RAS 5779 72-22-ISFSI -Staff Exhibit MM-Rec'd 6/5/02

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
	)	December 6, 2001

DECLARATION OF DR. WALTER J. ARABASZ

I, Dr. Walter J. Arabasz, declare under penalty of perjury and pursuant to 28 U.S.C. § 1746, that:

1. 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. An updated version of my *curriculum vitae* is attached hereto as Attachment A.

2. I was designated one of the State's testifying experts with respect to Contention Utah L, Basis 2, on June 28, 1999. I have reviewed the Applicant's SAR sections,

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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. I have participated in answering the Applicant's discovery to the State as well as assisted in the preparation of discovery for the State directed to the Applicant. I am also familiar with NRC regulations, Rulemaking Plan to amend Part 72, guidance documents, the methodologies for earthquake hazard evaluation and new developments pertaining to the latter.

3. I have reviewed the NRC Staff's preliminary and final Safety Evaluation Report ("SER") for the PFS facility, dated December 15, 1999 and September 29, 2000 respectively, as well as the Staff's Position on Utah L (April 28, 2000).

4. I assisted in the preparation of the State of Utah's Request for Admission of Late-Filed Modification to Basis 2 of Utah Contention L, filed on January 26, 2000 and the State's November 9, 2000 Request for Admission of Late-filed Modification to Basis 2 of Utah Contention L.

5. I was deposed by Private Fuel Storage ("PFS") on October 31, 2001. I was present at the State's deposition of PFS's witness on the appropriateness of using probabilistic seismic hazard methodology, Dr. C. Allin Cornell, held on October 31 and November 1, 2001.

6. I have reviewed relevant portions of PFS's Motion for Summary Disposition of Part B of Utah Contention L (November 9, 2001), with primary attention to PFS's Motion, its Statement of Material Facts on Which No Genuine Dispute Exists, and the attached declaration of Dr. C. Allin Cornell. I provide this declaration in support of the State's Response and Opposition to Applicant's Motion for Summary Disposition of Part B of Utah Contention L (December 7, 2001).

7. I first became involved in providing technical expertise to the State of Utah regarding seismic hazards at the PFS facility in August 1998. Arabasz Tr. at 124-125. 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 Applicant'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 Safety Evaluation Report ("PSER") (December 15, 1999) at 2-44 to 2-45; (4) Staff's finding the PSHA with a 2,000-year return period acceptable (Staff's Final Safety Evaluation Report ("FSER) (September 29, 2000)) at 2-41 to 2- 42); and (5) PFS's Motion for Summary Disposition of Part B of Utah Contention L (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").

8. I will proceed to frame the remainder of my declaration 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 Contention Utah L, Part B, as set forth in the Board's Order dated June 15, 2001. *See also* PFS's Summary Disposition Motion at 1-3. In my remarks 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. Deterministic Seismic Hazard Analysis

9. 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. *See e.g.*, State of Utah's Objections and Response to Applicant's Second Set of Discovery Requests With Respect to Groups II and III Contentions at 33-38 (June 28, 1999). 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." 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. (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. *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.

II. Bases of Contention Utah L, Part B, as Admitted

10. Basis 1 of Contention Utah L, Part B, 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).

Board's Order of June 15, 2001 at 2.

My scope of testimony with respect to Basis 1 excludes radiological dose consequences. Arabasz Tr. at 29. Basis 2, which also deals with radiological dose limits, is similarly outside my scope of testimony. Id. 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. 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. 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 (June 14, 2001) 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.

11. PFS argues, in part, in its Motion for Summary Disposition (at 10) 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. SECY-01-0178 (September 26, 2001). Whether the latter indeed moots the issue is questionable in light of the Commission's recent issuance of Staff Requirements relating to SECY-01-0178, wherein the Commission writes:

> 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.

Memorandum to William D. Travers dated November 19, 2001.

12. The key contested issue linked to Basis 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." PFS's Motion for Summary Disposition at 10. 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." PFS's Motion for Summary Disposition at 6. I agree with the proposition – but the latter critical part of PFS's claim of sufficient protection is challenged by the State's engineering 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 declaration, 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* Joint Declaration of Dr. Steven F. Bartlett, Dr. Mohsin R. Khan, and Dr. Farhang Ostadan ("Utah Joint Declaration").

13. Basis 3 of Contention Utah L, Part B, 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 probabipities for exceeding an SSE for central and eastern United States power reactors and the median and mean probabilities for exceeding an

SSE for the PFS facility.

Board's Order of June 15, 2001 at 2.

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. Request for Modification of Utah L (November 9, 2000) at 7. Basis 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}. *See* Request for Modification of Utah L (November 9, 2000) at 8-10.

14. PFS's witness, Dr. Cornell, challenges 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 "could 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.

15. 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 . . ." (Id. ¶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

> 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* Exhibit 3 in PFS's Motion for Summary Disposition at pages 2-3 of 7.

16. From the above, 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: "The 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.

17. Basis 4 of Contention Utah L, Part B, 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.

Board's Order of June 15, 2001 at 3.

The Staff's reliance on DOE-STD-1020-94 in its December 1999 PSER and its September 2000 FSER 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.

18. 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 conservatism 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 faciltities 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.

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.

20. A final point of particular relevance to Basis 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, attached to Utah Joint Declaration as Att. D.

21. Basis 5 of Contention Utah L, Part B, states:

> In supporting the grant of the exemption based on the 2000-year return period, the staff relies upon the 1998 exemption granted to DOE for the Idaho National and Environmental Engineering 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.

Board's Order of June 15, 2001 at 3.

22. 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. *See* State of Utah's Objections and Responses to Applicant's Seventh Set of Formal Discovery Requests to Intervenor State of Utah (September 28, 2001) at 16-1. *See also* Request for Modification of Utah L at Exhibit 1 (November 9, 2000); Deposition of Walter J. Arabasz (October 31, 2001) at 14-18, 42-43, 84-89; and State of Utah's Objections and Response to Staff's First Set of Formal Discovery Requests to State of Utah (November 5, 2001), Answer to Interrogatory No. 1 at 10-11.

23. 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. 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) at 4-1. 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. Id. 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 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.

Id. at 4-2.

24. 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 provide 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. 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.

25. 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.

26. 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.

27. Basis 6 of Contention Utah L, Part B, states:

> 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.

Board's Order of June 15, 2001 at 3.

28. 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 to be 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 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 criterion utilized" (id.), the contested issue once again becomes the conservatism (or non-conservatism) in design of SSCs at the PFS facility. As in ¶12 above, I defer the latter issue to the State's engineering 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* Utah Joint Declaration.

29. Part (b) of Basis 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.

30. PFS's witness, Dr. Cornell, attacks Basis 6(b) 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.

31. 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.

32. Another well-established standard linked to building codes are 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.

33. 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 x 10^{-3}. . . . The proposed Department of Defense tri-services seismic design provisions (Joint Departments of Army and Air Force, USA, 1985) suggests 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 x 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).

34. 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.

35. 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.

36. 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.

37. 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 the PFS site.

38. In this declaration I have attempted to systematically address each of the bases, within my scope of expertise and testimony, associated with Contention Utah L, Part B. 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." PFS's Motion for Summary Disposition at 6. I agree with the proposition – but the latter critical part of PFS's claim of sufficient protection is challenged by the State's engineering 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* Utah Joint Declaration.

Dr. Walter J. Arabasz

December 6, 2001

NUCLEAR REGULATORY COMMISSION

Docket No. _____ Official Exh. No. MM

In the matter of _____

Staff	✓	IDENTIFIED	✓
Applicant		RECEIVED	✓
Intervenor		REJECTED	
Other		WITHDRAWN	
DATE	6/5/02	Witness	ARABASZ
Clerk	L. Shinderling		