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NUCLEAR REGULATORY COMMISSION

Title: Private Fuel Storage, LLC

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

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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

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

June 24, 2002

The above-entitled matter came on for hearing, pursuant to notice, at 10:00 a.m. before:

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

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

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

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

E X H I B I T S

NUMBER	DESCRIPTION	MARK	RECD
STAFF			
V	HI-STORM FSAR	12161	12163
W	HI-STORM 100 overpack	12165	12168
X	PFSF General Agreement Revision 21	12168	12170
53	NUREG 1567	12173	12220
54	Statement of Consideration	12209	
55	Reg. Guide 360	12225	12226
56	Reg. Guide 360 1984	12227	12231
57	Reg. Guide 360 1992	12227	12231
58	NUREG 1536	12231	12235

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

(10:03 a.m.)

CHAIRMAN FARRAR: Good morning everyone. We're ready to begin a new sub-issue, having finished a couple of others last week. I see many of the usual suspects, but a couple of new faces. Ms. Chancellor, you --

MS. CHANCELLOR: Yes. On my left is Diane Curran, Attorney, representing the State of Utah who is actually located here in Washington, D.C. On my right, Dr. Marvin Resnikoff, who will be a witness for the State on radiation doses. And, of course, Mr. Braxton is here, the usual support.

CHAIRMAN FARRAR: Okay. And Mr. Turk, with you?

MR. TURK: Good morning, Your Honors. To my left is Mr. Michael Waters who will be the Staff witness on radiation doses. Mr. O'Neill, you know already.

CHAIRMAN FARRAR: Okay. Then are there any preliminary matters, Mr. Gaukler?

MR. GAUKLER: None, Your Honor.

CHAIRMAN FARRAR: All right.

MR. GAUKLER: I've handed out the testimony of Dr. Singh, Dr. Soler and Dr. Redmond, and

given three copies to the court reporter.

CHAIRMAN FARRAR: Okay. Dr. Singh, Dr. Soler, good to see you again. Hope the feeling is mutual. You've previously been sworn, so please consider yourselves still under oath. And is it Mr. or Dr."

DR. REDMOND: Dr.

CHAIRMAN FARRAR: Dr. Redmond, would you stand to be sworn, please. Raise your right hand. Whereupon,

EVERETT L. REDMOND

was called as a witness and, having been first duly sworn, was examined and testified as follows:

CHAIRMAN FARRAR: Thank you. Go ahead, Mr. Gaukler.

DIRECT EXAMINATION

MR. GAUKLER: Dr. Singh, Dr. Soler, and Dr. Redmond, do you have in front of you a copy of testimony of Krishna P. Singh, and Alan I. Soler and Everett L. Redmond, II, on Radiological Dose Consequence Aspects of Basis 2 of Section E of Unified Contention Utah L/QQ, April 1, 2002?

DR. REDMOND: Yes.

DR. SOLER: Yes.

DR. SINGH: Yes.

MR. GAUKLER: Was this testimony prepared by you, or under your supervision?

DR. REDMOND: Yes.

DR. SOLER: Yes.

DR. SINGH: Yes.

MR. GAUKLER: Do you have any changes to make to your testimony?

DR. REDMOND: No.

DR. SOLER: No.

DR. SINGH: No.

MR. GAUKLER: Do you believe this testimony to be true and correct?

DR. REDMOND: Yes.

DR. SOLER: Yes.

DR. SINGH: Yes, we do.

MR. GAUKLER: Do you adopt this testimony as your testimony in this proceeding?

DR. REDMOND: Yes.

DR. SOLER: Yes.

DR. SINGH: Yes.

MR. GAUKLER: Your Honor, I would request that the testimony of Dr. Singh, Dr. Soler and Dr. Redmond on radiological dose consequences be admitted and inserted into the transcript as if read.

CHAIRMAN FARRAR: Any objection?

MS. CHANCELLOR: No objection, Your Honor.

MR. O'NEILL: No, Your Honor.

CHAIRMAN FARRAR: All right. Then the reporter will bind the testimony into the record at this point, as if read.

(Insert pre-filed testimony of Dr. Redmond, Dr. Soler and Dr. Singh.)

April 1, 2002

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of	)	
	)	
PRIVATE FUEL STORAGE L.L.C.	)	Docket No. 72-22
	)	
(Private Fuel Storage Facility)	)	ASLBP No. 97-732-02-ISFSI

TESTIMONY OF KRISHNA P. SINGH, ALAN I. SOLER, AND EVERETT L. REDMOND II ON RADIOLOGICAL DOSE CONSEQUENCE ASPECTS OF BASIS 2 OF SECTION E OF UNIFIED CONTENTION UTAH L/QQ

I. WITNESSES AND SCOPE OF TESTIMONY

A. Krishna P. Singh ("KPS")

Q1. Please state your full name?

A1. Krishna P. Singh.

Q2. By whom are you employed and what is your position?

A2. (KPS) I am President and CEO of Holtec International ("Holtec"). My educational and professional qualifications are summarized in Testimony of Krishna P. Singh and Alan I. Soler ("Singh/ Soler Testimony") with respect to Sections D and E of Unified contention L/QQ, being filed simultaneously herewith.

B. Alan I. Soler ("AIS")

Q3. Please state your full name?

A3. Alan I. Soler.

Q4. Please summarize your educational and professional qualifications.

A4. (AIS) I am Holtec's Vice-President of Engineering. My educational and professional qualifications are summarized in the Singh/Soler Testimony, being filed simultaneously herewith.

C. Everett L. Redmond ("ELR")

Q5. Please state your full name?

A5. Everett L. Redmond, II.

Q6. By whom are you employed and what is your position?

A6. (ELR) I am a Principal Engineer and Manager of the Nuclear Physics Department with Holtec. I am responsible for all shielding, criticality, and confinement analysis work related to Holtec's dry cask storage systems. I am the author of the shielding analyses performed in support of the general NRC certification of Holtec's HI-STORM 100 Cask System under Docket 72-1014. I have also performed site-specific shielding analyses in support of deployment of the HI-STORM 100 Cask System at the Private Fuel Storage Facility ("PFSF") independent spent fuel storage installation ("ISFSI"), the subject of this licensing proceeding.

Q7. Please summarize your educational and professional qualifications.

A7. (ELR) My professional and educational experience is described in the *curriculum vitae* attached to this testimony. As indicated there, my professional background and work experience include significant expertise on matters pertaining to the shielding characteristics of the HI-STORM 100 Cask System and the radiation does associated with the use of the HI-STORM 100 Cask System. My work in those areas has included developing analytical methods and models for conducting shielding analyses and dose calculations, and performing site boundary dose evaluations for ISFSIs.

Q8. What is the basis of your familiarity with the PFSF?

A8. (ELR) Holtec is the supplier of the HI-STORM 100 Cask System that will be used to store spent nuclear fuel at the PFSF. I performed site-specific shielding and radiation site boundary analyses in support of the deployment of the HI-STORM 100 Cask System at the PFSF. Through the performance of those

analyses, I have become familiar with the site-specific characteristics of the cask layout arrangement at the PFSF ISFSI, the distance to the site boundary, and other factors used to calculate radiation dose rates at the site boundary due to normal, off-normal, and postulated accident conditions at that facility.

D. Scope of Testimony

Q9. What is the purpose of your testimony?

A9. (KPS, AIS, ELR) The purpose of our testimony is to respond on behalf of Private Fuel Storage LLC ("PFS" or "Applicant") to certain radiological dose consequences issues raised by the State, with respect to Basis 2 of Section E of Unified Geotechnical Contention, Utah L QQ, in which the State asserts:

> Relative to the PFS seismic analysis supporting its application and the PFS April 9, 1999 request for an exemption from the requirements of 10 C.F.R. § 72.102(f) to allow PFS to employ a probabilistic rather than a deterministic seismic hazards analysis, PFS should be required either to use a probabilistic methodology with a 10,000-year return period or comply with the existing deterministic analysis requirement of section 72.102(f), or, alternatively, use a return period significantly greater than 2000 years, in that:
>
> * * * *
>
> 2. PFS has failed to show that its facility design will provide adequate protection against exceeding the section 72.104(a) dose limits.

Q10. What assertions has the State made in regard to the radiological dose consequences of allowing PFS to use a probabilistic seismic hazard analysis with a 2,000-year return period?

A10. (KPS, AIS, ELR) In a declaration dated December 7, 2001, filed in Support of the State's Opposition to PFS's Motion for Summary Disposition on this part of the contention, State witness Dr. Marvin Resnikoff asserts that PFS has failed to adequately and conservatively calculate the potential increase in dose rates following a beyond design basis seismic event at the PFSF site. Specifically, Dr. Resnikoff asserts that:

i) Multiple cask tipovers at the PFSF will result in exceedance of the 25 mrem dose limit of 72.104(a). Resnikoff Decl. ¶ 14-15.

ii) There are significant differences between the PFSF site and the Holtec Cask Certificate of Compliance ("CoC") (id. ¶ 12) which invalidate the PFS analysis of cask tipover impacts.

iii) PFS has neither quantified the damage to the casks that would result from tipover of the casks, nor calculated the resulting radiation dose to workers or at the boundary; PFS's claim of negligible increase in radiation from tipped over casks is not supportable, and PFS "must calculate a bounding radiation dose at the fence line and to workers" (id. ¶ 19-24).

iv) PFS has not analyzed the effects of an increase in neutron dose due to concrete degradation to on site workers in the event of a prolonged tipover (id. ¶ 25-26).

v) PFS has not analyzed damage to the casks and potential increase in radiation due to collision among sliding casks (id. ¶ 27).

vi) PFS has not analyzed damage to the casks and potential increase in radiation due to lifting up of casks during an earthquake event (id. ¶ 28).

vii) The cask drop calculation of a stainless steel MPC from 25 feet does not evaluate the stresses that would result if the MPC were dropped on its edge (id. ¶ 29).

Q11. (KPS, AIS, ELR) Do you agree with Dr. Resnikoff's claims?

A11. No, we do not.

Q12. Why not?

A12. (KPS, AIS, ELR) First of all Dr. Resnikoff uses the wrong dose limits. His entire position is based upon the incorrect assumption that the applicable dose limit is the 25 mrem limit of 10 CFR § 72.104 for "normal operations and anticipated occurrences". In reality, a cask tipover during a seismic event is a beyond-design basis accident for which the applicable dose limit is the 5 rem limit of 10 C.F.R. § 72.106(b). Under Dr. Resnikoff's own analysis, the 5 rem limit of 10 C.F.R. § 72.106(b) is nowhere close to being exceeded.

Moreover, the assumptions used in the analyses that document the performance of these components also contain high levels of conservatism. These inherent conservatisms built into the PFSF design clearly establish that the radiological consequences of the postulated 10,000-year beyond design basis earthquake would be within all applicable regulatory dose limits. These analyses and conservatisms show the inaccuracy of Dr. Resnikoff's claims, even in the event of a more severe, postulated 10,000-year return period earthquake.

II. APPLICABLE DOSE LIMITS FOR A BEYOND DESIGN BASIS EVENT

Q13. In his analysis, Dr. Resnikoff evaluates dose consequences of cask tip over based on the dose limits found in 10 C.F.R. § 72.104 using 8760 hours per year to calculate the annual dose under 10 C.F.R. § 72.104 "for normal operations and anticipated occurrences". Is this a correct statement of the applicable dose limits for a hypothetical cask tip over event at the PFSF?

A13. (ELR) No, it is not.

Q14. Why not?

A14. (ELR) First, the dose limits of 10 CFR § 72.104 do not apply to accident conditions. The regulation states directly that the limits found in 10 C.F.R. § 72.104(a) are for "normal operations and anticipated occurrences." A cask tip over is not part of normal operations nor is it an anticipated occurrence. Rather it is a beyond-design basis accident.

Q15. Why is cask tip over an accident condition?

A15. (KPS, AIS, ELR) The HI-STORM 100 cask storage system is designed so that it will not tip over in normal operations, nor even under a design basis accident including a design basis earthquake. A cask tip over is a postulated, hypothetical, beyond-design basis accident condition.

Q16. Based on your experience in designing storage casks to meet radiological dose limits, what is your understanding regarding what dose limits apply to what conditions?

A16. (ELR) In designing storage casks, there are two sets of radiological dose requirements that may be applicable: normal dose limits and accident dose limits. In the event of a design basis accident, the dose due to an accident must be less than 5 rem at the controlled area boundary. Section 72.106(b) provides:

> [a]ny individual located on or beyond the nearest boundary of the controlled area may not receive from any design basis accident the more limiting of a total effective dose equivalent of 0.05 Sv (5 rem), or the sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue (other than the lens of the eye) of 0.5 Sv (50 rem). The lens dose equivalent shall not exceed 0.15 Sv (15 rem) and the shallow dose equivalent to skin or to any extremity shall not exceed 0.5 Sv (50 rem). The minimum distance from the spent fuel or high-level radioactive waste handling and storage facilities to the nearest boundary of the controlled area must be at least 100 meters.

Q17. What about beyond-design basis events?

A17. (ELR) While the regulations do not explicitly address beyond-design basis accidents because they are not part of the regulatory requirements that must be satisfied by a licensee, the same limits set by 10 C.F.R. § 72.106 for accident conditions would apply to the extent that such events are considered and evaluated. For example, the Standard Review Plan for Spent Fuel Storage Facilities, NUREG-1567 (March 2000) provides for evaluation of dose consequences for hypothetical accident conditions under 10 C.F.R. § 72.106(b). NUREG-1567 § 9.5.2.2.

III. EVALUATION OF RADIOLOGICAL DOSES FROM HYPOTHETICAL CASK TIPOVER EVENTS

Q18. Has Holtec evaluated the radiological dose consequences of a hypothetical cask tipover event?

A18. (KPS, AIS, ELR) Yes.

Q19. Please describe the nature of Holtec's evaluation.

A19. (KPS, AIS, ELR) As set forth in the Singh/Soler testimony, Holtec performed a hypothetical cask tip-over analysis for the PFSF even though it has been demonstrated that the casks will not tip over under either the design basis 2,000 year return period earthquake for the PFSF or under a beyond-design basis, 10,000 year return period seismic event. The tipover analysis showed that all stresses remained within the allowable values of the HI-STORM 100 Certificate of Compliance ("CoC") assuring integrity of the multi-purpose canister ("MPC")

confinement boundary with large safety margins, as described in the Singh/Soler testimony. Holtec has further qualitatively evaluated the potential radiological consequences of the hypothetical tipover event in its Final Safety Analysis Report ("FSAR") for the HI-STORM 100 Cask System. As discussed there, although the tipover has no effect on the MPC confinement function, it could cause localized damage to the radial concrete shield and outer steel shell where the storage cask impacts the surface. HI-STORM FSAR, § 11.2.3.3. However, because the areas of damage will be small and localized, no noticeable increase in the ISFSI site or boundary dose rates would be expected.

Q20. Has Holtec evaluated the potential dose consequences of multiple cask tipover events at the PFSF:

A20. (ELR) Yes.

Q21. How did Holtec do this evaluation?

A21. (ELR) Holtec reviewed qualitatively the effect that multiple cask tipover events would have on radiation doses at the site boundary compared to the normal dose limits that it had previously calculated for the PFSF site boundary of approximately 5.85 mrem. We determined that the dose consequences at the site boundary from multiple cask tipover events would be similar or less than the normal doses previously calculated and far below the 5 rem accident dose limit of 10 C.F.R. § 72.106(b). Because of the large margin between the normal dose limits calculated for the PFSF and the accident dose limit, there is no need to perform further calculation of the dose consequences of multiple cask tip-over events.

Q22. Please describe the calculation of normal dose limits that Holtec performed for the PFSF site and its results?

A22. (ELR) In the design basis analyses for the PFSF, a radiation dose analysis determined the direct radiation dose rate at the controlled area boundary from neutron and gamma (photon) radiation emanating off of the sides and top of the HI-STORM storage casks. The maximum 4000 casks at the ISFSI were considered in the analysis. The calculations were performed with the Monte Carlo radiation transport code MCNP-4A. Section 7.3.3.5 and Table 7.3.7 of the

PFSF SAR present the results of this calculation and show that a maximum value of 5.85 mrem/year was calculated for a 2000 hour/year occupancy time at the controlled area boundary assuming all casks contained fuel with a burnup of 40,000 MWD/MTU and a cooling time of 10 years. These analyses demonstrated that the doses at the boundary are well within the limits deemed acceptable by the NRC in 10 C.F.R. § 72.104(a) and 10 C.F.R. § 72.106(b) for both normal operations and accident conditions.

Q23. Please describe your comparison of the dose limits arrived at by this calculation to the expected radiological doses for casks in a tipped over condition.

A23. (ELR) In the upright position, the side of the storage cask is visible from all equidistant locations from the HI-STORM storage cask and the top is not visible from any location. Therefore, all equidistant locations from an upright HI-STORM storage cask will have the same dose rates. However, in a tipped over position, the profile of the cask would be considerably different from its upright position. If one were to walk around the tipped over storage cask maintaining a constant distance from its center, the 11 ft. diameter circular ends of the cylinder (the top or bottom of the cask) would be visible from some locations and not from others while the 20 ft. long side of the storage cask cylinder (now in the horizontal position) would also be visible from some locations and not others. Therefore, unlike the upright condition, the dose rate profile around a tipped over HI-STORM storage cask would not be uniform at equidistant locations from the cask. Accordingly, the comparison must take into account the following changes in the dose rate profile of the cask:

a. The top of the cask would be visible although no longer facing the sky. Therefore, the radiation leaving the top of the cask would reach certain locations at the controlled area boundary directly (with due consideration of any attenuation and scattering in the intervening air), as opposed to the strictly scattering effect of sky shine. This would be an increase in the dose rate contribution from the top of the cask. However, at the locations along the controlled area boundary where the top of the cask is now easily visible, the dose rate from the side of the storage cask would be greatly reduced because the line-of-sight to the side of the cask would be reduced.

b. The bottom of the cask, which is normally facing the concrete ISFSI pad and the ground below, would now be exposed. This means that radiation emanating from the bottom of the storage cask, which previously was immediately absorbed by the ground, could now reach locations along the controlled boundary directly, again with due consideration of attenuation and scattering provided by the intervening air. This would also cause an increase in the dose rate contribution from the bottom of the cask. However, at the locations along the controlled area boundary where the bottom of the cask was now easily visible, the dose rate from the side of the cask would be greatly reduced because the line-of-sight to the side of the cask was reduced.

c. Since the storage cask would now be lying on its side, a large portion of the outer radial surface of the cask would be shielded by the ground. In the upright position, all radiation that emanated off the side of the cask was able to scatter and reach the site boundary. In the tipped over position, a significant portion of the radiation leaving the side of the cask would now be unable to reach the site boundary because it would be immediately absorbed by the ground below the side of the cask. In addition, as discussed above, not all locations on the controlled area boundary would have line-of-sight to the side of the cask. This would result in a reduction in the dose rate at the controlled area boundary from radiation emanating off the side of the cask.

Overall, the decrease in dose rate from the side of the tipped over storage cask should more than compensate for the increase in dose rate from the top or bottom of the cask. Based on this discussion, it is my opinion that the dose rate at the controlled area boundary from a HI-STORM storage cask lying on its side would be less than the dose rate from a HI-STORM storage cask in the upright position.

Q24. What is the likelihood of multiple cask tipovers at the PFSF?

A24. (ELR) The storage casks at the PFSF ISFSI are positioned in fifty 2x40 arrays. The arrays of casks are positioned parallel to each other with a spacing of 35 feet between arrays. Because of the positioning of the casks, it is improbable that all 4,000 casks could ever completely tip over and come to rest on their sides on the ground. Even assuming the occurrence of an event that could tip over any of the casks, a more plausible scenario would have some casks lying on the ground

while the remainder would be upright in one of two positions: free standing, or leaning against other storage casks.

Q25. Is it possible for all 4,000 casks to tip over?

A25. (ELR) In order for all casks to be resting on the ground, the casks in the 2x40 arrays would have to all fall away from each other into the 35 feet wide pathway between the arrays. In any event, tip over of all 4,000 casks would not change the calculated radiation dose limits.

Q26. What effect would all 4,000 casks tipping over have on the overall radiation dose at the boundaries of the facility?

A26. (ELR) Overall, the decrease in dose rate from the side of the tipped over storage cask should more than compensate for the increase in dose rate from the top or bottom of the cask, which I have described above. Based on this discussion, it is my opinion that the dose rate at the controlled area boundary from a HI-STORM storage cask lying on its side would be less than the dose rate from a HI-STORM storage cask in the upright position. For all casks to successfully tip over, they have to fall in such a way that the tops and bottoms of casks would be facing other casks, which would minimize the dose contribution at the controlled area boundary from radiation emanating off the top and bottom of the casks, since this radiation would be directed toward other storage casks. In the upright position for the ISFSI, the sides of the cask are partially shielded by the position of casks next to each other. This self-shielding would still exist to a degree when all casks are tipped over because they would be lying next to each other. Therefore, based on the response for a single cask, it is my opinion that the dose rate from the entire 4,000 casks at PFSF lying on their sides would be similar to that from the ISFSI with all casks in the upright position.

Q27. How does this expected dose rate for 4,000 tipped over casks compare to the accident dose limit in 10 C.F.R. § 72.106(b)?

A27. (ELR) As stated, the normal dose at the site boundary calculated for 4,000 casks in their upright position used in my comparison is 5.85 mrem. Based on the above analysis, the expected dose rate for 4,000 tipped over casks at the site boundary would be of the same order of magnitude. Thus, there is approximately

three orders of magnitude of margin between the expected dose rate at the site boundary for 4,000 casks in a tipped over condition compared to the 5 rem accident dose limit in 10 C.F.R. § 72.106(b).

Q28. Are there any other conservatisms built into your evaluation of radiation doses at the site boundary resulting from 4,000 tipped over casks?

A28. (ELR) Yes, there are other significant conservatisms. The analyses that Holtec performed for the PFSF in the PFSF SAR for normal doses include a number of conservative assumptions that tend to result in overstating the doses at the site boundary. These conservatisms would be equally applicable to casks in a tipped over condition. Some of these conservative assumptions are as follows:

- The single most conservative assumption in the analysis that Holtec performed for the PFSF is that all 4,000 casks have the exact same burnup and cooling time. This is impossible, since the MPCs will be delivered over many years and each additional year of cooling further reduces the radiation source term. As an example, if the PFSF received 4 casks per week, 50 weeks per year, it would take 20 years to completely fill the ISFSI. This means that at the completion of the ISFSI, the first casks delivered will have an additional 15 years of cooling time compared to the last casks delivered.

- A conservative burnup of 40,000 MWD/MTU and a cooling time of 10 years was used by Holtec in its analysis. In a separate analysis performed by Stone & Webster, a more realistic value of 35,000 MWD/MTU and a cooling time of 20 years were used, resulting in a reduction of more than 50% in the calculated normal doses at the site boundary, from 5.85 mrem/year to 2.10 mrem/year.

- The analyses use a single design basis fuel assembly, which has the highest gamma and neutron radiation source term in all fuel storage locations.

- The analyses use a single irradiation cycle to calculate the source term. This does not recognize the down time during reactor operations for scheduled maintenance and refueling. This additional down time would reduce the source term by effectively increasing the cooling time.

Q29. Dr. Resnikoff claims that for calculating normal doses at the site boundary, on which you base your comparison, PFS should have assumed that "a hypothetical individual is located at the site boundary the entire year or 8,760 hours/ year" instead of the 2,000-hour per year occupancy time used in the PFSF SAR (referenced above). Resnikoff Decl. ¶ 14. Do you agree, and even assuming Dr. Resnikoff were correct what effect would that have on your conclusions?

A29. (ELR) I disagree with Dr. Resnikoff, and even assuming he were correct his results would not affect my conclusions. The regulations provide that the applicable dose limits are to be calculated for a "real" individual, and not a hypothetical individual as claimed by Dr. Resnikoff. See 10 C.F.R. § 72.104(a). The regulatory guidance provided in the SRP and Interim Staff Guidances (ISG) for ISFSIs further provides for using a "real individual" for calculating radiation doses as opposed to Dr. Resnkoff's hypothetical individual. NUREG-1567 § 11.5.3.2 and ISG 13 revision 0. Here, PFS calculated the annual dose limit at the site boundary assuming that a worker is present at the site boundary 40 hours a week for 50 weeks a year to produce a conservative upper bound 2000 hour per year exposure at the site boundary. PFSF Safety Analysis Report §7.3.3.5.

Moreover, even assuming Dr. Resnikoff's argument that one should consider a hypothetical individual located at the site boundary for the entire year were correct, it would have no effect on my conclusion that the radiological dose at the site boundary would be far less than the accident dose limit of 5 rem in 10 C.F.R. § 72.106(b). It would merely reduce the margin of conservatism somewhat less than an order of magnitude, from the three orders of magnitude of conservatism discussed above to a margin of conservatism of still more than two orders of magnitude. Thus, the dose consequences at the site boundary would continue to be far below the 5 rem accident limit of 10 C.F.R. § 72.106(b).

Q30. What conclusion do you draw of the radiological doses at the site boundary in the event of one or more casks were to tip over at the PFSF due to a beyond design basis seismic event?

A30. (ELR) Based on the responses above for a single cask and 4000 casks, and the other conservative assumptions used in the analyses as documented in the PFSF SAR, it is my opinion that whether the HI STORM storage casks are assumed to remain upright in a severe earthquake or tip over, the radiation dose at the site boundary will remain essentially unchanged regardless of whether one assumes that a single cask, any number of them, or all the casks, tip over. In either case, the dose at the boundary is far below the accident limits of 10 C.F.R. § 72.106(b).

IV. RESPONSE TO OTHER CLAIMS RAISED BY STATE

A. Differences between the HI-STORM 100 Certificate of Compliance and the PFSF Design Basis Analysis for the HI-STORM 100 Storage Cask

Q31. In his December 7, 2001 declaration, Dr. Resnikoff points to differences between the NRC-approved Certificate of Compliance ("CoC") design basis analysis for the HI-STORM 100 Cask System and the design basis analysis of the HI-STORM 100 for PFSF as challenging Holtec's evaluation of cask tipover effects at the PFSF. The cited differences include variations in the number of hours used to calculate the year long exposure dose, the size of the design basis ground motion, and the number of casks involved in a tipover. E.g., Resnikoff Decl. ¶ ¶ 12-14. Do any of these differences affect the validity of the Holtec's analysis of cask tipover effects at the PFSF site?

A31. (KPS, AIS, ELR) No. Holtec has performed general design analyses in its FSAR for the HI-STORM 100 storage cask which support the CoC that the NRC has issued for the HI-STORM 100 storage cask system under 10 C.F.R. Part 72. Under the CoC, nuclear power plant licensees may use the HI-STORM 100 storage cask system at their sites under the general license provision of 10 C.F.R. § 72.210 as long as they meet the conditions of both 10 C.F.R. § 72.212 and the CoC. However, in addition, satisfactory performance of the HI-STORM 100 cask may be demonstrated by site-specific analyses. Holtec has performed such site specific analyses for the PFSF. Those analyses show satisfactory performance of the HI-STORM 100 Cask System at the PFSF. Thus, differences between the Holtec FSAR and CoC and the PFSF design do not invalidate our analyses of cask tipover effects as claimed by Dr. Resnikoff. Moreover, everything in the PFSF design is consonant with the Holtec CoC.

Q32. Dr. Resnikoff claims that PFS's use a 2,000-hour year occupancy time to calculate radiation dose levels at the site boundary is inconsistent with the use of 8,760 hours for the Holtec CoC. Are these inconsistent?

A32. (ELR) No. While it is true that the number of hours is different, it must be understood that a site-specific evaluation was performed for the PFSF whereas the Holtec FSAR is a generic evaluation for widespread application. The site specific analysis for the PFSF takes into account the particular characteristics found at the PFSF site, as discussed above. Therefore, the assertion by Dr. Resnikoff that the

PFS SAR is not consistent with the Holtec FSAR in its use of 2,000 hours/year occupancy time is irrelevant.

Q33. What effect, if any, would the assumption of 8,760 hours occupancy time at the site boundary, versus the 2,000 hours used in Holtec's analysis, have on the Holtec's evaluation of cask tipover effects?

A33. (ELR) It would have no effect. As discussed above, large margins exist between the dose rates at the PFSF site boundary and the 5 rem accident limit of 10 C.F.R. § 72.106(b) under either assumption.

Q34. Dr. Resnikoff also points to the fact that the PFSF design basis ground motion exceeds that of the Holtec CoC. What, if any, significance does the inclusion of larger design basis ground motion for the PFSF have for the analysis contained in the Holtec CoC?

A34. (AIS) None whatsoever. Holtec's cask stability analyses for the PFSF shows that the larger design basis ground motion at the PFSF site would have no adverse effects on the performance of HI-STORM 100 Cask System at the PFSF.

Q35. Dr. Resnikoff also claims significance in the fact that the Holtec CoC analyzes a single cask tipover, whereas the PFSF will have over 4,000 casks potentially subject to tipover. How, if at all, does this affect Holtec's analysis of cask tipover effects for the PFSF?

A35. (AIS, ELR) It has no effect. Cask tip over is a hypothetical event as confirmed by Holtec's cask stability analyses for the PFSF at both the 2,000 design basis earthquake as well as the 10,000-year beyond-design basis earthquake. Moreover, as shown above, even assuming the 4,000 casks were to tip over, the dose rates at the PFSF site boundary would be far below the 5 rem accident limit of 10 C.F.R. § 72.106(b).

B. Potential for Damage to the Storage Casks or the MPC Resulting from Cask Tipover and the Effect on Radiation Doses

Q36. Dr. Resnikoff asserts that PFS has neither quantified the damage to the casks that would result from tipover of the casks, nor "calculated the resulting radiation dose to workers or at the boundary" and that "PFS's claim of negligible increase in radiation from tipped over casks is not supportable. . . ." Resnikoff Decl. ¶¶ 19-24. Do you agree with Dr. Resnikoff?

A36. (AIS, ELR) No. We have evaluated the damage to the cask that might result from cask tipover and have concluded based on the design of the cask and the shielding characteristics of the concrete that any damage to the cask would be localized and would have negligible effect on the radiation shielding capability of

the cask. Further, our comparison above of the radiological doses of casks in a tipped over configuration with casks in an upright configuration shows no significant difference in the radiation doses for the two configurations at the site boundary, therefore the dose rates from casks in a tipped over configuration would be far below the 5 rem accident limit of 10 C.F.R. § 72.106(b).

Q37. Please elaborate on your conclusion that cask tipover would have negligible effect on the radiation shielding provided by the storage cask.

A37. (AIS, ELR) As addressed in Section 11.2.3.3 of the HI-STORM FSAR, a hypothetical tip-over accident could cause localized damage to the radial concrete shield and outer steel shell where the storage cask impacts the surface. The localized damage from this hypothetical event would probably include some local crushing of the concrete contained within the steel enclosure near the point of impact with the target concrete pad. However, it is highly unlikely that any localized crushing and associated micro-cracking would create an uninterrupted radiation streaming path due to the homogeneity of concrete in the HI-STORM storage cask. In addition, since the concrete is fully encased in a steel structure, it is not possible for any concrete that may crush to become dislodged from the cask as it might in other cask systems where the concrete is exposed directly to the environment. Nor will there be any significant settling of damaged concrete since the enclosure shell is filled with concrete when it is poured and the damaged concrete would have nowhere to move. Therefore, any damaged concrete in the storage cask would remain inside the enclosure shell and continue to perform its shielding function.

Q38. Dr. Resnikoff also asserts that metal stretching or flattening and deformation of the cask would occur if the casks were subject to tipover which would adversely impact their shielding capability. Do you agree?

A38. (AIS, ELR) No. We do not agree. Since concrete is not fluid in nature and since there are four large steel ribs between the inner and outer shells of the storage cask it is highly unlikely that the storage cask would experience a general thinning of the concrete shielding as a result of concrete movement within the steel encasement. In addition, any damage due to a side impact (tip-over) will cause only localized damage to the concrete and outer shell of the storage cask in

the immediate area of impact, as discussed in Section 11.2.3.2 of the HI-STORM FSAR. Therefore, the roundness of the storage cask could only be reduced in the immediate area of the impact (between the cask and the ground) and this would not significantly affect the shielding performance, since the same mass of steel and concrete would still be present. In the event of a non-mechanistic tipover, we would expect local flattening to occur, but no significant change in thickness. As an estimate for illustration, consider the HI-STORM tipped over and the impact to occur over a 12" diameter circle near the top of the cask, causing a stretching of the outer steel shell by 0.5" in that vicinity. The change in volume introduced by the stretch is approximately equal to the perimeter times the thickness times the stretch, or (3.14 x 12") x 0.75" x 0.5" = 14.137 cubic inches (note 3.14 is the value of "pi"). If we conservatively assume that because of deformations beyond the elastic limit, the material is uniformly incompressible over the entire local region, then the volume change is accommodated by thinning of the plate section in the area of the stretch. This change in thickness, "dt", can be computed by equating the volume change due to stretch to a volume change due to "thinning", or $(3.14 \times (12"+2*0.5")^2 / 4) \times dt = 14.137$ cubic inches. Solving for "dt" gives the thinning as dt = 0.107". A change in thickness by this amount over such a local area would have little consequences to the site boundary dose.

Q39. Dr. Resnikoff claims that Holtec's starting premise of zero initial angular velocity for the cask tipover is unfounded, and that "the angular velocity will be greater than zero" which will cause more flattening of the cask than contemplated. Resnikoff Decl. ¶¶ 19-20. Do you agree ?

A39. (KPS, AIS) No, we do not agree. The assumption of zero angular velocity is appropriate. As discussed in the companion Singh/Soler testimony, under the 10,000-year return period earthquake, the analysis has shown that the HI-STORM storage cask does not tip over, and that the behavior of the cask is characterized by tilting from the vertical resulting in a plane of precession for a certain duration in the course of the earthquake event. The cask experiences an oscillatory rocking motion with limited return to the vertical position until the rocking finally ends when the earthquake subsides. Observation of the simulated motion experienced by the PFSF casks during the 10,000-year event and other non-PFSF simulations

of cask tipover leads us to conclude that, if the strength of the seismic event were increased to the point where the cask did tip over the initiating angular velocity propelling the cask towards the ground is quite small. Furthermore, the precessionary motion of the cask enables it to remain stable even while the center of gravity of the cask is well past the corner. As a result of the precessionary motion, the initial height of the cask center of gravity is apt to be much lower than the static tipover scenario (where tipover begins as soon as the center of gravity crosses the vertical plane containing the axis of overturning rotation). With less distance to fall, and a negligible initial angular velocity propelling the tip over, a cask tipping away from precessionary motion is expected to have substantially less kinetic energy of collision than one tipping from zero velocity with center of gravity of over corner.

Therefore, the starting premise used by Holtec in its cask tipover analysis of zero initial angular at the point at which the "center of gravity over corner" is exceeded is reasonable. The velocity might be somewhat increased from the tipover condition already studied, thereby increasing somewhat the deceleration of the cask upon hitting the pad or the point at which the cask initiates tipover might be below the center of gravity over corner velocity which would decrease the deceleration of the cask upon hitting the pad. In either event, the local deformation of the cask would generally be the same. Moreover, as stated above and discussed further below, Dr. Resnikoff's assumption that greater flattening of the cask would decrease its radiation shielding capability is erroneous.

Q40. What about Dr. Resnikoff's related claim made in paragraph 19 of his declaration that because "the angular velocity will be greater than zero" the top of the canister will be decelerating "at greater than 45g, in exceedance [sic] of the 45g design basis, thereby damaging the fuel assemblies . . . ." Do you agree with Dr. Resnikoff's statements?

A40. (KPS, AIS) No we do not. As discussed above, assuming zero initial angular velocity center of gravity over corner is a well-warranted assumption. Moreover, there is significant margin in the 45 g value stated in the HI-STORM FSAR in that the fuel assemblies can withstand g forces up to 63 g's under a side impact (Ref. , Chun, Witte, Schwartz, "Dynamic Impact effects on Spent Fuel Assemblies, UCID-21246, Lawrence Livermore National Laboratory, 1987).

This is based on a stress analysis of the fuel assembly as a supported beam between grid straps and has been accepted by the NRC as a meaningful limit to assess the onset of fuel damage under impact decelerations laterally to the axis of the fuel. Thus, decelerations would be potentially damaging to the fuel assemblies only if the decelerations were increased by 33%.

Moreover, even if the fuel assemblies were damaged there would be no release of radioactivity because the damaged fuel would be confined by the MPC. As discussed in the companion Singh/Soler testimony, the MPC design incorporates large margins of safety, enabling the cask to perform its safety function of confining the radioactivity of the spent fuel at accelerations well beyond its design basis. This is exemplified by the hypothetical 25 foot end drop of a loaded canister on a hard concrete foundation discussed in that testimony. In that case the target surface, assumed to be essentially unyielding, was modeled as a 22 ft. thick concrete slab of compressive strength 6,000 psi. The computed strain in the confinement boundary material as a result of this hypothetical drop is only 41% of the failure strain limits for the canister material.

In the case of a side impact with a larger than anticipated deceleration at the top of the MPC, the MPC shell is buttressed by the thick MPC lid in precisely that area where the impact loads would be greatest. Therefore, in our opinion, the MPC strains would be bounded by the values computed in the 25' end drop.

Q41. Dr. Resnikoff also asserts that if deformation occurs to casks during tipover that PFS will have to calculate "the potential increase in dose at the site boundary or to workers from such casks" because the deformations would not necessarily face the ground while the cask is prone and "[w]hen the HI-STORM 100 casks are in fact up righted, the flattened area of the cask (localized deformation) will not face the ground." Do you agree with these conclusions?

A41. (ELR) No. Dr. Resnikoff makes several fundamental errors. First, NRC regulations regarding the radiological consequences of a design basis accident at an ISFSI are applicable to the public, not the workers on the site who are governed by other occupational standards (discussed further below). Second, Dr. Resnikoff misunderstands the nature of shielding provided by the HI-STORM 100 cask. The effectiveness of radioactive shielding is based on the mass of the

shielding, not on the thickness. Because there is no-where for concrete that may be deformed to move, it will remain in place. Thus, a local deformation that may change the thickness of the concrete, by increasing the density, at a particular location will not change the mass and radiation shielding will be unaffected regardless of whether the deformation faces the ground. Even if there was a slight thinning of the steel as discussed above, the effect would not be noticeable at the site boundary.

Q42. Dr. Resnikoff also claims that PFS has not calculated the radiation dose at the boundary resulting from the bottoms of tipped over storage casks facing the fence line. Please describe the basis for not calculating such a scenario.

A42. (ELR) If the tipped over HI-STORM casks had been considered in the analysis the accident condition dose rates would not have been significantly affected as discussed above. In order for all casks to be resting on the ground, the casks in the 2x40 arrays would have to all fall away from each other into the 35 feet wide pathway between the arrays. If this were to occur, the tops and bottoms of casks would be facing other casks, which would minimize the dose contribution at the controlled area boundary from radiation emanating off the top and bottom of the casks, since this radiation would be directed toward other storage casks.

Further, the outer row of casks, which is the row Dr. Resnikoff is considering in his assertion, would have to fall inward towards the center of the ISFSI in order for the bottom of the casks to be facing the site boundary. The outer row of casks are positioned immediately adjacent to other casks, therefore, it is extremely improbable that a cask on the outer row would fall inward hitting an adjacent cask and still end up lying horizontally on the ground with the bottom facing the site boundary. In my opinion, it is far more likely that an outer cask would bump an inner cask in its movement and then fall away from the center of the ISFSI and end up resting on the ground with the top of the cask facing the site boundary. The top of the casks are heavily shielded and the resulting dose would be less than if the side of the casks were facing the site boundary. In addition, in the upright position for the ISFSI, the sides of the cask are partially shielded by the position of casks next to each other. This self-shielding would still exist to a degree when

all casks are tipped over because they would be lying next to each other. Therefore, based on the response for a single cask, it is my opinion that the dose rate from the entire 4000 casks at PFSF lying on their sides would be similar to that from the ISFSI with all casks in the upright position.

Q43. Are you familiar with the calculations made by Dr. Resnikoff in his analysis of radiation dose at the PFSF site boundary resulting from the bottoms of tipped over casks?

A43. (ELR) Yes. I have reviewed Attachment B to Dr. Resnikoff's December 7, 2001 declaration, entitled "Rough Calculations: Dose Emanating from Bottom of Tipped-Over Cask." In his rough calculations, Dr. Resnikoff estimates the dose rate on the bottom of the HI-STORM overpack and the dose rates at the site boundary in a few steps. His basic approach is to first estimate the dose rate on the bottom of an unshielded MPC and then determine the dose rate on the bottom of the HI-STORM accounting for the shielding between the bottom of the MPC and the bottom of the overpack. Since the MPC sits on a 22 inch tall pedestal, which provides substantial shielding, Dr. Resnikoff assumes for the purposes of his calculation that the only pathway for radiation to reach the bottom of the overpack is through the annular gap between the MPC/pedestal and the inner shell of the HI-STORM overpack. Attachment A to this testimony provides a figure which illustrates this gap. In this annular region, the only shielding is the baseplate of the overpack.

The first step in the calculation was to estimate the dose rate on the bottom of the MPC based on the dose rates on the bottom of a loaded HI-TRAC transfer cask. Since the HI-STORM is always positioned vertically, the dose rates on the bottom of a HI-STORM overpack have never been calculated. Therefore, the only dose rates available to Dr. Resnikoff to use for this calculation were the dose rates on the bottom of the HI-TRAC.

Second, he estimates the percentage of the area on the bottom of the overpack which covers the annulus between the MPC and overpack (see attached figure in Attachment A to this testimony) using the following formula:

Area percentage = $\pi(r_o^2 - r_i^2)/ \pi r_o^2$

where r_o is the outer radius of the annulus and r_i is the inner radius of the annulus. Using the percentage of area from the second step and the dose rate on the bottom of the MPC from the first step, he calculates the dose rate on the bottom of the overpack assuming that the baseplate of the overpack is the only shielding material.

Lastly, Dr. Resnikoff estimates the dose at the site boundary from the 80 casks in the outer row tipped over with the bottoms of these casks facing the site boundary. (An inherent assumption in his using only the casks in the outer row is that the tipped over casks inside the array are shielded by other casks and do not contribute any additional dose rate, which is consistent with points that I have previously made with regard to 4000 tipped over casks.) His estimates of the accident condition dose rates for the 80 casks in the outer row tipped over with their bottoms facing the site boundary range from 45.1 mrem/year to 451 mrem/year , depending on various assumptions. In either case these values are well below the 5 rem limit in 10 C.F.R. § 72.106(b).

Q44. Is Dr. Resnikoff's methodological approach correct?

A44. (ELR) As stated above, Dr. Resnikoff assumed in his analysis that the bottom of all 80 casks are facing the site boundary. As I have discussed earlier, it is far more likely that the tops of these 80 casks would be facing the site boundary since the casks are more likely to fall away from the ISFSI because the casks would bump into other casks if they fell inward. Therefore, I believe that the assumption that all 80 casks would be facing the site boundary is highly unrealistic. In addition, his estimation of the dose rate on the bottom of the overpack fails to account for the additional attenuation of radiation due to the MPC being positioned 22 inches above the baseplate of the overpack. As stated above, Dr. Resnikoff assumes that, as the worst case, the only shielding in the annular region between the MPC and inner shell of the overpack is the 2 inch thick baseplate of the overpack. In fact, there is considerably more shielding through the geometry where radiation must travel 22 inches from the MPC to the baseplate in an approximately 2.5 inch wide channel. This means that a significant amount of radiation will be scattered and absorbed in the walls of the pedestal and the

overpack along this 22 inches. Dr. Resnikoff does not account for this in his worst case analysis, however he does approximate this affect by taking 10% of the calculated area of the annulus in his analysis to produce the lower bound dose rates.

In conclusion, the dose estimates calculated by Dr. Resnikoff are much higher than what would reasonably be expected, even under the unrealistic assumptions that Dr. Resnikoff made in his analysis. In my review of his calculations, I also found some errors in the calculations in the form of material thicknesses, distances, and an error in a formula. The errors in material thicknesses, if corrected would increase the calculated dose rate while the correction to the formula and the distance would decrease the calculated dose rate. The decrease would more than offset the increase.

Q45. Before describing the other errors in Dr. Resnikoff's analysis, please describe generally the design of the bottom of the HI-STORM 100 cask as it relates to radiation shielding.

A45. (ELR) The bottom of the HI-STORM overpack is a 2 inch thick circular steel plate. When the overpack is laying on its side the bottom steel baseplate of the overpack will be visible. Attachment A to this testimony shows a figure of the HI-STORM overpack with an MPC inside and a hatched outline of the bottom of the overpack when tipped over. The hatching in the figure indicates areas of concrete behind the baseplate. Behind the center section of the baseplate there are 17 inches of concrete and 5 inches of additional steel before the MPC is reached. In the outer regions of the baseplate, the concrete extends from the baseplate to the top of the overpack. Therefore, it is clear from the figure that there is only a very small annular region which does not have any concrete or additional steel positioned behind it. This is the annular region between the MPC and the inner shell of the HI-STORM overpack. This is also the area that Dr. Resnikoff calculated the dose rates for. Since there is significant shielding behind the two shaded areas of the baseplate in the form of concrete and steel, the highest region of dose on the baseplate of the overpack will be in the annular region between the MPC and the overpack inner shell.

Q46. Now please describe the errors in Dr. Resnikoff's actual calculation of the doses from the bottom of a tipped over cask assuming no shielding from other casks.

A46. (ELR) I found the following items that were inaccurate in his calculations

a. The thickness of lead that Dr. Resnikoff used for the HI-TRAC when calculating the dose rate on the bottom of the MCP was 1.0 inch. The correct value is 1.5 inches. Since there is more shielding than he assumed, his calculated dose rate on the bottom of the MPC would be higher if this thickness was corrected.

b. The thickness of the base plate on the HI-STORM overpack is 2 inches rather than 3 inches. Assuming a 3 inch thick baseplate in the calculations provides more shielding than is actually there. Reducing this value to 2 inches would result in higher estimated dose rates.

c. The equation $I_2=I_1\theta/h$ below Table 3 in Section D should be $I_2=I_1\theta/(4\pi h)$. This would reduce the dose rates estimated in the calculations. This is an easily made mistake when calculating the dose from a line source.

d. The distance from the casks to the site boundary should be, at a minimum, 600 meters rather than 555 meters. Correcting this would reduce the estimated dose rates.

Q47. What would the results of Dr. Resnikoff's calculations be if these inaccuracies were corrected?

A47. (ELR) If the four inaccuracies discussed above were corrected, Dr. Resnikoff's calculated dose rates would be reduced by approximately a factor of 2.9.

Q48. Based on your review of Dr. Resnikoff's calculation, what is your conclusion regarding his claim that dramatically higher radiation doses at the boundary of the PFSF fence line will occur in the event of a cask tipover event at the PFSF site?

A48. (ELR) I disagree. Both Dr. Resnikoff's methodology and analysis are flawed and therefore his conclusion is similarly flawed. Moreover, even accepting Dr. Resnikoff's inaccurate calculations, he states in his declaration that the dose rates due to gamma rays would increase 1.8 to 18 times those calculated by PFS assuming 2000 hours occupancy at the site boundary and 7.7 to 77 times that calculated by PFS assuming 8,760 hours occupancy per year. The highest number cited by Dr. Resnikoff would result in an annual dose at the controlled area boundary of approximately 450 mrem/year (5.85 x 77). This is well below the 5 rem accident dose set forth in 10 CFR §72.106. In fact, at 450 mrem/year, it would take 11 years before the 5 rem limit were reached.

C. NEUTRON DOSES CALCULATION.

Q49. The State asserts that cask heat-up and loss of concrete shielding has not been adequately addressed by PFS. In particular, the State contends that "after 33 hours of 100% air inlet blockage, the concrete temperature will exceed the short-term limit of 350° F specified in the CoC for the HI-STORM 100 cask, " which will cause water to evaporate from the concrete, "reducing the amount of hydrogen available for neutron capture;" and that "PFS has not analyzed the effects of an increase of neutron dose to on-site workers from the prolonged tip over of HI-STORM 100 casks." Resnikoff's Decl. ¶¶ 25-26. Do you agree with this claim?

A49. (KPS, AIS, ELR) No, Dr. Resnikoff makes several errors in his analysis. First, Dr. Resnikoff fails to consider the proper regulatory provisions and guidance for accident scenarios – the occupational dose applicable to workers are different from those that govern the maximum applicable dose to the public. Second, Dr. Resnikoff misinterprets and misuses the analysis of air inlet blockage in the CoC. Finally, Dr. Resnikoff's analysis assuming all the water from the concrete would evaporate is highly unrealistic. The effect of thermal degradation of a cask in a tipover condition on the water content of the concrete and its neutron shielding capability is insignificant.

Q50. Why is the occupational dose to on-site the workers not pertinent in determining whether the applicable dose limits to members of the public (10 C.F.R. § 72.104 for "normal operations and anticipated occurrences" and 10 C.F.R. § 72.106(b) for "accident" conditions) have been exceeded?

A50. (ELR) The reason why the occupational dose to on-site the workers is not pertinent in determining whether the applicable dose limits to members of the public have been exceeded is the occupational dose applicable to workers is governed by different regulatory provisions than those that govern the maximum applicable dose to the public. The regulations under 10 C.F.R. 72 only address the general public beyond the controlled area boundary, not workers on site. The PFSF site will have to meet the regulatory requirements of 10 C.F.R. 20 which governs the radiation workers.

Q51. How does Dr. Resnikoff misuse and misinterpret the Holtec CoC provisions regarding blockage of the air vents?

A51. (KPS, AIS, ELR) Dr. Resnikoff, in paragraph 25 of his declaration of December 7, 2001 makes an incorrect assumption that for the hypothetical cask

tip over, "...the chimney effect is reduced dramatically and this is equivalent to the intake vents being blocked". Blockage of all the intake vents in a tipped over condition is, however, not possible. The HI-STORM overpack is a cylindrical vessel having four intake vents at the bottom (10" high x 15" wide) and four exit vents at the top (6" high x 25" wide). These top and bottom vents are spaced 90° apart around the circumference of the overpack. In a hypothetical tipover event, the overpack cylinder will come to rest on the ground with a line of contact with the cylindrical surface. For a worst case scenario, the projected outline of at most one intake vent and one exit vent can straddle this line of contact. If the vent openings were flat and the ground smooth then the straddled vents would be blocked. But because the openings are formed on a cylindrical surface, areas of the straddled vent openings away from the contact line are not blocked and the three other intake and three exit vents are open. For this reason, to assume that all-inlet-ducts will be blocked as a result cask tip over condition is physically impossible. Therefore Dr. Resnikoff misinterprets the 33 hour time limit provided in the CoC for standing the cask upright as this is assuming that all of the inlet ducts are blocked, which, cannot happen as a result of a tip over. Therefore, the 33 hour time limit provided for by the CoC is inappropriate for this condition.

Q52. Before turning to the next issue, would you please explain the importance of the water in the concrete in regards to the concrete's neutron shielding capability.

A52. (ELR) Yes. High energy fast neutrons must be slowed down (have their energy reduced) and captured in the shielding material in order to reduce the dose rate on the exterior of the cask. Neutrons lose the most energy in collisions with Hydrogen atoms. While collisions with other atoms will reduce the energy, Hydrogen is the best attenuator for neutrons. In concrete, a significant portion of the Hydrogen is in the form of bound water. There may also be Hydrogen contained in the aggregate depending upon the type of aggregate used.

Q53. What effect would an increase of the concrete temperature of a tipped over cask have on the water content of the concrete and its neutron shielding capability?

A53. (KPS, ELR) The effect would be minimal. There is a limited range of temperatures to which the concrete could be subjected in the event of a cask tipover, even assuming that the cask remained in a tipped over condition for a long period of time. This range of temperature would not cause significant evaporation of water, and in turn the impact on the neutron shielding capability of the concrete would be insignificant. In addition, any Hydrogen contained in the aggregate in the concrete would not be affected by the increase in temperatures.

(KPS) It is not easy to evaporate water within concrete, because it is in a confined space, and as the water evaporates, the air pressure increases. In turn, the increased air pressure will convert the water vapor back to liquid water. Likewise, concrete does not lose its moisture content as easily as water might evaporate from a free surface. In order for large, extensive, sustained water evaporation from the concrete to occur, exposure to high temperatures on the order of 600 degrees Fahrenheit or greater for a period of months ("Properties of Concrete", A.M. Neville, 4th Edition, (Pages 385 – 387)) will be necessary. The cask in a tipover condition will not attain this range of temperatures, even if such a condition is assumed to persist for a long time with a bounding assumption that one air vent at both the top and the bottom of the cask were blocked (See response to Q51). Although this particular geometry has not been analyzed, based on our experience modeling comparable scenarios we expect the concrete temperature to remain below 350°F which is far below the 600° F required for extensive water evaporation from the concrete. Even assuming all vents were blocked as claimed by Dr. Resnikoff, the bounding steady state temperature for the concrete would be, well below the 600°F necessary for extensive sustained water evaporation. Therefore, the evaporation of water from the concrete of a tipped over cask would be minimal even if the cask remained in a tipover position for a period of months.

Further, there will be a temperature profile in the concrete body of the tipped over HI-STORM overpack. The hottest concrete will be the inner concrete surface contacting the overpack inner shell which is heated by the MPC. The temperature will decrease radialy outward to approach the overpack enclosure shell surface temperature. The temperature will also be much less in the concrete

away from the ends of the MPC. Therefore, there are the heated regions in the overpack where the amount of water loss may be larger and regions in the overpack away from the inner heated regions where the temperatures are such as to preclude any water loss.

(KPS, ELR) Thus, a cask tipover event would not cause a significant increase in neutron radiation because the cask simply will lose very little shielding due to the loss of hydrogen atoms in the water within the concrete even under a worst case scenario.

Q54. Of what consequence therefore is Dr Resnikoff's assertion that if all the water evaporates from a HI-STORM cask, that neutron dose rate will increase 57.3 time for a dose result of 108 mrem per hour?

A54. (KPS, ELR) It is of no consequence. Dr. Resnikoff's analysis, in "Calculation of Neutron Dose at Elevated Concrete Temperatures" on which he bases his claim assumes that all Hydrogen in the concrete was in the form of water and available to be evaporated and in fact would be evaporated. Resnikoff Decl. ¶ 26. As discussed above, evaporation of all of the water is very difficult to achieve. Likewise, neutron shielding capability of the concrete also depends on the aggregate that is used in making the concrete. If that aggregate contains Hydrogen, then a very substantial amount of this Hydrogen would still remain even after assuming that somehow all the water could be removed from the concrete.

Q55. Why is it important if a worker receives the occupational dose limit of 5 rem?

A55. (ELR) 10 C.F.R. 20 § 20.1201 sets the occupational limit for radiation workers at 5 rem per year. Therefore, if a worker receives 5 rem, they are prohibited from working in a radiation environment for the remainder of the year. This may have an impact on the operating entity in that they may have to hire additional workers to perform specific tasks. Therefore, a worker receiving 5 rem is not a problem for the worker but may end up being a logistics problem for the operating entity.

In the case of PFSF, Dr. Resnikoff states that worker may receive the 5 rem limit in just over 46 hours based on his calculation of a contact dose rate of 108 mrem/hr. The implication is that this is a problem for PFSF and is something that

should have been considered. In reality, even if his calculations were correct, it is unreasonable to assume that a worker would be in contact with an overpack for an extended period of time. Radiation workers at nuclear utilities have to deal with areas of high radiation (much higher than 108 mrem/hr) on a daily basis and they do so without exceeding the 5 rem per year limit through careful planning and the use of the temporary shielding. The same would be true at PFSF if the cask hypothetically tipped over and all of the water evaporated from the concrete. Therefore, the fact that a worker may reach a limit of 5 rem is of no practical concern for PFSF.

Q56. What is your conclusion regarding Dr. Resnikoff's analysis?

A56. (KPS, ELR) While Dr. Resnikoff tries to make much out of his calculation that a worker would exceed the 5 rem per year dose limit after 46 hours at the postulated neutron radiation dose rate, he ignores common radiation shielding practices that would be used to maintain the dose to an individual as low as possible. In addition, his line of argument has no impact on the conclusions for the general public. Therefore, the discussion revolving around his questionable calculations does not have any bearing on the licensing of the PFSF.

D. OTHER CLAIMS RAISED BY THE STATE OF UTAH

1. Sliding Impacts

Q57. Dr. Resnikoff claims that the HI-STORM cask could slide up to 370 inches in the x direction and 230 inches in the y direction during a 2,000-year earthquake. Do you agree?

A57. (AIS) No. Dr. Resnikoff bases his claim on the results from a calculation by another State expert. In our opinion, as shown in companion testimony, the expert testimony relied on by Dr. Resnikoff is completely erroneous with respect to sliding of the cask. Our calculations show that the casks will not undergo sliding impact during a 2,000-year earthquake. In a hypothetical sliding scenario for a 10,000-year earthquake, confirmatory analyses (by Sandia Laboratory) have indicated that a cask may slide up to 15 inches. Since the casks are nearly 48" apart, this will not result in any collision of casks. Moreover, even if sliding impact of the casks were to be postulated to occur without regard to results from

analyses, the velocities of the impact will be much smaller than the velocity of impact determined in the hypothetical cask tipover event. Thus, even if they were to slide and impact one another, any damage would be less than that predicted due to the hypothetical tipover case. Certainly, no diminution of radiation shielding would occur.

2. Potential Effects to Storage Casks Due to Uplifting and Dropping

Q58. The State asserts that the HI-STORM cask can be uplifted by up to 27 inches in a 2,000-year earthquake. Do you agree with this assertion?

A58. (AIS) No. Dr. Resnikoff's claims are contrary to numerous cask stability analyses that we have done for the PFSF at varying design basis earthquakes, and at the 10,000-year beyond design basis earthquake. As noted in the previous answer, the results that Dr. Resnikoff relies on are fundamentally incorrect. On the other hand, our analysis have been confirmed by the analysis done by Sandia Laboratories for the NRC Staff. Based on our analysis, during the design basis earthquake, there could be a maximum uplift of approximately **2.31"** at one corner of the storage cask. No liftoff of the entire cask is indicated.

Q59. Even assuming that an earthquake could cause the cask to be lifted up 27 inches, what effect would the subsequent drop have on the storage cask and MPC capability to perform their safety related functions?

A59. (AIS) None. Even if a storage cask were lifted twenty-seven inches and dropped, there would be no impact to the shielding effectiveness of the storage cask or the confinement function of the MPC. Such a drop would have no impact on the confinement capability of the MPC. As the hypothetical MPC drop analysis shows, the unprotected MPC can be subjected to a twenty-five (25) foot drop without adverse radiological consequences. A mere twenty-seven inch drop, while the MPC is protected by the storage cask, would not result in any significant harm to the storage system and certainly would not have any radiological consequences due to deformation or damage to the storage cask, as discussed above.

Q60. Of what consequence would the fact that the 27 inch you just unrealistically assumed in the above question was greater than the 12 inches referred to in the CoC?

A60. (KPS, AIS) The twelve inch drop limit listed in the HI-STORM is intended to maintain the decelerations within a prescribed regulatory limit which is well below the "failure limit" for the MPC. The failure limit, as observed earlier, could not be reached even when the MPC is assumed to free fall from a height of 300 inches (25 feet). Because the 27 inch drop is claimed for a beyond-the-design-basis event by the State, the 12 inch CoC limit, which is a regulatory limit applicable to normal handling of casks, is entirely inapplicable.

3. Potential Effects on the MPC of an On-Edge Impact

Q61. Dr. Resnikoff claims that Holtec Report HI-2002572, *Evaluation of the Confinement Integrity of a Loaded Holtec MPC Under a Postulated Drop Event* is inadequate, because it assumes that the HI-TRAC cask will drop vertically. He further asserts that it "is more likely that the HI-TRAC cask would drop on edge" as opposed to flat on the surface and that "the shear stresses would then be considerably more severe than in a vertical drop." Do you agree with his claims?

A61. (KPS/AIS) No we do not. The HI-TRAC transfer cask is a geometrically symmetrical structure with a radially symmetric MPC inside it. Moreover, the cask is held by the crane hook along its axis of symmetry. Failure of the hook (itself a counter factual assumption given the margin of safety inherent in its design) however, would lead to a symmetrical fall of the cask. In view of the symmetry in mass and geometry, an inclined drop can not be reasonably postulated. Therefore, should a drop occur because of an earthquake, there would not be enough time for the cask to rotate from the vertical. And in any event, at the PFSF as described in the Testimony of Wayne Lewis, HI-TRAC transfer cask would be supported only by the crane for only a very brief moment in time.

V. CONCLUSION

Q62. Considering all the potential effects and scenarios raised by Dr. Resnikoff, what effect, if any, could a beyond design basis seismic event have on the radiation dose calculations?

A62. (KPS, AIS, ELR) Based on the responses above for a single cask and 4000 casks, and the other conservative assumptions used in the design and applicable analyses, whether the HI-STORM storage casks are assumed to remain upright in a severe earthquake or tip over, or slide into and impact each other, the radiation doses at the site boundary will remain essentially unchanged. Regardless of

whether one assumes that a single cask, any number of them, or all the casks tip over or impact each other, the dose to the general public will be several orders of magnitude below the 5 rem accident limit of 10 C.F.R. § 72.106(b).

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EDUCATION

Massachusetts Institute of Technology
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PROFESSIONAL EXPERIENCE

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1999–Present	Nuclear Engineer and Manager of Nuclear Physics Group
1995-1999	Nuclear Engineer
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PROFESSIONAL SOCIETY MEMBERSHIPS/ACTIVITIES

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SPENT FUEL STORAGE TECHNOLOGY

- Developed Holtec's shielding analysis methods for dry cask storage licensing.
- Developed Holtec's shielding analysis methods and models for performing site boundary dose calculations for an ISFSI.
- Performed site boundary dose evaluations in support of 10CFR 72.212 evaluations.
- Developed preferential fuel loading plans for Holtec's dry cask systems to reduce personnel exposure and off-site dose.
- Interacted with NRC on numerous occasions in vigorous technical discussions about shielding issues as they pertain to Holtec's dry cask storage systems.
- Created all computer models of HI-STAR 100, HI-STORM 100, 100-ton and 125-ton HI-TRACs used in the shielding analysis reported in the HI-STAR SAR and HI-STAR and HI-STORM TSARs under Dockets 71-9261, 72-1008, and 72-1014
- Author of Shielding Evaluation Chapters in the HI-STAR SAR and HI-STAR and HI-STORM TSARs under Dockets 71-9261, 72-1008, and 72-1014
- Primary reviewer for Criticality Evaluation Chapters in the HI-STAR SAR and HI-STAR and HI-STORM TSARs under Dockets 71-9261, 72-1008, and 72-1014
- Performed criticality analysis for both PWR and BWR spent fuel pool reracking.
- Served as primary reviewer for numerous criticality analyses for spent fuel pool reracking.

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9. J.M. Ryskamp, E.L. Redmond II and C.D. Fletcher, "Reactivity Studies on the Advanced Neutron Source Preconceptual Reactor Design," *Proc. Topl. Mtg. Safety of Non-Commercial Reactors*, Boise, ID, October 1-4, 1990, Vol. I, p. 337 (1990).

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CHAIRMAN FARRAR: Mr. Gaukler, did you have --

MR. GAUKLER: One preliminary matter. I have, in terms of rebuttal, a couple of short questions and answers, which I could do now. This is the pre-filed testimony of Dr. Resnikoff, or we could postpone it until later, whatever Your Honor's desire.

CHAIRMAN FARRAR: This is --

MR. GAUKLER: This is the only rebuttal we have as of this point in time.

CHAIRMAN FARRAR: Ms. Chancellor, how would you --

MS. CHANCELLOR: I think our preference is to keep all the rebuttal together, because something may come up in cross examination, and then it's difficult to keep straight whether you're dealing with this rebuttal, or that rebuttal.

CHAIRMAN FARRAR: All right. Then we'll -- Mr. Turk?

MR. TURK: I agree with Ms. Chancellor.

CHAIRMAN FARRAR: Okay. Then, Mr. Gaukler, thank you for the suggestion, but on matters like this we tend to be governed by opposing counsel's wishes.

MR. GAUKLER: Just offering the Board and

the parties an opportunity, or choice.

MS. CHANCELLOR: Your Honor, I do have one preliminary matter, something I forgot. Do we need to set up a video conference for the Stamatakos rebuttal? Dr. Arabasz will be in Salt Lake City, and I don't know whether we need to wait and see how the testimony goes today, but I guess it could be as early as Wednesday morning, more likely Wednesday after lunch, but I don't know the Echols Broadcast Center in Salt Lake City. It's not always easy to get air time there.

MR. TURK: I was hoping we could stipulate the Stamatakos testimony in.

MS. CHANCELLOR: Of course not, Mr. Turk. But we may be able to -- my goal is to try and deal with the Stamatakos rebuttal through cross examination, but I can't be sure that I can do that. There's the potential that Dr. Arabasz may need to take the stand, but the operating premise at the moment is that should be able to do it through cross.

CHAIRMAN FARRAR: Now you also want him not just as a possible witness of your own, but to be handy --

MS. CHANCELLOR: To view the Stamatakos -- the cross examination of Dr. Stamatakos, because I

would request to take a break so that I can phone Dr. Arabasz after cross examination. Maybe take a break and --

CHAIRMAN FARRAR: Yeah.

MS. CHANCELLOR: -- see if there are any additional questions.

CHAIRMAN FARRAR: What day are you thinking this will happen?

MS. CHANCELLOR: Wednesday of this week.

CHAIRMAN FARRAR: Why don't you see when you can get the conference facilities?

MS. CHANCELLOR: You want us to organize the Echols?

CHAIRMAN FARRAR: Yeah.

MS. CHANCELLOR: Typically, it's being done through your end, but we can see what --

CHAIRMAN FARRAR: Okay. Then we'll see when it's available on what, Wednesday afternoon?

MS. CHANCELLOR: It depends when we get through with the radiation dose witnesses, and I can't imagine --

CHAIRMAN FARRAR: Why don't we do this? We'll find out today when it's available on Wednesday.

MS. CHANCELLOR: Okay.

CHAIRMAN FARRAR: Not block any particular

time to come back, and folks, we'll let you know when it's available. Then maybe by the end of the day we can pick an hour or so that we would reserve it.

MS. CHANCELLOR: Okay. Thank you, Your Honor.

MR. TURK: Your Honors, I have a preliminary matter also. Back in Salt Lake City, I believe the Licensing Board had inquired about the status of the proposed rule making, and the rule making plan concerning geological and seismic criteria for Part 72.

On June 18, last week, the Commission issued a Staff Requirements Memo, an RSM, with respect to SECY-02-0043. In effect, back in March, the Staff had submitted a SECY paper to the Commission proposing the rule. On June 18, last week, the Commission issued its RSM approving with certain, I would call them minor modifications, the proposed -- the issuance of the proposed rule. And I understand that -- I spoke to somebody in the SECY's office this morning. Both the SRM and the SECY paper are available publicly, and they can be obtained either on the website, or through Adams.

CHAIRMAN FARRAR: If I understand that correctly, that's a proposed rule, not a final rule.

MR. TURK: That's correct. And the proposed rule has not been issued for comment yet. This is a step in the process, by which the Commission has now told the Staff go ahead and publish the proposed rule with the modifications that the Commission pointed out.

CHAIRMAN FARRAR: With a comment period of how long, do you know?

MR. TURK: It's going to be a 75 day comment period.

CHAIRMAN FARRAR: All right.

MR. TURK: I don't have a specific date under which the Staff proposes to publish, but I would expect some time this summer it'll go out, so that sometime in the fall, the commentary would expire. And then sometime after that, the final rule would be adopted, whatever it may be.

CHAIRMAN FARRAR: And how does that tie in with the Chairman of the Commission's letter to Dr. Neilsen's letter which, I think, dealt with two tracks. There was the rule making track, and there was this adjudication track. And if I remember that letter correctly --

MR. TURK: That's exactly right, Your Honor. We have submitted as Staff Exhibit U, the

letter from Chairman Meserve to Dr. Neilsen and to Mr. Silber, in which he indicated that these are two separate tracks. The fact that the proposed rule will come out sometime probably before your decision is issued does not affect the basis for your review of the exemption request in this proceeding. It's a separate track.

CHAIRMAN FARRAR: What if the final rule comes out before our decision? Can we assume that it would have an effective date that would exclude proceedings like this one?

MR. TURK: We would be speculating now, because I don't know how it would be couched in terms of its effective date. But typically, once the rule is published, it'll state the effective date. If the application has not yet been granted, then I would think it would apply to the application that's in-house, whether it's in adjudication or under Staff review, but that's speculation.

MS. CHANCELLOR: May I ask whether this part of the Commission's negative approval of the SECY Rule Making Plan was that the Staff had to conduct additional review, and will that be part of the Rule Making package?

MR. TURK: The SECY paper, which went up

to the Commission in March, included a response to the Commission's request that the Staff consider return periods in the range of 2000 years to 10,000 years. And that's going to be part of the proposed rule that goes on the street for public comment. That remains in the Rule Making package at this time.

MS. CHANCELLOR: But in response to that March package, didn't the Commission say that the Staff had to conduct additional analysis to -- in addition to getting comments from the public, additional analysis to support the Rule Making?

MR. TURK: I think you're speaking about the Rule Making Plan, which actually came out before March. That came out last fall. In any event, the documents are what they are, and I think there's a clear path. If you take a look at the modified Rule Making Plan, the Commission's comments on that, the next step was the Staff's proposal to the Commission of Proposed Rule. And now we have the Commission's response to the Staff, advising them you can go ahead and publish the proposed rule for comment, with these modifications. It's a separate track.

CHAIRMAN FARRAR: For our purposes, we should probably assume that since the Chairman wrote to Dr. Neilsen, he's aware of the repercussions, and

he's in charge of the Agency, and he will see that things are done appropriately. And we will follow whatever instructions we've given.

JUDGE LAM: And, Mr. Turk, after the 75 days comment period, what's the usual length of time for the Staff to resolve the comments, and publish the final rule?

MR. TURK: It varies from case-to-case, rule-to-rule. It should be on the order of months. How many months I couldn't say. It depends upon the nature of the comments, and how much time is required to evaluate them. But I personally don't expect that that rule will become final before you issue your decision.

MS. CHANCELLOR: Unless they take over a year to write it. Right?

MR. TURK: My comment was the opposite, Ms. Chancellor. I said I personally don't expect that it will come out before the decision is issued.

One other preliminary matter I would note. Ms. Curran has passed out today the revised testimony of Dr. Resnikoff. Could -- I would appreciate it if she could explain on the record how the testimony differs from the original testimony, because we also had a transmission on Friday of the amended testimony,

and then another one on Saturday. And I mentioned to Ms. Curran this morning that I couldn't see a difference between the Saturday and Friday transmissions, so just for the record, could she point out to us what's new in this testimony that she's passed out this morning?

MS. CURRAN: Okay. The version of the amended testimony that was sent out on Friday is just -- I incorrectly sent out the wrong version. And I noticed afterwards that --

CHAIRMAN FARRAR: Wait. Before you get to that correction, how did the Friday version differ from the version we got several months ago?

MS. CURRAN: Well, that is addressed in response to question 3 of the amended testimony.

CHAIRMAN FARRAR: It refers -- question 3 refers to questions 11, 13, and 20. And so we just wanted to make sure we knew how that differed. I think Mr. Turk's question is how did that differ from the original testimony, and then how does the Saturday correction change what was sent on Friday.

MS. CURRAN: Okay.

CHAIRMAN FARRAR: If you want, Dr. Resnikoff could --

MS. CURRAN: I think it was a clerical

error that I made in not sending out the right version that he had sent me, so I think I need to explain it.

CHAIRMAN FARRAR: Okay.

MS. CURRAN: And I see that I need to make yet another correction, which I apologize for.

CHAIRMAN FARRAR: All right.

MS. CURRAN: The amended testimony, the substantive changes are in response to question 20. And that is the only response that is changed.

CHAIRMAN FARRAR: Okay. So in question -- in answer 3 --

MS. CURRAN: There's an error.

CHAIRMAN FARRAR: Where it says the corrections are in 11, 13 and 20, it's really only in 20.

MS. CURRAN: That'S right.

CHAIRMAN FARRAR: Okay. And then in 20, is where you have lined out -- you have additions and line-outs, and those indicate the changes from the original from several months ago.

MS. CURRAN: Yes. And those are the only substantive changes.

CHAIRMAN FARRAR: Okay.

MS. CURRAN: The answer to question 3 was intended to be a guidepost to where the changes were,

and unfortunately I got it wrong.

CHAIRMAN FARRAR: That's all right.

MS. CURRAN: And then, of course, there is also Exhibit 141A, which is added to Exhibit 141.

CHAIRMAN FARRAR: Mr. Turk, does that answer your question?

MR. TURK: Yes, it does. I appreciate it. And incidentally, Exhibit 141A, that hasn't changed, or has that changed, now that you sent out the Saturday correction?

MS. CURRAN: There'S been no changes to Exhibit 141A since it was originally filed on Friday.

CHAIRMAN FARRAR: Okay. Any other preliminary matters? All right. Mr. Gaukler, did you have any other questions? They're available for --

MR. GAUKLER: They're available for cross.

MS. CHANCELLOR: Your Honor --

CHAIRMAN FARRAR: Yes.

MS. CHANCELLOR: -- this really deals with the testimony on K, but did you receive an email that Ms. Braxton sent to Mr. Cutchin about certain testimony in K not being bound into the record?

CHAIRMAN FARRAR: When was that email sent?

MS. CHANCELLOR: It was a few days before

we left Salt Lake City, so it would have been about the 15th of -- 14th of June, but there's actual testimony where you directed -- it was not directed that it be bound into the record, and the transcripts actually do not have the testimony bound into the record.

CHAIRMAN FARRAR: You mean no one asked us to do that, or I forgot to say it?

MS. CHANCELLOR: I don't know how it occurred, but there doesn't seem to be -- if you look at the transcript, it's not actually bound into the record. Anyway, I just wanted to alert you that there's a problem with some of the procedure with respect to the K testimony.

CHAIRMAN FARRAR: Okay. Tell Jean. Talk to our law clerk at a break, fill us in on that and we'll go check it out.

MS. CHANCELLOR: Okay.

MR. TURK: Was that only with respect to State testimony, or did you notice if other parties had the same problem?

MS. CHANCELLOR: I don't believe it was the State testimony. I think it was PFS and --

MR. TURK: Perhaps we can all go back -- we'll all go back tonight.

CHAIRMAN FARRAR: Right. I know we had a problem the first couple of days, the reporters didn't have the proper instructions, but I thought all those transcripts got corrected.

MS. CHANCELLOR: Ms. Braxton mentioned that I think it's only Dr. Resnikoff's testimony that's bound into the record, and that none of the other testimony is bound. None is.

CHAIRMAN FARRAR: Okay.

MS. CHANCELLOR: Except Dr. Resnikoff.

CHAIRMAN FARRAR: Let's work on it during a break.

MS. CHANCELLOR: Okay.

CHAIRMAN FARRAR: Mr. Gaukler, the witnesses are ready for cross examination?

MR. GAUKLER: Yes, they are.

MR. TURK: May I ask if PFS is introducing exhibits with these witnesses?

MR. GAUKLER: There's no exhibits introduced with these witnesses.

MR. TURK: I'm ready to start, Your Honor.

CHAIRMAN FARRAR: All right. Go ahead, Mr. Turk.

MR. TURK: Good morning, gentlemen. Dr. Singh and Soler, you can relax. Most of my questions

will be for Dr. Redmond. And, Dr. Redmond, I only have on the order of a dozen areas to inquire about. I think we should be done within a half an hour.

DR. REDMOND: Okay.

MR. TURK: Let me introduce myself first. My name is Sherwin Turk. I'm counsel with the NRC Staff.

CROSS EXAMINATION

MR. TURK: I'd like to ask you, first of all, which regulatory guidance have you followed in developing your dose estimates?

DR. REDMOND: Regulatory guidance would be 10 CFR 72-104, which is the normal condition dose rates limits, and 10 CFR 72-106, which is the accident dose limits, and then various, or NUREG 1567 which is the standard review plan for site-specific licenses. And also, NUREG 1536, which is standard review plan for general licenses. And, of course, also - sorry - the interim staff guidances. Specifically, the one that comes to mind is ISG 13, which deals with the real individual.

MR. TURK: Okay. Did you utilize any guidance with respect to 10 CFR, Part 20?

DR. REDMOND: Yes. I believe we had 10 CFR, Part 20, as well. And the site-specific analysis

does address 10 CFR, Part 20 issues.

MR. TURK: Okay. In 10 CFR, Section 72.106B, there is a concept expressed concerning the Owner Controlled Area Boundary. Could you explain what the Owner Controlled Area, or OCA Boundary is?

DR. REDMOND: It's the boundary for which the -- the owner controls the property. In the case of Private Fuel Storage, it's 600 meters out beyond where the OCA is located, where the fence is. That's the property over which they exercise control.

MR. TURK: And in this case, is that the area demarcated by the exterior fencing around the site?

DR. REDMOND: I would assume, yes.

MR. TURK: Are there any residences, or industrial or business structures located at the fence of the OCA boundary for the PFS site?

DR. REDMOND: As far as I know, there is not. I have not visited the site, so I have not seen it personally. But to my knowledge, there are no businesses, residents or industry in the area. The nearest resident, I believe, is two and a half miles away.

MR. TURK: And by comparison, how far away from the spent fuel storage pads and the CTB is the

fencing?

DR. REDMOND: I'm sorry. I didn't quite understand that.

MR. TURK: You indicated the nearest residence is about two and a half --

DR. REDMOND: Two and a half miles.

MR. TURK: -- miles away.

DR. REDMOND: Right.

MR. TURK: How far from the pads in the canister transfer building is the fencing that surrounds the Owner Controlled Area?

DR. REDMOND: 600 meters. Now I'm mixing units, so it'll take me a minute to -- which is what? About 2,000 feet, so less than a half a mile. Thank you.

MR. TURK: At various places in your testimony, and I noticed in answers -- I'll just give you a list of answers. I don't know if you need even to turn to them, but I looked in answers 23, 25, 26, 30, 42 and 61. You provide an overall assessment of whether tip-over of 4,000 casks at the PFS site would result in doses that are either equal to or more than the doses for the normal situation in which casks remain upright.

DR. REDMOND: That's correct.

MR. TURK: I wasn't sure I understood your final position. Is it your view that the doses would remain essentially the same, regardless whether the casks remain upright or tip over?

DR. REDMOND: Yes. My final position would be that the doses would remain essentially the same, or if not, lower. I mean, there's no -- tipping over the cask is not going to have an impact on the dose rates at the Controlled Area Boundary.

MR. TURK: And we're speaking about the dose at the OCA boundary.

DR. REDMOND: That's correct. That's without regard for orientation of the cask, just as a general statement.

MR. TURK: The casks have both a top and bottom surface, as well as the radial surface surrounding the cask.

DR. REDMOND: That's correct.

MR. TURK: Is the dose at the top of the cask the same as, or less than, the dose on the bottom of the cask?

DR. REDMOND: The -- I've never calculated the dose rate at the bottom of the cask. It's never been done, because it's a hypothetical condition for which the bottom of the cask would be exposed. It

would be my opinion that the general average surface dose rate would probably be less -- well, equivalent or less than on the bottom than on the top. There are -- with that said, however, there is a localized area of increased dose on the bottom compared to the top.

MR. TURK: So your view would be that the dose that would emanate from the bottom of the cask is larger than the dose from the top of the cask.

DR. REDMOND: In one area it will definitely be larger, and that is because of the region between the annular -- the annular region between the pedestal and the body of the overpack. At that point, there is only two inches of steel on the baseplate. However, with that said, if you move off of that, and you're underneath the MPC, you now have considerably more shielding if -- equivalent or more shielding than you do on the top of the overpack. And if you move to the -- under the body of the overpack, you have the same amount of shielding, effectively, as you do on the top, so there will be an area of localized increase.

MR. TURK: Incidentally, what we're talking about now is gamma and neutron radiation?

DR. REDMOND: Correct.

MR. TURK: And that's because alpha and

beta radiation consists of particle radiation?

DR. REDMOND: Alpha and beta radiation will never leave the MPC.

MR. TURK: And that's because they're stopped, effectively, by the MPC channel.

DR. REDMOND: Well, and the fuel itself. The fuel, the cladding, everything inside. The main free path is extremely small. It probably won't even escape the fuel assemblies.

MR. TURK: On page 12 of your testimony, answer 28.

DR. REDMOND: Okay.

MR. TURK: This is at the top of page 12, and I'm going to have a few questions for you concerning the bullets that appear at the top of page 12.

First of all, you indicate that: "Whereas, Holtec used a burn-up of 40,000 MDW over MTU." And by the way, why don't we put into the record what that acronym stands for.

DR. REDMOND: Megawatt days per metric ton uranium.

MR. TURK: "Whereas, Holtec used that value", you state that, "a more realistic value of 35,000 MDW over MTU was utilized by Stone & Webster."

Could you explain why the 35,000 is a more realistic value than the 40,000?

DR. REDMOND: Well, if you look at the inventory of spent fuel that's out there, certainly, the inventory of spent fuel that's been built up today, the burn-up, maximum burn-ups tend to be in the 30s, so 35,000 is a reasonable burn-up.

Now as you're moving forward in time, of course, burn-ups will increase, but the fuel that will be shipped to Private Fuel Storage is going to be the fuel that has been the longest discharged, so based on the performance of the plants and the inventories available right now in the spent fuel pools, 35,000 is a reasonable average burn-up.

MR. TURK: Also, at the top of page 28, you indicate that -- this is the third bullet. "The analyses use a single irradiation cycle to calculate the source term." Could you explain what that is, and why --

DR. REDMOND: Certainly. Can you tell me which question that is, please? My page numbering is different than your's.

MR. TURK: It's the very last bullet in answer 28.

DR. REDMOND: Oh, 28? Okay. Right. A

single irradiation cycle means that -- well, let me pause for a second and just give a little background.

Spent fuel assemblies in nuclear power plants operate for two to three cycles. There's a certain amount of down-time between cycle for refueling. And historically, that down-time has been quite extensive. It's been reduced nowadays to less than 30 days, but the fuel assemblies are in for two to three cycles, depending on how the plant is operated.

What I assumed in the analysis is conservatively that the fuel assembly is in the reactor from the time it goes in, until the time it's discharged, without any of this change in cycle or down-time due to refueling, so conservatively, I've assumed it's in there continuously.

What this does is it maximizes the burn-up, and minimizes the amount of cooling time associated with it, because I'm not taking credit for any cooling time that would have occurred between cycles. For example, if it's a burn-up of 40,000 and you achieve 20,000 burn-up in the first cycle, and 20,000 in the second cycle, and you had a down-time of 60 days, I'm not accounting for that, conservatively not accounting for that.

MR. TURK: You're not reducing the amount of time at which the fuel is in the reactor and being used in the fission process.

DR. REDMOND: No.

MR. TURK: You haven't decreased that. You're only assuming that the fuel stays in the reactor vessel the whole time.

DR. REDMOND: Right. What I'm doing is reducing the effective cooling time of the assembly, the effective amount of decay time associated with it which, of course, reduces -- decay reduces source term, so I'm maximizing the source term.

MR. TURK: In your answers 32 and 33, you discuss the use of a 2,000 hour occupancy at the OCA Boundary. I assume that's the OCA Boundary. You say the "site boundary".

DR. REDMOND: Yes, that's the OCA Boundary.

MR. TURK: Could you explain your understanding under the regulations of why that value is the significant or the correct value to use, the 2,000 hour occupancy, in calculating off-site doses for an accident?

DR. REDMOND: Certainly. The regulation, 10 CRF 72-104, states that, "The dose to any real

individual beyond the Controlled Area Boundary must be less than 25 millirems." The real individual, in this particular case, is -- the nearest residence, as I've said before, is two and a half miles away. At that location, one would have to assume 8,760 hours, which we did do in the analysis. Because, as I said before, there is no land or no residence, or buildings, or occupation in the area of the Owner Controlled Area Boundary, it's reasonable to assume something less than that. This is supported by Interim Staff Guidance 13, which is the real and definite real individual. And 2000 hours is based on a 40 hour work week, with 50 weeks a year, so it's a reasonable working dose rate, if you will, a dose rate based on a working year.

MR. TURK: In essence then, since there's no residence at the OCA Boundary, you don't have to calculate a dose at that boundary for a residence, for a person who's located inside a residence.

DR. REDMOND: That's correct.

MR. TURK: And then even if you're assuming a 2000 hour presence at the OCA Boundary, that would assume that somebody is actually working in the fields, or working in very close proximity to that site fence.

DR. REDMOND: Forty hours a week, 50 weeks a year, which based on my understanding of the land usage is still extremely conservative.

MR. TURK: And that would also assume that if an accident happened at the PFS site, such as casks tipping over during a seismic event, that people would remain at the site boundary, nonetheless, for that entire period of time, for the 2000 hours. Correct?

DR. REDMOND: Correct.

MR. TURK: So in essence, even the 2000 hour calculation would be conservative?

DR. REDMOND: Based on my understanding of the land usage around PFS, yes, it would be.

MR. TURK: In answers 36 to 37, and here we may straying into Dr. Singh and Soler. You'll have to tell me if that's correct. I think answer 36 is indicated to be Dr. Soler and Dr. Redmond, and the same with 37.

DR. REDMOND: Right.

MR. TURK: You use the phrase, "Localized damage to the cask."

DR. REDMOND: Correct.

MR. TURK: Could you explain what you mean by "localized damage"?

DR. REDMOND: Well, it would be just that,

damage that would be localized to a certain area of the cask. In the sense that, for example, the ventilation ducts on the HI-STORM overpack are localized, openings in the overpack. They're small. Localized implies not the entire overpack.

MR. TURK: And in using that phrase, are you essentially talking about the types of damage that occur -- that might occur, as expressed in answer 37? And there, you use phrases like, "Localized crushing and associated microcracking of the concrete."

DR. REDMOND: Yes, localized damage, again, is the -- localized to a small area of the overpack, not the entire overpack.

MR. TURK: And with respect to the steel shell that surrounds the concrete, is that -- would that be this minor flattening that's described in your testimony?

DR. REDMOND: Yes. We're talking about the outer steel shell of the overpack, which encases the concrete of the HI-STORM overpack.

MR. TURK: Dr. Redmond, in answer 43 -- I should ask Dr. Soler first, did you wish to add anything to Dr. Redmond's answers?

DR. SOLER: I am perfectly content with his answer.

MR. TURK: Okay. Now turning to answer 43, again, this is Dr. Redmond's answer. You discuss some of the calculations performed by Dr. Resnikoff.

DR. REDMOND: Correct.

MR. TURK: One of the areas that you discuss is the fact that Dr. Resnikoff calculated an annual dose resulting from an accident. I believe this is at the top of page 22. It's the last paragraph that begins with the words, "Lastly, Dr. Resnikoff estimates."

DR. REDMOND: Okay.

MR. TURK: And you indicate that Dr. Resnikoff has calculated a dose rate with the conditions as stated in that paragraph, ranging from 45.1 millirems per year, to 451 millirems per year. Could you explain how you understand Dr. Resnikoff calculated that with respect to the time used in the calculation? Do you understand my question?

DR. REDMOND: I think I do. If you'll give me just a second to review what I've written.

MR. TURK: Let me see if I can sharpen it a little bit. The value that was provided was a dose per year, which to me sounds like an annual dose. And I'm wondering how you understand that he calculated that dose. How many hours was assumed in the

calculation?

DR. REDMOND: I believe in this calculation, the 451 millirem per year is based on 8,760 per hours per year, as opposed to the analysis we did with a 2000 hour. I believe this is based on 8,760.

MR. TURK: And in order for the 8,760 hours to be relevant, somebody would have to be at the OCA Boundary for 8,760 hours a year?

DR. REDMOND: Yes. Basically, they'd have to be living there, be it in a tent or whatever, for 24 hours a day, 365 days a year.

MR. TURK: And that's even after the accident occurred, we assume that -- Dr. Resnikoff would be assuming that they simply stay in that location 24 hours a day the whole year.

DR. REDMOND: Correct.

MR. TURK: And was any shielding provided for that person in Dr. Resnikoff's calculation, or is the person assumed to be standing outside by the tent, essentially?

DR. REDMOND: No, they're assumed to be there, standing outside or in a tent.

MR. TURK: So there's no shielding provided by a structure or a residence.

DR. REDMOND: No. No.

MR. TURK: Under Dr. Resnikoff's calculation.

DR. REDMOND: Correct.

MR. TURK: And I take it, you believe that's an incorrect manner in which to do the calculation for the accident dose?

DR. REDMOND: Sure. The accident dose should, in my view, be calculated similar to the way the normal condition would be of calculating --

MS. CHANCELLOR: Excuse me, Dr. Redmond. It's difficult to hear you. Could you speak up just a little?

DR. REDMOND: Certainly. My apologies.

The accident condition dose should be calculated, in my opinion, in a manner similar to the normal condition dose rate.

MR. TURK: By that you mean a 2000 hour dose experience should be used.

DR. REDMOND: Yes, taking into account the usage of the land.

MR. TURK: Okay. In answer 46, you provide different areas in which you believe Dr. Resnikoff's calculation is incorrect.

DR. REDMOND: Correct.

MR. TURK: And then you indicate in answer 47 that, "If the four inaccuracies discussed in answer 46 were corrected, Dr. Resnikoff's calculated dose rates would be reduced by approximately a factor of 2.9." Have you reviewed Dr. Resnikoff's amended testimony?

DR. REDMOND: Yes, I have.

MR. TURK: Has he made the corrections that you point out in answer 46?

DR. REDMOND: Each of the four items pointed out in item 46 has been corrected in the amended testimony, and the dose rates have reduced by give or take that factor. In addition, though, Dr. Resnikoff has added in an additional component this time around that was not in the previous calculations. He's added some neutron dose rate, which is a minor contributor.

MR. TURK: He had not included neutron doses in his original calculations?

DR. REDMOND: No. In the original calculations for the tipped-over condition, the dose rate is at the bottom of the overpack. Dr. Resnikoff only considered gamma radiation.

MR. TURK: Now turning to answers 58, 59, and 60. Now these are Dr. Soler, up to 60, where Dr.

Singh has a hand, it looks like.

Dr. Soler.

DR. SOLER: Yes.

MR. TURK: In answer 59, you discuss a 27 inch drop, and you compare that to a 25 foot drop. Could you explain for the 25 foot drop, what does that drop involve?

DR. SOLER: That drop involved, assuming that an MPC was -- which is normally in a transfer cask. The transfer cask doors fail and disappear. And at the same time, the crane or the slings that are holding the MPC also fail, so that the MPC loaded drops 25 feet through the opening of the HI-STORM and impacts the base of the HI-STORM. Now that is the real situation. The analysis model assumes that it drops 25 feet onto a very, very thick slab of concrete, attempting to simulate a rigid surface.

MR. TURK: In the calculation then, do you put in a more rigid surface than is provided for by the base of the HI-STORM cask?

DR. SOLER: Yes.

MR. TURK: And that, in effect, increases the --

DR. SOLER: That would increase the decelerations that we predict.

MR. TURK: And in that situation, is the MPC in tact at the end of the drop, the 25 foot drop?

DR. SOLER: Excuse me. Could you repeat that?

MR. TURK: Yes. In the analysis of the 25 foot drop of the MPC from the position within the Hi-=Trac transfer cask down into the base of the HI-STORM storage cask, does the MPC remain in tact?

DR. SOLER: Oh, in tact. Yes, it remains in tact. There is no rupture of the MPC.

MR. TURK: And what deceleration value applies to that situation?

DR. SOLER: Applies to that situation, I think I'm going to have to defer that to Dr. Singh, who whispered in my ear. What is it?

DR. SINGH: Well, the maximum deceleration -- you know, the deceleration varies through the body of the canister. The maximum deceleration, to my recollection, is about 300 Gs. Now we're looking at the integrity of the confinement boundary, which is a calculation to determine the extent of strain sustained by the MPC.

MR. TURK: The testimony at answer 59 indicates that in that hypothetical MPC drop, and just for the record, MPC is the multi-purpose canister, you

say that, "It can be subjected to that drop without consequences." In other words, the confinement boundary remains in tact.

DR. SINGH: That's correct.

DR. SOLER: Correct.

MR. TURK: The design-basis for the multi-purpose canister, as I recall, is 60 Gs for the cask drop?

DR. SINGH: That's correct.

MR. TURK: And as we saw in earlier testimony, in the event of a cask tip-over at the PFS facility, the calculated deceleration value is on the order of somewhere between 43 and 43.5 Gs?

DR. SINGH: Below 45 Gs, yes.

MR. TURK: Below 45 Gs.

DR. SINGH: That's correct.

MR. TURK: In describing this 27 inch drop, is that a value that you believe is an applicable value, or is that something that Dr. Resnikoff uses in his calculations?

DR. SOLER: That is a number that Dr. Resnikoff uses.

MR. TURK: And does that, in essence, assume that the cask sitting on the storage pad is forced up due to seismic forces --

DR. SOLER: Yes.

MR. TURK: -- by some number of feet up into the air?

DR. SOLER: Yes.

MR. TURK: And is it your understanding that that's based upon Dr. Kahn's ALTRAN report?

DR. SOLER: That is my understanding.

MR. TURK: Do you believe that's a realistic, or even conservative assumption?

DR. SOLER: I believe it's entirely unrealistic.

MR. TURK: In the event there was to be a drop of the MPC within the canister transfer building, what affect would the structure of the CTB have with respect to shielding of any radiation doses that could result?

DR. REDMOND: The building will provide shielding, obviously for anything that would -- any radiation. The building provides normal condition, or provides shielding anyway for the HI-STORM overpack. Radiation coming off the HI-STORM overpack is attenuated by the building and the structures in the building.

MR. TURK: Could you describe the nature of the shielding that's provided by the structure's

walls? How thick are the walls, and how are they positioned with respect to the canister transfer cells?

DR. REDMOND: I'm not familiar with the structure of the building. I mean, they provide attenuation capability, but I don't know the thickness of the walls, or I don't have familiarity with the building.

MR. TURK: Are either of you gentlemen familiar with the CTB structure?

DR. SOLER: Not to the extent that I could comment on the thickness of the walls, no.

MR. TURK: Okay. That's all I have, Your Honors.

(Judges conferring.)

CHAIRMAN FARRAR: We were debating whether we wanted to ask some questions now, but we think it would be better to have the State just proceed with its cross examination.

MS. CHANCELLOR: Could we have a five minute break, Your Honor?

CHAIRMAN FARRAR: Sure. Is that all you need, or --

MS. CHANCELLOR: Well, if we could make it ten, I think this radiation dose testimony is going to

go much faster than we anticipated.

CHAIRMAN FARRAR: Okay. Then it's -- well, we'll take our only break we'll take before lunch, and take that now. It's three minutes of. Let's be back at ten after.

MS. CHANCELLOR: Thank you.

(Off the record 10:57:00 - 11:11:15 a.m.)

CHAIRMAN FARRAR: Ms. Chancellor, is the State ready to proceed?

MS. CHANCELLOR: Yes, we are, Your Honor.

CHAIRMAN FARRAR: Okay.

MS. CHANCELLOR: Good morning. My name is Denise Chancellor, representing the State of Utah. Like Mr. Turk, unfortunately Mr. Redmond, most of my questions will be directed at you. I would request that the witnesses don't whisper into the other person's ear while there's a question pending on the floor. And with that, let's get started.

Dr. Soler, is it fair to say that the bulk of the testimony that you have submitted, the seismic exemption, basically relates back to Section D, the Dynamic Analysis?

DR. SOLER: Except for the portions which refer to tip-over here. I mean, if you count dynamic analysis, if you count tip-over as a dynamic analysis,

then I would say yes.

MS. CHANCELLOR: And Dr. Singh, would the bulk of your testimony also relate back to dynamic analysis?

DR. SINGH: I don't really understand the question. By "dynamic analysis" do you mean, for example, tip-over, drop, and so on?

MS. CHANCELLOR: Yes. Correct.

DR. SINGH: Well, then it's -- our contribution to this testimony is the structural aspects or the behavior of the cask under postulated events.

MS. CHANCELLOR: And, Dr. Singh, you don't have experience with analyzing the radiation dose consequences. Is that -- with radiation dose consequences. Is that correct?

DR. SINGH: No, I don't, not direct. I don't do radiation analyses myself.

MS. CHANCELLOR: And, Dr. Soler, it's correct that you don't do radiation dose consequences.

DR. SOLER: That is correct.

MS. CHANCELLOR: And, Dr. Redmond, you do radiation dose consequences. Is that correct?

DR. REDMOND: Yes, I do.

MS. CHANCELLOR: And that's your area of

focus. Correct?

DR. REDMOND: Correct.

MS. CHANCELLOR: And you testified that you have not visited the PFS site. Is that correct?

DR. REDMOND: That's correct.

MS. CHANCELLOR: And can you describe any of the houses that are located around the PFS site buildings?

DR. REDMOND: No, I assume, based on my understanding of the site, beyond the buildings within the -- near the SVC, that there are none. But as I said, I have not visited the site.

MS. CHANCELLOR: And you don't know where ranch houses are located, for example?

DR. REDMOND: No, I do not.

MS. CHANCELLOR: And you don't know of any land use plans for the area, say for the next 20 years?

DR. REDMOND: No, I do not.

MS. CHANCELLOR: So you don't know if somebody will move into the area within the next 20 years.

DR. REDMOND: No.

MS. CHANCELLOR: And you don't know whether the houses on the reservation will expand

because of all the funds they're getting from PFS. Right?

DR. REDMOND: I wouldn't have an idea. No.

MS. CHANCELLOR: And during your deposition, I believe you stated that you have not reviewed the calculations for cask performance, cask tip-over, Stone & Webster's pad sliding analysis, those dynamic-type of analyses.

DR. REDMOND: That's correct.

MS. CHANCELLOR: Is that still the case?

DR. REDMOND: Yes, it is.

MS. CHANCELLOR: And you also testified in your deposition that you're not an expert in thermal or concrete analysis. Do you recall that?

DR. REDMOND: Yes.

MS. CHANCELLOR: And is that still the case?

DR. REDMOND: That's correct.

MS. CHANCELLOR: You obtained your Ph.D. about five years ago. Is that right?

DR. REDMOND: Yes, 1997.

MS. CHANCELLOR: And the focus was on analysis using Monte Carlo?

DR. REDMOND: Yes, the title of my thesis

was "Multi-group Cross-section Generation with Monte Carlo Methods", or via Monte Carlo methods.

MS. CHANCELLOR: And can you describe what is Monte Carlo, other than a place in Europe?

DR. REDMOND: Well, the name is very appropriate. Basically, it's a radiation transport technique, analysis technique. Basically, you track individual particles using games, basically. You're playing games, as you would in Monte Carlo, for figuring out if a particle is going to scatter, or if it's going to interact or get absorbed, and you track multiple particles to assess what the quantity is you're looking for, be it a dose rate, a flux, or anything else. So you represent reality with a computer code.

MS. CHANCELLOR: And you use Monte Carlo -- did you use Monte Carlo for the normal operation dose computation -- let me back up.

Did you do a normal operation dose computation for the PFS site?

DR. REDMOND: Yes, I did.

MS. CHANCELLOR: And did you use Monte Carlo for that analysis?

DR. REDMOND: Yes, I did. It's the most state-of-the-art code, or technique for doing this

sort of analysis.

MS. CHANCELLOR: And the site-specific dose analysis for PFS was based on a 2000 hour year period. Is that correct?

DR. REDMOND: That's correct, at the Owner Controlled Area Boundary. And again, the analysis at the nearest resident was done for 8,760 hours.

MS. CHANCELLOR: And the dose that you came up with at the fence post using Monte Carlo was five --

DR. REDMOND: About 5.85. I'd have to look.

MR. GAUKLER: 5.8 what?

DR. REDMOND: Sorry. Millirem per year, based on a 2000 hour occupancy.

MS. CHANCELLOR: Dr. Redmond, are you familiar with PFS' seismic exemption request?

DR. REDMOND: Yes.

MS. CHANCELLOR: Isn't it correct that PFS in April of '99, initially asked for a 1,000 year return period earthquake as the design-basis earthquake?

DR. REDMOND: I believe that's correct. I'm familiar with the exemption request in terms of the dose consequences mostly.

MS. CHANCELLOR: Do you know what the design-basis earthquake is that PFS amended its exemption request to?

DR. REDMOND: I would be speculating. I could take a guess, but I don't know for sure.

MS. CHANCELLOR: I'm sure Mr. Gaukler will instruct you not to guess. Are you familiar with the dose analysis that would have been required under the 1998 Rule Making Plan when PFS submitted its exemption request, the two-tiered approach that NRC had?

DR. REDMOND: No.

MS. CHANCELLOR: If I describe it, let me see if you're familiar with it. Under the '98 rule making, there was a two-tier approach where the applicant would analyze the dose consequences under accident conditions, but under 104A. And if they could meet the normal operations under 104A, they could get a 1,000 year return period earthquake. Otherwise, they would have to analyze dose consequences under 104B, and a 10,000 year design-basis earthquake would apply. Are you familiar with that concept at all?

DR. REDMOND: Not beyond what I read in this - in previous testimony.

MS. CHANCELLOR: Oh, I think I misspoke.

I said 104b. I meant 106b.

MR. TURK: Objection. It's 104a.

MS. CHANCELLOR: 104a and 106b. They were the two regulations I was referring to. So do you recall whether you performed any calculations back in April of 1999 to support PFS' exemption request?

DR. REDMOND: No. The analysis I performed is for their site-specific analysis, but not specifically for an exemption request.

MS. CHANCELLOR: For the operational dose, where you came out with the 5.85 millirems --

DR. REDMOND: That was done for their license, not specifically for an exemption request.

MS. CHANCELLOR: Right. But that's the analysis that you have done. Correct?

DR. REDMOND: That's correct.

MS. CHANCELLOR: Have you performed any other -- other than the Monte Carlo normal operational doses, have you performed any other quantitative analysis for the PFS site with respect to radiation doses?

DR. REDMOND: No, I have not.

MS. CHANCELLOR: Isn't it true that you could have used Monte Carlo to perform radiation dose analysis at the Control Area Boundary for accident

conditions?

MR. GAUKLER: Objection. Isn't that defined with epivacent conditions?

MS. CHANCELLOR: For the qualitative analysis that you opine on in your testimony, such as if all 10,000 casks fell down, and what would be the dose consequences at the Area Control Boundary? Could you have used Monte Carlo to conduct a quantitative analysis?

DR. REDMOND: Certainly. The same techniques used for the normal condition could have been used for the hypothetical accident of 4,000 casks tipping over, but it is not our practice to do hypothetical conditions, so it has not been performed. But yes, it could have been used.

MS. CHANCELLOR: So in your testimony you use, basically, an analogy to render a qualitative opinion?

DR. REDMOND: Yes, and experience.

CHAIRMAN FARRAR: Dr. Redmond, if you'd be sure to keep your voice up.

DR. REDMOND: Oh, sorry.

MS. CHANCELLOR: I'm curious, Dr. Redmond. In answer 24, you come up with a 52 by 40 array when you talk about casks at the PFS site.

DR. REDMOND: Correct.

MS. CHANCELLOR: Can you describe how -- isn't it true that there are two halves of the storage facility with 250 casks in each half?

DR. REDMOND: Yes. Well, I'd have to look at my diagram, but they're still arranged in a two by forty array, essentially, and then multiple rows of that.

MS. CHANCELLOR: Aren't they arranged in -- well, let's start with each pad.

DR. REDMOND: Uh-huh.

MS. CHANCELLOR: There are two by four casks on each pad. Right?

DR. REDMOND: Right. And then the pads are positioned end-to-end, which effectively create what I consider to be a two by forty array, because you went from a two by four. Now you put the pads end-to-end, and you get two by forty array. And then you have 50 of those.

MS. CHANCELLOR: Staff's Exhibit X, let me show you that.

MR. TURK: May I make a suggestion, or ask the Board for direction. It might be that it's useful to introduce the Staff's exhibits at this time if we're going to question on them. I won't have any

problem if we do that.

MS. CHANCELLOR: Your Honor, this is a pre-filed exhibit. I believe it's already been added into the record.

MR. TURK: It hasn't been entered yet. We were going to do it with Mr. Waters' testimony. There are three exhibits associated with Mr. Waters' testimony.

CHAIRMAN FARRAR: It has not been identified yet?

MR. TURK: It has been marked for identification by us as we sent out testimony to people.

CHAIRMAN FARRAR: But not --

MR. TURK: But not offered into the record yet.

CHAIRMAN FARRAR: Not offered for identification into the record.

MS. CHANCELLOR: There are numerous exhibits that have a diagram of the PFS site. I just happened to pull this one out of my binder. It may be confusing if this is entered prior to the testimony.

CHAIRMAN FARRAR: Do you have PFS 84 handy?

MS. CHANCELLOR: Can I just show him a

diagram of the PFS site?

CHAIRMAN FARRAR: Yeah. That's fine.

MS. CHANCELLOR: Dr. Redmond, here's a diagram of the PFS site that is taken from SAR Figure 1.2-1. Are you familiar with this general layout of the PFS site?

DR. REDMOND: Yes, I am.

MS. CHANCELLOR: And isn't it correct that the casks are arranged in two halves, basically?

DR. REDMOND: Yes. They're basically in two halves, but within each half, again, you have what I said here was a two by forty array of casks.

CHAIRMAN FARRAR: Ms. Chancellor, maybe we can short circuit this. I think the problem here is none of us have thought of it in these terms before, but he's saying -- he's taking the two by four on one cask, times the ten casks in a column, and making that two by forty.

DR. REDMOND: That's correct.

CHAIRMAN FARRAR: Which is not how I visualized it.

MS. CHANCELLOR: Okay.

CHAIRMAN FARRAR: I had not visualized it that way before, but that's what I think he's doing.

DR. REDMOND: That's exactly right,

because the spacing the pads is such that it's effectively the same.

MS. CHANCELLOR: Okay.

CHAIRMAN FARRAR: So for your purpose, ten pads are one pad.

DR. REDMOND: Right.

CHAIRMAN FARRAR: Because of the narrow spacing between them in that direction.

DR. REDMOND: Right. That's correct.

CHAIRMAN FARRAR: Okay.

MS. CHANCELLOR: Dr. Redmond, if you turn to answer 32 on page 14.

DR. REDMOND: Okay.

MS. CHANCELLOR: And this is getting at the 2000 hours versus the 8,760 hours. In the second sentence you state, "The site-specific analysis for the PFS facility takes into account the particular characteristics found at the PFS site, as discussed above." Can you please describe what the particular characteristics at the PFS site are with respect to the 2000 hour occupancy time?

DR. REDMOND: The fact that the nearest resident is two and a half miles away, that the land beyond the Owner Controlled Area Boundary is unoccupied, no buildings to my knowledge, and is not

used on a regular basis.

MS. CHANCELLOR: And it's true that the Certificate of Compliance for the HI-STORM, the radiation dose analysis there was based on 8,760 hours?

DR. REDMOND: The Certificate of Compliance for HI-STORM, I have to say, does not dictate an occupancy time. The analysis in the HI-STORM FSAR did use 8,760 hours as a bounding approach.

MS. CHANCELLOR: So it would be more conservative to use 8,760 hours, than 2000 hours. Correct?

DR. REDMOND: It would certainly be more conservative to do that, but it is more appropriate to use the 2000 in this case because of the land usage.

MS. CHANCELLOR: The land uses that you're not familiar with. Is that correct?

DR. REDMOND: To the extent that I am familiar with it, yes, it would be more appropriate.

MS. CHANCELLOR: In Section 106D for the accident dose analysis, it states, "Any individual located on or beyond the nearest boundary of the Controlled Area, may not receive from any design-basis accident the more limited of a total effective dose equivalent of 5 rem."

What is the -- for purposes of your testimony that has been pre-filed, what is the duration time applicable to the 5 rem accident limit in 106b?

DR. REDMOND: The analysis that's been done for Private Fuel Storage did not analyze tip-over of the casks, because it was hypothetical, so we did not do that. And in that regard, there is no dose consequences to the HI-STORM overpack. There was reference back to the HI-STORM FSAR for accident conditions related to the Hi-TRAC transfer cask. And the analysis in the HI-STORM FSAR assumed a 30 day duration for the accident.

MS. CHANCELLOR: Thirty day duration. Sorry, I didn't hear the last part.

DR. REDMOND: Thirty day duration for the accident associated with the Hi-TRAC transfer cask.

MS. CHANCELLOR: And what was the doses of the 30 day duration for the HI-TRAC?

DR. REDMOND: With regulatory guidance by the NRC, I believe in NUREG 1536.

MS. CHANCELLOR: And is that the damage to fuel cladding?

DR. REDMOND: No, I don't believe it's related to that.

MS. CHANCELLOR: Specifically, where in 1536? I can give you a copy of it, if you want.

DR. REDMOND: I'd have to go looking for it. I don't -- it's been a while since I reviewed the document.

MS. CHANCELLOR: So for purposes of the pre-filed testimony where you compare the accident, the dose consequences at the Owner Controlled Area, what time duration are you using?

DR. REDMOND: I believe in my pre-filed testimony, I didn't use a time period. I believe in my testimony what I said was that with the dose rates calculated by Dr. Resnikoff, it would take a minimum of, I don't know, maybe two years to reach the 5 rem limit, so in my testimony, I don't believe I actually applied a duration.

MS. CHANCELLOR: If you were to do a quantitative analysis, what would you -- what would be the duration time to use?

DR. REDMOND: A quantitative analysis of what exactly?

MS. CHANCELLOR: Of the radiation dose to a person at the fence post.

DR. REDMOND: Well, the analysis for -- we wouldn't do an analysis for a HI-STORM cask,

obviously, because it's a hypothetical condition. And for the transfer cask, again, what's been done was a 30 day duration in the HI-STORM FSAR.

MS. CHANCELLOR: So you would just use analogy. You wouldn't do a -- you couldn't see any scenario in which you would need to do a quantitative analysis from accident conditions at the PFS site that may affect a person at the Owner Controlled Boundary. Is that your testimony?

DR. REDMOND: For direct radiation dose, that is correct.

MS. CHANCELLOR: Okay. In NUREG 1536 on page 11-2, dose limit for design-basis accidents, I don't see any time limit. In Acceptance Criteria 4, Item 2, "Any individual located at or beyond the nearest Controlled Area Boundary must not receive a dose greater than 5 rem to the whole body, or any organ, from any design-basis accident." There doesn't appear to be a time limit. Are you certain that there's a time limit that you have seen in NUREG 1536, or is that --

DR. REDMOND: No, I'm not certain about that. I was -- I thought there was, but I'm not certain about NUREG 1536. However, in NUREG 1567, which deals with the site-specific evaluation, it is

-- the 30 day time limit -- the suggested 30 day time interval is mentioned, but that NUREG is not applicable to the HI-STORM FSAR, which is what I was talking about before.

MS. CHANCELLOR: 1567 is generic or site-specific?

DR. REDMOND: Site-specific. 1536 is generic.

MS. CHANCELLOR: And you say that 1567 is not applicable to the PFS site?

DR. REDMOND: No. I said it's not applicable to HI-STORM FSAR.

MS. CHANCELLOR: Oh, FSAR. Right, because that's a generic analysis. Okay. I understand.

MR. TURK: I'm sorry. You said 1536 is not applicable to the HI-STORM COC FSAR?

DR. REDMOND: No. What I said was that NUREG 1567 is not applicable to the HI-STORM FSAR, because NUREG 1567 is a site-specific. NUREG 1536 is the generic standard review plan that applies to the HI-STORM FSAR.

MS. CHANCELLOR: Mr. Turk asked you this question, but I still didn't understand the answer. In answer 36, you state that, "Any damage to the cask from a tip-over would be localized." And what is the

basis of your opinion that the damage to the cask would be localized? And can you quantify what you mean by "localized"? Would it be as large as the vents? Would it be as big as a quarter? Would it be -- what do you mean by "localized"?

DR. REDMOND: Localized is kind of a generic term. The vents are fairly large, but relative to the overall surface area of the overpack, it's quite small, so --

MS. CHANCELLOR: That's what, ten inches by fifteen inches?

DR. REDMOND: Some of them. The ones on the bottom are. The ones on the top are six by twenty-five, six inches by twenty-five. So in that sense, it's localized relative to the large surface area of the overpack. So localized is -- has, you know -- can vary a little bit. Certainly, something the size of a quarter is localized.

Now as far as the damage goes, it's my opinion that the damage from a cask tipping over would be localized. It would not affect the entire overpack.

MS. CHANCELLOR: Well, how do you know it will have a negligible affect on radiation shielding if you can't quantify, or give some sort of a range of

what localized damage to the cask means?

DR. REDMOND: Well, as I've -- in the testimony provided, there is discussion concerning concrete cracking, for example. The HI-STORM overpack is designed with a steel shell inside and outside, so any localized damage is still not going to result in loss of concrete. It simply cannot go anywhere, so in that sense, localized damage to the concrete will result in a negligible change in dose, because the concrete is not going to disappear. If the concrete were to disappear from the overpack, then there would be some affect, but not that's not possible in the HI-STORM overpack.

MS. CHANCELLOR: Isn't it true that the metal skin on the outside of the cask could stretch upward, thereby allowing the concrete to thin out?

DR. REDMOND: I'm not qualified to say whether that's possible or not.

MS. CHANCELLOR: And, therefore, you can't quantify how much flattening or change in thickness there would be if the metal skin were to stretch.

DR. REDMOND: I'm not able to quantify that, no. But again, that is, indeed, a localized effect.

MS. CHANCELLOR: And isn't it true that

there has not been any full-scale or model test of an actual HI-STORM cask up?

DR. REDMOND: That's correct.

MS. CHANCELLOR: In answers 41, 50 and 55, you referred -- your testimony deals with doses to on-site workers. And have you done any quantitative analysis of doses to on-site workers?

DR. REDMOND: No. The analysis has been done for Private Fuel Storage, but I've performed, calculated the dose rate at their security fence, and demonstrated it to be less than 2 millirem per hour.

MS. CHANCELLOR: Could you repeat that? Your voice dropped. I didn't quite hear it. I was turning the page. Sorry.

DR. REDMOND: The analysis that I performed --

CHAIRMAN FARRAR: Dr. Redmond, what you found with the microphones, if you'll stay about six inches away and keep your voice up, that works better.

DR. REDMOND: Oh, thank you. The analysis that I performed for Private Fuel Storage calculated the dose rate at 2 millirem at the security fence, and demonstrated it to be less than 2 millirem per hour. I have not done any other calculations of dose to workers for various operations, for example.

MS. CHANCELLOR: And you haven't computed any neutron dose rates at the Owner Controlled Boundary.

DR. REDMOND: No, that's not correct. The neutron dose rates were included in the calculation of 5.85 millirem per year at the Owner Controlled Area Boundary.

MS. CHANCELLOR: But not under accident conditions. Is that correct?

DR. REDMOND: That's correct.

MS. CHANCELLOR: Just under normal operations.

DR. REDMOND: That's correct.

MS. CHANCELLOR: Okay.

DR. REDMOND: Again, because the accident for the HI-STORM overpack is hypothetical.

MS. CHANCELLOR: And when you did -- when you extrapolated from your operational dose quantitative analysis to that extrapolation, isn't it true that you didn't -- that you believe that most of the doses would come from the sides of the cask, and not from the bottom in an accident condition, a hypothetical -- what you call hypothetical accident conditions where the casks are all tipped over?

DR. REDMOND: I'm a little confused by

your question, because you're relating the normal condition dose at the fence post, and said something about extrapolation.

MS. CHANCELLOR: Okay. In your testimony, you extrap -- isn't it true that you extrapolate from the 5.67 or whatever it was dose rate, 5.85 dose rate under normal operating conditions. Don't you use that as basically the basis for extrapolating what will happen under accident conditions at the Owner Controlled Area?

DR. REDMOND: Yes, there are some analogies made. That's the baseline, and I basically say that it's my opinion that the dose rates will not be significantly different than that.

MS. CHANCELLOR: And in that analogy, isn't it true that you don't account for any additional radiation that may come from a certain area in the base of the cask where you stated that the radiation doses would be higher than from the side or the top of the cask?

DR. REDMOND: That's true. I have not done any quantitative analysis of a tipped over condition, so I have not calculated the dose rate from the bottom of the overpack. But again in my testimony, I do talk about the orientations of the

overpacks. And in order for the bottoms to contribute significantly to the dose at the Owner Controlled Area Boundary, they would have to be positioned facing them.

MS. CHANCELLOR: And what --

DR. REDMOND: If they're positioned facing inward towards the other casks, it's negligible.

MS. CHANCELLOR: And what -- isn't it true that you have no experience with respect to the orientation at which the casks may fall over during an earthquake, if they were to fall over.

DR. REDMOND: Well, that's certainly true. It's my opinion, though, that they would fall -- you have a two by forty array of casks, and you have multiple arrays of these, so they have to fall down. If they were all to fall down, they have to fall down. There's a limited amount of space around the casks for them to fall over, so they're going to have to fall with a certain orientation. It's my opinion, although not backed up by analysis, that they would fall such that, say the outer row would fall facing with the tops facing the Owner Controlled Area Boundary. That's just with the amount of space surrounding the ICEC. That's my viewpoint.

MS. CHANCELLOR: Isn't it true that

they're going to topple over at ground orientations and some will fall on top of others, some will --

DR. REDMOND: Sure. And if some fall on top of others, then the bottom of the cask is not facing the Owner Controlled Area Boundary. It's facing the ground, if a cask is resting on top of another cask.

MS. CHANCELLOR: Well, a cask could be lying down on its side, and another cask could fall on top of it, and both the bottoms of the casks could be facing the Owner Controlled Boundary. Right? Or part of one of them.

DR. REDMOND: Well, the one that's laying flat on the ground certainly could be. The one that is tilted cannot be, because if you take a glass and you tilt it, for example, like this, obviously everything is coming down towards the wood. It's not facing the Owner Controlled Area Boundary.

MR. GAUKLER: Have the record show that Dr. Redmond tipped the glass up at an angle, approximately a 30 degree angle, and was talking about the reference of the bottom of the glass with respect to the top of the ledge which the glass was sitting.

MS. CHANCELLOR: Dr. Redmond, let's see. Answer 55, you say -- at the end of answer 55, you

say, "The fact that a worker may reach a limit of 5 rem is of no practical concern to the PFS facility." What do you mean by that statement?

DR. REDMOND: The regulations govern how much dose a worker can receive. The regulations dictate that a worker cannot receive more than 5 rem a year. If a worker receives - and this is for power plants anywhere. If a worker exceeds 5 rem per year they're not permitted to work in the radiation field. So if the workers at PFS were to receive the limit, then they would not be permitted to work in a radiation field any more, and PFS would have to hire additional workers.

MS. CHANCELLOR: You're not saying that workers are expendable.

MR. GAUKLER: Objection.

DR. REDMOND: Obviously, not. I mean, the workers are being protected by the regulations.

MS. CHANCELLOR: But not their jobs.

DR. REDMOND: I wouldn't know the structure is set up in that regard. I mean, I would assume at a power plant, if you reach your limit, you're simply assigned a desk job or something like that. There's plenty of jobs that don't require radiation exposure.

MS. CHANCELLOR: How many people are employed at PFS?

DR. REDMOND: I have no idea.

MS. CHANCELLOR: But it would create a logistics problem for PFS in replacing that worker who had received a 5 rem dose.

MR. GAUKLER: Objection; beyond the scope of the testimony.

MS. CHANCELLOR: No, it's not.

CHAIRMAN FARRAR: I didn't hear you, Mr. Gaukler.

MR. GAUKLER: Objection; beyond the scope of the testimony, I believe.

MS. CHANCELLOR: If you look at the -- in the middle of the answer 55 on page 28, "A worker receiving 5 rem, it's not a problem for the worker, but may end up being a logistics problem for the operating entity." I believe that's squarely within the scope.

CHAIRMAN FARRAR: Objection overruled. Question we might have up here is whether this is within the scope of -- even though it's within the scope of the testimony, whether it's within the scope of the contention. But since it's in the testimony, we'll allow it to proceed.

MR. TURK: Or we can strike the sentence in the testimony.

CHAIRMAN FARRAR: Oh, Mr. Turk. You know we don't like to strike things.

MR. TURK: But I don't think we need testimony on it, because the issue is not will a cask tip-over is a seismic event result in a loss of jobs. That's not the issue before us.

MS. CHANCELLOR: I'll move on, Your Honor.

MR. TURK: Yeah, that's fine.

MS. CHANCELLOR: Dr. Redmond, is it your testimony that PFS will receive only lower burn-up fuel, as opposed to in answer -- what was the answer number? Just one second. 28, on page 12. You talk about a conservative burn-up of 40,000 MWD per MTU, and that cooling time was used by Holtec. A more realistic number for PFS is 35,000 MWD per MTU. Correct?

DR. REDMOND: Correct.

MS. CHANCELLOR: Isn't it true that the reason PFS site -- one of the claimed reasons for the PFS site is that nuclear power plants want to ship their fuel off-site so that they can decommission?

DR. REDMOND: Yes, that's correct.

MS. CHANCELLOR: Isn't it true that plants

that decommission will have both high burn-up and low burn-up fuel?

DR. REDMOND: That would depend on the plant being decommissioned.

MS. CHANCELLOR: But there would be cases where if a plant just closed down, it would still have some higher burn-up fuel.

DR. REDMOND: Again, it depends on the plant. Possibly. Certainly, some plants that have already shut down do not have fuel that are really in excess of 40,000.

MS. CHANCELLOR: Isn't it true that Holtec is applying for an amendment to its license to allow preferential loading of fuel for the HI-STORM?

DR. REDMOND: That's correct.

MS. CHANCELLOR: And preferential loading of fuel means that you can have higher burn-up fuel on the interior of the MPC and lower burn-up fuel on the exterior. Is that correct?

MR. TURK: Objection. Your Honor, are we speaking about the HI-STORM 100 that PFS has applied to use, or are we speaking about an amendment to the HI-STORM cask that PFS has not incorporated in its license application?

CHAIRMAN FARRAR: Can you clarify that,

Ms. Chancellor?

MS. CHANCELLOR: I -- well, as the amendment has not yet been granted, PFS can't in its SAR, cannot apply for Holtec cask use that has not yet been approved. But if this amendment occurs prior to when PFS is granted its license there is, I guess, the potential the PFS could change its license application, and -- to request preferentially loaded fuel to be stored at the PFS site.

MR. TURK: That's the whole point, Your Honor. If HI-STORM is granted an amendment to its COC, and PFS wants to use the amended cask, they would have to apply for an amendment to the PFS application. That's not before you.

CHAIRMAN FARRAR: I think that's right, Ms. Chancellor.

MS. CHANCELLOR: Is it true that if PFS were to use anything other than what is in their license application, that they would not have to do a complete quantitative analysis of radiation dose affects for using different burn-up fuel, if you know?

MR. TURK: Objection on the same basis.

MR. GAUKLER: Also, I didn't understand the question; vague and ambiguous.

MS. CHANCELLOR: What I'm trying to get

at, Your Honor, is that is this radiation dose analysis that is on the record now, is that going to suffice for any potential -- for any future amendments to PFS' license application? That's all I'm trying to establish, and that, I believe, is within the scope of the contention.

MR. GAUKLER: Your Honor, I think it's asking for speculation on the part of the witness.

CHAIRMAN FARRAR: Or is it asking for a legal conclusion? Hold on a minute.

(Judges conferring.)

CHAIRMAN FARRAR: Ms. Chancellor, we don't think this line of inquiry is very useful. I think the Commission Jurisprudence is basically you act on the license application that's in front of you. And if there's a possibility that an applicant will do something else in the future, that's a matter that gets dealt with in the future proceeding. And while in the last three months I've not kept up with recent Commission decisions because I've been elsewhere, I think they had one to that effect fairly recently, if I'm not mistaken.

MS. CHANCELLOR: I'll move on, Your Honor.

CHAIRMAN FARRAR: Okay.

MS. CHANCELLOR: I just want to clear up

a couple of things on the certificate -- clarify some testimony relating to the Certificate of Compliance. The -- Dr. Singh, 60 G fuel, cask, MPC drop, 25 foot drop. Isn't it true that in the Certificate of Compliance for the HI-STORM, that there is a maximum of 63 G based on the damage to the fuel cladding?

DR. SINGH: That's correct.

MS. CHANCELLOR: And that the Certificate of Compliance with respect to the HI-STORM, based on a maximum lift of 11 inches, is 45 G?

DR. SINGH: That's correct.

MS. CHANCELLOR: Okay. Thank you. And that the Certificate -- that Holtec, for its Certificate of Compliance, performed a thermal analysis of the HI-STORM, based on the assumption that all four air ducts at the base of the cask would be blocked?

DR. SINGH: I believe we have performed such an analysis, yes.

MS. CHANCELLOR: And that under that generic analysis, the casks would need to be uprighted in 33 hours.

DR. SINGH: To my knowledge, the cask is upright the whole time.

MS. CHANCELLOR: Assuming the casks

weren't uprighted, based on your generic analysis on the assumption that all four air ducts would be blocked, isn't it true that the casks would need to be uprighted within 33 hours?

DR. SINGH: I think your basis of your question is faulty. Let me clear it up for you. The cask --

MS. CHANCELLOR: No. I would request that you answer the question that I asked. I'm not asking whether it's possible. I'm asking you to assume that the casks are tipped over, and that based on the generic analysis, that all four air ducts would be blocked, isn't it true that there is a regulatory requirement in the generic COC that the casks would have to be uprighted within 33 hours?

MR. GAUKLER: I object on several grounds.

CHAIRMAN FARRAR: Go ahead, Mr. Gaukler.

MR. GAUKLER: I object on several grounds. First of all, she has imposed a regulatory requirement in that question which I don't think exists, and it calls for a legal conclusion. Second, I think the witness ought to be able to allow -- be able to explain his answer as he deems fit. Albeit, he should answer that question, obviously. I think she was trying to preclude him from explaining an answer. And

I think he disagrees with the question, as well, the premise of the question.

CHAIRMAN FARRAR: It's a hypothetical question. If the hypothesis is not a provable one, that's something you can ask about on redirect. And while a witness can usually explain his answer, this is a specific question that take the factual and legal basis of it is given, and even if you don't like the question, answer it, and other counsel can sort it out later if they think they have a problem with it, so the objection is overruled and you may answer.

DR. SINGH: Well, you know I'm always eager to answer questions.

MS. CHANCELLOR: Yes, we have noticed that DR. Singh.

DR. SINGH: But the question has to be fundamentally correct to answer it. I can't answer a question that has a wrong premise.

CHAIRMAN FARRAR: Legally you can. Assume all the vents are blocked, what -- if that happened, and I'm not saying it can happen, if that happened, what are you required to do?

DR. SINGH: What I was going to say is the vents blocked calculation in our FSAR assumes the cask to be vertical to begin with. Therefore, the -- if

you refer to our FSAR, you can't phrase the question the way you phrased.

CHAIRMAN FARRAR: That's your opinion. Unfortunately for you, she can phrase the question anyway she wants. If the casks were tipped over and all the vents were blocked, however that might happen, what do you have to do?

DR. SINGH: If the casks were tipped over and all vents were blocked, the cask will need to be uprighted over a reasonable length of time.

MS. CHANCELLOR: Over what length of time?

DR. SINGH: Over a reasonable length of time, such as 30 days. It will not need to be uprighted in 33 hours in the case of PFS.

MS. CHANCELLOR: And Staff's Exhibit FF, which is a copy of the Holtec Certificate of Compliance, with excerpts from -- what is it? Certificate of Compliance 1014, Appendix A, Technical Specifications for the HI-STORM 100 cask system, on page 11-5. It states, and I quote: "As in the case of 100 percent air inlet blockage accident, the concrete short term limit of 350 degrees would be expected to be reached at approximately 33 hours." Do you agree with that statement?

DR. SINGH: For our COC, for the analysis

carried out, that statement is correct.

MR. TURK: I'm sorry. May I get the page reference?

MS. CHANCELLOR: It's page 11-5, and it's the next to the last page of Staff Exhibit FF. And do you know whether PFS has a requirement in its SAR to upright any casks that have tipped over within 33 hours?

DR. SINGH: I don't believe PFS postulates a cask tipped over, to my knowledge.

MS. CHANCELLOR: That's not my question. If a cask tips over, does PFS have to upright the cask within 33 hours based on its commitment in the SAR, if you know?

DR. SINGH: To my knowledge, they have no such commitment.

MS. CHANCELLOR: Thank you. Do you know whether PFS has any recovery plan to upright casks should they tip over?

DR. SINGH: I have not reviewed that portion of the FSAR recently to give you a definitive answer.

MS. CHANCELLOR: Dr. Soler, do you know whether PFS has any -- I have to have the answer. One question.

DR. SOLER: I do not know. It's not in -- I did not review that portion of the SAR.

MS. CHANCELLOR: And, Dr. Redmond, do you know?

DR. REDMOND: No, I do not.

MS. CHANCELLOR: That's all we have, Your Honor.

CHAIRMAN FARRAR: Thank you, Ms. Chancellor. Let me follow-up on that last one. Does your -- the cask moving equipment you plan to have on-site for regular operations, can they upright a tipped over cask? Can that equipment upright a tipped over cask, or would you have to bring in something else?

DR. SINGH: A tipped over cask can be uprighted using a standard lift yoke provided by our company, and a standard crane.

CHAIRMAN FARRAR: Is --

DR. SINGH: I'm not aware what kind of a crane PFS will have at the site.

CHAIRMAN FARRAR: But, I mean, you have -- the machine that's going to move these casks out of the canister transfer building out to the pad, that machine could be -- would be adapted with this yoke or whatever you're talking about?

DR. SINGH: Yes.

CHAIRMAN FARRAR: Okay. Let me ask, I guess Dr. Redmond. In Regulation 72-104a that Ms. Chancellor mentioned, and I think you're familiar with, it talks about normal operations and anticipated occurrences. What is your understanding, or what understanding did you apply to the phrase "anticipated occurrences"?

DR. REDMOND: Anticipated occurrences would typically mean, for example, elevated temperatures beyond what was considered to be normal. Anticipated occurrences do not --

CHAIRMAN FARRAR: You need to keep your voice up, please.

DR. REDMOND: Anticipated occurrences do not cover things like casks tipping over. Those are accidents, so it's -- in general, anticipated occurrences don't have an impact on the radiation dose, direct radiation dose.

CHAIRMAN FARRAR: So these are things that while they're not normal operation, they're not far outside the bounds of normal operation?

DR. REDMOND: That's correct.

CHAIRMAN FARRAR: And why do you put that limit on that? In other words, why wouldn't they be things that are far outside the bounds of normal

operations, but still within the design-basis accident?

DR. REDMOND: Well, if they're within the design-basis accident, they fall within regulations of 10 CFR 72-106, which is design-basis accidents. But as far as --

CHAIRMAN FARRAR: I see that, but I'm trying to get a handle, other than by reference -- other than by negative inference drawn from the terms of 72-106b, where do I find what anticipated occurrences is intended to cover, since I don't find it in the definitions?

DR. REDMOND: I think Dr. Singh might be able to help out.

DR. SINGH: The regulations actually define three different circumstances. One is normal operation. The other one is off-normal, and then --

CHAIRMAN FARRAR: Meaning close to normal, or not far from normal.

DR. SINGH: Off-normal is an event of short duration that violates the parameters set for the normal condition. Now local --

CHAIRMAN FARRAR: What's the third one?

DR. SINGH: And the third one would be accident condition, extreme environmental phenomena,

such as design-basis earthquake and so on. Now under each set of conditions, there are basically -- the off-normal is the bridge that you are looking for, between normal and accident.

CHAIRMAN FARRAR: And how do I know where it starts and where it stops?

DR. SINGH: Well, the NRC regulations provide fairly in-depth description of how a particular loading should be categorized. And we, in our FSAR, for example, the HI-STORM FSAR, we take the entire universe of loadings, and we split them up into basically three bins, if you will, normal, off-normal, and accident.

CHAIRMAN FARRAR: Would every person fluent in the field put things in -- put the same things in the same bins, or is there some question about some judgment on that?

DR. SINGH: I would think that everybody will do the same. There may be very minor variations, but I've seen the other -- for example, other applications NRC has reviewed. They follow the same approach.

CHAIRMAN FARRAR: Let me ask counsel, is anticipated occurrences defined -- since it's not defined in Part 72, is it defined somewhere else?

MR. TURK: Your Honor, perhaps if I ask one question of the witness, we can get some regulatory guidance on the record?

CHAIRMAN FARRAR: Okay.

MR. TURK: I would ask Dr. Singh to turn to NUREG 1567, if you have that there.

DR. SINGH: No, I don't.

MR. TURK: Section 15.1.

CHAIRMAN FARRAR: Before --

MR. TURK: That's my representation by counsel.

CHAIRMAN FARRAR: You have us more interested in the regulations themselves.

MR. TURK: I'm looking in 10 CFR Part 72. I don't see a specific definition, but that's on the spur of the moment.

CHAIRMAN FARRAR: Okay.

MR. TURK: Regulatory Guidance, however, does have a definition of off-normal event.

CHAIRMAN FARRAR: Again, I thought this was a -- there was a simple answer. Maybe there is, and let's defer an answer.

MR. TURK: I'm sure it's a simple answer, but we'd have to have the right reference in front of us.

CHAIRMAN FARRAR: Okay. Rather than take time now, if somebody wants to come up with that --

MR. TRAVIESO-DIAZ: Mr. Chairman.

CHAIRMAN FARRAR: Yes.

MR. TRAVIESO-DIAZ: May I suggest that we take this up after lunch, so we have some time for reflection.

CHAIRMAN FARRAR: Okay.

MS. CURRAN: Judge Farrar.

CHAIRMAN FARRAR: Yes, ma'am.

MS. CURRAN: I just wanted to comment that I have spent some time recently looking for a definition of the word "accident", and I couldn't find that.

MR. TURK: I'd like to know what normal is.

CHAIRMAN FARRAR: The Board will not take offense to that remark, Mr. Turk.

(Laughter.)

CHAIRMAN FARRAR: All right. Let's leave that until after lunch. Ms. Chancellor, you said you were otherwise finished. Why don't we go through some Board questions. Then people will have everything in front of them as they take their lunch break.

JUDGE LAM: Dr. Redmond, in your Monte

Carlo analyses, how much more radiation is coming out from the bottom of the cask relative to the top and the cylindrical surfaces?

DR. REDMOND: Well, again we didn't calculate the radiation coming out the bottom of the cask, because we didn't analyze the hypothetical tip-over, so I cannot give you quantitative numbers for that. As far as the radiation coming off the top of the cask relative to the radiation coming off the side of the cask, at distance from a single cask, HI-STORM cask, for example, the contribution to the dose to an individual from radiation emanating off the top of the cask is about 2 percent or so. It's very small, as far as radiation coming off the top. And the dose rate on the top of an overpack is less than -- calculated dose rates in our HI-STORM FSAR are less than, I think, 5 millirem per hour. Whereas, on the side of the overpack, your calculated dose rates are somewhere in the neighborhood of maybe 40 or better millirem per hour.

JUDGE LAM: The reason I asked you this question, Dr. Redmond, is Dr. Resnikoff does have a point in saying the bottom of the cask provide the minimal amount of shielding relative to the top, and the cask cylindrical surfaces. If and when a cask's

orientation, it's bottom is facing the fence, then one does need to have some quantitative estimate as to what is the increases in doses.

Now I understand in your testimony you quoted Dr. Resnikoff's number. It's about 77 higher than the normal, therefore, you came up with a conclusion of about 500 millirem per year. But still, the question is, I also understand you. You rely on an argument saying well, it's unlikely all the bottom will be facing the fence. With that understanding, don't you think it would be prudent for you to conduct an analysis showing if and when the bottom is facing the fence, what would the increase in radiation doses be?

DR. REDMOND: Well, let me clarify a couple of things. As far as the amount of shielding on the bottom of the overpack relative to the top of the overpack, there is only one area where the bottom of the overpack has less shielding, and that is in the annular region between where the MPC -- you know, the MPC fits inside the overpack, and there's a two and a half inch gap between it and the inner shell of the HI-STORM overpack, so when you lay the -- if you lay the cask down, that annular region only has a two inch thick shield on the bottom, if you will. It's the

baseplate. But within -- outside of that annular region, the amount of shielding is basically the same as it is on the top, because it's the body of the overpack.

Underneath the MPC directly, there is a five inch steel -- five inches of steel, plus 17 inches of concrete, plus two inches of steel on the baseplate, which gives you more concrete actually than you have on the top of the overpack in the same location. And it gives you -- let me do the quick math. Less steel than you have on the top, but not by a great deal. So the shielding is much less in one area only, and the other areas it's comparable to the top of the overpack.

Now as far as whether it would be prudent to calculate the doses from the bottom of the cask, we never found it necessary to do so, because the tip-over is considered a hypothetical condition, and we don't, as a general rule, analyze hypothetical conditions. We've also never needed to calculate the dose rate from the bottom of a cask for normal occupational exposure. It hasn't been necessary. If it was necessary, then it would be done. It would be performed, but it would be performed in a configuration that would be appropriate for that

analysis. For example, when the HI-STORM cask is being moved via the transporter, it is elevated off the ground, so the bottom of the cask, while not facing an individual, is exposed because it's above the ground, so you do get some scattering. But we've never been -- it's never been necessary to calculate that. Again, if we did want to -- did need to calculate the dose from the bottom of the overpack, it would be in the configuration that would be appropriate.

JUDGE LAM: So you are saying, Dr. Redmond, the amount of shielding at the bottom of the cask is roughly equivalent to the top of the cask?

DR. REDMOND: In all areas except the annular region between the MPC and the overpack. In that area it's considerably less.

JUDGE LAM: All right. Then the question is what type of impact would that be in terms of shielding?

DR. REDMOND: Well, it would, obviously, be an elevated dose rate compared to the top of the overpack. You're talking about an annular region that is two and a half inches wide by sixty-seven inches in diameter, roughly speaking, so if a cask were tipped over, it would be not light a flashlight, but like a

small ring that you would be seeing. Now at distance, 600 meters away, it's going to fan out quite a bit, so there's going to be a small effect. I haven't done the calculations, but it would be my opinion that because of the small area you're talking about, especially relative to the side of the overpack which is a very large area, that the amount of radiation, the dose rate is probably going to be, give or take about the same, but I don't have done calculations to say that.

JUDGE LAM: That would be a relatively easy calculation, wouldn't it, if you were to do it?

DR. REDMOND: It would not be extremely difficult to do. It would require changes to the models, of course, to do that, but it is possible.

JUDGE LAM: I see. One final question, Dr. Redmond. What population size did you use in the Monte Carlo analysis?

DR. REDMOND: That depended on the calculation. If it's a neutron calculation, for example, the coupled neutron gamma calculation, typically I run a half a million particles, 500,000 or 750,000. It depends. The gamma calculations were split into three separate calculations based on the energy group structure, so I could optimize different

energy groups. And they're typically 30 million to maybe 100 million, depending.

In addition, the calculations were performed separately for radiation coming off the side and the top of the cask, so as to further optimize for the particular configuration.

JUDGE LAM: Thank you.

JUDGE KLINE: Yeah. Could you just explain to us, in the event of a cask tip-over, with all the bottoms facing the fence, what's the practical health physics response to that? I mean, assume you're -- as a health physicist you're faced with an array of casks pointing at the fence. Is there anything you can do at that point to further protect the public?

DR. REDMOND: Oh, sure.

JUDGE KLINE: Okay. Tell us about that.

DR. REDMOND: I mean, obviously the first thing you're going to try to do is upright the casks. But if you have to go and gets cranes or something like that, any shielding will help, any temporary shielding. A steel plate, for example. Just bring steel plate up, put it next to the bottom of the overpacks. Obviously, the first thing you would do is to go take measurements and to find out, you know, if

what I've already said is reasonable. What's the dose rate on the side compared to the bottom? Standard health physics practice would be to use temporary shielding, and you could do that. Even if you have one cask tipped over position in the crawler, for example, such that it blocks the bottom of the overpack, will effectively provide additional shielding, so there's plenty of things that can be done.

JUDGE KLINE: But couldn't you just go and stake out a bigger exclusion area at the fence?

DR. REDMOND: Sure, if you've got the property to do so, yeah. That's certainly an option, as well. But I was focused more on the --

JUDGE KLINE: I understand, but with respect to the calculations, if -- would you really have to do a Monte Carlo analysis? I mean, with respect to the shine from the bottoms, would it come out a whole lot different if you just surveyed the bottoms and did an inverse square calculation out to the fence?

DR. REDMOND: Sure. If you had a survey of the bottom, you could certainly take that approach.

JUDGE KLINE: I mean, would it come out a whole lot different from a Monte Carlo approach?

DR. REDMOND: Not a great deal.

JUDGE KLINE: Okay. Thanks.

CHAIRMAN FARRAR: Is the fence you've been talking about in your calculations, or the edge of the Controlled Area, is that the fence that's within 150 feet of where the casks will be, or is this the larger area of the land being leased?

DR. REDMOND: The large area of the land. When I talk about --

CHAIRMAN FARRAR: All right. Then the actual fence is -- embraces 100 acres or so, and there's a larger --

DR. REDMOND: There's a -- the distance to the Controlled Area Boundary is 600 meters.

CHAIRMAN FARRAR: Okay.

DR. REDMOND: But the fence is the 150, the security fences.

CHAIRMAN FARRAR: So the calculation -- you're talking about bringing in plates, steel plates, you which you put inside the actual fence, wouldn't you? Rather than --

DR. REDMOND: Inside the security fence.

CHAIRMAN FARRAR: Right.

DR. REDMOND: If you wanted to bring in steel plates or something like that, you'd position

them right next to the overpacks.

CHAIRMAN FARRAR: Right next to them.

DR. REDMOND: Yeah. I mean, that's the easiest place to do it.

CHAIRMAN FARRAR: Right. This would be a good time to break, unless the redirect would be so short that we could finish it up now.

MR. GAUKLER: I think we should take a break beforehand.

CHAIRMAN FARRAR: Okay.

MR. TURK: And I will have some follow-up questions also, Your Honor, along the lines of Ms. Chancellor's --

CHAIRMAN FARRAR: All right. It's almost -- I take it we've moved faster than we thought we would.

MS. CHANCELLOR: Well, some of us thought we'd move faster than others, but I think that it's going very rapidly. I don't know what the other parties think, but we'll certainly be done by tomorrow, maybe even noon tomorrow.

CHAIRMAN FARRAR: And our plan --

MS. CHANCELLOR: Of course, you know, you could always double that.

MR. TURK: I wouldn't expect it to be

quite that quick, although I don't know the amount of cross the State has for the Staff. I would expect we'll need another hour or so with these witnesses after lunch.

CHAIRMAN FARRAR: All right.

MR. TURK: Maybe slightly more than an hour. And then Ms. Taft's testimony might take the rest of the day, and then Dr. Resnikoff may take more than half a day tomorrow. Probably would.

CHAIRMAN FARRAR: But the -- our goal was to finish the three sets of witnesses by the end of Wednesday.

MR. GAUKLER: By Wednesday noon.

MS. CHANCELLOR: Wednesday noon was our goal.

CHAIRMAN FARRAR: Okay.

MS. CHANCELLOR: That's right. And Wednesday, end of the day Wednesday was sort of the fall back position, but I don't see why we couldn't get through by end of the day Tuesday.

CHAIRMAN FARRAR: All right. It's now 12:25. Let's take a few minutes extra. We'll come back at 1:30.

(Whereupon, the proceedings went off the record at 12:25: p.m. and resumed at 1:33 p.m.)

CHAIRMAN FARRAR: We're back on the record after lunch. When we broke, we were anticipating the Applicant's redirect unless there are some preliminary matters. If not, go ahead, Mr. Gaukler.

MR. GAUKLER: There is one preliminary matter I would like to just point out. In identifying the regulations the definition for anticipated operational occurrences in the context of 10 CFR Part 50, I'll just give you an idea by analogy the obligatory meaning.

CHAIRMAN FARRAR: Where is that?

MR. GAUKLER: That's in 10 CFR Part 50 Appendix A, General Design Criteria and under definitions and explanations.

CHAIRMAN FARRAR: At that beginning?

MR. GAUKLER: Yes, it's at the top of the third page in Appendix A. In the January 1, 2002 revision. I don't know where it's in the other revision.

CHAIRMAN FARRAR: Can I ask the page number you are looking at?

MR. GAUKLER: I'm looking at page 787 of the January 1, 2002.

MS. CHANCELLOR: What's the term called again?

MR. GAUKLER: Anticipated operational occurrences. This is in respect to nuclear power plants. Anticipated operational occurrences mean "those conditions of normal operation which are expected to occur one or more times during the life of nuclear power unit and include but are not limited to lose of power to all recirculation pumps, tripping of the turbine generator set, isolation of the main condenser and loss of all off-site power."

CHAIRMAN FARRAR: Thank you, Mr. Gaukler. People will be free to argue that it does not mean by analogy.

MR. TURK: Your Honor, I did not find a specific reference in the regulation to the term but I only had the one hour over lunch hour break to look. We do however have other references that we will point out during examination of the witness.

CHAIRMAN FARRAR: All right.

MR. TURK: Which will be somewhat different from Part 50 use of that term.

CHAIRMAN FARRAR: Okay. Thank you all.

MR. TURK: But I would no to either of them regardless whether one uses the once or more during a lifetime facility or what we will show you which is the perhaps once per year. Whatever the

definition is, that is not a design basis accident and it is not an accident that goes beyond the design basis. It's something that you can describe as something that is expected to occur and that could occur during the operation of the facility.

CHAIRMAN FARRAR: If you keep talking I'll have to give Ms. Chancellor a chance to talk or take up her suggestion and strike your remarks. Thank you, Mr. Tulk. But as I indicated everyone not to minimize that position but on a serious note, everyone will have a chance to argue their own position on that. Mr. Gaukler.

MR. GAUKLER: Thank you, Your Honor.

REDIRECT EXAMINATION (con'd)

MR. GAUKLER: Dr. Singh, Dr. Redmond was questioned by Ms. Chancellor with respect to the burn-up rate and the cooling time for fuel that might be expected to be stored at the PFS site over time. Based on what you know, would you expect that the dose rate of spent fuel to be stored at the PFS would increased significantly over time?

DR. SINGH: No, I don't.

MR. GAUKLER: And why is that?

DR. SINGH: The reason is that PFS will not package its own canisters. The canisters will be

packaged in other words loaded at the nuclear power plants where they were produced and the assemblage once they are loaded in the MPC they have to be transported to the PFS facility under 10 CFR 721 Regulations. These regulations are extremely strict with respect to the dose that can come out of the transport package.

Because of that, the canisters that will arrive at PFS regardless of cooling time, burn-up and so on will have to meet a very severe dose limit. That's why I don't expect the dose to increase over time in any significant quantity.

MR. GAUKLER: Can I take your answer to mean that if a facility were to load a HI-STORM cask and store it at the nuclear power plant site without going through transportation under Part 71 it could load higher fuel and a shorter cooling time of fuel?

MS. CHANCELLOR: Objection, Your Honor. You ruled that this line of questioning was outside the scope. You wouldn't allow me to pursue this line of questioning with respect to what could happen in the future, with respect to the type of fuel that may be loaded and to a HI-STORM cask so therefore it's beyond the scope of redirect.

CHAIRMAN FARRAR: Where are you going with

this, Mr. Gaukler?

MR. GAUKLER: I'm just making the point to show why the 40,000 MTU and ten year cooling time was conservative in the analysis we used. That was referred to in the testimony.

CHAIRMAN FARRAR: Ms. Chancellor, I think I kept you from going where you wanted to go because it had to do with matters that would require an amendment of the license to pursue Mr. Gaukler's questions within the scope of the existing system. So I'm going to give him a little leeway.

MS. CHANCELLOR: But only to the extent that Mr. Gaukler is stating that the HI-STORM on-site at a nuclear power plant could have higher burn-up fuel than fuel stored at PFS. But that gets to whether that type of fuel, the higher burn-up fuel that could be used on-site at a nuclear power plant could be stored at PFS. That's where you wouldn't let me go. I just don't see how this is within the scope of redirect because it's not conservative if PFS can't do it. That's my point, Your Honor.

MR. GAUKLER: I can rephrase my question.

CHAIRMAN FARRAR: Give me a minute here before you do.

(Judges conferring.)