapse at the design ground motion.... For most regions of the nation, the maximum considered earthquake ground motion is defined with a uniform likelihood of exceedance of 2 percent in 50 years (return period of about 2500 years.)

Provisions, Part 2—Commentary at 37.

The National Research Council's Panel on Seismic Hazard Analysis noted the following:

> [A]TC-3 (Applied Technology Council, 1978) has suggested the design seismic hazard level should have a 10 percent probability of exceedance in 50 years, which corresponds to an annual exceedance probability of about 2×10^{-3}.... The proposed Department of Defense tri-services seismic design provisions (Joint Departments of Army and Air Force, USA, 1985) suggests [sic] for category II facilities a dual level for the design seismic hazard. Such facilities should remain essentially elastic for seismic hazard with about a 50 percent probability of exceedance in 50 years or about a 1×10^{-2} annual exceedance probability and should not fail for a seismic hazard that has about a 10 percent probability of exceedance in 100 years . . ."

Panel on Seismic Hazard Analysis, *Probabilistic Seismic Hazard Analysis*, National Academy Press, Washington, D.C. (1988) at 31-32.

Procedures for estimating the probability of exceeding some level of ground motion during an exposure period of interest are commonly given for design guidance. For example, DOE-STD-1020-94 includes such a procedure at A-1, and Leon Reiter in his text, *Earthquake Hazard Analysis*, similarly includes such a procedure, including a graph from NUREG/CR-1582, 2 (1980), for relating return period, period of interest and desired

probabilities of exceedance during the period of interest. L. Reiter, *Earthquake Hazard Analysis*, Columbia University Press (1990) at 185.

The cited paper by Paté-Cornell does not convincingly establish as a norm for public safety that "hazards are measured as annual probabilities (or frequencies) of occurrence, regardless of the length of the activity in question, the exposure time, the estimated facility life, or the licensing duration." Cornell Dec. ¶49. First, in the context of noting that "current PRA [probabilistic risk analysis] methodology tends to focus on the technical causes of system failure" (while ignoring human and organizational factors), Paté-Cornell writes: "Classical technical PRA's tend to focus on the probability that an extreme value of the loads to which a system may be exposed (during a given year or lifetime) exceeds its capacity." Paté-Cornell paper at 148, footnote 4, underlining added. Second, while hardly a commentary on "virtually all areas of public safety," the paper reviews five precedents as examples of safety targets: (a) nuclear power plants in the U.S., (b) cancer risks in the U.S., (c) offshore oil and gas industry in Norway, (d) fatality accident rate in the U.K., and (e) the Dutch government standards. Significantly, cases (b) and (d) involve risk measured per individual or worker lifetime. In case (c) the Norwegian Petroleum Directorate temporarily adopted a severe-accident criterion in terms of an annual probability of major initiators of platform failure but "recently backed away from their severe-accident criterion . . . because this criterion was leading to a 'numbers game' that seemed to be distracting both the industry and the regulators from fundamental safety issues. . ." Id. at 150. Third, after discussing issues that have emerged in recent years in safety debate, Paté-Cornell proposes an approach to a global safety strategy, of which one element (of six) is that "it should be ensured that the *annual probability of catastrophic failure* (the severe accident criterion) is less than a specified threshold, e.g., 10^{-4} per year." Id. At 151. Fourth, the cited paper includes discussion of "time horizon" as a relevant risk factor, albeit in the context of shorter lifetime of aging facilities versus new ones.

Dr. Cornell attempts to bolster his argument by noting that "risk acceptance guidelines promulgated by the NRC" (for nuclear power plants) are in terms of annual risk for Core Damage Frequency and Large Early Release Frequency. Nevertheless, within a context of evolving regulatory guidance for ISFSIs, the Staff itself uses the metric of total probability of exceedance during a 20-year operational period to justify a DBE with a 2,000-year mean return period for dry-cask ISFSIs. Attachment to SECY–01-0178 at 7, included as State's Exhibit 128.

Finally, Dr. Cornell explains the reasons for focusing on annual risks in making safety decisions, in part, because "any facility providing a needed service will, at the end of its operating life, most likely be replaced by some other facility used for the same purposes with its own, similar risks." Cornell Dec. ¶49. While consideration of risk involving where spent fuel is now stored or may eventually be stored in the future at Yucca Mountain may be relevant for a societal global safety strategy (such as described in the Paté-Cornell paper), the issue at hand is a risk-acceptance decision specific to the PFS site.

Q. 16: Do you have anything further to add?

A. 16: In my testimony I have attempted to systematically address each of the subsections, within my scope of expertise and testimony, associated with unified contention Utah L/QQ, Section E. In my opinion, the key contested issue is the validity of PFS's claim that it has met the Commission's requirement to show that "the 2000-year design standard is sufficiently protective of public safety and property" as called for by the Commission in CLI-01-12. PFS's claim fundamentally rests on the proposition that sufficient protection "depends on both the probability of occurrence of the seismic event (often expressed as the mean annual probability of exceedence or "MAPE" of a given earthquake level) and the level of conservatism incorporated in the design procedures and criteria."[13] I agree with the proposition – but the latter critical part of PFS's claim of sufficient protection is challenged by the State's engineering and dynamic analyses experts, who dispute PFS assertions that it has demonstrated adequate conservatism in design of SSCs at the PFS facility. I defer to these experts for more complete discussion of their disputes, which go the heart of "appropriately conservative" and "sufficiently protective" design of the PFS facility. *See* Engineering and Dynamic Analyses Expert Testimony.

Q. 17: Does this conclude your testimony?

A. 17: Yes.

[13] PFS's Motion for Summary Disposition at 6.

ATTACHMENT 3b TO
STATE OF UTAH'S COMMENTS ON
PROPOSED RULE, 67 FED. REG. 47745 (2002)

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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

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

On May 17, 2002 the above-entitled matter came on for hearing, pursuant to notice, before:

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

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

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

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1 INDEX

2 EXAMINATION

6

EXHIBITS

7

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1 correct?

2 A. Correct.

3 Q. And you generally would agree that it's

4 appropriate to express potential earthquake hazards

5 as a mean annual probability of exceedance;

6 correct?

7 A. No.

8 Q. Well, isn't it true that the mean as

9 opposed to the median would capture more

10 uncertainty in the analysis?

11 A. That's true. If I could elaborate,

12 maybe I could speed up the process.

13 Q. Fine.

14 A. Here we have in the exemptions

15 "contest", the issue of median versus mean. And

16 the median, as we have heard in Dr. Cornell's

17 testimony and Dr. McCann's testimony, is embedded

18 in Reg Guide 1.165 as a reference probability, or

19 in this context or the context of Reg Guide 1.165,

20 how one would select the reference probability for

21 a new nuclear power plant. And so then we have the

22 train of reasoning as described in the paper by

23 Murphy and others, and I think probably most

24 lucidly explained in the Yucca Mountain Topical

25 Report 2, that the issue of the median versus the

1 mean and looking for a reference probability for
2 nuclear power plants. Murphy, the paper by Murphy
3 et al established that for a sample of nuclear
4 power plants in the Central and Eastern United
5 States specifically, that the median of the medians
6 for the annual exceedance probability of ten to the
7 minus fifth happened to be the same as the median
8 of the mean. In other words, if one went back to
9 those 29 nuclear power plants and recalculated
10 their annual exceedance probability compared to the
11 SSC that it originally had been determined by a
12 DSHA, the reference probability could be equally
13 stated as 1.10 to the minus five median or 1.10 to
14 the minus four mean.
15 Q. Now, just wholly apart from the context
16 of this case, isn't it true that expressing the
17 hazard as a mean annual probability of exceedance
18 as opposed to a median annual probability of
19 exceedance would capture, better capture the
20 uncertainty in the analysis; correct?

21 A. Would better capture the uncertainty?

22 Correct.

23 Q. And that's because the mean takes into

24 account the values that you may have for some

25 several large events and includes that in the

1 average, in essence; correct?

2 A. It better accounts for the outlyers,

3 yes.

4 Q. And generally, you would agree, apart

5 from the issues raised by Reg Guide 1.165 that the

6 use of a mean annual probability of exceedance

7 would be preferable to the use of a median annual

8 probability of exceedance. Is that correct?

9 A. With the qualification you stated,

10 that's correct.

11 Q. Now, I'd like to go on to the bases for

12 Section E, Bases 3, 4, and 5. Basis 3 concerns the

13 issuance with respect to Reg Guide 1.165. Basis 4

14 concerns questions you raised with respect to the

15 Staff's reliance on DOE Standard 1020-94. And

16 Basis 5 reflects issues you raised with respect to

17 Staff's reliance on the INEEL exemptions; correct?

18 A. Correct.

19 Q. And my understanding of the contention

20 itself and of your testimony in your declaration is

21 that these bases go to issues you have with the

22 logic that the Staff used in granting the

23 exemptions; correct?

24 A. Yes. If I could help by putting this in

25 context. In my testimony I used the phrase "moving

1 target", so that up to the motion for summary
2 disposition at the end of last year, I think it's
3 fair to say that the arguments for the exemptions
4 were chiefly based on Staff's reasoning. And with
5 the motion for summary disposition last fall,
6 following the deposition notably of Dr. Cornell, I
7 would say this is where PFS for the first time
8 introduced its rationale and framework for
9 justifying the exemption request for the 2000 year
10 return period.
11 So that now what has happened
12 historically, some of these bases have been carried
13 forward in the legal process from early stages. So
14 some of the criticisms arose with the Staff
15 justifications that were introduced in the
16 preliminary SER, in something like December, 1999;
17 then some of the Staff's rationale changed in the
18 next stage in the final SER, September a year
19 later; and then some of them changed again going
20 into the consolidated SER.

21 Two of the strands that stayed constant

22 were the reference reliance on DOE Standard 1020

23 and the PC-3 and the TMI, INEEL ISFSI exemptions.

24 That appeared sort of consistently through the SER.

25 But if I were to show you a road map and

1 the State, in fact, has an exhibit that could do
2 this, to say, "Okay. This is where the Staff has
3 gone with its reasoning to justify the 2000 year
4 bases starting here in September or December of
5 1999," and then the next step, and we put these
6 side by side and looked at them, then we could
7 quickly sort out where or at least I and the State
8 are taking an issue with what we think is the
9 Staff's flawed logic.
10 And elsewhere, where the Staff has, in
11 Dr. McCann's testimony, I think has taken or
12 there's clearly been evolution in this process of
13 policy thinking. And Dr. McCann referred to the
14 DOE arena as more mature in terms of establishing
15 standards that you can point to and say, "Okay,
16 let's make a decision based on this."
17 In this process, because the standards
18 or the reasons that the Staff is offering for
19 justifying the 2000 years, there are ad hoc
20 reasoning, there's inconsistency in places and

21 particularly as it relates to the DOE arena. The

22 fixation on a number, the 2000 years, without also

23 embracing the paradigm that requires a target

24 performance goal that is quantified, and the

25 reliance or this fundamental coupling, again, of

1 that number with the design side, the conservatisms
2 and acceptance criteria.
3 Q. So if I understand your answer, Bases 3
4 and 5 go to issues you have with the particular
5 justification of the logic the Staff may have
6 advanced with respect to the exemptions, not to the
7 technical adequacy of the 2000 year mean return
8 period earthquake itself in terms of whether that
9 earthquake is sufficiently protective of the public
10 health and interest.
11 A. First, let me refresh myself. I'm not
12 familiar with the Bases 3 and 5 by number. But
13 then the last part of your question -- I'm sorry.
14 I got distracted by refreshing myself with 3 and 5.
15 Something important in the last part of your
16 question, I know I had to be careful about agreeing
17 to.
18 Q. First of all, have you finished
19 refreshing yourself with respect to Bases 3, 4, and
20 5? Take your time doing that. Look at your

21 testimony where you briefly discuss them. I kind

22 of lumped those three together as kind of one

23 category.

24 MS. CHANCELLOR: Maybe it would help if

25 you referred to 3 as the Reg Guide. I think

1 Dr. Arabasz knows the concepts but he can't put
2 whether the INEEL is 5 or 6 or 4.
3 Q. Basis 3 is the Reg Guide issue.
4 A. The median versus the mean.
5 Q. Yes.
6 A. Got it.
7 Q. Basis 4 is DOE Standard 1020-94 and the
8 Staff's reference.
9 A. Got it.
10 Q. Basis 5 is the Staff's reference to the
11 INEEL exception. With that background, would you
12 please reread my previous question for Dr. Arabasz.
13 (Record was read as follows: "So if I
14 understand your answer, Bases 3 and 5 go to
15 issues you have with the particular
16 justification of the logic the Staff may have
17 advanced with respect to the exemptions, not to
18 the technical adequacy of the 2000 year mean
19 return period earthquake itself in terms of
20 whether that earthquake is sufficiently

21 protective of the public health and interest.")

22 A. My problem is, both with the logic, and

23 if I don't agree with the logic then I have

24 problems with the number. Because the number then,

25 as I have described, at least, and whether one

1 adopts the DOE paradigm or doesn't, then takes you
2 into this arena of decision-making or agreement
3 with the 2000 year number that's coupled with the
4 risk reduction ratio and the conservatism. So I
5 can't agree a priori with the 2000 number.
6 Q. With respect to the DOE paradigm, you
7 don't necessarily see -- first of all, with respect
8 to the DOE paradigm, you haven't done any analysis
9 yourself of the risk reduction factors that are a
10 part of the PFS facility?
11 A. On the design side, no. And again,
12 reaffirming this is where I have to pass off to the
13 engineers and rely on their judgment to continue
14 the train of logic.
15 Q. I understand. And I guess my question
16 was that the issues raised by Bases 3, 4, and 5,
17 don't go to the technical merit of whether we have
18 a certain level of conservatism in the design of
19 the PFSF such that it meets the target performance
20 goal or does not; isn't that correct? That's what

21 I was trying to drive at.

22 A. Correct. With you leading me by shaking

23 your head.

24 Q. I won't shake my head. Do you agree

25 with my last question?

1 Can you reread the question? I will
2 keep my head still.
3 (The record was read as follows: "And I
4 guess my question was that the issues raised by
5 Bases 3, 4, and 5, don't go to the technical
6 merit of whether we have a certain level of
7 conservatism in the design of the PFSF such
8 that it meets the target performance goal or
9 does not; isn't that correct? That's what I
10 was trying to drive at.")
11 A. Correct. My concern with the 2000 years
12 again would be is there sufficient conservatism on
13 the design side? And I'm not qualified on answer
14 that part of it.
15 Q. And Bases 3, 4, and 5 don't really
16 pertain to that part of it as you see the issue?
17 A. No. What they pertain to is a rational
18 approach to justifying, as a matter of sound
19 earthquake policy making, a number, namely a
20 standard of a 2000 year mean return period design

21 basis earthquake, both in the context, it seems to

22 me, of this facility and another facility as it

23 relates to the logic in the modified rulemaking

24 plan.

25 Q. Now, with respect to just the question

1 boundary would not apply to that plan; correct?
2 A. That's an outlyer in the statistics.
3 And it doesn't greatly affect the outcome in that
4 table in an analysis. But it is indicative with
5 its, I believe, what is it, a 26,000 year mean
6 return period? It is indicative of moving away from
7 the plate boundary or in that case clearly outside
8 of what anyone in the Intermountain area would
9 consider a seismic reactive area.
10 Q. Now, if you were going to do a risk-
11 graded approach, and you wanted to compare the -- a
12 risk-graded approach for ISFSI versus nuclear power
13 plants, and you wanted to compare what would be an
14 appropriate mean return period earthquake for a
15 place like the PFSF, it would be appropriate to
16 compare the mean return period earthquake for the
17 PFSF to an analogous return period earthquake for a
18 nuclear power plant.
19 A. I think I'm following your question,
20 yes.

21 Q. And I think, therefore, assuming like we

22 discussed that one times ten to the minus four was

23 the mean annual probability of exceedance for the

24 design basis of nuclear power plants, it would be

25 appropriate in applying the risk-graded approach in

1 determining the appropriate design basis for the
2 PFSF, to compare its mean return period design
3 basis earthquake to the equivalent to a mean annual
4 probability of exceedance of one times ten to the
5 minus four?
6 A. Correct.
7 Q. Now I'd like to turn to Basis 4 of the
8 contention which is the Staff's reference to DOE
9 Standard 1020-94. And if I understand your
10 testimony with respect to Basis 4 and what we have
11 discussed today, you don't disagree with the
12 1020-94 concept; correct?
13 A. I do not disagree with it. Correct.
14 Q. And your concern is that the Staff did
15 not fully implement what you believe to be the
16 1020-94 concept, or adopt it. Is that what you are
17 saying?
18 A. Correct. I believe the Staff
19 selectively chose a number out of this paradigm
20 without, again, embracing the total approach

21 involved.

22 Q. And if I understand the DOE paradigm as

23 we have been talking about is you have a design

24 basis earthquake and you have some margin in your

25 design such that you achieve a probability of

1 A. Could I explain what's in Basis 6 here?

2 Q. Certainly.

3 A. There's some historical perspective that

4 is important in terms of, again, a moving target

5 with the Staff's justification. And also, it

6 introduces another paradigm for decision-making

7 about acceptable risk; on the one hand an annual

8 probability, on the other hand the issue of a total

9 exceedance probability.

10 If you track me, you have to track the

11 Staff because they were the initiators of the

12 rationale put forward. So as you track me, you

13 track my response to their moving rationale. In

14 the preliminary SER, they introduced the comparison

15 to building codes. And unfortunately at the time,

16 they referred to an obsolete document, the 1994 UBC

17 which had been superseded by the UBC 2000. And

18 they also, in their argument, used the notion of a

19 total probability of exceedance, which required a

20 premise on the lifetime of the facility. And so

21 this is a thread that will carry through that comes

22 again back in the modified rulemaking plan, but the

23 Staff's reasoning of using a total probability of

24 exceedance for justifying the 2000 year.

25 In terms of the 2000 year now as it

1 relates to the IBC 2000, I think it has an
2 implication for sound policy making for justifying
3 a mean return period basis for ISFSIs in the larger
4 arena, given the move to the 2500 year return
5 period in the IBC 2000, which the broad engineering
6 community will be aware of, aware of the change in
7 the DOE Standard 1020 version 2002, which a broad
8 community will be certainly aware of.
9 And then the fixation on the 2000 year
10 number in NRC policy making sort of sticks out as a
11 sore thumb. It invites close inspection and
12 examination. It survives if, again, NRC policy
13 making embraces the rest of the DOE paradigm. On
14 its own as a 2000 year number, again, it invites
15 inspection and criticism.
16 Q. So basically you are saying that, like
17 you say in the Question and Answer 14, you can't
18 compare just the mean return period earthquake for
19 two facilities; correct?
20 A. In my testimony, when I address this,

21 let me look at --

22 Q. Page 13?

23 A. Yes. And going down to the second full

24 paragraph, left justified. "Granting that 'the

25 safety achieved depends on both the DBE MRP and the

1 design procedures and criteria utilized,"' then I
2 agree and have to defer to the engineering side,
3 mainly the State's engineering experts, to complete
4 the analogy with the PFS facility in terms of
5 adequate or sufficient protection. Adequate
6 conservatism.
7 Q. So again, this issue would not go to the
8 basic hypothetical we just asked you in terms of
9 assuming that Dr. Cornell is correct on the
10 conservatisms that he has enunciated in his
11 testimony, then we would have shown the seismic or
12 the achievement of a seismic performance level on
13 the order of that provided for by DOE 1020;
14 correct?
15 A. Correct.
16 MS. CHANCELLOR: I'm going to object.
17 Dr. Arabasz has stated that as far as conservatism
18 goes, he hands off to the State's expert. He said
19 this is a hypothetical with a capital H. Mr.
20 Gaukler keeps coming back to this and the record

21 shouldn't reflect that Dr. Arabasz agrees with

22 PFS's fundamental underlying argument that its

23 facility is conservative because his testimony

24 states he hands off to the other State's experts.

25 JUDGE FARRAR: Mr. Gaukler, it has

1 could with- stand that seismic loading.

2 JUDGE LAM: So your views of seismic

3 safety really are global in the sense that you

4 consider both the seismic requirement and standard

5 and the design margin of the facility being built.

6 THE WITNESS: Correct.

7 JUDGE LAM: And Dr. Arabasz, in your

8 Exhibit 124 and 120A, they talk about the latest

9 proposal making plans, soliciting comments on the

10 mean annual exceedance probability between the

11 range of five times ten to the minus four, and one

12 times ten to the minus four, which means in the

13 range of 2000 years to 10,000 year return period

14 earthquake. If you have not already done so, what

15 comments would you provide to the Commission?

16 THE WITNESS: In some of my testimony

17 earlier this morning I would raise the concern for

18 sound policy making that in one instance would

19 relate to clear visibility before the engineering

20 and design community and awareness that other

21 standards have advanced to a 2500 year number. And

22 my concern also that the regulatory framework

23 contain standards, guidance, against which this

24 2000 year number, if adopted, can be rationalized

25 rather than simply the selection of a number

1 without the accompanying framework for standards in
2 guidance, in this case notably the understanding
3 and agreement on a desired performance goal and
4 standards that one could go to, to insure the
5 appropriate conservatism accompanying that number
6 in design.
7 JUDGE LAM: Professor Arabasz, reading
8 your resume, I understand you are intimately
9 familiar with the seismic activity within the State
10 of Utah. Is that correct?
11 THE WITNESS: Correct. Well, I will be
12 modest. But I have lived in Utah since 1974 and it
13 has been a main stay of my job to be monitoring the
14 earthquake activity.
15 JUDGE LAM: With that background,
16 Professor Arabasz, may I ask you for a moment just
17 disregard whatever degree of conservatism built
18 into the design of this particular facility that we
19 are considering. Just disregard what the degree of
20 conservatisms, assuming you don't know that. And

21 with your intimate knowledge of the State of Utah

22 seismic activity, what would you consider an

23 appropriate level of requirement for the return

24 earthquake period?

25 THE WITNESS: I would base my answer on

1 an experience and understanding of the rate of
2 earthquake activity in the Intermountain area
3 compared to the plate boundary as a point of
4 reference; and also an understanding of the
5 difference in return period of large earthquakes on
6 the major active faults here in the Intermountain
7 area compared to those in California. And simply
8 put, the large active faults have relatively longer
9 return periods compared to faults in California.
10 So you want to insure a mean return period design
11 basis motion that will fit or give some assurance
12 that whatever you put on the landscape can survive
13 that expected motion from a larger-sized earthquake
14 rather than just accepting a number based on a
15 probability argument. Let's say 2000 years.
16 Q. So do you have a number for us, just an
17 expert guess? Now, of course you know the longer
18 the return period, the safer the standard is. One
19 has to balance without being excessively cautious
20 what you just said. Like for example, the State

21 has maintained that 2000 year is not adequate. And

22 furthermore, in one of the State's briefs, the

23 State says if the Board ruled against 10,000 year

24 requirement perhaps the Board would select and

25 decide a number somewhere between. That is why I'm

1 asking you this question. Do you have an opinion
2 if not 2000 year, what should it be?
3 THE WITNESS: I have been asked this
4 question before and I have been fairly guarded and
5 careful in my answer because I want to respect a
6 regulatory framework that can be rationalized. And
7 I cannot, having said that, pick a number separate
8 from the conservatisms on the right-hand side of
9 the equation so that if we are considering
10 unanchored casks at a PFSF and if we reach a
11 conclusion that given a design basis earthquake
12 there is a low risk reduction ratio or a
13 conditional probability that doesn't get me to a
14 performance goal adequately, then I am forced to
15 come up on the MAPE side higher than 2000 years.
16 Going back to your original question,
17 you are asking me for some kind of intuition about
18 geological behavior and trying to guess or give an
19 opinion regarding a mean return period relating to
20 the earthquake activity rate or the return period

21 of large earthquakes on the major active faults.

22 Here in the Salt Lake valley, the move to the 2500

23 year maximum considered earthquake in the building

24 code was very, very important, as Dr. Cornell

25 explained; because, were it along the plate

1 boundary, one on a time scale of hundreds of years,
2 one would experience the kind of seismic loading
3 you want to have some defense against.
4 Here in the Intermountain area, or
5 specifically in the Salt Lake valley, the average
6 return period of a large surface rupturing
7 earthquake on the part of the Wasatch fault here in
8 the Salt Lake valley is approximately 1400 years.
9 Or on average one to 2000 years. So then we have
10 an average rate and then you would use a Poisson
11 model to estimate what the likelihood of an event
12 of that size is within some period of
13 consideration.
14 When we move to Skull Valley, the return
15 periods become longer. The mean return period for
16 the Stansbury fault, we don't have great
17 information on -- we have a knowledge of a most
18 recent event perhaps on the order of 8000 years and
19 a prior event of 15,000 years or longer. We don't
20 have information to really understand that beast.

21 We know from the slip rate of the order of .4

22 millimeters per year plus or minus a millimeter a

23 year, excuse me, a tenth of a millimeter a year,

24 that that fault has been storing energy for at

25 least 8000 years and it's capable of delivering a

1 A. I do.

2 Q. Were you also here during the testimony

3 of Dr. McCann and Dr. Stamatakos as well as

4 Dr. Cornell in which they discussed the use of

5 median, of a median value in Regulatory Guide

6 1.165?

7 A. Yes, I was.

8 Q. And did you understand that the use of a

9 median value was selected in order to resolve the

10 difference between the EPRI and LLNL assessment

11 teams with respect to mean values?

12 A. I addressed this in my testimony, and

13 this is the famous median vs. mean controversy, and

14 I recall Dr. McCann testifying that his memory

15 differed from Dr. Cornell's in terms of how the

16 decision to proceed with the median occurred, as

17 best I can recollect. In other words,

18 understanding the issues relating to mean and

19 median, the Staff nevertheless proceeded to make

20 the median -- the reference probability in Nureg

21 Guide 1.165, and in my familiarity with this matter

22 that this is most lucidly explained in the Yucca

23 Mountain Topical Report 2.

24 Q. Would you agree that it's more

25 appropriate to use a mean annual probability of

1 exceedance rather than a median annual probability
2 of exceedance in establishing the seismic hazard
3 exceedance probability for a nuclear facility?
4 A. A man I respect once told me to file a
5 sentence in my mind and engrave it: "It all
6 depends." And we I think talked about this at
7 length in my testimony this morning with
8 Mr. Gaukler about the statistical preference of the
9 mean. However, if the context is regulatory
10 guidance, then we're back to the median in the Reg
11 Guide 1.165.
12 Q. In the Staff's SER and SER Supplement
13 No. 2 with respect to the PFS facility, the Staff
14 in fact uses a mean value, do they not?
15 A. That's correct.
16 Q. And you don't disagree with the choice
17 of a mean value rather than a median value in
18 establishing a ground motion design basis for the
19 PFS facility?
20 A. I take issue with that. That's one of

21 the bases that the Staff as they put forward their

22 reasons cite for the justification of the

23 equivalency of the 1x10-5 median for a nuclear

24 power plant, its equivalency to a 1x10-4 mean, and

25 they cite the disputed document by Murphy and

1 others, 1997. Unfortunately, they do not
2 explicitly acknowledge as other discussions of this
3 issue do that that equivalency is based on the
4 nuclear power plants in the central and eastern
5 United States.
6 Q. My question to you was, do you take
7 issue with the Staff's using a mean value in the
8 SER as opposed to a median value?
9 A. You said at the PFS site?
10 Q. Yes.
11 A. And yes, I --
12 MS. CHANCELLOR: I thought Dr. Arabasz
13 had just answered that question.
14 MR. TURK: I don't think he did, your
15 Honor.
16 JUDGE FARRAR: I don't think so. Go
17 ahead.
18 THE WITNESS: May I have the question
19 again, please, Mr. Turk?
20 (The record was read as follows: "My

21 question to you was, do you take issue with the

22 Staff's using a mean value in the SER as

23 opposed to a median value?")

24 THE WITNESS: The question, as I

25 understand it, I can interpret differently if we're

1 talking about the ultimate conclusion as opposed to
2 the logic that the Staff proposes for reaching that
3 conclusion.
4 Q. Excuse me. I'm not asking about the
5 logic, I'm asking if you take issue with the bottom
6 line that the Staff uses a mean annual probability
7 of exceedance value in the SER as opposed to using
8 a median value.
9 JUDGE FARRAR: You may answer that yes
10 or no, you can, and then you can go on and explain
11 why your answer.
12 A. Okay. I will agree with the bottom
13 line, because we reached that this morning in my
14 testimony with Mr. Gaukler.
15 Q. I'm sorry. And the bottom line is that
16 it is appropriate to use a mean annual exceedance
17 probability?
18 A. What I arrived at in my discussion with
19 Mr. Gaukler again was that I don't know what the
20 answer is, because there's an analysis yet to be

21 performed, a regulatory process yet to be

22 considered to reach that conclusion. However, I

23 agreed that at the end of that process it's likely

24 that the number would be approximately 1x10-4.

25 Q. I'm sorry. I don't think you're

1 understanding my question, or at least you're not
2 answering directly.
3 MS. CHANCELLOR: He's answered --
4 Q. (By Mr. Turk) I'm asking you -- I'm not
5 asking you about what number should be plugged in.
6 I'm only asking you, is it more appropriate to use
7 a mean value or a median value in assessing the
8 seismic hazard at the PFS facility.
9 JUDGE FARRAR: Well, you asked him if he
10 disagreed with the Staff.
11 MR. TURK: Okay.
12 THE WITNESS: That's how I understood
13 the question, your Honor.
14 JUDGE FARRAR: So the question is, do
15 you disagree with what the Staff did?
16 MR. TURK: Well, it's more specific,
17 your Honor. The question was, does he take issue
18 with the Staff's use of a mean value rather than
19 using a median value. I'm not asking about the
20 number that's input, I'm asking about the

21 description of a seismic hazard -- is it more

22 appropriate to be done using a mean value or a

23 median value.

24 JUDGE FARRAR: At the site.

25 MS. CHANCELLOR: Your Honor, object.

1 Mr. Turk asked the question, and you said that
2 Dr. Arabasz could give a yes answer; if he needed
3 to explain it, then he should do so. And that is
4 exactly what he did. He said the conclusion of a
5 mean may be correct, but he disagreed with the
6 Staff's rationale as to how they got to that mean
7 value. And that was the discussion that he had
8 that Mr. Turk felt like he didn't get just a yes
9 answer.
10 MR. TURK: The witness stated he agrees
11 with the bottom line, and I was merely looking to
12 put on the record what that means. And I think if
13 the witness listens to the question he can provide
14 whatever explanation he wants. But please listen
15 to the question.
16 MS. CHANCELLOR: Please let him answer.
17 JUDGE FARRAR: Let's start with a new
18 question. And on cross-examination counsel is
19 entitled to try to pin you down and you're entitled
20 to explain why -- to give a full explanation. But,

21 and we've said this before during the course of the

22 trial, it does help to give a direct answer and

23 then as full an explanation as you think is

24 warranted.

25 Is there a question pending?

1 MR. TURK: Why don't I ask a new
2 question.
3 JUDGE FARRAR: Right.
4 Q. (By Mr. Turk) Just to be sure that I
5 have an answer on the record, do you take issue
6 with the Staff's using a mean annual probability of
7 exceedance for the PFS facility in the SER in
8 Supplement 2 as opposed to using a median value for
9 the annual probability of exceedance?
10 A. Yes, I do, and I think this has been the
11 continuing thread in this issue of median versus
12 mean that the reference probability under Reg Guide
13 1.165 is specifically given as a median probability
14 of 1x10-5 with guidance about how one proceeds to
15 arrive at an alternative reference probability.
16 And because we are -- you framed your question
17 specifically with the PFS site, then the
18 equivalency with a 1x10-4 mean would not a priori
19 apply because we are not considering a site in the
20 central or eastern United States.

21 Q. Is it correct that nuclear power plants

22 in the central and eastern United States have a

23 mean annual probability of exceedance design basis

24 of approximately 1x10-4 on a mean annual

25 probability of exceedance basis?

ATTACHMENT 4a TO
STATE OF UTAH'S COMMENTS ON
PROPOSED RULE, 67 FED. REG. 47745 (2002)

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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

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

On May 17, 2002 the above-entitled matter came on for hearing, pursuant to notice, before:

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

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

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

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24

25

1 INDEX

2 EXAMINATION

6

EXHIBITS

7

19

20

21

22

23

24

25

1 A. I still can't hear you.

2 Q. DDD.

3 MS. NAKAHARA: I think it is FFF.

4 Q. Excuse me. FFF. If you look at page --

5 JUDGE FARRAR: Mr. Gaukler, let me

6 interrupt. While we are on this, we asked one of

7 the previous witnesses about the difference between

8 this area in the Rockies versus the tectonic plate.

9 And while we all understand what's going on at the

10 tectonic plate boundary, I think the way one of the

11 witnesses described it is there's an awful lot

12 going on inside or we wouldn't have the Rockies.

13 How does that relate to your previous answer?

14 Because you have been very careful to distinguish

15 the two. And intellectually we know why, but as a

16 practical matter, why do you do so?

17 THE WITNESS: I have reread the

18 transcripts from Saturday and Monday and you have

19 lots of information before you that relates to the

20 importance of steep hazard curves along the plate

21 boundary versus shallower hazard curves elsewhere.

22 So now we have the story of the five dollar

23 calculator and the calculation of those MRPs that

24 went along with those five power plants. And two

25 things are very, very important in my mind, and it

1 relates to seeking a reference probability for a
2 new nuclear power plant.
3 There's some logic, if one looks at the
4 PFS site, where one might have to consider what the
5 reference probability of a new nuclear power plant
6 at that site may be. We saw in this document,
7 Yucca Mountain Topical Report 2, that the DOE had a
8 job in front of it, namely it had to establish an
9 MAPE for Frequency Category 2 events that had been
10 introduced in the rulemaking for Part 60, saying,
11 "Okay, you have to consider these unlikely events."
12 And it seems to me what DOE did was say, "Okay, we
13 are going to select one times ten to the minus four
14 and we are going to justify in connection with a
15 reference probability for new nuclear power
16 plants." And they went through a train of logic
17 that led them to one times ten to the minus four.
18 They did not make that calculation of
19 the five nuclear power plants and say, "This gives
20 us enough justification for setting the reference

21 probability at a 5000 year earthquake at Yucca

22 Mountain as a benchmark." And the reason they did

23 not, I believe, is because there's something very

24 special about where those nuclear power plants

25 happen to lie, the steep hazard curves at those

1 sites as opposed to coming into the interior of the
2 Western United States, into the Intermountain area.
3 If you looked at that famous Exhibit R
4 or S, the steep hazard curves, ultimately
5 introduced as JJ, you would see for INEEL, for
6 Yucca Mountain, for Salt Lake City, for PFS,
7 shallow hazard curves that Dr. Cornell took great
8 time to instruct you on, comparing California,
9 those at Salt Lake City, and the important
10 implications that steep hazard curves in California
11 have vis-a-vis shallower ones in the Intermountain
12 area or the Central and Eastern United States in
13 terms of implications for risk reduction ratios.
14 Those five power plants are consistent
15 with DOE's Table C-3 where, for the DOE facilities
16 near the plate boundary again, Lawrence Livermore,
17 and so on, they could justify risk reduction ratios
18 of the order of 20 that allowed for PC-4 a MAPE of
19 5000 years instead of 10,000 years. And that key
20 piece of information tells me this is why, if you

21 go into the regulatory arena and attempt to set the

22 reference probability for a new nuclear power plant

23 in the Western United States, you would not end up

24 for the whole Western United States at 5000 years.

25 And I believe that if the Staff, indeed, as

1 Dr. McCann testified, associated 5000 years with
2 the design basis earthquake for a nuclear power
3 plant in the Western United States, I think they
4 are on shaky ground.
5 JUDGE LAM: So Professor Arabasz, are
6 you saying these averagings have no meaning; one
7 should not do the averages here?
8 THE WITNESS: One can do those meanings
9 but you have to observe that coincidentally where
10 those five nuclear power plants are, except for
11 Palo Verde west of Phoenix, which is the outlyer,
12 that they are along the plate boundary, they have
13 steep hazard curves, and they are consistent with
14 the DOE logic that says, you know, if you go to our
15 DOE sites, and I believe if you go to those four
16 nuclear power plants, you are going to find equally
17 steep hazard curves and you are going to be led to
18 or you can justify a different reference
19 probability than elsewhere in the country.
20 Q. (By Mr. Gaukler) Now, Dr. Arabasz --

21 any further questions from the Board?

22 Dr. Arabasz, I was going to focus you on

23 whether or not it's reasonable to say that,

24 approximately, the mean for nuclear power plants

25 nationally on a design basis -- strike that.

1 The mean annual probability of
2 exceedance for a nuclear power plant nationally is
3 approximately one times ten to the minus four. Not
4 making a distinction necessarily between the East
5 and the West.
6 A. Nationally, I don't have enough
7 information. The information I have is the
8 analysis from the Central and Eastern United States
9 plants. We have the information from the five
10 nuclear power plants that appear in the Yucca
11 Mountain Topical Report. And elsewhere, we don't
12 have any guidance.
13 Q. Doesn't the Yucca Mountain Topical
14 Report basically use as one times ten to the minus
15 four as an approximate average for the mean annual
16 probability of exceedance for nuclear power plants
17 generally?
18 A. At bottom, I think that's probably where
19 you would end up. Except for the plate boundary.
20 Q. And that would be a reasonable number to

21 expect generally as an approximate matter, for the

22 mean annual probability of exceedance for nuclear

23 power plants nationally?

24 MS. CHANCELLOR: Objection. Asked and

25 answered. Dr. Arabasz has explained the

1 distinction between the national one times ten to
2 the minus four and those on the western plate
3 boundaries.
4 JUDGE FARRAR: Have we covered this
5 sufficiently, Mr. Gaukler or is there something
6 more to extract here?
7 MR. GAUKLER: I think he has answered
8 the question. Let me ask one more time in
9 accordance with a similar answer in a deposition.
10 Q. (By Mr. Gaukler) Do you recall that
11 when I asked in your deposition whether using a
12 mean of one times either the minus four or
13 approximately represents all the nuclear power
14 plants in the United States, that your answer was,
15 "That's a reasonable judgment." And I can show you
16 the question and answer.
17 A. You don't need to. Sure. Let me agree
18 to what I said in my deposition.
19 Q. That that would be a reasonable
20 judgment?

21 A. Yes.

22 Q. Okay.

23 MS. CHANCELLOR: Dr. Arabasz shouldn't

24 agree just to move this along. I think he has

25 testified that there is a distinction, and he can

1 change his opinion from his deposition based on
2 further analysis and review. And I don't want him
3 to feel like he is forced to agree.
4 MR. GAUKLER: Let me mark this as an
5 exhibit.
6 JUDGE FARRAR: Dr. Arabasz, let me make
7 sure you understand the old Dale Carnegie thing
8 about winning friends and influencing people. You
9 are here to influence people, not necessarily to
10 win any friends. And we have been here for five or
11 six weeks and we want to get everything on the
12 record that you have on your mind. And so the fact
13 that you said something at your deposition, you may
14 agree that you said it but there's always an
15 opportunity to explain why your answer then was
16 incomplete or your answer may be reconsidered. In
17 other words, we don't like witnesses saying one
18 thing at one time and another at another time,
19 unless there is an explanation. And most times, in
20 scientific matters, there is. So the fact that you

21 said something once before doesn't mean that you

22 are locked into it if you have a different thought

23 process today. Everyone is anxious to hear that.

24 THE WITNESS: Thank you for that

25 guidance. I think I do have a different opinion

1 today than I did at the deposition. In fact, even
2 than I did last Saturday. It was a real epiphany
3 for me to make the connection between that footnote
4 in Table C-3 about the tectonic plate boundary and
5 the reference probability for a nuclear power
6 plant. And I sat probability, I'm ashamed to say,
7 inattentive to that one key piece of information
8 through the State's cross-examination on Monday,
9 and so on. And I think that this really is very,
10 very fundamental. We can look at that table of
11 five nuclear power plants and then we have to be
12 very careful before we make the leap that this
13 somehow is guiding the reference probability for
14 new nuclear power plants in the Western United
15 States.
16 JUDGE FARRAR: Okay.
17 JUDGE FARRAR: Mr. Gaukler, while we
18 were doing that, you handed out an exhibit you
19 wanted or document you wanted marked for
20 identification?

21 MR. GAUKLER: Yes.

22 JUDGE FARRAR: And this will be --

23 MR. GAUKLER: That's what I'm trying to

24 figure out. Off the record for a minute?

25 JUDGE FARRAR: I think it is 103.

1 MR. GAUKLER: Let's go off the record
2 for a second, your Honor.
3 JUDGE FARRAR: Okay.
4 (Discussion off the record and
5 EXHIBIT-102A WAS MARKED.)
6 JUDGE FARRAR: We are going to change
7 the marking system here in light of some exhibits
8 on another issue having been pre-marked by the
9 Applicant, even if not by the reporter. So we will
10 now, for future PFS exhibits today, adopt a suffix.
11 So this will be 102A. This is the excerpts from
12 the deposition of Dr. Arabasz and the court
13 reporter has already marked it as PFS 102A in
14 accordance with our off-the-record discussion.
15 Q. (By Mr. Gaukler) Dr. Arabasz, have you
16 had a chance to look at what's been marked as
17 Exhibit 102A?
18 A. I haven't been. I haven't read it
19 carefully. I'm just waiting for direction to look
20 at a particular comment.

21 Q. I was going to refer you to just the

22 question and answer on Page 71. And the other

23 stuff is all background leading up to it, where I

24 asked you, "So therefore, using a mean of 1E to the

25 minus four approximately represents all the nuclear

1 power plants in the Western, Eastern United
2 States?"
3 And you say, "That's a reasonable
4 judgment."
5 A. Could you point me again to a page and
6 line number?
7 Q. Page 71, lines 7 through 10.
8 A. Yes.
9 JUDGE FARRAR: If you need a minute to
10 read the earlier pages, why don't you do take.
11 A. I think following up on the line of
12 question that you put to me, in retrospect at that
13 time I did believe that that was a reasonable
14 judgment. And as I described to you with my
15 epiphany this past weekend, I just have changed my
16 opinion.
17 JUDGE FARRAR: Do you need to read the
18 earlier pages in anticipation of the next question?
19 Why don't you take a minute and refresh yourself.
20 A. I'm ready.

21 Q. Just a follow-up. If I understand the

22 issue --

23 JUDGE FARRAR: Hold on.

24 (Board confers off the record.)

25 JUDGE FARRAR: Go ahead, Mr. Gaukler.

1 Q. Just going back, if I understand
2 correctly, you read thought this in terms of the
3 western nuclear power plants which have a five
4 times ten to the minus four mean value for the mean
5 annual probability of exceedance; correct?
6 A. Correct.
7 Q. And that's with respect to because they
8 have relatively steep hazard curves; correct?
9 A. Yes.
10 MS. CHANCELLOR: Point of clarification.
11 When you say Western U.S. are you talking about the
12 plate boundaries or generically Western United
13 States?
14 MR. GAUKLER: I'm referring to the five
15 plants that were the basis of the average.
16 Q. (By Mr. Gaukler) So if you didn't have
17 the steep hazard curves, then it would be
18 reasonable to represent the nuclear power plants by
19 a mean of one times ten to the minus four, do you
20 believe?

21 A. I'm going to say yes, and let me explain

22 the basis of my saying yes. We have information

23 from the Central and Eastern United States. We

24 have information from the five plants along the

25 plate boundary. And I don't have information in

1 between. Based on the information, the education
2 that Dr. Cornell gave in this hearing regarding the
3 relative slopes of hazard curves in the Western
4 United States, outside of plate boundary and in the
5 Central and Eastern United States, at bottom I
6 believe that we would come to that one times ten to
7 the minus four number for the Western United States
8 outside of the plate boundary.
9 Q. Okay. And, therefore, for areas like
10 the PFSF you think that's what you would come to as
11 a bottom line for a reasonable representation for a
12 mean; correct?
13 A. Scientists always have to be careful
14 about what the answer is going to be, but I think
15 that is where we would end up.
16 Q. Okay. You mentioned that Palo Verde was
17 one of the five plants that was part of the
18 discussion last Saturday that was part of this
19 average of five times ten to the minus four?
20 A. Yes.

21 Q. And that's not on a plate boundary;

22 correct?

23 A. Correct.

24 Q. So that would be an exception to -- in

25 other words, your concern about being on a plate

1 boundary would not apply to that plan; correct?
2 A. That's an outlyer in the statistics.
3 And it doesn't greatly affect the outcome in that
4 table in an analysis. But it is indicative with
5 its, I believe, what is it, a 26,000 year mean
6 return period? It is indicative of moving away from
7 the plate boundary or in that case clearly outside
8 of what anyone in the Intermountain area would
9 consider a seismic reactive area.
10 Q. Now, if you were going to do a risk-
11 graded approach, and you wanted to compare the -- a
12 risk-graded approach for ISFSI versus nuclear power
13 plants, and you wanted to compare what would be an
14 appropriate mean return period earthquake for a
15 place like the PFSF, it would be appropriate to
16 compare the mean return period earthquake for the
17 PFSF to an analogous return period earthquake for a
18 nuclear power plant.
19 A. I think I'm following your question,
20 yes.
21 Q. And I think, therefore, assuming like we

22 discussed that one times ten to the minus four was

23 the mean annual probability of exceedance for the

24 design basis of nuclear power plants, it would be

25 appropriate in applying the risk-graded approach in

1 an experience and understanding of the rate of
2 earthquake activity in the Intermountain area
3 compared to the plate boundary as a point of
4 reference; and also an understanding of the
5 difference in return period of large earthquakes on
6 the major active faults here in the Intermountain
7 area compared to those in California. And simply
8 put, the large active faults have relatively longer
9 return periods compared to faults in California.
10 So you want to insure a mean return period design
11 basis motion that will fit or give some assurance
12 that whatever you put on the landscape can survive
13 that expected motion from a larger-sized earthquake
14 rather than just accepting a number based on a
15 probability argument. Let's say 2000 years.
16 Q. So do you have a number for us, just an
17 expert guess? Now, of course you know the longer
18 the return period, the safer the standard is. One
19 has to balance without being excessively cautious
20 what you just said. Like for example, the State

21 has maintained that 2000 year is not adequate. And

22 furthermore, in one of the State's briefs, the

23 State says if the Board ruled against 10,000 year

24 requirement perhaps the Board would select and

25 decide a number somewhere between. That is why I'm

1 asking you this question. Do you have an opinion
2 if not 2000 year, what should it be?
3 THE WITNESS: I have been asked this
4 question before and I have been fairly guarded and
5 careful in my answer because I want to respect a
6 regulatory framework that can be rationalized. And
7 I cannot, having said that, pick a number separate
8 from the conservatisms on the right-hand side of
9 the equation so that if we are considering
10 unanchored casks at a PFSF and if we reach a
11 conclusion that given a design basis earthquake
12 there is a low risk reduction ratio or a
13 conditional probability that doesn't get me to a
14 performance goal adequately, then I am forced to
15 come up on the MAPE side higher than 2000 years.
16 Going back to your original question,
17 you are asking me for some kind of intuition about
18 geological behavior and trying to guess or give an
19 opinion regarding a mean return period relating to
20 the earthquake activity rate or the return period

21 of large earthquakes on the major active faults.

22 Here in the Salt Lake valley, the move to the 2500

23 year maximum considered earthquake in the building

24 code was very, very important, as Dr. Cornell

25 explained; because, were it along the plate

1 A. Yes.

2 Q. Of 10,000 years. And where did you say

3 that was for?

4 A. For the central and eastern United

5 States.

6 Q. Is it a larger return period, in other

7 words, 15,000 or 20,000 years for the western

8 United States?

9 A. This was a subject of extended

10 questioning and testimony this morning, and the

11 line of my testimony indicated that we have a -- we

12 have information and a number in terms of an MAPE

13 for the central and eastern United States; we have

14 information and a number from Yucca Mountain

15 Topical Report No. 2 for a sample of five nuclear

16 power plants, four of which are along the western

17 North American plate boundary; and we also have

18 information in Yucca Mountain Topical Report No. 2

19 in terms of the reference probability that was

20 linked to frequency class 2 at Yucca Mountain.

21 Q. I haven't heard an answer to my

22 question. You were careful to indicate that the

23 10,000-year return period was for the central and

24 eastern United States. I then asked you, is there

25 a different return period for the western United

1 States. I have not heard an answer to that.

2 A. I think it's fair to characterize my

3 testimony this morning as saying that I don't know

4 what the number is for the western United States

5 outside of the plate boundary margin, but I agreed

6 with Mr. Gaukler, I believe, that it was reasonable

7 that the number likely would settle around 1x10-4

8 or 10,000 years MAPE.

9 Q. So your understanding is that with the

10 exception of nuclear power plants located on the

11 tectonic plate boundary of the west coast, the

12 10,000-year return period would be appropriate for

13 nuclear power plants in the western United States?

14 A. When we say "would be appropriate," this

15 is a tough question for me because I can only

16 imagine that such a determination would be made

17 based on an extensive process; and with the

18 information available to me and as presented in

19 this hearing, I am reaching the judgment that yes,

20 it probably would be, for the western United States

21 outside of the plate boundary, 1x10-4.

22 Q. And what plate are we talking about

23 here?

24 A. We're talking about the boundary between

25 the North American plate and the Pacific plate

1 passing through California and the Juan de Fuca
2 plate beneath the Pacific Northwest.
3 Q. How does the Juan de Fuca plate
4 correlate with the other two plates you mentioned?
5 A. There is a different type of plate
6 boundary along western North America. Through most
7 of the plate boundary course through California the
8 plates simply -- the plate on the left, on the
9 Pacific side, is moving in a horizontal direction
10 with respect to the North American plate. The
11 North American plate moving to the -- in a
12 southerly direction compared to the Pacific plate
13 moving in a northerly direction.
14 Beneath the Pacific Northwest --
15 Q. I'm sorry. Just for clarification,
16 you're saying the continental plate, the North
17 American plate is moving northward and the Pacific
18 plate is moving southward?
19 A. The other direction. If you looked
20 across the plate boundary there would be a

21 right-handed sense of displacement. The plate on

22 the other side would be moving to the right. So if

23 we were in California looking toward the Pacific,

24 the plate, the Pacific plate would be moving to the

25 right.

1 Q. Well, then you're saying the Pacific
2 plate is moving northerly.
3 A. I thought that was what I had said. If
4 I misspoke --
5 Q. No, just so I understand what you're
6 saying.
7 A. Yes.
8 Q. The Pacific plate is moving northerly,
9 and the North American plate, is that moving also,
10 or is it relatively standing and the Pacific plate
11 is moving?
12 A. We're into where one fixes the point of
13 reference in terms of relative motion on the globe.
14 Q. Well, let's pick San Onofre, for
15 instance. San Onofre is located somewhere at the
16 confluence of the North American plate and the
17 Pacific plate?
18 A. Correct.
19 Q. And what's happening there with respect
20 to plate movements?

21 A. My geography fails me in terms of which

22 side of the San Andreas fault the -- I'm assuming

23 that the San Onofre plate is on the west side of

24 the San Andreas fault, and it would be moving to

25 the right with respect to the North American plate.

1 Q. Assuming San Onofre is located on the
2 Pacific plate, then is it your opinion that San
3 Onofre is moving northward relative to the northern
4 American continent?
5 A. Correct.
6 Q. Okay. Let's take Diablo Canyon, then.
7 Is Diablo Canyon located at the confluence of these
8 two plates?
9 A. When we say confluence, it's somewhere
10 in the vicinity of the plate boundary. And to the
11 best of my understanding, Diablo Canyon also would
12 be on the Pacific side; but there is a complex
13 boundary. For example, the San Andreas Fault is
14 not the only part of the boundary, that we have the
15 Hosgri fault offshore that is part of the zone, the
16 wider zone of deformation.
17 Q. Well, come back to my question. Is the
18 confluence, in other words, the meeting up of the
19 Pacific plate and the North American plate, is that
20 happening in the vicinity of the Diablo Canyon

21 plant?

22 MS. CHANCELLOR: Your Honor, I'm not

23 sure where this line of questioning is going, being

24 able to pinpoint where two tectonic plates meet. I

25 haven't objected up till now, but it's just not

1 obvious that this is -- I don't want to say it
2 isn't relevant, but --
3 JUDGE FARRAR: It's certainly
4 interesting, but --
5 MR. TURK: It's most relevant, your
6 Honor, and I will make that clear.
7 JUDGE FARRAR: Then on that
8 representation, we'll overrule the objection.
9 THE WITNESS: Mr. Turk, could you define
10 confluence for me?
11 Q. (By Mr. Turk) Well, I'll let you
12 describe it any way you want. You indicated that
13 you believe the five nuclear power plants, I guess
14 with the exception of Palo Verde?
15 A. Correct.
16 Q. Listed in the topical report for Yucca
17 Mountain, you thought all those were located near
18 or were influenced by plate tectonics, correct?
19 A. That they had the common feature of a
20 steep hazard curve which was associated with their

21 location near a plate boundary.

22 Q. Okay. Now I'm asking, with respect to

23 Diablo Canyon, where is that in relation to a plate

24 boundary?

25 A. It is close to the plate boundary.

1 Q. How close?

2 A. I would say within tens of miles.

3 Q. Tens of miles being less than fifty?

4 Less than thirty? How many tens are we talking

5 about?

6 A. I don't know the precise location of

7 Diablo with respect to the San Andreas Fault.

8 Q. And by the way, Palo Verde you mentioned

9 is not near a plate boundary, correct?

10 A. Correct.

11 Q. Approximately how far away is Palo Verde

12 from a plate boundary?

13 A. I would guess something in the order of

14 one to two hundred miles.

15 MS. CHANCELLOR: I'd instruct the

16 witness not to guess.

17 JUDGE FARRAR: Where is it? Arizona

18 somewhere, isn't it?

19 THE WITNESS: It's west of Phoenix, and

20 I believe it's 36 miles west of Phoenix. Something

21 of that that order.

22 Q. (By Mr. Turk) And the fact that it's

23 located that distance and far away from a plate

24 boundary was the reason why you think that's not

25 one of the plate tectonic affected sites listed in

1 the table, correct?

2 A. Correct, that its seismic hazard curve

3 is not influenced by proximity to large faults with

4 high maximum magnitudes and to a rate of seismic

5 activity that would result in a hazard curve being

6 steep as in most of California, and particularly

7 those California sites close to the plate boundary.

8 Q. You mentioned the San Juan de Fuca

9 plate.

10 A. The Juan de Fuca.

11 Q. Juan de Fuca?

12 A. J-u-a-n, d-e, F-u-c-a.

13 Q. Now, how does that interface with the

14 other two plates we've been talking about?

15 A. There is a geological feature called a

16 triple point located in offshore northern

17 California with the intersection with the Gorda

18 Ridge. And this triple point allows relative

19 motion between three plates to be accommodated in a

20 fashion where horizontal motion, as along the

21 famous San Andreas Fault where the displacement is

22 in a horizontal direction, crossing farther

23 northward across the triple point boundary the

24 motion is transformed such that the motion of the

25 Pacific side plate, or in this case the Juan de

1 Fuca plate as it interact with the North American
2 plate is a convergent motion where the Juan de Fuca
3 plate slipped out so it pushes its way underneath
4 the North American continent, giving rise to the
5 Cascade Range and volcanic activity in the Pacific
6 Northwest.
7 Q. And is that located somewhere near
8 Seattle?
9 A. In the case of a convergent plate
10 boundary the zone of interaction between the two
11 plates is broader, whereas in California the locus
12 of displacement between the two plates is, in a
13 simple-minded way, along the line, namely the San
14 Andreas Fault, and the Pacific Northwest the zone
15 of interaction between the two plates is broader
16 because of this inclined geometry.
17 Q. And by inclined geometry you mean the
18 fact that the Juan de Fuca plate is pushing
19 underneath the North American continent plate?
20 A. Correct. And so there is an interface

21 between the two plates that is broader because of

22 this inclined geometry than the interface along the

23 San Andreas Fault.

24 Q. And do you have an estimate for how

25 large that zone of interaction is? Are we talking

1 again in terms of maybe tens of miles?

2 A. Several tens of miles to more than a

3 hundred.

4 Q. And when you say more than a hundred,

5 you mean much more than a hundred, or is that

6 pretty much the upper limit?

7 A. No, I would not choose 100 as an upper

8 limit. The issue technically would relate to the

9 geometry of the plate interface along which there

10 is seismogenic, or in essence frictional contact

11 between the two plates as opposed to the

12 deformation that is induced in the overriding North

13 American plate. For example, the Cascade Range

14 clearly is a product of that deformation.

15 Q. Where does the North American plate end?

16 If we're looking at the Pacific Northwest, what's

17 the furthest reach of the North American plate

18 relative to some place on the ground? Is it under

19 the ocean? Is it under land?

20 A. Alaska would be part of the North

21 American plate.

22 JUDGE FARRAR: Mr. Turk, I hate to

23 interrupt, but a lot of this --

24 MR. TURK: It's coming.

25 JUDGE FARRAR: -- we can almost take

1 judicial notice of.

2 MR. TURK: Well, if you'll allow me a

3 bit more, your Honor.

4 JUDGE FARRAR: Go ahead.

5 Q. (By Mr. Turk) In the state of

6 Washington where does the North American plate edge

7 or boundary exist?

8 A. At the surface offshore with basically

9 an oceanic trench. The point at which the Juan de

10 Fuca plate begins its dive under the North American

11 continent is west of the Washington coast offshore.

12 Q. And approximately how far west of the

13 Washington coast?

14 A. I could only guess.

15 MS. CHANCELLOR: Instruct the witness

16 not to guess.

17 Q. (By Mr. Turk) I don't want your guess,

18 either. Have you ever seen a map of where that

19 plate boundary is?

20 A. Yes, I've seen maps many times. I have

21 not paid particular attention in terms of scaling.

22 Q. Well, it's not right next to the coast,

23 correct?

24 A. No.

25 Q. Would you agree that it's more than ten

1 miles off coast?

2 A. Yes.

3 Q. Can you give any better bounds to that?

4 For instance, is it more than a hundred miles off

5 course?

6 MS. CHANCELLOR: Objection, your Honor.

7 Dr. Arabasz has testified that --

8 MR. TURK: It's quite relevant, your

9 Honor.

10 JUDGE FARRAR: I understand, but the

11 problem is -- my colleagues know a lot more about

12 this than I do, but I even know about this. If

13 you're trying to get him to say the PFS site is not

14 influenced by being near tectonic plate boundaries,

15 we know that.

16 MR. TURK: I'm not going there.

17 JUDGE FARRAR: Then I am very intrigued,

18 so keep going. Off the record.

19 (Discussion off the record.)

20 JUDGE FARRAR: Say that again.

21 MR. TURK: I'm sorry?

22 JUDGE FARRAR: Say that again. That you

23 don't do this all the time. And Ms. Chancellor,

24 Mr. Turk has not shown a proclivity to waste the

25 Board's time in the future, so when he says --

1 sorry, in the past. So when he makes a
2 representation that it's going somewhere, we give
3 him some leeway to demonstrate that.
4 MR. TURK: Thank you.
5 THE WITNESS: Is there a question
6 pending?
7 Q. (By Mr. Turk) Yes. The question was,
8 you had indicated you've seen maps of the tectonic
9 plates, you indicated you know that the Juan de
10 Fuca begins its dive under the North American plate
11 more than ten miles away from the coast of
12 Washington, and I was asking you, is it on the
13 order of a hundred miles away? Can you tell me
14 that? What's your best estimate based on your
15 having looked at maps and your experience as a
16 seismologist?
17 MS. CHANCELLOR: Does Mr. Turk have a
18 map he can show Dr. Arabasz?
19 MR. TURK: Unfortunately, I tried to get
20 one and I was not able to over the lunch hour.

21 JUDGE FARRAR: And I take it, Mr. Turk,

22 that this is an order of magnitude miles we're

23 talking about?

24 MR. TURK: Yes.

25 JUDGE FARRAR: So --

1 THE WITNESS: I would make an estimate
2 that it's less than a hundred miles.
3 Q. (By Mr. Turk) And you mentioned that
4 there were five plants listed on that table in the
5 Yucca Mountain Topical Report. Do you remember
6 what those plants were?
7 A. San Onofre, Diablo Canyon, Palo Verde,
8 Washington Nuclear Power Plant 2, I believe that
9 was the designation, and Washington Nuclear Power
10 Plant 3. Washington Nuclear Power Plant 2, if I
11 remember correctly, located near Satsop; Washington
12 Nuclear Power Plant 3 located northwest of Richland
13 along the Columbia River; Palo Verde located
14 approximately 30 miles west of Phoenix; San Onofre
15 located east of San Clemente; and Diablo Canyon
16 located west of San Luis Obispo, California.
17 Q. Washington No. 2 you said is located
18 near Satsop, Washington?
19 A. If I have the numbers 2 and 3 correctly
20 memorized, yes. Or it may be vice versa if my

21 memory's failed me.

22 Q. If I suggested to you that No. 3 is

23 located near Satsop rather than No. 2, you wouldn't

24 quarrel with that? It's one or the other, but --

25 A. It's one or the other.

1 Q. And Satsop is located approximately how
2 far away from the Washington coast?
3 A. I would guess within 50 miles of the
4 Washington coast.
5 Q. That's a guess?
6 MS. CHANCELLOR: He said he estimated, I
7 believe. Objection.
8 Q. (By Mr. Turk) Was it a guess or an
9 estimate?
10 A. Estimate.
11 Q. And Richland, Washington. That's where
12 the other Washington nuclear power plant is located
13 that was listed in the Topical Report?
14 A. That's correct.
15 Q. How far is Richland from the coast?
16 A. I would estimate in the range of two to
17 three hundred miles.
18 Q. You recognize, then, that the Richland
19 location is not close to where the San Juan de Fuca
20 plate interacts with the North American continent

21 plate, correct?

22 A. Correct.

23 Q. Nor is it close to where the Pacific

24 plate interacts with the North American plate,

25 correct?

1 A. I'll quibble with "interaction,"
2 because --
3 Q. Well, let's talk about location. Is
4 Richland, Washington located close to where those
5 two plates interface?
6 MS. CHANCELLOR: Objection, your Honor.
7 Mr. Turk is trying to get Dr. Arabasz to talk about
8 location without -- without the underlying seismic
9 activity that's going on, and when he tried to
10 explain it Mr. Turk was forcing him to talk about a
11 geographic distance as opposed to the influence of
12 plate tectonics.
13 JUDGE FARRAR: We'll overrule the
14 objection. But Mr. Turk, we've got to get to this
15 point you're --
16 MR. TURK: We're just about at the end .
17 JUDGE FARRAR: Okay.
18 THE WITNESS: Question again, please?
19 MR. TURK: Could you read back the
20 question, please?

21 And your Honor, I have to inform you I

22 may not be able to finish today. I may have to

23 continue into the next period.

24 JUDGE FARRAR: Then -- I'll withhold

25 comment. Let's get see where we're --

1 MS. CHANCELLOR: So will I.

2 JUDGE FARRAR: Let's see where this

3 goes.

4 (The record was read as follows: "Well,

5 let's talk about location. Is Richland,

6 Washington located close to where those two

7 plates interface?")

8 JUDGE FARRAR: What we need to -- we

9 need to be sure we're talking about where the

10 plates meet as opposed to where there may be

11 action, tectonic action resulting, maybe in some

12 distance resulting from -- okay, so let's use the

13 word where they -- well, I guess interface is okay

14 for that purpose.

15 A. I would estimate something in the order

16 of a hundred miles.

17 Q. I'm sorry. What's a hundred miles?

18 A. The distance from Richland, Washington

19 to the zone of interface between the Juan de Fuca

20 plate and the North American plate.

21 Q. You indicated that Richland is located

22 approximately two hundred to three hundred miles

23 away from the North American plate boundary,

24 correct?

25 A. Correct, with the plate then subducting

1 beneath the Pacific Northwest.

2 Q. Which plate is subducting?

3 A. The Juan de Fuca plate.

4 Q. And is it your belief that the Juan de

5 Fuca plate influence, that that subduction

6 influence extends two hundred to three hundred

7 miles to the east towards -- to where Richland,

8 Washington is located?

9 A. In the general scheme, yes. Richland

10 obviously on the east side of the Cascades. The

11 Cascade Mountain range is there because of the

12 plate interaction between the Juan de Fuca plate

13 and the North American plate.

14 Q. And approximately how far to the east of

15 those mountains is Richland, Washington? Do you

16 know?

17 A. I would estimate within approximately 50

18 miles.

19 Q. That's your best estimate?

20 A. Yes.

21 Q. So is it your opinion that the Richland

22 site's hazard, its seismic hazard is influenced

23 significantly by the Juan de Fuca plate subduction

24 under the North American plate?

25 A. I can't answer that question without

1 looking at the hazard curve and an understanding of
2 what is driving the hazard at the Richland site.
3 Q. There may be other faults or earthquake
4 sources there that could influence the seismic
5 hazard at the Richland site?
6 A. Yes, there could be.
7 Q. But you don't know whether the seismic
8 hazard there is influenced more by those sources or
9 by the subduction of the Juan de Fuca plate?
10 A. I don't. I infer that, given the mean
11 annual probability of exceedance as calculated in
12 that table, that the seismic hazard curve is steep.
13 Q. But you don't know what causes that
14 curve to be steep?
15 A. No, I do not.
16 Q. You don't know whether the seismic
17 hazard curve's steepness is caused because of any
18 location close to plate boundaries, do you?
19 A. I infer that.
20 Q. But it would be possible to infer to the

21 contrary also, right, that there is some other

22 fault located nearby that's responsible for having

23 the greatest influence on that seismic hazard

24 curve's steepness, correct?

25 A. Correct.

1 MS. CHANCELLOR: Objection, your Honor.
2 Dr. Arabasz said that he would need to look at a
3 seismic hazard curve to determine what actually
4 influences the hazards at the Richland site. This
5 is getting pretty abstract.
6 JUDGE FARRAR: Can you answer the
7 question without that sort of documentation to look
8 at?
9 THE WITNESS: May I ask the question be
10 repeated, please?
11 MR. TURK: Could you read the question
12 back, please?
13 (The record was read as follows: "But it
14 would be possible to infer to the contrary
15 also, right, that there is some other fault
16 located nearby that's responsible for having
17 the greatest influence on that seismic hazard
18 curve's steepness, correct?")
19 THE WITNESS: Correct.
20 Q. (By Mr. Turk) In other words, there may

21 well be another dominant pair, if you will, in

22 terms of magnitude and location of earthquake -- of

23 a fault that will be responsible for the steepness

24 of the curve for that facility, the Washington No.

25 2 facility, correct?

1 A. Correct. And what I would end up with
2 is the attaching importance to the steepness of the
3 hazard curve more so than the label affixed in the
4 DOE table that characterizes or that relates to
5 sites near a plate boundary.
6 Q. In fact, you indicated you had an
7 epiphany, I believe that was your word, when you
8 looked at the table in that Yucca Mountain Topical
9 Report and you saw five nuclear power plants listed
10 there, and you suddenly came to the realization
11 that those plants were located near the plate
12 boundary. That's what you had concluded, correct?
13 A. That, and that there was something
14 particular about them, their steep hazard curves
15 other than Palo Verde.
16 Q. Well, isn't it true now that you're not
17 sure whether -- in fact, maybe only three of those
18 power plants can be located close to the plate
19 tectonic boundaries that would be influenced by
20 them, even if there's maybe some other seismic

21 source responsible for the shape of the curve for

22 Hanford No. 2, correct?

23 A. Yes.

24 Q. In which case your conclusion that the

25 5,000-year return period mean, or that the mean,

1 the annual probability of exceedance for those
2 nuclear power plants being 5,000 years may not be
3 due to plate tectonics at all but may be due to
4 plate tectonics and some other factors, correct?
5 A. For two of the -- excuse me. From the
6 sample of five I will allow that Palo Verde is a
7 outlier and does not fall in the category of being
8 influenced by its proximity to the plate boundary.
9 The Satsop site I will allow either conclusion.
10 Q. Satsop or Richland?
11 A. Excuse me, Richland.
12 Q. Would you allow the same conclusion for
13 Satsop?
14 A. No.
15 Q. So it's just two out of five that you
16 would recognize may not be plate tectonic -- may
17 not reflect plate tectonic effects?
18 A. I'm uncertain about Richland, so we have
19 that arithmetic.
20 Q. I'd like to come back to a question that

21 I started with, and that was whether you were

22 familiar with the radiological risks imposed by

23 different nuclear facilities, and you indicated

24 you're not familiar with the -- I'm sorry -- you do

25 not consider the radiological risk of an ISFSI. Do

1 you know what is the radiological risk of a nuclear
2 power plant? Do you know anything about the
3 radioactive contents of a nuclear power plant
4 reactor?
5 A. It's one of those things that I just
6 don't want to know, but to answer your question
7 directly, no.
8 Q. Do you know anything about the pressures
9 under which a nuclear power plant operates?
10 A. I can't quantify it, no.
11 Q. Well, do you know anything about it at
12 all?
13 A. Yes, I know something, and I say that
14 because I've been interrogated by probability
15 experts before and they will always insist that I
16 have -- I know something. And I know that there
17 are driving pressures and temperatures that are
18 described to be a cause of a diffusion of
19 radioactivity, and correspondingly, reportedly the
20 lack of such driving forces for pressure and

21 temperature for an ISFSI.

22 Q. You say reportedly that those driving

23 pressures and temperatures don't exist for an

24 ISFSI. Do you know one way or the other?

25 A. I say reportedly because my information