CHAIRMAN FARRAR: Go ahead, Mr. Gaukler.

MR. GAUKLER: Dr. Singh, if I understood your previous answer what you are saying is that the fuel that can be stored at the PFS site is limited by the fuel that can be transported 10 CFR Part 71. Correct?

DR. SINGH: That is correct.

MR. GAUKLER: Is it true that the fuel that could otherwise be stored at the PFS site under this license will be restricted or limited by what can be transported under the transportation regulations and requirements of the NRC?

DR. SINGH: That is correct.

MR. GAUKLER: And right now for example could PFS transport fuel with a burn-up of 40,000 MWT/MTU and a cooling time of 10 years to the PFS site under the current transportation set-up?

DR. SINGH: No, we can not.

MR. GAUKLER: Why is that?

DR. SINGH: The reason is that the dose from a canister with 40,000 burn-up and 10 year cooling time would exceed the dose permitted under transportation regulations that is 10 CFR 71 in the HI-STORM transport cask.

MR. GAUKLER: And therefore that makes

PFS's use of 40,000 MTU burn-up and 10 year cooling time a very conservative number for its dose calculation. Correct?

DR. SINGH: That makes it a conservative number. That's correct.

MR. GAUKLER: There is also some testimony and discussion of which way the cask may be pointed. Should they in a hypothetical tip over event tip over, if more than one were to tip over? Dr. Redmond mentioned his belief that they could not all be pointed in all the same way. Dr. Singh, do you have any other reasons or could you elaborate on why you believe the casks could not all be pointed in the same way assuming a hypothetical tip over event in which multiple casks tipped over?

DR. SINGH: Yes, she and I view the world in a deterministic way. If you have a large number of casks and they are all free standing and you subject them to an earthquake with ever increasing intensity of course eventually the intensity would be large enough to make the casks tip over. But because the parameters that govern tipping, that govern the dynamic response of the cask are not constant from one cask to another, the response of all the casks cannot be identical.

You cannot have each cask with its own friction surface, with its own fuel assemblies, orientated in its own way in each storage location to behave exactly the same way under an given earthquake event. It simply is from a deterministic standpoint impossible. That's why to postulate that all casks will line themselves up as properly trained soldiers and all point the same way is simply impossible. It can't happen in the real world even if you were to increase the earthquake to the point where casks begin to tip over.

MR. GAUKLER: Two point in that, Dr. Singh. First of all, would it be correct to say that the simulations that Dr. Soler showed of a cask on a pad with a 10,000 year event shows how casks will react differently? Those casks did not react the same. Is that correct?

DR. SINGH: That is correct but let me caution you. In the interest of making sure that the information is correct on the record, the analyses that Dr. Soler presented was supposed to be bounding analyses. He took all fuel assemblage and assumed they were glued to the casks. The MPC was glued to the cask. In other words, everything was together and that created a certain symmetry to the behavior of the

cask. Even then they were not all in face. But in the real world it's impossible to make casks behave the same way. Every one of them is on a pad.

MR. GAUKLER: Is there any other reason why you believe the casks would not all tip in the same direction focusing specifically on the PFS site?

DR. SINGH: Yes, of course at the PFS site the spacing is so close that each cask does not sufficient real estate around it to come down and align itself with all the others. At PFS it's even more impossible. It's more impossible in an acceptable terminology.

MR. GAUKLER: And one reason for that limitation is the space between the casks. Is that correct?

DR. SINGH: Space between?

MR. GAUKLER: That casks.

DR. SINGH: That is correct.

MR. GAUKLER: And that space is what? Approximately fifteen feet, is that correct?

DR. SINGH: About, yes. The spacing is not 15 feet.

MR. GAUKLER: Excuse me.

DR. SINGH: The center distance, yes.

MR. GAUKLER: So that means the space is

approximately four feet in between the casks.

DR. SINGH: Yes, it's a lot less than the height of the cask.

MR. GAUKLER: Dr. Redmond, we have some discussion on the dose rates from the top, the bottom, the sides of the cask. I just want to go through and clarify a few things and ask you a few additional questions on that point. I believe at one point you said that the dose rate at the top of the cask was 5 milli-REM per hour. Is that correct approximately?

DR. REDMOND: Approximately.

MR. GAUKLER: At that the dose rate at the surface of the cask at the top?

DR. REDMOND: Right. It's on the surface.

MR. GAUKLER: And you said the does rate on the side was approximately --

DR. REDMOND: I took approximately 40 milli-REM per hour and that would be based on the HI-STORM FSAR.

MR. GAUKLER: Let's just keep it simple and just take a single cask that is standing by itself on a pad just to keep a simple example in mind. When you have a single cask standing on a pad a great majority of the dose consequence at the boundary would be at the bottom of the cask. Correct?

DR. REDMOND: Correct.

MR. GAUKLER: I think you said something like only two percent would come from the top and that means that about 98 percent would come from the side.

DR. REDMOND: That's correct.

MR. GAUKLER: The factors that lead to that conclusion are the fact that the sides have a bigger area. Correct?

DR. REDMOND: A bigger area and the orientation in the upright position. But significantly a bigger area.

MR. GAUKLER: So the orientation and the bigger area of the side of the cask with respect to the boundary leads to having a far greater dose consequence on the side than on the top. Correct?

DR. REDMOND: Correct.

MR. GAUKLER: Now if a cask were to tip over and let's take the same cask and the top of the cask was pointing towards the boundary and the bottom was not pointing towards the boundary, how would you compare that those consequences at the boundary in this hypothetical example where you have one cask tipped over with the top of the cask faced towards the boundary?

DR. REDMOND: The dose rate would be less

than it would be if the side were facing the boundary.

MR. GAUKLER: And why is that?

DR. REDMOND: Because a combination of things. The dose rate on the top is lower and the surface area is less so the amount of radiation coming off the top is less than it is coming off the side.

MR. GAUKLER: What you are saying is that the dose rate at the top of the cask 5 milli-REM per hour is less than the dose rate coming off the side of the cask at 40 milli-REM per hour. Correct?

DR. REDMOND: Correct.

MR. GAUKLER: Then the actual area of the top of the cask facing the boundary would be less than a cask in its upright position back to the side of the cask.

DR. REDMOND: Certainly.

MR. GAUKLER: Now we were also talking about the comparability of the radiation from the top of the cask with respect to the radiation from the bottom of the cask. If I understood your testimony correctly the radiation from the top of the cask would be comparable to the radiation from the bottom of the cask except for this annular ring which you described as something like two and a half inches by a diameter of approximately 67 inches. Correct?

DR. REDMOND: Correct.

MR. GAUKLER: And but for the annular ring you would generally expect the same dose from the top and the bottom of the cask?

DR. REDMOND: Excluding the annular ring, yes, roughly the same.

MR. GAUKLER: Now if you were to include the annular ring and let's take the situation where we have a cask tipped over with the bottom of the cask now facing towards the fence, the boundary.

DR. REDMOND: Okay.

MR. GAUKLER: I would like comparing your opinion to the situation where the cask is standing upright given the fact that before when the top of the cask faces the boundary when tipped over, it is significantly less. When you have the bottom facing it, does this annular ring in effect make up a big portion of it or does it overcome the differences between the top and the side?

DR. REDMOND: The annular ring on the bottom is about 500 square inches in area. The bottom surface area of the overpack is on the order of about 13,000 square inches. Now in its upright position or for that matter laying on its side the surface area at the side of the overpack is about 20,000 square

inches. I'm only assuming a quarter of the surface area because if you're facing it you're not seeing the entire surface area of the side of the overpack. So you'd see about a quarter of it.

MR. GAUKLER: You're saying only a quarter faces the fence.

DR. REDMOND: Right. So you are looking at about a ratio of about a factor of 40 difference in surface area between the annular ring and the side of the overpack. It would be my opinion that the increase in dose in that annular region would probably be less than a factor of 40 different than the side dose rate. Therefore the dose at the distance from the bottom of the overpack would be comparable to the side of the overpack.

MR. GAUKLER: I missed the last part.

DR. REDMOND: Therefore the dose at the distance would be comparable in my opinion from the side of the overpack and the bottom of the overpack because the increase in dose rate in the annular surface region is offset by the lower surface area.

JUDGE LAM: So you are saying, Mr. Gaukler, I don't mean to interrupt you.

MR. GAUKLER: That's all right.

JUDGE LAM: Dr. Redmond, you are saying it

doesn't matter which surface is facing the fence now. The bottom, the side or the top.

DR. REDMOND: During lunch I had a time to think about this a little bit more and think about it from the surface area perspective and as I said if you look at the bottom of the overpack the annular region is about 500 square inches between a two and a half inch gap between the MPC and the overpack.

As I said before you will have an increase in dose rate there simply because of reducing shielding. So the question ultimately is does that dose rate increase larger than such that the amount of radiation coming out is more than the amount of radiation coming out of the side of the overpack.

If you take the ratio of the area of that annular region at the bottom which is about 500 to about a quarter of the surface area on the side which is about 20,000 you are looking at a ratio of about a factor of 40. So the question is one of does the dose rate on the bottom at that annular region increase by a factor of 40 compared to the side of the overpack. I haven't done calculations as I said before to estimate what that dose is. But based on the fact that you have two inches of steel there and you do have 22 inches of a narrow window to travel, the 22

inches being the height of the pedestal, so the height between the base plate and the MPC, I would say that the factor of 40 is reasonable and probably conservative such that the dose rate, the total dose at distance from the bottom of the overpack would be comparable to the side.

JUDGE LAM: Now in your testimony you rely on the argument that is physically impossible to have the bottom all facing the fence. With what you just testified there is no reason for you to rely on that argument. Is that correct?

DR. REDMOND: Well, I won't say I don't need to rely on it. I would say that it's defense and depth if you will. The casks in my opinion still cannot all end up facing with their bottoms facing the boundary. If that were to happen somehow then the argument I made would indicate that the dose would not increase. It would essentially the same.

JUDGE LAM: So what you are saying is that even if Dr. Resnikoff is correct or 80 casks they have bottoms facing the fence you would not increase the doses?

DR. REDMOND: That's what I'm saying. In fact that's correct.

JUDGE LAM: Thank you.

MR. GAUKLER: Now is it also correct, Dr. Redmond, that even assuming Dr. Resnikoff's calculation that his dose limits don't come anywhere near the five REM accident limit.

DR. REDMOND: That's correct. Even if you take Dr. Resnikoff's increase in dose rate and assume that it be correct the five REM limit is not in danger of being broken. In fact I believe my testimony indicates more than a year or two years before you reach the limit.

MR. GAUKLER: Dr. Redmond, you were asked by Ms. Chancellor your qualifications to evaluate the stretching of the concrete especially in the steel.

DR. REDMOND: Steel.

MR. GAUKLER: And I think you stated you didn't have any such qualifications. Is that correct?

DR. REDMOND: I'm not qualified to evaluate that.

MR. GAUKLER: In the testimony, who did you rely upon to evaluate the stretching of the steel?

DR. REDMOND: Dr. Soler evaluated that.

MR. GAUKLER: And that is reflected in question and answer 38 on page 15. Is that correct? Could you focus on that?

DR. REDMOND: That's correct.

MR. GAUKLER: That's the answer that both you and Dr. Soler responded to in respect to the stretching of the steel. Correct?

DR. REDMOND: That's correct.

MR. GAUKLER: I think it that Dr. Soler testifies with respect to the stretching of the steel what would happen with respect to the steel that would be Dr. Soler's area?

DR. REDMOND: That's correct.

MR. GAUKLER: Dr. Soler, in terms of the stretching of the steel upon impact, what did you conclude? What would happen to the steel?

DR. SOLER: First of all the calculation in the testimony is illustrated. In other words I simply assumed that the denting if you will of the steel in the vicinity of an impact would be essentially a 12 inch diameter area. If you postulate that you stretch around the perimeter that 12 inch diameter area you stretch by a half an inch uniformly so that you end up with a 13 inch diameter plate.

You then calculate the volume of matter that you need to fill that area and you find that since that metal can't come from anywhere else but what existed from the beginning. You end up with a thinning of about 0.1 inches of thickness in that

area. But all you really doing is moving around mass. You are not losing metal by thinness. It's a stretching to fill an additional space.

Now the 12 inches comes from observing the results of the actual numerical analyses of the tip over where the top of the cask impacts the ground, the cement and the soil under it and observing the area that is highly stressed in the concrete immediately below the point of impact and looking at that and saying it's approximately 12 inches is a reasonable number to characterize what I'll call the dent that may occur. Then this calculation in the testimony was simply a means to characterize what potential thinning you might get.

MR. GAUKLER: Dr. Redmond, given that the mass that changed as Dr. Soler made reference to, what effect if any would you expect this type of thing that Dr. Soler described to have on radiation of those consequences?

DR. REDMOND: Eventually no effect.

MR. GAUKLER: Why is that?

DR. REDMOND: If the mass stays the same obviously all the shielding material is still there.

MR. GAUKLER: Speak up a little bit.

DR. REDMOND: If the mass of the area

still remains the same obviously all the shielding materials is still present. So if you had a thinning in one location it's moved somewhere.

MR. GAUKLER: Mass has moved somewhere.

DR. REDMOND: So you'll have an increase in shielding in another area. So you have offsetting competing effects. There might be a slight increase and a slight decrease in another area. In addition the small area that he's talking about you are looking at here compared to I believe the 20,000 square inches I quoted earlier is negligible as well.

MR. GAUKLER: So I think you made two points. The first one is that the mass isn't changed. Since shielding is a function of mass that the total shielding capability remains the same essentially.

DR. REDMOND: Essentially.

MR. GAUKLER: So essentially you just have some distribution of the shielding.

DR. REDMOND: Right.

MR. GAUKLER: A distribution over some small area. Is that correct?

DR. REDMOND: That's correct.

MR. GAUKLER: Dr. Singh, you were asked some questions by Ms. Chancellor with respect to the Certificate of Compliance for the generic HI-STORM

cask. First of all, does the Certificate of Compliance for the generic HI-STORM cask apply to PFS?

DR. SINGH: No, it does not.

MR. GAUKLER: Why not?

DR. SINGH: The general Certificate of Compliance, the parameters, the conditions applicable that are required in there are not applicable to PFS. PFS is seeking a site specific certification to load casks.

MR. GAUKLER: Therefore its specifications fall in the FSAR, correct?

DR. SINGH: That's correct.

MR. GAUKLER: And they reference certain parts of your FSAR, correct?

DR. SINGH: They can if the reference is appropriate, yes.

MR. GAUKLER: Now you hesitated in answering the question from State's counsel in terms of effect of exceeding the 33 hour limit with respect to blocked ducts as referenced in the generic HI-STORM COC. Why were you hesitating in answering that question? What were the specific reasons?

DR. SINGH: I was having a problem with the predicate to the question. The blocked duct in the HI-STORM COC or HI-STORM FSAR I should say, that

evaluation is with the cask assumed standing upright. It is not for the condition where the cask is lying down. The way Ms. Chancellor phrased her question it made it impossible for me to answer it without violating the first part of the statement. That's why I was hesitating.

MR. GAUKLER: What's the basis of the 33 hours and what does it signify?

DR. SINGH: In our general COC, we ask for an inspector to visually check the condition of the ducts every 24 hours. The 33 hours came about this way. An inspector is due to inspect at the end of 24 hours. Therefore let's assumed that the ducts got blocked 24 hours ago. The inspector now notices that the ducts are blocked. He goes back and reports it. Let's assume it takes another eight hours before they remove the duct. That's 32 hours.

We said well let's put down 33 hours. We calculated the 33 hours in a very conservative way by assuming that the cask is shrouded in a heavy blanket. There is no heat release. The bottom ducts are blocked and concrete heat is 350 degrees under that what one would call an aerobatic (PH) condition when the temperature reads 350 degrees. That's 33 hours.

MR. GAUKLER: So the consequence at 33

hours is the fact that the concrete exceeds the short term temperature limits under these conservative assumptions at the inside of the cask?

DR. SINGH: That's correct. Under these conservative assumptions underlying, yes.

MR. GAUKLER: And assuming that the cask ducts were blocked longer, would there be any health and safety consequences?

DR. SINGH: No, there won't be.

MR. GAUKLER: Why not?

DR. SINGH: Because increasing first of all the actual temperature rise it does not reach 350 degrees if you make a suitable thermal model. You don't get 350 degrees in 33 hours. It would be more like 80 or 100 hours at the heat load for our HI-STORM COC.

Second the increase in temperature of concrete does not reduce its shielding effectiveness. 350 degrees is a temperature limit in the ACI code and it's used by -- regulations to protect reenforced concrete, concrete that has rebars in it.

Now rebars and concrete expand by slightly different amounts when you raise the temperature. Therefore the limit the temperature to which reenforced concrete can be raised. The concrete in

HI-STORM is completely homogenous. There are no rebars. Therefore it can withstand much higher temperatures even though the regulatory limits are lower.

MR. GAUKLER: And putting aside even assuming that the concrete does exceed its temperature limits and it might lose some of its shielding capability, does that cause a health and safety problem in terms of potential releases of radioactivity from the canister?

DR. SINGH: No, it would not but I don't like the predicate of your question.

MR. GAUKLER: Okay.

DR. SINGH: You said assume that the shielding decreases. I don't believe it decreases.

MR. GAUKLER: Assuming the shielding wasn't there, would you have any release of radioactivity or any egregious consequences that would --

DR. SINGH: No the increasing temperature even if the temperature were to get over 350 degrees and even if this temperature increase were through the body of HI-STORM there would be no significant reduction in the shielding effectiveness of the system.

MR. GAUKLER: Furthermore, this temperature limit has nothing to do with the potential release of radioactivity from the MPC. Is that correct?

DR. SINGH: It has absolutely nothing to do with that.

JUDGE LAM: Would there be any structural impact to the dehydration at that temperature?

DR. SINGH: Not really. Actually that's the reason we made HI-STORMs with a steel structure and with concrete added for shielding. Concrete does not play any role other than shielding. The temperature limits in the codes and standards and NRC regulations are focused to maintaining the integrity between the rebar and the concrete interface because of course temperature rise causes differential expansion and that can loosen the joint.

We deliberately designed HI-STORM to be homogenous concrete surrounded by steel structure so which carries all structure loads. Concrete carries no structure load. It's strictly a shielding media. For this region this cask can withstand temperatures well in access of 1,000 degrees Fahrenheit without any significant loss in its structural capability for short durations of course.

MR. GAUKLER: Dr. Singh, you also were asked questions about the 12 inch drop limit in the COC with respect to whether or not there's a -- COC had a 12 inch drop limit with respect to the dropping of a cask on the surface.

DR. SINGH: I believe it was 11 inches.

MR. GAUKLER: Eleven inches, excuse me. Now if the cask is dropped from a higher level than the COC -- Strike that for a second.

CHAIRMAN FARRAR: Your question sounded fine to me.

MR. GAUKLER: If the cask is dropped from a higher level than the 11 inches hypothesized in the COC or provided in the COC, what happens? Is there any health and safety consequence?

DR. SINGH: No, there is no health and safety consequence. The only consequence that you would have to report to the NRC and go through a lot of paperwork to justify why nothing happened.

MR. GAUKLER: Now I think that it might be fair to say that the design basis is 11 inches but you have a lot of conservatism over and above that design basis. Is that another way to look at it?

DR. SINGH: That is exactly right.

MR. GAUKLER: In fact you've done this

analysis that we have talked about before where you have a canister dropped 25 feet without the protection of the cask onto a hard concrete surface. Correct?

DR. SINGH: That is correct.

MR. GAUKLER: And there is no breach of the cask even under those severe conditions. Correct?

DR. SINGH: That is right.

CHAIRMAN FARRAR: If that's the case why wouldn't you have that in the Certificate of Compliance?

DR. SINGH: The Certificate of Compliance is established using stress limits, deformation limits, which were far more severe than what a actual physical evaluation of the problem would give you.

For example the NRC limits stresses in the material to and I'm going to use a number for illustration purposes 40,000 psi which corresponds to a strain limit which is less than five percent of the strain in carbon steel and less than one percent of the strain in stainless steel and this material would fail.

Therefore there's a huge built-in reserve in the structure that is not recognized by the regulations or by any of the evaluations that we do. We limit ourselves to what the regulatory limits are

and we calculate allowable heights within those regulatory limits.

But if one were to calculate the actual capacity of the structure to withstand a drop event that's an entire different evaluation. For example materials don't fail from high stress. They fail from high strain. All of ASME code rules and NRC regulations are predicated on stresses limits. I could give a long speech on that one.

MR. GAUKLER: I think we are past the point of long speeches, Dr. Singh. The Board and all the parties are anxious to get the facts on the record and then go onward. Just on this point, I would like to follow up with a couple of clarifications. You had also mentioned a 60 G limit or 61 G limit for the fuel.

DR. SINGH: 63.

MR. GAUKLER: 63 G limit for the fuel. Again that's a design basis limit that has a lot of conservatism in it.

DR. SINGH: That's an artificial limit as well.

MR. GAUKLER: You also referenced the 45 G cask tip over limit.

DR. SINGH: That's correct. Same comment

applies.

MR. GAUKLER: Same comment. Design limit with a lot of conservatism in it.

DR. SINGH: Yes.

CHAIRMAN FARRAR: Mr. Gaukler.

MR. GAUKLER: I'm done I think.

CHAIRMAN FARRAR: Good. I was just going to ask how you were doing.

MR. GAUKLER: I was checking with my colleagues and I got the negative sign from them. There is nothing more to go over. I am done.

CHAIRMAN FARRAR: Mr. Turk.

MR. TURK: There are a number of areas I want to go into, Your Honor. I know we want to move along but I think these are worth putting on the record before these witnesses step down.

CHAIRMAN FARRAR: Okay.

MR. TURK: I'm aware that the Board has an interest in concluding the proceeding as expeditious as possible but if it doesn't make the record now, it won't be made. That's important not just for this Board which may already have its understanding of how it's going to decide the facts I don't know but then we still have the commission that will be reviewing the record. I need to make the record to make sure

that it exists at the time that there is a reviewing body in place.

CHAIRMAN FARRAR: There are a lot of people with the salt palace who thought we made up our mind before we ever got out there.

MR. TURK: Because we don't know how the Board will rule we don't know how the reviewers will look at the record.

CHAIRMAN FARRAR: I was just remembering April 8th fondly or not so fondly when you think about it.

MR. TURK: Can I have five minutes to organize papers?

CHAIRMAN FARRAR: It's quarter after. Is five enough or do you need ten? We will come back at 2:25 p.m. Off the record.

(Whereupon, the foregoing matter went off the record at 2:14 p.m. and went back on the record at 2:27 p.m.)

CHAIRMAN FARRAR: On the record.

MR. TURK: Thank you, Your Honor. Let me note for the other parties that I indicated to the judges during the break that I intend to introduce various regulatory guidance documents. I will do that with these witnesses and particularly Dr. Redmond to

the extent that he is familiar with it. If he is not familiar with it, then with Mr. Waters.

RECROSS EXAMINATION

MR. TURK: First of all, Dr. Redmond, most of my questions are going to be directed to you. I would like to start first of all with certain exhibits that the staff had prefiled. Take a look at this first document which is Staff Exhibit V which I would asked to have marked for identification.

(Whereupon, the above-referred to document was marked as Staff's Exhibit V for identification.)

MR. TURK: Mr. O'Neill will help me with these. I appreciate his assistance. While it's being distributed I note for the record that Staff Exhibit V is a one-page document which has drawn number 1495, Sheet one of six for the HI-STORM storage cask. I believe this is part of the HI-STORM FSAR. The number 1495 appears at the bottom right hand corner if the exhibit is held on its side with the label Exhibit V at the top. Dr. Redmond, are you familiar with this drawing?

DR. REDMOND: Yes, I am.

MR. TURK: Is this in fact a drawing of the HI-STORM cask with the MPC inside?

DR. REDMOND: Yes it is.

MR. TURK: If we look at and it depends on how you are going to hold this, I would ask that you turn it so that the cask is upright. That would mean that the marking of Staff Exhibit V would be at the right hand upper margin.

DR. REDMOND: Okay.

MR. TURK: And 1495 would appear at your lower left corner. This would represent the cask in its upright position.

DR. REDMOND: That's correct.

MR. TURK: And the annulus would that be indicated where there's a blank space essentially between the canister and the overpack.

DR. REDMOND: Yes it is.

MR. TURK: This is what you were describing before as the annular region that extends down towards the bottom of the cask.

DR. REDMOND: That's correct.

MR. TURK: Your Honor, I think this is strongly illustrative. I would ask that this would be admitted at this time.

CHAIRMAN FARRAR: Any objection?

MR. GAUKLER: No objection, Your Honor.

MS. CHANCELLOR: No objection but just one

question. This is taken from the Holtec HI-STORM FSAR, is that correct?

MR. TURK: I would ask the witness to confirm or Dr. Singh.

DR. REDMOND: Yes, it is taken from the FSAR.

CHAIRMAN FARRAR: It is not the PFS FSAR. It's the HI-STORM FSAR. Correct, Dr. Singh?

DR. SINGH: Yes.

MS. CHANCELLOR: No objection, Your Honor.

CHAIRMAN FARRAR: Mr. Gaukler?

MR. GAUKLER: No objection.

CHAIRMAN FARRAR: Then Staff Exhibit V will be admitted.

(The document referred to having previously been marked for identification as Staff Exhibit V, was received into evidence.)

MR. TURK: incidentally I would note that in this drawing at the bottom of the cask there is an area that there is a lot of different dots. Is that the concrete shielding at the bottom of the cask?

DR. REDMOND: You are referring to below the MPC?

MR. TURK: Yes.

DR. REDMOND: Yes it is. That's the concrete and then the slanted lines are the steel.

MR. TURK: In that regard just below the MPC there are some very small lines about 1/16 of inch in length which are angled from the left down towards the right at the bottom. That's the steel of the MPC, correct?

DR. REDMOND: Yes.

MR. TURK: So that's the shielding at the bottom of the MPC but that's part of the MPC itself.

DR. REDMOND: Yes, that's a two and a half inch thick steel base plate.

MR. TURK: Okay. And just below that there's an area that appears to be cross hatched within the concrete base of the HI-STORM cask. Would you describe what that area consists of?

DR. REDMOND: Immediately below the base plate of the MPC you have five inches of steel. That's what you are seeing there.

MR. TURK: That's part of the overpack construction.

DR. REDMOND: Correct. That's part of the pedestal of the overpack. So you have five inches of steel followed by 17 inches of concrete.

MR. TURK: Then of course the steel plate

at the bottom.

DR. REDMOND: That's correct which is two inches thick.

MR. TURK: I'm going to move to another diagram. If anyone has questions on this one, it would be an appropriate time. I'm going to distribute a document that has been marked for identification as Staff Exhibit W.

(Whereupon, the above-referred to document was marked as Staff Exhibit W for identification.)

MR. TURK: Incidentally with respect to this last exhibit V, is it correct that this annulus if you would look at the annular region pointing down to the bottom of the cask doesn't directly face the outside? There is a steel plate between it and the outside. Correct?

DR. REDMOND: That's correct. You have two inches of steel there on the bottom.

MR. TURK: Also in the lower left hand corner as we view this drawing V in its upright position, I see the annulus extends off to the left. Is that where the vent would be?

DR. REDMOND: Yes it is. That's one of the four ventilation ducts on the bottom.

MR. TURK: And then there's also a space at the top of the cask also for vents at the top of the cask. Correct?

DR. REDMOND: That is correct.

MR. TURK: There is no direct line of sight between the scent (PH) fuel and outside, is there?

DR. REDMOND: No, absolutely not.

MR. TURK: Okay. Staff Exhibit W I believe the reporter has copies. I would identify this on the record as a drawing from what appears to be a HI-STORM calculation number HI-2002444, figure 5.3.11 entitled "HI-STORM 100 overpack cross sectional elevation view" revision 0. Dr. Singh, is this a drawing that comes from the HI-STORM FSAR?

DR. SINGH: It seems that way. I believe that's correct.

DR. REDMOND: Yes it is a drawing from Chapter five of the HI-STORM FSAR.

MR. TURK: I would either of you whoever is more familiar with the drawing to explain what this drawing shows as compared to Staff V. Are you familiar with that?

DR. REDMOND: Yes I am.

MR. TURK: For instances the MPC is not

shown in this drawing.

DR. REDMOND: Correct. The purpose of this drawing was to provide dimensions to aid in the showman review of the HI-STORM 100 system so additional dimensions are shown here on the drawing. The MPC is not present.

MR. TURK: In your testimony before you were pointing out the thickness of various elements of the overpack. I see at the bottom of this drawing the baseplate of two inches, the pedestal shield of 17 inches and other references to dimensions.

DR. REDMOND: Correct.

MR. TURK: The baseplate is shown to be two inches. Is that correct or did I misunderstand you? Did you say that they are two and a half inches of steel at the bottom?

DR. REDMOND: No, there is two inches of steel at the baseplate of the HI-STORM overpack. On the baseplate of the MPC it is two and a half inches. It is noted that the MPC is not shown on this drawing.

MR. TURK: Your Honor, as I believe this diagram is also helpful in illustrating the construction of the cask and the location of various shielding elements, I would ask that this exhibit be admitted at this time.

CHAIRMAN FARRAR: Any objections?

MR. GAUKLER: No objection, Your Honor.

MS. CHANCELLOR: No objection.

CHAIRMAN FARRAR: Then Staff W will be admitted.

(The document referred to having previously been marked for identification as Staff Exhibit W, was received into evidence.)

MR. TURK: I would like to pass out one more drawing at this time. This is a drawing that has been referred to at various times in testimony yesterday and today. I'm asking Mr. O'Neill to distribute copies of Staff Exhibit X for identification.

(Whereupon, the above-referred to document was marked as Staff Exhibit X for identification.)

MR. TURK: There was a time when we all rushed to provide drawings to the Board and this was one of the drawing that was rushed to the attention of the Board in a prior session. For identification purposes let me indicate this is Figure 1.2-1 from PFS SAR entitled "PFSF General Arrangement" Revision 21. I would ask if any of you gentlemen have seen this

drawing before.

DR. REDMOND: Yes.

MR. TURK: Dr. Redmond, in fact you were questioned about this drawing earlier today.

DR. REDMOND: That's correct.

MR. TURK: This does show the layout of the storage pads in the PFS facility as well as the location of the canister, the transfer building, the security fencing and other features of the facility. Correct?

DR. REDMOND: That's correct.

MR. TURK: Your Honor, I also think this is useful for demonstration purposes to provide a better understanding of the testimony we have already had. I would ask that it be admitted at this time.

CHAIRMAN FARRAR: Any objections?

MR. GAUKLER: No objection, Your Honor.

MS. CHANCELLOR: It is duplicable of one of our exhibits but I won't object. I would also note that it's a reduced copy of what actually appears at Figure 1.2-1 in the PFS SAR.

CHAIRMAN FARRAR: We have a larger version that was PSF 84 but just to keep things going we will admit this one also.

(The document referred to having

previously been marked for identification as Staff Exhibit X, was received into evidence.)

MR. TURK: Your Honor, it is also specified in Mr. Waters's testimony.

CHAIRMAN FARRAR: Okay.

MR. TURK: So if for no other reason it would be of assistance.

CHAIRMAN FARRAR: Right. It's the rule we have followed thus far.

MR. TURK: Dr. Redmond, have you read the testimony of Mr. Waters filed in this proceeding.

DR. REDMOND: Yes I have.

MR. TURK: Are you aware that Mr. Waters did perform a very specific calculation with respect to the PFS site assuming that the casks were to tip over and in fact that all 4,000 casks were to tip over?

MS. CHANCELLOR: Objection, Your Honor. This is beyond the scope of what's to be taken up in recross. It's not within the scope of my cross or in direct.

MR. TURK: It's indirectly a question to the next question I'll ask, Your Honor.

MS. CHANCELLOR: Besides I object to the

premise of the question. There is no evidence that Mr. Waters has performed site specific quantitative calculations.

CHAIRMAN FARRAR: Objection overruled. Go ahead, Mr. Turk.

DR. REDMOND: I'm familiar with the calculations as outlined and discussed in his testimony.

MR. TURK: The reason I asked you the question is in your testimony you indicated that you would assume you would calculate the accident dose using the 2,000 hour presence of an individual just as had been done for the normal dose. Do you recall that testimony?

DR. REDMOND: Yes I do.

MR. TURK: I'm asking now are you aware that Mr. Waters used a different value for estimating the length of time in which an individual is present under accident conditions?

DR. REDMOND: Yes I am.

MR. TURK: In fact he used a 30 day value, did he not?

DR. REDMOND: That's correct.

MR. TURK: In your testimony you referred to the fact that you were aware that there was

regulatory guidance in which a 30 day value was put provided. Do you recall that?

DR. REDMOND: Yes.

MR. TURK: And at first you thought that it would located in NUREG 1536.

DR. REDMOND: That is correct.

MR. TURK: Have you have an opportunity to rethink where that regulatory guidance occurs?

DR. REDMOND: I believe in my testimony earlier I did also reference to NUREG 1567 in a later question. I do know that it is in 1567 but I have not had a chance to review 1536 again to see if it is there.

MR. TURK: Your Honor, at this time I would like to distribute another document. It consists of pages from NUREG 1567 and I would ask Mr. O'Neill to help with this distribution. We had to do some extemporaneous surgery on the document so you may find more than one staple in your copy but I will indicate for the record which pages you should find in the copy that is being handled to you earlier in the case.

CHAIRMAN FARRAR: And unlike the others this was not previously distributed.

MR. TURK: That's correct, Your Honor.

We'll have to go to another new staff number which raises a new question. The last staff exhibit that had been introduced was a sketch by Dr. Ofoegu which was Staff Exhibit ZZ.

CHAIRMAN FARRAR: Right.

MR. TURK: Can I ask your indulgence and ask that we depart from the letters and I will begin Staff Exhibit No. 53.

(Whereupon, the above-referred to document was marked as Staff Exhibit No. 53 for identification.)

CHAIRMAN FARRAR: Right. And we'll put the same footnote in our opinion to help people so people won't be looking for one to 52 just like we did the Applicant's one to 78.

MS. CHANCELLOR: Why are we going -- We're going to 53 because ZZ is 52.

MR. TURK: For the record, let me indicate that Staff Exhibit 53 for identification consists of the coverpage of NUREG 1567 entitled "Standard Review Plan for Scent (PH) Fuel Dry Storage Facilities." In this exhibit I have also attached pages 9-10, 9-14, 9-15 and then pages 15-1 and 15-6. Hopefully you all have the same pages I've just mentioned. Dr. Redmond, you indicated that you are familiar with NUREG 1567.

DR. REDMOND: Yes I am.

MR. TURK: I would ask you to turn to page 9-15 of this document. At the top of that page under the subtitle "Accident Conditions" do you see the following statement "For hypothetical accident conditions the duration of the release is assumed to be 30 days (720 hours)."?

DR. REDMOND: Yes I do.

MR. TURK: And it continues to state that "A bounding exposure duration assumes that an individual is also present at the controlled area boundary for 30 days. This time period is the same as that used to demonstrate to compliance with 10 CFR 100 for reactor facilities licensed for 10 CFR 50 and provides good defense and depth since recovery actions to limit releases are not expected to exceed 30 days."

DR. REDMOND: Yes.

MR. TURK: And is this then the reference you had in mind when you indicated you were aware of a 30 day calculation value for accident doses?

DR. REDMOND: Yes it is.

MR. TURK: Your Honor, I'm going to examine on other pages that I have included in this exhibit. Your Honor, I would ask that this regulatory guide, the page which are attached to this exhibit, be

admitted at this time as Staff Exhibit 53.

CHAIRMAN FARRAR: Any objections?

MS. CHANCELLOR: Objection, Your Honor.

CHAIRMAN FARRAR: On what grounds?

MS. CHANCELLOR: This deals with release levels I believe it deals with gases. It may not necessarily deal with radiation from neutrons and gammas. I don't think that a foundation has been established as to what this document represents and whether the witness could not identify where in this document the 30 day limit was. This goes to Mr. Waters's testimony. Maybe once Mr. Turk examines Mr. Waters about it, it would be entered but at the moment I don't think that there is a sufficient foundation laid to enter this exhibit.

MR. TURK: I just want to state clearly for the record that Dr. Redmond was not asked to identify this in 1567.

CHAIRMAN FARRAR: Right but in any event let's hold off until Mr. Waters takes the stand.

MR. TURK: All right. It will just make it a little prolonged in that regard.

CHAIRMAN FARRAR: You can still ask questions about although I guess I would raise the questions why do we want to ask these people about

this document since it's a staff document and your guy can testify about it.

MR. TURK: That's fine, Your Honor.

CHAIRMAN FARRAR: Much more quickly and fluency than these people.

MR. TURK: I pass on the question of the 30 day calculation and we can pursue that later. I would just ask Dr. Redmond. You are familiar with this document?

DR. REDMOND: Yes.

MR. TURK: Ms. Chancellor raised an objection as to whether or not the 30 day dose calculation is appropriate for neutron and gamma. She is correct that this discussion of accident conditions comes up in the discussion of confinement. Are you aware of that?

DR. REDMOND: Yes I am.

MR. TURK: Are you aware if there are any other standards expressing this guidance with respect to shielding of neutron and gamma radiation?

DR. REDMOND: There's another chapter in the document dealing with shielding evaluation but I don't recall if the 30 day limit is addressed there.

MR. TURK: Another part of the cross examination dealt with and this I believe was a

question posed by Judge Farrar the definition of normal and anticipated occurrences versus accident conditions and also some reference to off-normal conditions. Do you recall that there were some questions about that?

DR. REDMOND: Yes I do.

MR. TURK: Are you familiar with NUREG 1567 in so far as it discusses the definition of those conditions?

DR. REDMOND: I would have to say no I'm not.

MR. TURK: Are you familiar with Regulatory Guide 3.60?

DR. REDMOND: I may have reviewed it but I simply can't remember.

MR. TURK: Lastly in the same regard are you familiar with ANS, American Nuclear Standard, 57.9?

DR. REDMOND: 57.9 I believe I have read it but I don't recall exactly what the topic is.

MR. TURK: Your Honor, we will cover those with Mr. Waters's testimony.

CHAIRMAN FARRAR: Right.

MR. TURK: In questioning by Ms. Chancellor, you had indicated that you would not a

quantitative analysis for cask tip over because that is a hypothetical event as I believe you used the term.

DR. REDMOND: Yes.

MR. TURK: In stating hypothetical, do you mean that it's beyond a design basis event?

DR. REDMOND: Yes it is.

MR. TURK: At the PFS facility?

DR. REDMOND: That's correct and in our HI-STORM FSAR.

MR. TURK: With respect to blockage of all vents, there was some discussion of blockage about four vents. Now Dr. Singh indicated that the cask position for which the blockage of vents analysis was done involved the cask in its upright position. Is that correct, Dr. Singh?

DR. SINGH: Yes.

MR. TURK: If the cask is lying down so that you don't have four vents at the base of the cask that are blocked and say you have a cask in a horizontal position, you would in essence have a total of eight vents from which heat might be dissipated. Can you address that? Are we still looking at a blockage of four vents if the cask is in a horizontal position or do you now have to assume a blockage of

eight vents?

DR. REDMOND: Are you asking me?

MR. TURK: I guess, Dr. Singh, it's probably more appropriate for you.

DR. SINGH: Well geometrically if you lay the cask horizontally you would not block any of the vents completely. You will now have to postulate artificially which ones are blocked.

MR. TURK: I suppose the worst case situation would be the cask is lying directly over the upper and lower vent on one side of the cask in which those two vents would be almost totally blocked.

DR. SINGH: Partially blocked and then the other two would be at 45 degrees and you would have two at the top.

MR. TURK: So the other six vents would not be blocked merely because the cask was in its horizontal position.

DR. SINGH: That is correct.

MR. TURK: Then another case could be when the cask is lying in a position --

CHAIRMAN FARRAR: Wait a minute, Mr. Turk. What happens to the chimney effect then? Does it work?

DR. SINGH: The chimney effect is

partially disabled. You have a reduced chimney effect. It is only affecting the points you affect. It's reduced. Because the column is now shorter. The HI-STORM is now horizontal. Therefore the vertical distance between the set of ducts is reduced so you have a reduced chimney effect.

CHAIRMAN FARRAR: The design. Let's back up. When the cask is vertical in its ordinary position. The four sets of ducts aren't connected, are they?

DR. SINGH: They are at 90 degrees at that.

CHAIRMAN FARRAR: There are in effect four sets of chimneys. But is there a ring at the top and the bottom so that the top and bottom of the four ducts are connected?

DR. SINGH: There is a complete -- between the MPC and the HI-STORM therefore say a particle that enters one duct at zero degrees. That's it for many of the four ducts.

CHAIRMAN FARRAR: So now when the cask is tipped over horizontal that annulus becomes like a partial chimney.

DR. SINGH: Yes, you continue to have the chimney effect. In other words, now --

CHAIRMAN FARRAR: Not through the way you originally contemplated but through the annulus.

DR. SINGH: Right.

MR. TURK: In another situation if the cask was not lined directly upon an upper and lower vent but instead the cask had fallen into a position whereby the vents are not directly underneath the cask then would you have all eight vents still open?

DR. SINGH: None of the eight vents would be obstructed by the ground.

MS. CHANCELLOR: I didn't quite hear that. Could you repeat that answer?

DR. SINGH: I said none of the eight vents would be obstructed by the ground.

MS. CHANCELLOR: That is cask tip over?

DR. SINGH: In the configuration that Mr. Turk described.

MR. TURK: The 33 hour short-term temperature limit that you discussed in cross examination that's a limit that applies to the concrete, correct?

DR. SINGH: The way the calculations were done the temperature concrete was limiting.

MR. TURK: That is not a short-term temperature for the fuel or the fuel cladding,

correct?

DR. SINGH: That is correct.

MR. TURK: In our testimony you indicated that if the cask was tipped over -- You talked about upright within 30 days that was based upon an assumption that all the vents were blocked.

DR. SINGH: Yes.

MR. TURK: Would another solution be to clear the vents rather than to necessarily upright the cask?

DR. SINGH: Yes, that would work just as well but the design configuration of the cask is vertical. I think the licensee would restore the system to its intended configuration as soon as possible.

MR. TURK: First we are making the assumption that the casks tip over which is already beyond the design basis accident at PFS, correct?

DR. SINGH: Yes.

MR. TURK: Assuming that you do reach that beyond design basis accident, do you think it's realistic to assume that all vents of the cask would be blocked?

DR. SINGH: No, it's not.

MR. TURK: Dr. Redmond, you indicated

before that you had read Mr. Waters's testimony.

DR. REDMOND: That's correct.

MR. TURK: Did you find any basis to disagree with his calculations?

DR. REDMOND: No, the analysis that he describes for the tip over is and I believe he states it excessively conservative or extremely conservative analysis and I would agree with that. The other analysis regarding the thermal temperature is a more realistic analysis compared to that done by Dr. Resnikoff.

MR. TURK: Also I believe Judge Lam asked you a question about Dr. Resnikoff's testimony in which Dr. Resnikoff had calculated a factor of 77 times normal dose, his predicted dose.

DR. REDMOND: Right.

MR. TURK: Has Dr. Resnikoff revised that figure in his amended testimony?

DR. REDMOND: Yes, it's gone down.

MR. TURK: If I'm not mistaken he has revised it down now to a factor of five above normal doses.

DR. REDMOND: I believe that's correct.

MR. TURK: I'm sorry at the low end that's one-half of normal doses.

MS. CHANCELLOR: Objection, Your Honor. What does this have to do with the scope of cross examination or redirect?

MR. TURK: It's a follow up to Judge Lam's question in the 77 factor was referenced. I'm just asking for clarification as to what Dr. Resnikoff's current factor based on his amended testimony as this witness understands it.

CHAIRMAN FARRAR: Objection overruled.

DR. REDMOND: That's correct.

MR. TURK: I think he provided a range of values, did he not, from one-half of the normal dose up to 5 times the normal dose?

DR. REDMOND: Right.

MR. TURK: Dr. Singh, this one may be self explanatory. In your questioning a short while ago, you were talking about the 11 inch drop limit under the COC. You indicated that in your view if you had a drop of more than 11 inches the only consequence would be that you would have to file more papers with the NRC. You recognize of course that if a facility was to exceed the 11 inch drop they would have to conduct analyses or further demonstrate that there is no public health and safety impact of that consequence.

DR. SINGH: Yes, it would be a serious breach of the Certificate of Compliance and of course it would have significant consequences. I should have added that 11 inches --

MR. TURK: I'm sorry. When you say significant consequences are you saying there will be dose consequences?

DR. SINGH: No.

MR. TURK: In a regulatory framework.

DR. SINGH: In a regulatory framework. I meant to clarify that the regulatory limit is extremely conservative which is an overused term. The limit is very low. The reason here the 11 inches is because there is no reason to raise the HI-STORM over 1 inches if you are carrying it from one location to another. The COC promotes carrying the load at a low elevation. That's why 11 inches is set.

MR. TURK: I don't think I have anything else, Your Honor.

CHAIRMAN FARRAR: Thank you, Mr. Turk. Ms. Chancellor, you can have another go round if you like.

MS. CHANCELLOR: Thank you, Your Honor. I would like.

CHAIRMAN FARRAR: Do you need some time to

organize?

MS. CHANCELLOR: No, it's fine, Your Honor. I think I can manage.

RECROSS EXAMINATION (con'd)

MS. CHANCELLOR: Dr. Redmond, you testified that you could make some adjustments to your model and your Monte Carlo analysis of radiation from the face of the HI-STORM cask, is that correct? I believe you testified to that in response to Judge Lam's question.

DR. REDMOND: That's correct.

MS. CHANCELLOR: Approximately how long would it take you to do such an analysis?

DR. REDMOND: A few days probably to do the calculations.

MS. CHANCELLOR: In response to Judge Kline, Judge Kline suggested that a bigger exclusion area could be staked out. Do you recall that testimony?

DR. REDMOND: I do.

MS. CHANCELLOR: Do you know whether the northern boundary of the PFS site abuts private property?

DR. REDMOND: I do not know.

MS. CHANCELLOR: Dr. Singh, do you?

DR. SINGH: I've seen the site but I didn't know the property boundaries.

MS. CHANCELLOR: Dr. Soler, do you?

DR. SOLER: I believe that at least on some of the sides there wouldn't be a problem but I can't speak for all four sides.

MS. CHANCELLOR: Which sides can you speak for?

DR. SOLER: Only what I visualized from a road two and a half miles away. It seemed to be an intermittable distance there were no houses in sight. There were no buildings in sight. In fact I think there were no trees in sight. That's about all I can say.

MS. CHANCELLOR: Do you know who owns the land to the west of the PFS site?

DR. SOLER: No I do not.

MS. CHANCELLOR: You don't know who owns the land to the north of the PFS site?

DR. SOLER: No.

MS. CHANCELLOR: Do you know who owns the land to the south of the PFS site?

DR. SOLER: I believe the Bureau of Land Management runs some of it but I'm not familiar with the details.

MS. CHANCELLOR: Do you know who owns the land to the east of the PFS site?

DR. SOLER: No.

MS. CHANCELLOR: Dr. Redmond, you stated in response to Judge Kline that maybe in the case of cask tip over the steel plate could provide some additional shielding if it was brought on to the site. Do you have any idea how you get that steel plate to the site?

DR. REDMOND: I would assume that you bring it in by truck.

MS. CHANCELLOR: Are you familiar with the transportation system in Skull Valley?

DR. REDMOND: No I am not.

MS. CHANCELLOR: Isn't it correct that steel plate would provide little or no effect on shielding of neutrons?

DR. REDMOND: It would provide some.

MS. CHANCELLOR: I think it was you, Dr. Singh, I can't remember. You stated that the spacing of the casks on the pads were very close together. Isn't it true that the pads could be loaded differentially? That not all pads would be fully loaded?

DR. SINGH: That's quite possible, yes.

MS. CHANCELLOR: And, Dr. Singh, you mentioned the cask transporter at the PFS site. Could you please describe it? Are you familiar with the cask transporter at the PFS site?

DR. SINGH: Yes I am.

MS. CHANCELLOR: Could you describe that cask transporter and how it actually picks up and loads the casks?

DR. SINGH: That's a tall order describing a piece of machinery.

MS. CHANCELLOR: But I'm sure you would be up to it.

DR. SINGH: It's called a crawler to the best of knowledge. The equipment that PFS has plans to use is in the colloquial name for it a crawler. It has two large caterpillars that in the manner of a tank and it has a top platform that is connected to the lift yoke and then in turn that picks the cask.

MS. CHANCELLOR: It's connected to what?

DR. SINGH: To a lift yoke.

MS. CHANCELLOR: A lift yoke.

DR. SINGH: Which in turn connects to the cask. HI-STORM cask have anchor locations at the top suitable for lifting or upending.

MS. CHANCELLOR: So when the cask

transporter takes the cask from the canister transfer building to the pad does the yoke attach to the top of the HI-STORM cask, the yoke on the cast transporter?

DR. SINGH: It can at the top or bottom. Typically it's convenient to connect to the top.

MS. CHANCELLOR: Then it lifts the cask up.

DR. SINGH: That's correct.

MS. CHANCELLOR: And then is it just basically hanging from the --

DR. SOLER: It would be tied in place generally speaking to prevent it from swinging. But it's held from the top.

MS. CHANCELLOR: Held from the top. So it has to be picked up somewhat in order to be able to move it off the floor of the canister plant.

DR. SINGH: Yes, it has to clear the floor to be carried.

MS. CHANCELLOR: How long is this yoke? Does it have a cable on it?

DR. SINGH: No the yoke is a steel structure with suitable points to connect it to the yoke.

MS. CHANCELLOR: So the transporter has to be moved directly over the cask and the yoke attached

to the center or the bottom of the cask.

DR. SINGH: If you are lifting the cask vertically in other words if the cask is originally in the vertical orientation, then you will connect the lift yoke to the top of HI-STORM and then connect the crawler lift platform to the yoke or the other way around. You make the necessary connections and then you lift it.

MS. CHANCELLOR: But the transporter has to be driven right near the cask in order to attach it.

DR. SINGH: Yes, for picking it up in the vertical situation that's what you would do.

MS. CHANCELLOR: Isn't it correct that PFS needed to increase the spacing of the rows between the cask to 35 feet to allow for the cask transporter to move between the rows?

DR. SINGH: That is the design election PFS engineers made. It was not necessary.

MS. CHANCELLOR: But the cask transporter couldn't fit down the five foot spacing between the casks in the north-south direction.

DR. SINGH: That may be true. I guess what I just got done telling you is that the mode of movement that the engineers for PFS contemplated

required them to open up the spacing. But there are other ways to get the cask to its intended location.

MS. CHANCELLOR: And what other ways are there at the PFS site to get that cask to its intended locations?

DR. SINGH: They would use an air pad.

MS. CHANCELLOR: A what?

DR. SINGH: And air pad.

MS. CHANCELLOR: What's an air pad?

DR. SINGH: An air pad is a pressurized pillow that essentially eliminates friction between the heavy object which is the HI-STORM and the concrete slab. You can move it easily. You can move the HI-STORM cask from one location to another with minimal force which is done at many sites. It's not a figment of imagination. It is actually used.

MS. CHANCELLOR: You don't use a cask transporter for this.

DR. SINGH: You can. There are many alternatives available to moving, upending a HI-STORM cask. HI-STORM because as I said earlier is an all steel structure. It can be manipulated in a variety of ways. You can pick it up using the crawler. You can use a heavy haul trailer. You can use an air pad. A variety of translocation devices can be used for

moving it and upending it.

MS. CHANCELLOR: But the operational mode at the PFS site is to move the cask with a cask transporter either from the canister transfer building to the pad or from the pads to the canister transfer building. Isn't that correct?

DR. SINGH: I believe so but let me preface this. I did not participate or Holtec did not participate in developing the movement or distance of the cask and therefore I should not be giving you testimony in a definitive manner in how they do it.

MS. CHANCELLOR: So you can't say definitively that the cask transporter could be used in the case of casks that have fallen over to upright such casks. Correct?

DR. SINGH: I can speak to the issue in a generic manner. One can upright a HI-STORM horizontal cask using a transporter and and appropriate lift yoke. It can be done. Whether PFS plans to do it, it is something we will have to ask the PFS engineers.

MS. CHANCELLOR: But the cask transporter needs a 35 foot corridor in order to safety move amongst the rows of casks. Correct?

DR. SINGH: I don't believe so.

DR. SOLER: It mostly needs that to turn

not to move straight ahead.

MS. CHANCELLOR: Thank you, Dr. Soler.

CHAIRMAN FARRAR: Ms. Chancellor, let me interrupt. When you say an air bag --

DR. SINGH: Air pad.

CHAIRMAN FARRAR: Air pad.

DR. SINGH: P-A-D.

CHAIRMAN FARRAR: Is that like a hovercraft?

DR. SOLER: Even the specialists don't have it.

CHAIRMAN FARRAR: How do you get the air pad under the cask?

DR. SOLER: -- jacks through the vents. HI-STORM is designed to be lifted from inside the four inlet vents by using jacks. You jack it up and slip the air pads under.

DR. SINGH: Then pressurize the pad and then it lifts off. It's the standard way to move them.

CHAIRMAN FARRAR: Then what motivates the pad to move forward?

DR. SOLER: The friction.

MS. CHANCELLOR: And the cask weighs approximately 175 tons. Is that correct?

DR. SINGH: Yes.

MS. CHANCELLOR: Twenty feet high?

DR. SINGH: Yes.

MS. CHANCELLOR: About 11 and a half feet in diameter?

DR. SINGH: Yes.

MS. CHANCELLOR: In response to questions by Mr. Gaukler you stated that the generic Certificate of Compliance was really not applicable to the PFS site. You didn't mean that in its entirety, did you?

DR. SINGH: Well, the Certificate of Compliance the way an RC (PH) writes either you use it or you don't. There is no such thing as partial compliance. It is either certified under the COC to be used or it is not. Certainly there are elements of the Certificate of Compliance that can be both used in another certificate.

MS. CHANCELLOR: If PFS does not use the generic Certificate of Compliance limitations isn't it true that PFS would have to do a site specific analysis comparable to the analysis that Holtec conducted with the generic COC under the conditions of the PFS site?

MR. TURK: I believe that calls for a legal conclusion. I would object.

CHAIRMAN FARRAR: Overruled.

DR. SINGH: If I understand your question right I'm going to make an attempt to answer you. Under the general COC, every plan user still has to make a safety evaluation. That is 72.212 provisions. Under site specific COC the actual evaluations are done and submitted to the NRC for approval at a site specific certificate event. That's the limit of my legal knowledge.

MS. CHANCELLOR: I'm not asking you for your legal knowledge, Dr. Singh. I certainly don't intend to call upon that. But with respect to the analysis that must be done for example for the requirement that the cask be inspected such that the vents are not blocked within a 33 hour period. That comes from the generic COC, doesn't it? Did PFS basically hook onto that requirement from the generic COC?

DR. SINGH: Well, it doesn't have to. If they did it's only a matter of choice. It doesn't have to.

MS. CHANCELLOR: The other choice would be that PFS would have to do a site specific analysis to determine what would happen if those air vents were blocked for longer than 33 hours.

DR. SINGH: Yes.

MS. CHANCELLOR: Now with respect to the casks lying down on their sides and having somewhat of a chimney effect, this chimney is pretty short. Isn't it?

DR. SINGH: This chimney was shorter than the vertical chimney.

MS. CHANCELLOR: The vertical chimney is about 20 feet. Correct?

DR. SINGH: Yes.

MS. CHANCELLOR: The cask lying on its side around the annulus where the chimney effect is basically only around the annulus, is that an 11 foot diameter circle? It has to be less than that. Correct? Because the annulus is inside the outside diameter of the cask.

DR. SINGH: I don't understand your question.

MS. CHANCELLOR: If you have a vertical cask, you have a chimney effect from the vents that are at the bottom of the cask to the top of the cask, so you have this chimney effect, passive cooling that is close to 20 feet in height. Correct?

DR. SINGH: That's correct, yes.

MS. CHANCELLOR: If the cask tips over on

its side, the diameter of the cask is about 11 feet.

DR. SINGH: Yes.

MS. CHANCELLOR: And the annulus is less than that. Correct? The annulus is on the parameter of the cask.

DR. SINGH: The appropriate term would be the cross flow area. The flow area in the vertical chimney is the cross sectional area of the annulus. The flow area in the horizontal configuration for the same chimney process to proceed is much larger because now the length of the cask is available for upward flow of air. So you have a larger flow area, and you have a shorter chimney height.

As I said to Judge Farrar to his question earlier, the entire process of heat transfer is different. There is still a chimney. There is still a natural convection, the buoyancy driven natural convection effect, but it is not in the same manner, in the same form in the vertical gaskets.

MS. CHANCELLOR: But you also stated and this is what was confusing to me that if the cask were tipped over none of the vents would be facing the ground. Did I understand that testimony correctly?

DR. SINGH: No, I didn't say that.

MS. CHANCELLOR: Okay.

DR. SINGH: I said that none of the vents would be completely blocked because the cask by definition would be a cylinder. A cylinder to a horizontal surface makes a line contact. It does not make a surface contact. You will always have some opening at the very bottom even if the vent were aligned.

MS. CHANCELLOR: But the vent is only ten inches wide. Isn't it?

DR. SINGH: It's ten inches high, I believe.

MS. CHANCELLOR: 15 inches wide.

DR. SINGH: 15 inches wide.

MS. CHANCELLOR: I had a 50-50 chance. Okay.

DR. SINGH: Strictly speaking, the act of tipping the cask over will not block any of the vents, no matter which way you lay it down.

CHAIRMAN FARRAR: Going back to chimneys where the cask is horizontal. At each end, instead of four vertical chimneys, you have two circular chimneys. Each subchimney is only a quarter of the circumference. Right?

DR. SINGH: Well, let me see if I understand how you visualize the geometry. The

chimney is one chimney. The air enters at three locations in the vertical --

CHAIRMAN FARRAR: Yes. But let's assume it's lying horizontally and the one vent is on the ground. So now you have a vent at 90 degrees up from the bottom, another on the other side 90 degrees. All they have left to get out the top is a quarter of the circumference compared to the 20 feet Ms. Chancellor was talking about in the vertical direction.

DR. SINGH: That's correct. The vertical height would be half of the diameter of the cask, approximately five and a half feet.

CHAIRMAN FARRAR: Right.

DR. SINGH: In the distance between the air inlet location and the exit location.

CHAIRMAN FARRAR: Right.

DR. SINGH: But the cross flow area available for that air once it enters, it does not behave as a beam of light.

CHAIRMAN FARRAR: Oh, okay.

DR. SINGH: It enters and because of temperature differences along the length of the canister, the air mixes. If you do an evaluation, you will see if you put a smoke particle in, it wanders around in the cask and it finally comes out.

CHAIRMAN FARRAR: So it could enter and then go down what used to be the vertical chimney which is now a horizontal chimney.

DR. SINGH: Right.

CHAIRMAN FARRAR: Okay.

MS. CHANCELLOR: And Dr. Singh, there would still have to be inspections of the casks during the 33 hour period to ensure that the vents were not blocked. Correct?

MR. GAUKLER: Objection. I don't know this foundation, where the 33 hour period came from because we were talking about something else before.

MS. CHANCELLOR: We're talking -- Well, I'll see what the ruling is.

CHAIRMAN FARRAR: Say that again, Mr. Gaukler.

MR. GAUKLER: I don't know how the 33 hour limit ties into the previous questions and answers she's just been asking him. Foundation.

CHAIRMAN FARRAR: Overruled. Go ahead.

DR. SINGH: I'll gladly answer the question if I understood it. What did you ask?

MS. CHANCELLOR: Let me rephrase it. The generic COC and the PFS SAR has a requirement that the vents be inspected every three hours to ensure that

the vents are not blocked.

DR. SINGH: 33 hours, you mean?

MS. CHANCELLOR: 33 hours.

DR. SINGH: Okay.

MS. CHANCELLOR: Isn't it true that the inspection program would still need to be conducted even if the casks were lying on their sides?

MR. TURK: May I ask for clarification? Is this with regard to both the PFS site and the COC? That's what I heard the last question to be. I thought we're only talking about the COC.

CHAIRMAN FARRAR: Overruled. Do you understand the question?

DR. SINGH: I'm going to be guessing at that question.

CHAIRMAN FARRAR: Then --

MS. CHANCELLOR: Will the PFS inspection program still need to be in effect for inspecting the vents to determine whether the vents are blocked or not if some or all of the casks are in a horizontal position? Will they still need to conduct the inspection program to determine whether the vents remain open?

DR. SINGH: I don't believe that in the regulatory space it would be the normal inspection

phase now to the recovery operations. I'm speaking strictly from my knowledge of the way casks certification is worked out. If the system is in a deviant condition, in other words it's no longer in a normal upright condition of what it's intended to do, then the plant or that facility is in the recovery mode. They would be doing much more than inspections.

They would be seeking to upride the cask, ensure that the dose is minimized, use appropriate means such as steel plates, lead blankets and other means to minimize the dose. They will use appropriate measures to mitigate those to personnel, off-side those, and recover the cask and restore it to its engineered normal condition.

MS. CHANCELLOR: And are you aware of any specific recovery program that PFS has if such a condition occurs?

DR. SINGH: I am not aware of it. I have not studied it.

MS. CHANCELLOR: Dr. Soler, are you?

DR. SOLER: No.

MS. CHANCELLOR: Dr. Redmond?

DR. REDMOND: No I am not.

MS. CHANCELLOR: Dr. Soler, any of you, have you done a quantitative assessment of the reduced

chimney effect if the casks are lying on their sides?

DR. SINGH: Yes. We have made simulations of casks lying horizontally with bottom ducts blocked. We have found the temperature rise is fairly modest.

MS. CHANCELLOR: At the PFS site?

DR. SINGH: Yes. We have done this on our own accord.

MS. CHANCELLOR: Is that part of your testimony?

DR. SINGH: Anything I say is part of my testimony.

MS. CHANCELLOR: Is it part of your written testimony?

DR. SINGH: I don't believe so.

MS. CHANCELLOR: If we don't have those calculations, I request that we have a copy of those calculations that Dr. Singh is referring to.

MR. GAUKLER: I'm going to have to know what calculations Dr. Singh is referring to. We did make some calculations available to State Counsel.

MS. CHANCELLOR: I certainly don't know. I request that Dr. Singh respond.

MR. GAUKLER: You can pick it up, Dr. Singh. Right?

MS. CHANCELLOR: Dr. Redmond, have --

CHAIRMAN FARRAR: So we have calculations done not in the support of the written testimony, but it's something that you did for your own verification at some other point. Do I understand correctly what you just said?

DR. SINGH: Yes.

CHAIRMAN FARRAR: Yes is sufficient. Now, Ms. Chancellor, you asked him about those. He answered.

MS. CHANCELLOR: How do I know whether the calculations are supportive of what he's saying?

CHAIRMAN FARRAR: Where are the calculations available?

DR. SINGH: I have a copy here. But I should complete my response to you, Your Honor. Judge Lam asked me the question if you recall, what would happen if the casks were horizontal and ducts were blocked. I gave some testimony at the time which was based on my experience with the behavior of the structure.

My curiosity got the better of me, and going back I did some detailed evaluations. We documented it in an internal calculation package. We did not wish to burden the Board with even more volume of calculations. We continue to do evaluations. If

a question is raised internally within the company, we do such evaluations. This is just part of our ongoing work.

CHAIRMAN FARRAR: Mr. Gaukler, then you can make those available.

MR. GAUKLER: We did. If those are the calculations Dr. Singh is referring to, we did make those available to the State on June 11.

MS. CHANCELLOR: I can't keep up with the calculation, Your Honor.

MR. GAUKLER: If there's a question of June 11, I have the letter here with me to back it up.

CHAIRMAN FARRAR: Jane, why don't you go ahead?

MS. CHANCELLOR: Dr. Redmond, have you given any consideration to the probability of an increase in dose as a function of what levels of ground motion will form the design basis at the PFS site?

DR. REDMOND: No. My analysis has simply been normal condition casks sitting on the pad.

MS. CHANCELLOR: Based on a 2000 year. You didn't recall the design basis upgrade. Correct?

DR. REDMOND: No.

MS. CHANCELLOR: Just one second, Your

Honor. I think I'm done.

JUDGE LAM: Let me ask Dr. Singh a follow up question to what you have done in your analysis you performed with response to my question about horizontal casks. Did the latest result that you obtained change any of your testimony earlier?

DR. SINGH: No. It did not.

JUDGE LAM: So it was a confirmatory analysis that you performed, and you provide no contradictory results.

DR. SINGH: That's correct. The statements that I made stand, they remain valid. These calculations simply confirm them.

JUDGE LAM: Right. Because if I recall correctly, our dialogue has to do with if the casks tip over, the -- purpose canister would not break. The storage cask concrete would not break. Furthermore, if any of the ventilation area were blocked nothing would melt. That's the context of our perception. Is that right?

DR. SINGH: Yes. That is correct.

MS. CHANCELLOR: I have no further questions, Your Honor.

CHAIRMAN FARRAR: Thank you, Ms. Chancellor. Can I assume that the staff for the

Applicant needs another go around? Mr. Gaukler?

MR. GAUKLER: I don't think I have any redirect. I would say that if the Board desires, we can make the calculation available to the Board. We have made it available to the State.

MR. TURK: I have one item, Your Honor, that I was thinking of doing with Mr. Waters, but I think these witnesses are more appropriate. It has to do with the COC for the HI-STORM cask. In fairness to Ms. Chancellor this is something that I should have covered with my original cross examination, but it shouldn't take more than a minute.

CHAIRMAN FARRAR: Go ahead.

MR. TURK: I would ask Mr. O'Neill to assist me with this again. I'm asking to distribute a copy of certain pages from the Statement of Consideration that accompanied the Commission's approval of the HI-STORM 100 cask. This is published in 65 Federal Register 25.241.

Your Honor, you will recall that the COC itself is part of the record. That's Staff Exhibit FF, I believe, as in Frank. What I'm distributing now is portions of the Statement of Consideration that accompanied the approval of the COC. What I've attached here --

CHAIRMAN FARRAR: Do you want this marked?

MR. TURK: Yes. I would ask this to be marked as Staff Exhibit Number 54 for identification.

CHAIRMAN FARRAR: All right.

(Whereupon, the above-referred to document was marked as Staff's Exhibit No. 54 for identification.)

MR. TURK: I put in here just the cover page to indicate what the document is. Then I've attached the section dealing with comments on radiation protection. These are comments that accompanied the issuance of the Statement of Consideration and the COC. I would ask the witness, Dr. Redmond, turn to what appears here as page 72-SC-104. I note those are page numbers that appear in the NRC's loose-leaf volume of regulations and accompanied Statements of Consideration.

DR. REDMOND: Okay.

MR. TURK: In the center column at the bottom, do you see comment B-17?

DR. REDMOND: Yes.

MR. TURK: You note that the commentor with respect to the HI-STORM cask objected to the use of a 30 day duration for accident dose calculations.

MS. CHANCELLOR: Your Honor, I object to

this line of questioning.

CHAIRMAN FARRAR: Mr. Gaukler, why isn't this legal? I mean, this is an official commission publication. Why do we need to talk to the witness about it?

MS. CHANCELLOR: Exactly.

CHAIRMAN FARRAR: It is what it is. I don't care what he thinks about it. We care what the commission or the authors thought about when they were writing it.

MR. TURK: The question that came up before with respect to testimony, what's the proper period of time in which to calculate the presence of an individual at the OCA boundary. The COC Statement of Consideration addresses that specifically.

CHAIRMAN FARRAR: Then do we much care what this witness says about it? I would advise this is something you would cite in your post-hearing argumentation if it's different from what the witness said. Or maybe I'm missing something here.

MR. TURK: The whole regime that we're in right now where we're counting on what's the appropriate standard really goes to the legal question. If I ask him one question, Your Honor, I would simply ask him if this response to comment B-17

is consistent with your view that a 30 day assumption is to be used for accident calculations for the HI-STORM 100 casks.

MS. CHANCELLOR: Objection, Your Honor. It mischaracterizes the witness's testimony.

MR. GAUKLER: I think this is a legal conclusion. I think we ought to go with that. Save it for the briefs.

CHAIRMAN FARRAR: Yes. I think we've gone far enough Mr. Turk. Let's not ask the witness about it.

MR. TURK: Should we simply leave it as marked then?

CHAIRMAN FARRAR: Yes.

MR. TURK: That's it.

CHAIRMAN FARRAR: Okay. Is that a wrap up of these witnesses?

MS. CHANCELLOR: Yes, Your Honor.

CHAIRMAN FARRAR: Okay. Thank you gentlemen. We appreciate you coming and sharing your testimony. I don't know if we get to see you again.

PARTICIPANT: You won't see me.

CHAIRMAN FARRAR: Same to you, sir.

(Laughter.)

CHAIRMAN FARRAR: As the spectators at

this event for the first time can see that we've formed a peculiar bond among ourselves from all the weeks out in Salt Lake City. Thank you gentlemen. Mr. Gaukler, that's the only set of witnesses that you had.

MR. GAUKLER: That's correct, Your Honor.

CHAIRMAN FARRAR: Mr. Turk.

MR. TURK: Your Honor, we'll be putting on the testimony of Mr. Michael Waters. We'd like a few minutes to set up. I think it might be the best time right now to take our afternoon break.

CHAIRMAN FARRAR: All right. Let's do that. It's 3:36 p.m. Let's come back at 3:50 p.m. Off the record.

(Whereupon, the foregoing matter went off the record at 3:36 p.m. and went back on the record at 3:52 p.m.)

CHAIRMAN FARRAR: On the record. Please raise your right hand.

WHEREUPON,

MICHAEL WATERS

was called as a witness by Counsel for the Staff and, having been first duly sworn, assumed the witness stand, was examined and testified as follows:

CHAIRMAN FARRAR: Thank you.

MR. TURK: Your Honor, let me indicate for the record that I distributed to the parties and the Board as well as to the Court Reporter copies of the NRC Staff testimony of Michael Waters concerning Part E of contention L/QQ. At the top of this document, the date is April 1, 2002 and revised 6/21/02. Wherever the testimony is different from the testimony that was filed on April 1st, we have indicated that with strike out and underlying.

I would note that in some cases the change was nothing more than, as on page 9, entering in the exhibit number B & W which you'll find seven lines from the bottom. Then if you look at page 12 three lines from the bottom, there's a minor change. Similarly, at the bottom of page 16 the last line as well at the top of page 17, there's a slight revision and another revision in the middle of page 17. And the last question and answer were renumbered. I believe those are the extent of the changes. If I'm missing anything though, they would show up with underlying and strike out.

CHAIRMAN FARRAR: All right. Thank you, Mr. Turk. That's very helpful.

DIRECT EXAMINATION

BY MR. TURK:

Q Good afternoon, Mr. Waters.

A Good afternoon.

Q Mr. Waters, you've filed a copy of your written testimony for presentation in these proceedings.

A Yes.

Q Do you have a copy of that testimony before you?

A Yes I do.

Q Is that the document entitled "NRC Staff Testimony of Michael Waters concerning radiological dose considerations related to unified contention Utah L/QQ Part E (Sizemic Exemption)" dated April 1, 2002 and revised June 21, 2002?

A Yes.

Q Have you also prepared a statement of your professional qualifications?

A Yes.

Q Is that statement attached to the back of this testimony?

A Yes.

Q Do you have any corrections or revisions to your testimony or your statement of professional qualifications beyond those which appear in this document as I've indicated to the Licensing Board a

few minutes ago?

A No I do not.

Q With the revisions that are marked in your testimony, is your testimony true and correct to the best of your knowledge, information, and belief?

A Yes it is.

Q Do you adopt your written testimony as your sworn testimony in this proceeding?

A Yes I do.

MR. TURK: Your Honor, at this point I would ask that the testimony of Mr. Waters be admitted and bound into the record as it read.

CHAIRMAN FARRAR: Any objection.

MR. GAUKLER: No objection, Your Honor.

MS. CHANCELLOR: No objection, Your Honor.

CHAIRMAN FARRAR: All right. Then the Reporter will bind the testimony into the record at this point as it read.

(Whereupon, the above-referred to document was received in evidence.)

MR. TURK: Thank you. Your Honor, I don't have any additional direct questions going to the substance of the issue before you which is the PFS application and sizemic exemption request. But as I mentioned during the cross examination of Dr. Redmond,

April 1, 2002
Revised 6/21/02

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-ISFSI
	)	
(Independent Spent	)	
Fuel Storage Installation)	)	

NRC STAFF TESTIMONY OF MICHAEL D. WATERS CONCERNING RADIOLOGICAL DOSE CONSIDERATIONS RELATED TO UNIFIED CONTENTION UTAH L/QQ, PART E (SEISMIC EXEMPTION)

Q1. Please state your name, occupation, and by whom you are employed.

A1. My name is Michael D. Waters. I am employed as a Health Physicist in the Spent Fuel Project Office, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission ("NRC"). A statement of my professional qualifications is attached hereto.

Q2. Please describe your current responsibilities.

A2. In my position as a Health Physicist, I perform technical reviews of spent nuclear fuel ("SNF") storage casks, independent spent fuel storage installations ("ISFSIs"), and transportation packages, primarily in the areas of shielding, confinement, containment, radiation protection, and criticality. In addition, I continue to be responsible for certain reviews initiated in my former position as a Project Engineer in SFPO, involving management of the safety reviews of applications for these designs and facilities. My safety reviews have included both new ISFSI license applications and amendments to existing licenses.

Q3. Please explain what your duties have been in connection with the NRC Staff's review of the application of Private Fuel Storage, L.L.C. ("PFS" or the "Applicant") for a license to construct

and operate an ISFSI on the reservation of the Skull Valley Band of Goshute Indians, geographically located within Skull Valley, Utah (the "proposed PFS Facility").

A3. As part of my official responsibilities, I served as a Project Manager for portions of the NRC Staff's safety evaluation of the proposed PFS Facility, and provided general technical oversight and advice on technical reviews performed by other NRC Staff ("Staff") members. My involvement included review of the Applicant's Safety Analysis Report ("SAR") and participation in the Staff's preparation of the "Safety Evaluation Report Concerning the Private Fuel Storage Facility," issued on September 29, 2000 ("SER"), and Supplement No. 2 to the SER, dated December 21, 2001 ("SER Supplement No. 2"). Those two documents have since been incorporated into the NRC Staff's "Consolidated Safety Evaluation Report Concerning the Private Fuel Storage Facility," issued in March 2002 ("Consolidated SER").

I also assisted the Staff in its preparation of the Final Environmental Impact Statement ("FEIS") for the proposed PFS Facility, NUREG-1714 (December 2001), in which I reviewed general design issues associated with the proposed PFS Facility and its potential radiation impacts on the environment. In addition, I assisted the Staff in preparing the "NRC Staff's Response to Applicant's Motion for Summary Disposition of Utah Contention L, Part B," dated December 7, 2001; and the "NRC Staff's Objections and Responses to the 'State of Utah's Twelfth Set of Discovery Requests directed to the NRC Staff,'" dated October 3, 2001.

Q4. Have you performed any other work among your duties at the NRC that is relevant to the Staff's evaluation of the license application for the proposed PFS Facility?

A4. Yes. On behalf of the Staff, I performed a shielding and radiation protection evaluation of the HI-STORM 100 storage cask system, and a shielding evaluation of the HI-STAR 100 transportation cask system. PFS has proposed to use both of these systems at the PFS Facility. The NRC approved the HI-STORM 100 storage cask design for general use under

Subpart L of 10 C.F.R. Part 72, in the HI-STORM 100 Certificate of Compliance ("CoC") (May 31, 2000). The NRC certified the HI-STAR 100 transportation cask design for SNF transport under 10 C.F.R. Part 71, in CoC No. 9261 for the HI-STAR 100 transportation package (Revision 0, March 31, 1999).

Q5. What is the purpose of this testimony?

A5. The purpose of this testimony is to provide the NRC Staff's views with respect to one portion of Unified Contention Utah L/QQ, Part E, insofar as that contention concerns the potential dose consequences that may result in the event of a beyond-design-basis hypothetical cask tipover.

Q6. Are you familiar with Unified Contention Utah L/QQ, Subpart E.2.?

A6. Yes. As admitted by the Licensing Board, Unified Contention Utah L/QQ, Subpart E.2., states as follows:

> **Unified Contention Utah L/QQ (Geotechnical)**
>
> * * *
>
> **E. Seismic Exemption.**
>
> 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 probablistic rather than a deterministic seismic hazards analysis, PFS should be required either to use a probablistic 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 failed to show that its facility design will provide adequate protection against exceeding the section 72.104(a) dose limits.

Q7. Please identify the Commission's requirements pertaining to the dose limits for an ISFSI, such as the proposed PFS facility, that you considered in your evaluation of this matter.

A7. The Commission's requirements concerning the dose limits for an ISFSI are set forth in 10 C.F.R. Part 72. Specifically, 10 C.F.R. § 72.104(a) provides that annual dose equivalents to any real individual who is located beyond the controlled area boundary will not exceed 25 mrem to the whole body, 75 mrem to the thyroid, or 25 mrem to any other critical organ as a result of exposure to discharges of radioactive material or direct radiation from the ISFSI, during "normal operations and anticipated occurrences." Further, the Commission has established radiation dose limits for individuals located on or beyond the nearest boundary of the controlled area for any "design basis accident," as set forth in 10 C.F.R. § 72.106(b). Specifically, under accident conditions, individuals may not receive the more limiting of a total effective dose equivalent (referred herein as "dose") of 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 50 rem.

Q8. Has the Applicant demonstrated that its proposed facility design will provide adequate protection against exceeding the section 72.104(a) dose limits for normal operations and anticipated occurrences?

A8. Yes. The Staff reviewed the Applicant's dose analysis for normal conditions and anticipated occurrences, set forth in Chapter 7 of the PFS SAR and found it to be acceptable, as documented in Chapters 11 and 15 of the Staff's Consolidated SER.

Q9. In its evaluation, did the Staff consider whether exposures from design-basis accidents or design-basis seismic events at the proposed PFS Facility would exceed the dose limits specified in 10 C.F.R. 72.104(a)?

A9. No. Such an evaluation would have been inappropriate, in that the requirements of 10 C.F.R. § 72.104(a) apply only to "normal operations and anticipated occurrences," and do not apply to design-basis accidents or a design-basis seismic event. Design basis accidents and design basis seismic events do not constitute normal operations or anticipated occurrences; rather,

by definition, they constitute "design basis" accidents or events, for which the dose limits in 10 C.F.R. § 72.106(b) apply.

Q10. In Unified Consolidated Contention Utah L/QQ, Subpart E.2, the State of Utah asserts that PFS should be required either to use a probablistic methodology with a 10,000-year return period, comply with the deterministic analysis requirement of 10 C.F.R. § 72.102(f), or use a return period significantly greater than 2000 years, in that "PFS failed to show that its facility design will provide adequate protection against exceeding the section 72.104(a) dose limits." Do you believe that this is a valid concern?

A10. No.

Q11. Please provide the bases for this conclusion.

A11. First, as stated above, the dose limits specified in 10 C.F.R. § 72.104(a) apply to normal operations and anticipated occurrences, and do not apply to design basis accidents or design basis seismic events, for which 10 C.F.R. § 72.106(b) applies.

Second, the State's assertion appears to be premised on certain language in SECY-98-126 (June 4, 1998), in which the Staff had proposed the use of a two-tiered approach in conducting probabilistic seismic hazard analyses ("PSHAs"). Under that proposed approach, a 1,000-year return period might have been proposed for SSCs whose failure would not result in exceedance of the dose limits in 10 C.F.R. § 72.104(a), whereas a 10,000-year return period would have been necessary if the dose limits in § 72.104(a) were exceeded. However, as discussed in the NRC Staff's Testimony of Drs. John Stamatakos, Martin McCann and Rui Chen, filed herewith, the approach proposed in SECY-98-126 has been superseded by SECY-01-0178, in which the Staff proposed (and the Commission approved) the use of a single-level design basis earthquake with a ground motion that is commensurate with the level of risk associated with an ISFSI, instead of the graded approach that was proposed in SECY-98-126 and cited in Part E of this contention.

Accordingly, the Staff considers that the two-tiered approach proposed in SECY-98-126, and its reference to the dose limits in § 72.104(a) to be inapplicable, and there does not exist any valid basis to require PFS to demonstrate that its exemption request satisfies the dose limits specified in 10 C.F.R. § 72.104(a).

Q12. Has the Staff conducted an evaluation to determine if the does limits specified in 10 C.F.R. § 72.106(b) would be satisfied in the event that a design basis earthquake occurs at the proposed PFS Facility?

A12. Yes. The Staff has concluded that in the event that a design basis earthquake occurs at the proposed PFS Facility, the dose limits specified in 10 C.F.R. § 72.106(b) would not be exceeded.

Q13. Please provide the bases for this conclusion.

A13. As set forth in the Staff's Consolidated SER, sections 15.1.2.6 and 15.2 (pages 15-29 to 15-32, and 15-122), the occurrence of a design basis earthquake with a mean annual probability of occurrence of 5×10^{-4} (2,000-year return period) would not impair the ability of SSCs important to safety to maintain subcriticality, confinement, and sufficient shielding of the spent nuclear fuel. Accordingly, the dose limits in 10 C.F.R. § 72.106(b) will not be exceeded in the event that a design basis earthquake occurs at the proposed PFS Facility.

Q14. Did the Staff's evaluation consider whether a cask tipover could occur in the event of a design basis seismic event?

A14. Yes. The Staff reviewed the Applicant's analyses, with respect to whether tipover of a cask at the proposed PFS Facility could occur as a result of a design-basis seismic event at the proposed PFS Facility, which was described in Chapters 2, 3, and 4, and section 8.2.6.1, of the Applicant's SAR. As discussed in section 5.1.4.4 of the Consolidated SER, based on its review of

this matter, the Staff concluded that the Applicant had adequately demonstrated that the design-basis seismic event would not cause cask tipover.

Q15. Did the Applicant and Staff also consider the potential consequences of a hypothetical cask tipover, if that event were to occur?

A15. Yes. The Applicant provided an analysis, in accordance with the Standard Review Plan (NUREG-1567), in which it considered whether a hypothetical cask tipover (*i.e.*, a tipover that is non-mechanistically assumed to occur) would impair the cask's ability to maintain subcriticality, confinement and sufficient shielding of the stored fuel.

In its analysis, the Applicant determined that deceleration forces would be less than the HI-STORM 100 design basis values for the MPC. As a result, the MPC would maintain its integrity, maintain its confinement function, and would not release radioactive materials. Therefore, there would be no resultant doses due to a release of radioactive materials. Further, with respect to potential increases in direct radiation, the Applicant stated that localized damage to the radial concrete shield and outer steel shell, where the cask impacts the pad, could result in an increased surface dose rate due to the damage; however, the Applicant indicated that the localized areas would be small and would not produce a "noticeable increase" in the dose rates at the owner controlled area ("OCA") boundary. In sum, the Applicant indicated that there would not be a significant increase in radiation exposures above normal operating conditions as a result of a hypothetical cask tipover. Therefore, based on the Applicant's confinement and shielding analysis of a hypothetical cask tipover, the design basis accident dose limits of 10 C.F.R. § 72.106(b) would not be exceeded. The Applicant's conclusions with respect to this matter are presented in Section 8.2.6 of the PFS SAR.

As set forth in section 5.1.1.4 of the Consolidated SER, the Staff agreed that a hypothetical cask tipover at the proposed PFS Facility would result in stresses in the MPC that are bounded by

those evaluated in the Staff's HI-STORM 100 SER, and that the Staff's conclusions in the HI-STORM 100 SER with respect to the structural integrity of the MPC are valid for the proposed PFS Facility. Further, as set forth in section 15.1.2.1 of the Consolidated SER, the Staff reviewed the Applicant's method of analysis, inputs, assumptions and conclusions, and agreed with the Applicant that deformations of the storage cask as a result of a tipover event would not impose unacceptable loads on the MPC. Accordingly, the Staff concluded that a hypothetical tipover would not impair the cask's ability to maintain subcriticality, confinement and sufficient shielding of the stored fuel.

Q16. Did the Staff also consider whether an earthquake that exceeds the design basis seismic event would result in cask tipover at the proposed PFS Facility?

A16. Yes. In this regard, it should be noted that beyond-design basis seismic events are not required to be considered in the licensing or evaluation of a proposed facility. However, in preparing for hearings on this contention, the Staff considered whether a 10,000-year return period seismic event (*i.e.*, a seismic event that is significantly beyond the design basis) would cause the storage casks at the proposed PFS Facility to tipover. As set forth in the NRC Staff's Testimony of Drs. Goodluck I. Ofoegbu and Daniel J. Pomerening, and in the NRC Staff's Testimony of Jack Guttmann and Dr. Vincent Luk, filed herewith, the Staff has concluded that the storage casks would not tipover even in the event of a 10,000-year return period earthquake at the proposed PFS Facility.

Q17. Notwithstanding the Staff's conclusion that neither a design basis seismic event nor a 10,000-year return period seismic event would result in cask tipover at the proposed PFS Facility, did the Staff also analyze the potential offsite dose consequences that might result from a hypothetical multiple cask tipover event, if it were to occur at the proposed PFS Facility?

A17. Yes.

Q18. Please describe the dose consequence analysis that was conducted by the Staff, pertaining to this hypothetical multiple cask tipover event.

A18. On behalf of the Staff, in preparing to address this contention at hearing, I conducted an analysis of a multiple cask tipover event at the proposed PFS Facility. In this analysis, I considered (a) the potential for damage to the cask shield that might result from impact on the concrete storage pad; (b) the potential for thermal degradation of the cask's radial concrete shield in the form of hydrogen loss from the concrete, with the cask assumed to be in a horizontal position; and (c) the potential effect on offsite doses that might be caused by spacial reorientation of the casks from a vertical to tilted or horizontal position (*i.e.,* the potential for direct offsite exposures to the top, side, and/or bottom of the casks).

Q19. Please describe the Staff's evaluation, with respect to the first issue identified in response to Question 18 above, *i.e.,* the potential for damage to the cask shield that might result from impact on the concrete storage pad.

A19. I conducted an analysis, in which I considered the nature, configuration, and amount of shielding provided in the HI-STORM 100 cask system, including the multipurpose canister ("MPC") contained within the cask. Important shielding components within the MPC and/or overpack are shown in Holtec International Drawing No. 1495, Sheet 1, of the HI-STORM 100 FSAR (Staff Exhibit V) and Figure 5.3.11 of the FSAR (Staff Exhibit W). Within the radial sides of the canister and overpack shields, there are a total of approximately 3.25 inches of steel and 26.75 inches of concrete. In the top of the canister and overpack, there are a total of approximately 14.75 inches of steel and 10.5 inches of concrete. In the bottom of the canister and overpack, there are a total of approximately 9.5 inches of steel and 17 inches of concrete. There are openings and penetrations in the overpack shield (such as the small annulus region between the pedestal shield and overpack wall, and the air inlet and outlet vents), and these openings may result in radiation

streaming and higher surface dose rates in surrounding areas. However, the openings have an insignificant effect on the overall shielding ability of the top, side, and bottom of the HI-STORM cask, with respect to mitigating OCA boundary dose rates.

As stated above, the hypothetical tipover of a storage cask at the proposed PFS Facility would not impair the cask's ability to maintain subcriticality, confinement and sufficient shielding of the stored fuel. However, it is possible that there could be localized damage near the cask impact area, as noted by the Applicant in its hypothetical tipover analysis. I understand that the State of Utah has postulated that this could be in the form of crushing, "micro-cracking," or flattening of the concrete, or thinning of the steel shell. If this were to occur, the surface dose rates in localized areas of each cask could increase, in theory, due to the postulated damage to the shield.

However, even if one postulates that damage to the shield would occur, this would result in only minor increases in dose rates at the surface of the casks. Each cask would continue to maintain its shielding after a hypothetical tipover to sufficiently attenuate radiation from the spent fuel. In this regard, it should be noted that there would be no significant loss of bulk shielding mass or severe discontinuities in any direction around the radial concrete shield. The concrete is encased in a steel cylindrical shell, with no means of escape after a hypothetical cask tipover. Any postulated minor discontinuities within or damage to the concrete (resulting from crushing, cracking, or flattening of the concrete), or thinning of the steel shell, would have either no effect at all, or would only slightly increase dose rates at the surface of each cask within the vicinity of the damage. These localized dose increases would be minor and confined to a relatively small area of the total surface area of each cask.

In the event such damage occurs and leads to an increased dose rate near the cask, any change in the surface radiation flux near the damaged area likely would not be detectable at the

OCA boundary. This is because the relatively small, additional amount of radiation escaping from these areas would have significantly dissipated at 600 meters (*i.e.*, at the OCA boundary). Radiation dissipation would be caused by scattering and absorption interactions in the surrounding air, and by divergence of the radiation flux as it is emitted in every direction away from the casks.

Further, any minor increases in dose rates would likely be in areas where each horizontal cask is in contact with the storage pad. Therefore, additional radiation that could escape from these areas would be shielded and absorbed by the storage pad underneath. In addition, in any assumed arrangement of tipped casks (whether in a random array or sequential pattern), only the casks located along the "outer periphery" of the arrangement (*i.e.*, the casks on the storage pads located along the outer perimeter of the two pad clusters) could effectively contribute to off-site doses. Except for minor contributions from skyshine, any tipped casks situated on the interior pads of a hypothetical cask arrangement (damaged or undamaged) would be substantially shielded by the casks positioned along the outer periphery of storage pads.

In sum, any minor irregularities in the cask shields that might result from shield damage incurred in a cask tipover, resulting in an increased dose rate at or near the cask surfaces, would not contribute significantly to the total radiation dose rate at the OCA boundary.

Q20. Please describe the Staff's evaluation, with respect to the second issue identified in response to Question 18 above, *i.e.*, hypothetical thermal degradation of the concrete shield in the form of hydrogen loss.

A20. As presented in Section 7.3.3.5 of the PFS SAR and in Holtec Report No. HI-971645, "Radiation Shielding Analysis for the PFS," Rev 1, the maximum normal condition dose rate (for an undamaged cask in the upright position) is estimated by the Applicant to be 0.00293 mrem/hr (*i.e.*, 5.85 mrem/yr ÷ 2,000 hours/yr) at the OCA boundary (~600 meters). This total dose consists of an individual neutron dose rate of approximately 0.000552 mrem/hr (~19% of total) and

an individual gamma dose rate of approximately 0.00237 mrem/hr (~81% of total) at the OCA boundary. This is based on the conservative assumption that 4,000 casks are filled with design-basis fuel with a burnup and cooling time of 40,000 MWD/MTU and 10-years, respectively.

The Staff performed sensitivity calculations of the surface dose rates (gamma and neutron) from postulated reductions in hydrogen content within the HI-STORM 100 cask's radial concrete shield. The Staff performed dose rate calculations with SCALE, a state-of-the-art Monte Carlo radiation transport computer code, to compare changes in dose rates from postulated reductions in hydrogen content within the radial concrete shield. The reductions in hydrogen content were based on reference data that lists hydrogen densities in a particular type of concrete at different temperatures. In general, as radial concrete temperature increased, the hydrogen content decreased.

The Staff predicted worst-case temperatures (with the COBRA-SFS computer code) within the radial concrete shield, making the conservative assumptions that the cask rests in a horizontal position, and that all inlet and outlet vents are blocked, so as to minimize convective heat transfer through the HI-STORM annulus. Based on the temperatures predicted for regions of the radial concrete shield, and the hydrogen content data for concrete at various temperatures, the hydrogen content was conservatively reduced in layers within the SCALE shielding model of the concrete radial shield.

The Staff performed multiple dose calculations (for gamma and neutrons) for fuel with a burnup of 40,000 MWD/MTU and cooling time of 10 years (representative of PFS design-basis analysis fuel). Based on these sensitivity calculations, the peak neutron and gamma dose rate at the surface of the cask could increase by factors of 6.77 and ~~1.39~~ 1.37, respectively, as a result of the assumed worst-case thermal degradation (via hydrogen loss). The total dose rate at the surface of the cask increases by a factor of 1.54 when considering the relative contributions of

neutrons and gammas to the total normal condition dose rate. Assuming that all 4,000 casks tipover and experience thermal degradation in the radial shield, one could conclude, conservatively, that the off-site dose rates could increase by a factor of approximately 2.4 ([6.77 x 19%] + [~~1.39~~ 1.37 x 81%]). This factor is based on the assumption that increases to off-site neutron and gamma dose rates would be approximately proportional to the respective increases to the peak neutron and gamma dose rates on the radial surface. In addition, this factor accounts for the relative contribution of neutron radiation (~19% of total) and gamma radiation (~81% of total) to off-site dose rates at the OCA boundary. A factor of 2.4 increase for a tipover of 4,000 casks would constitute only a minor increase over the normal dose rate, and would not exceed the (design basis) accident dose limit of 5 rem.

By comparison, in my evaluation, I determined that the (design basis) accident offsite dose limit of 5 rem could only be exceeded if the off-site dose rate at the OCA boundary increases to approximately 6.94 mrem/hr. This assumes that: (1) the only postulated dose to persons off-site would be from direct radiation, as the confinement system of each cask would maintain its integrity (*see* discussion of cask confinement and shielding, *supra*); and (2) a hypothetical person at the site-boundary is unshielded, stationary, and continually exposed to the accident dose rate for thirty days after the hypothetical tipover event (*i.e.*, 6.94 mrem/hr x 30 days x 24 hrs/day = 5 rem). A dose rate of 6.94 mrem/hr corresponds to an increase above the maximum normal condition off-site dose rate by a factor of approximately 2,400 (*i.e.*, 6.94 mrem/hr ÷ 0.00293 mrem/hr = 2,369).

Inasmuch as postulated thermal degradation of the concrete shields of 4,000 casks could lead to no more than a factor of 2.4 increase, it would not exceed the (design basis) accident dose limit.

Q21. Please describe the Staff's evaluation, with respect to the third issue identified in response to Question 18 above, *i.e.*, spacial reorientation of the casks from a vertical to a tilted or horizontal position.

A21. In my analysis, I considered the extent to which dose rates might increase as a result of spacial reorientation of the casks, from a vertical to a tilted or horizontal position. In this regard, as discussed above, I considered the amount of shielding at the top, side, and bottom of the casks that may face off-site and affect off-site dose rates.

Further, based on a review of the "Radiation Shielding Analysis for the PFS," Holtec Report No. HI-971645 (March 14, 2001), and the storage configuration of the 4,000 casks depicted in PFS SAR Figure 1.2-1 (Staff Exhibit X), it is evident that the sides of the casks located along the outer periphery of the storage pads (*i.e.*, the casks which directly face the OCA boundary) are the dominant contributor (~99% of total) to off-site dose rates during normal upright conditions. The tops of all the casks in the entire storage array contribute only a minor amount (~1% of total) to off-site dose rates through skyshine interactions in the atmosphere. The bottoms of the casks do not contribute to off-site dose rates in their normal (upright) position. Also, the sides of the casks that are located on interior storage pads (inside the outer periphery) do not significantly contribute to off-site dose rates because they are shielded by the closely-spaced casks (*i.e.*, 15 to 16 feet cask-to-cask pitch) on the outside periphery of the storage pads. Even if the casks tipped over, the same would be true: Either the top, side, or bottom of tipped casks on the outer periphery of the storage pads would be the dominant contributor to off-site dose rates, in the direction faced by the cask surface.

Also, if the top or bottom of any particular horizontal or tilted cask (located along the outer periphery) increased the off-site dose rates in a particular direction (*e.g.*, the north OCA boundary), the contribution from the side of the cask that had directly faced the OCA boundary under normal

upright cask conditions (*i.e.*, prior to reorientation) would obviously decrease. As a result, one would not expect to see a significant increase (relative to a factor of 2,400) in off-site dose rates at any point of the OCA boundary, as a result of the tops or bottoms of multiple casks directly facing off-site on the outer periphery of the storage pads (as compared to the normal condition in which when the sides of these casks, which are the dominant dose contributors during normal upright cask conditions, face off-site).

This conclusion is further supported by an analysis I conducted of the worst-case changes to off-site dose rates, from examination of the peak one-meter dose rates for the tops, sides, and bottoms of the casks and the normal condition off-site dose rates. Based on Holtec Report No. HI-971645, the total peak dose rate at one meter from the top of the cask is 0.87 mrem/hr, consisting of an individual neutron dose rate of 0.62 mrem/hr (~71% of total) and individual gamma dose rate of 0.25 mrem/hr (~29% of total). The total peak dose rate at one meter from the side of the cask is 5.01 mrem/hr, consisting of an individual neutron dose rate of 0.42 mrem/hr (~8% of total) and individual gamma dose rate of 4.59 mrem/hr (~92% of total).

Calculations of the maximum dose rates from the bottom of the HI-STORM cask, at one meter, are not available because the bottom of the cask is normally face-down and does not contribute to off-site doses during normal operations or design-basis accidents. However, the maximum one meter dose rate would be bounded by a consideration of the calculated dose rates at one meter from the bottom of the 125-ton HI-TRAC transfer cask with the pool lid, as shown in Table 5.1.8 of the HI-STORM FSAR.

The shielding configuration at the bottom of the HI-STORM 100 storage cask provides superior attenuation ability as compared to the shielding configuration at the bottom of the HI-TRAC transfer cask. On the bottom of the HI-STORM overpack, there are approximately 7 inches of steel to attenuate gamma radiation and 17 inches of concrete to attenuate both neutron and gamma

radiation. By comparison, on the bottom of the HI-TRAC cask with a pool lid, there are approximately 3 inches of steel and 2.5 inches of lead to attenuate gamma radiation, with no concrete or other material to attenuate neutron radiation. In addition, the HI-TRAC dose value is based on "hotter" fuel with a 45,000 MWD/MTU burnup and 9-years cooling time, which bounds the design basis PFS fuel with a 40,000 MWD/MTU burnup and 10-years cooling time.

The bottom of the HI-TRAC transfer cask, at one meter, results in a dose rate of 292 mrem/hr, consisting of an individual neutron dose rate of 167 mrem/hr (~57% of total) and an individual gamma dose rate of 125 mrem/hr (~43% of total). Because this dose rate would exceed the expected dose rate from the bottom of the HI-STORM cask (with its superior shielding), this dose rate may be considered to bound the dose rate at one meter from the bottom of the HI-STORM cask. However, I consider this value to be very conservative for the HI-STORM cask bottom, because of the substantially superior shielding offered by the bottom design of the HI-STORM cask as compared to that of the HI-TRAC transfer cask.

During normal upright conditions, the sides of the casks on the outside periphery of storage pads face off-site toward all sides of the OCA boundary. The normal condition peak neutron and gamma dose rates at one-meter from the side of each cask is 0.42 mrem/hr and 4.59 mrem/hr, respectively. This radiation diverges and is attenuated before it reaches the OCA boundary, leading to bounding OCA boundary neutron and gamma dose rates of 0.000552 mrem/hr and 0.00237 mrem/hr, respectively.

Three hypothetical conditions may be postulated, in which up to 4,000 casks tipover at the proposed PFS Facility, with resulting dose rate effects as follows:

(1) If all casks on the outer periphery tipped over, with their tops facing off-site in the north direction, the off-site dose rates could decrease approximately by a factor of ~~14.6 (*i.e.*, [(4.59~~

~~mrem/hr ÷ 0.25 mrem/hr) x 81%]~~ 3.1 (*i.e.*, 1 ÷ {[(0.25 mrem/hr ÷ 4.59 mrem/hr) x 81%] + [(0.62 mrem/hr ÷ 0.42 mrem/hr) x 19%]}).

(2) If all casks on the outer periphery tipped over, with their bottoms facing off-site in the north direction, the off-site dose rates could, conservatively speaking, increase by a factor of 97.6 (*i.e.*, [(125 mrem/hr ÷ 4.59 mrem/hr) x 81%] + [(167 mrem/hr ÷ 0.42 mrem/hr) x 19%]).

(3) If all casks on the outer periphery tipped over, with their sides facing off-site in the north direction, the off-site dose rates would remain essentially the same as during normal upright conditions (i.e., a factor of 1.0).

Therefore, if all casks on the outer periphery of the storage pad area tipped over, or tilted, with the tops, bottoms, and sides facing off-site, the change to the off-site dose rate could range from a decrease by a factor of ~~14.6~~, 3.1, to an increase by a factor of 97.6. These factors are based on the assumption that increases to off-site neutron and gamma dose rates would be approximately proportional to the respective increases to the peak neutron and gamma dose rates at one meter from the top or bottom, as compared to the dose rate at one meter from the side of the cask. Also, these factors account for the relative contribution of neutron radiation (~19% of total) and gamma radiation (~81% of total) to off-site dose rates at the OCA boundary during normal conditions. Finally, it should be noted that this result would not be substantially different if all 4,000 casks tipover, in that the casks which are not on the outer periphery of the storage pads would not significantly contribute to the resulting offsite dose rate.

Based on the worst-case results shown above for all three hypothetical conditions, the off-site dose rates could increase by a factor of 97.6. However, this predicted factor of 97.6 is well below the factor of 2,400 increase which is needed to exceed an offsite dose of 5 rem, as discussed above.

Q22. Based on your considerations and analyses of the effects on off-site dose rates resulting from cask impact damage, cask thermal degradation, and cask spacial reorientation, as discussed above, what is your overall conclusion concerning potential changes in off-site dose rates that might occur in the event that any or all of the 4,000 casks at the proposed PFS Facility were to tipover?

A22. If there is hypothetical tipover of multiple (*i.e.,* up to 4,000) casks with impact damage to the shield, thermal degradation of the radial concrete shield, and/or cask reorientation, off-site dose rates would not increase by more than a conservative factor of 97.6. Therefore, the (design basis) accident dose limit of 5 rem in 10 C.F.R. § 72.106(b) would not be exceeded.

Q23. Does this conclude your testimony?

A23. Yes.

Michael D. Waters

EDUCATION

M.S. Nuclear Engineering Sciences, University of Florida, 1995
B.S. Nuclear Engineering, University of Florida, 1993

WORK EXPERIENCE

U.S. NUCLEAR REGULATORY COMMISSION

March 2002 to present — Health Physicist, NMSS, Spent Fuel Project Office (SFPO)

Review the adequacy of spent fuel storage casks, storage facilities, and transportation package designs to provide radiological protection to public and the workers, with a focus on the major technical disciplines of shielding, criticality, containment, and dispersion analysis. Perform detailed technical reviews and conducted independent confirmatory analyses with state-of-the-art methods to determine compliance of proposed designs with federal safety requirements in 10 CFR Parts 20, 71, and/or 72. Prepare written safety evaluations reports, federal rulemakings, and environmental assessments for assigned projects. Develop NRC policy on health physics issues related to storage casks and storage facilities.

May 1996 to February 2002 — Project Engineer, NMSS, SFPO

Project Manager (PM): Scheduled, coordinated, and prepared licenses, amendments, and approval certificates for several spent fuel storage installations, spent fuel storage and transportation cask designs, and transportation package designs. Coordinated multi-disciplined technical review teams to make regulatory findings on the adequacy of proposed designs. Developed NRC policy on assigned technical and licensing issues.

Technical Reviewer: Reviewed the adequacy of several spent fuel storage cask, storage facility, and transportation package designs primarily in the major technical disciplines of shielding, criticality, containment, radiological protection, and operating and maintenance procedures. Performed detailed technical reviews and conducted independent confirmatory analyses with state-of-the-art methods to determine compliance of proposed designs with federal safety requirements in 10 CFR Parts 20, 71, and/or 72. Prepared written safety evaluations reports, federal rulemakings, and environmental assessments for assigned projects.

Major NRC Casework and Publications:

SFPO Project Manager (backup) for the Private Fuel Storage Facility (PFSF) license application review. Review team member for the PFSF environmental impact review.

SFPO Project Manager for the Fort St. Vrain independent spent fuel storage installation (ISFSI), Three Mile Island Unit 2 ISFSI, SPEC-300 transportation package.

Primary shielding and radiological safety reviewer of the HI-STAR 100 transportation cask design (Part 71), HI-STAR 100 storage cask design (Part 72), and HI-STORM 100 storage cask design

(Part 72). Primary shielding, radiological safety, criticality, and/or containment reviewer of multiple other storage and transportation cask designs (Part 71 and 72).

Co-author of NUREG-1571, *"Information Handbook on Independent Spent Fuel Storage Installations,"* December 1996. Primary author of *"Reconsideration of Dose Assessments for Future Independent Spent Fuel Storage Installation Multi-Row Cask Arrays,"* Sixth International Conference on Nuclear Engineering,1998.

UNIVERSITY OF FLORIDA

Jan 1993 - April 1996 — Research Assistant/Graduate Student, Department of Nuclear Engineering Sciences

Responsibilities: Developed computer codes to analyze and evaluate the characteristics of industrial fuel designs and performed cost-benefit analyses to determine optimum fuel designs. Investigated the University's hazardous mixed waste problem, interviewed research laboratory personnel, identified root causes of waste generation, and determined inexpensive methods to mitigate waste.

OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

May 1993 - August 1993
May 1992 - August 1992 — Professional Intern, Oak Ridge National Laboratory

Responsibilities: Performed various studies with the RELAP-5 thermal hydraulic code and commercial plotting software. Developed experiments and standard procedures, as part of a program to confirm criticality design features of the reactor spent fuel storage racks.

NRC AWARDS

NRC Special Act Award - August 1, 2001
NRC Performance Award - July 18, 2000
NRC Performance Award - March 18, 1999

there are some staff regulatory guidance documents that I'd like to introduce. I'd like to do that at this time.

CHAIRMAN FARRAR: All right.

BY MR. TURK:

Q Mr. Waters, you're familiar are you not with NUREG 1567 which has been admitted as Staff Exhibit 53 in this proceeding.

A Yes I am.

MR. GAUKLER: I don't think that was admitted yet. It's been marked.

MR. TURK: My notes indicate that Exhibit 53 was admitted.

CHAIRMAN FARRAR: No. I think we said we'd wait until your witness got on.

MR. TURK: Oh, okay. My apologies.

BY MR. TURK:

Q You're familiar with this document?

A Yes I am.

MS. CHANCELLOR: Your Honor, could we do this as part of redirect? This is not part of his prefiled testimony. I don't understand why we're doing this now.

MR. TURK: I don't know if the place in time makes a difference, Your Honor. I do want to put

it in. I was going to do it with the other witnesses. It was suggested that perhaps it's better to do it with the Staff witness. These are documents that would apply to Mr. Water's testimony. The State would then be able to examine on it as well as on his written direct testimony.

MS. CHANCELLOR: Your Honor, Mr. Turk forgot to put in an Exhibit. Maybe he can do it in rebuttal or in redirect.

CHAIRMAN FARRAR: He didn't know the exhibit that we're talking about. I think you objected to it going in with a witness who wasn't too familiar with it. So we told him to wait until his own witness got on, I think. How many of these exhibits do you have, Mr. Turk?

MR. TURK: We intend to introduce in addition to this one portions of NUREG 1536, ANSI Standard 57.9, Regulatory Guide 3.60, and I think that does it. So that's a total of four.

CHAIRMAN FARRAR: Ms. Chancellor, we might as well have them in there now.

MS. CHANCELLOR: The question is do we need them in at all.

CHAIRMAN FARRAR: You can be heard on that one when he moves.

MS. CHANCELLOR: Okay.

MR. GAUKLER: I think I'd agree with, Your Honor. It would be most efficient to do it at this point.

CHAIRMAN FARRAR: Go ahead, Mr. Turk.

BY MR. TURK:

Q Mr. Waters, you are employed in the Stenfield (PH) Product Office of the Office of Nuclear Material Safety and Safeguards.

A Yes.

Q In your position in that office, do you use NUREG 1567 in evaluating the adequacy of the ISFSI applications?

A Yes I do.

Q In particular, do you utilize Section 9.5 involving the calculation of accident doses in your work?

A Yes.

Q Do you also utilize Section 15.2 in your review of accident analyses?

A Yes I do.

MR. TURK: Your Honor, I've attached as part of Staff Exhibit 53, pages from those two sections of the Regulatory Guidance document. I'd ask that it be admitted at this time.

MS. CHANCELLOR: Objection, Your Honor. They're not relevant. The 9.5.2.2 is not relevant to neutron and gamma radiation. That's what we're talking about with respect to the dose at the fence post at the PFS site.

MR. GAUKLER: I have no objection, Your Honor.

CHAIRMAN FARRAR: Mr. Turk, do you have any response?

MR. TURK: Yes, Your Honor. Section 9.5 deals with confinement. As indicated during Dr. Redmond's testimony, because the MPC is expected to remain intact even during the beyond design basis cask tip over accident, we do not expect to see any release from within confinement. However, at the same time, this is the only regulatory guidance that exists with respect to calculation of accident doses following something like a cask tip over event.

We will establish that through Mr. Waters. Ms. Chancellor is free to cross examine on whether it's a correct premise or not. We will establish that this is the standard that is utilized by the Staff if we were to look at neutron and gamma doses such as would exist during direct radiation doses. To whatever extent we're right in using it or not right

in using it is a matter that can be cross examined upon. It doesn't go to the admissibility of the document.

I would also note that there was other corroborative regulatory guidance on this point which we hope to get to as we proceed with these exhibits. Incidentally, one of the documents that you did not admit when I was questioning Dr. Redmond involves the COC for the HI-STORM cask. There's a specific discussion of whether use of this type of analysis, the 30 day calculation, applies or it may be viewed to bound the direct radiation dose. We'll get to that too Your Honors will commence.

(Judges conferring.)

CHAIRMAN FARRAR: We will admit Staff 53. But it remains to be seen how much weight it has in terms of bearing on the issues in front of us.

(The document referred to having previously been marked for identification as Staff's Exhibit Number 53, was received into evidence.)

MS. CHANCELLOR: If that's the case, Your Honor, I would request that all of 9.5 be added to this exhibit. It starts 9.5.2.1.

MR. TURK: I want to object if the State

wants to make those copies and introduce it. I don't think it's necessary. The only use for making of a document is to address the question of what's the proper amount of time to use in calculating the accident dose. If the State has some purpose for the other material to introduce, I'm not aware of that purpose. I don't think it's relevant to my purpose. I have no objection if they can show relevance to admitting some other pages.

MS. CHANCELLOR: Your Honor, we didn't bring all of our Regulatory Guides with us.

MR. TURK: I'll lend you mine.

MS. CHANCELLOR: I don't know what 9.5 addresses. All I know is this deals with confinements. I don't know if there's a discussion of what confinements systems are. All I'm saying is that --

CHAIRMAN FARRAR: You're saying that we need more to put all of this in context.

MS. CHANCELLOR: Exactly.

CHAIRMAN FARRAR: Well, let's find a way to do that. For now, we'll let this in.

MR. TURK: Thank you, Your Honor.

BY MR. TURK:

Q Mr. Waters, let's address for a moment the

point made my Ms. Chancellor. If you look at the top of page 9-15, there's a discussion of the 720 hour or 30 day assumption of duration of release. Do you see that at the top of 9-15?

A Yes.

Q Specifically that appears in a discussion of confinement adequacy. Correct?

A Yes.

Q Do you use the same 30 day calculation at the NRC Staff if you were looking at the direct radiation dose from gamma and neutron?

A We have done so for our accents of transfer casks which -- could be lost such as the HI-TRAC or the HI-STORM 100.

Q Is there any other regulatory guidance that you're aware of that would apply specifically to calculation of neutron and gamma doses in an accident condition?

A Not for direct radiation, no.

Q In the event of an accident, is there any reason to expect that the release of radiological material such as would be addressed by calculations of confinement doses? Would the time period differ for a direct radiation dose?

A No.

Q If you would turn to page 15-1 of this exhibit in the discussion of accident analyses, the second paragraph under Section 15.1. I'll read the statement. I would ask for your comment. "Off-normal events are those expected to occur with moderate frequency or once per calendar year. ANSI/ANS 57.9 refers to these events as design event II." Are you familiar with that statement?

A Yes I am.

Q Is it your understanding then that when the NRC speaks of off-normal events for an ISFSI that they are in turn referring to events classified as the ANSI/ANS design event II?

A Yes. That's the basis for categorizing normal, off-normal and accident events.

Q In the very next paragraph, I'll read the following statement. "Accident events are considered to occur infrequently, if ever, during the lifetime of the facility. ANSI/ANS 57.9 subdivides this class of accidents into design event III, a set of infrequent events that could be expected to occur during the lifetime of the ISFSI and design event IV, events that are postulated because they establish a conservative design basis or SSCs important to safety." Do you see that statement?

A Yes.

Q That's consistent with your understanding of NRC classification of events as accidents. That it's based upon the equivalent of ANSI/ANS design events III and IV.

A Yes. That's how we categorize design basis accidents which require design 72.106 B-2.

Q 72.106 B.

A Yes.

Q Okay. The last statement of that paragraph reads "The effects of natural phenomenon such as earthquakes and other stated events are considered to be accident events." Is that consistent with your understanding?

A Yes.

Q When we're looking at natural phenomenon that go to the design basis of a facility, are we now addressing ANSI/ANS design event IV?

A Yes we are for natural phenomenon.

MR. TURK: I'd like to pass another pair of documents out. Before I do that, let me step back for a second. I'm going to ask to distribute a copy of Regulatory Guide 3.60. I would ask to have this marked as Staff Exhibit 55 for identification.

CHAIRMAN FARRAR: All right.

(Whereupon, the above-referred to document was marked as Staff's Exhibit No. 55 for identification.)

MR. TURK: For the record, let me indicate that I've distributed three pages which are Regulatory Guide 3.60. This document is entitled "Design of an independent spent fuel storage installation (dry storage)."

BY MR. TURK:

Q Mr. Waters, are you familiar with this document?

A Yes I am.

Q Is this in fact a Regulatory Guide that's utilized by the NRC Staff in evaluating the design of an independent spent fuel storage installation?

A Yes it is.

Q I would ask you to turn to the bottom section on page one entitled "C: Regulatory Position." The first statement that appears there states "ANSI/ANS 57.9-1984 is acceptable to the NRC Staff for use in the design of an ISFSI that uses a dry environment as the mode of storage subject to certain statements." Do you see that?

A Yes.

Q In fact, then does ANSI/ANS 57.9 apply to

the PFS facility?

A Yes it does.

MR. TURK: Your Honor, I would ask that this document be admitted at this time.

MR. GAUKLER: No objection, Your Honor.

CHAIRMAN FARRAR: Ms. Chancellor?

MS. CHANCELLOR: No objection, Your Honor.

CHAIRMAN FARRAR: All right. 55 will be admitted.

(The document referred to having previously been marked for identification as Staff's Exhibit No. 55, was received into evidence.)

MR. TURK: I would like to distribute at this time a pair of documents. Let me explain what I'm about to do. The ANSI standard referred to in Reg Guide 3.60 is the 1984 version. There has been a modification or an updating of that ANSI standard in 1992. I propose to distribute both the 1984 and the 1992 standards as they define these different design events. I think for simplicity I could make it a single exhibit, but maybe it's best just to do it as two successive exhibits so there's no confusion.

CHAIRMAN FARRAR: So we'll mark these as 56 and 57?

MR. TURK: Yes, Your Honor.

(Whereupon, the above-referred to documents were marked as Staff's Exhibit Nos. 56 and 57 for identification.)

MR. TURK: Number 56 would be the 1984 version of the document. Number 57 would be the 1992 version and the cover sheet that has the date of each.

CHAIRMAN FARRAR: Okay.

BY MR. TURK:

Q Mr. Waters, are you familiar with these documents?

A Yes I am.

Q Are they in fact the sections of definitions provided in the ANSI Standard 57.9 at least with respect to the design events?

A Yes.

Q I would simply ask so that we are all on the same page if we look for instance beginning with the 1984 document which is Staff Exhibit 56 for identification, the definition of design events begins by stating "Design events are occurrences which need to be considered in system and installation design.

They can be classified according to their expected frequency of occurrence and when so classified used in conjunction with objectives

associated with maintenance of system capability to provide a logical and systematic approach to protection by design. This standard employs four design event categories." And it goes on to define them. Do you see that statement?

A Yes.

Q Then in the next column on page two of the 1984 document, Staff Exhibit 56 for identification, we see design event I is defined as "That set of events that are expected to occur regularly or frequently in the course of normal operation of the ISFSI."

And certain examples are provided, correct?

A Yes.

Q Design event two is defined as: "That set of events that, although not occurring regularly, can be expected to occur with moderate frequency, or on the order of once during a calendar year of ISFSI operation."

Do you see that?

A Yes.

Q Now, going back to the discussion that we had before, as to the classification of accidents under 72.106b, that would not include design 1 or 2 events, under this definition, correct?

A No, it would not.

Q And whether those events would be classified as normal, or anticipated occurrences under 10CFR72.104(a)?

A Yes.

Q Okay. Let's move down now to design event 3, on page 2 of the 1984 document. It states that: Design event 3 events "Consist of that set of infrequent events that could reasonably be expected to occur during the lifetime of the ISFSI. Do you see that?

A Yes.

Q And that is consistent with your understanding?

A Yes.

Q Next page, design event 4 is defined as: "The events that are postulated because their consequences may result in the maximum potential impact on the immediate environments. Their consideration establishes a conservative design basis for certain systems with important confinement features. Typically this set of events will consist of plant specific design events as defined in design phenomena. Examples are A, natural phenomena; and B, man-induced low probability."

This design event 4 essentially establishes the envelope of the design basis for an ISFSI, is that correct?

A Yes, it does.

Q And one last piece, just below that, there is a definition of design phenomena, which are defined as: "Those natural phenomena, and man-induced low probability events, for which an ISFSI is designed."

And it is your understanding, if I'm not mistaken, that that would include earthquakes?

A Yes, earthquake is a natural phenomena.

Q So that the design earthquake would be a design event 4 under this classification?

A Yes.

Q The 1992 document, I won't ask to go through each of the words. But is it your understanding that that document is essentially -- essentially defines these events in the same manner as the 1984 document?

A Yes, it does.

MR. TURK: Your Honor, I would like to ask that Staff Exhibit 56 and 57 for identification be admitted.

MR. GAUKLER: No objection, Your Honor.

MS. CHANCELLOR: No objection, Your Honor.

CHAIRMAN FARRAR: All right, they will both be admitted.

(The documents referred to, having been previously marked for identification as Staff Exhibits 56 and 57 were received in evidence.)

CHAIRMAN FARRAR: Is the witness available now, Mr. Turk?

MR. TURK: No, I have one more, Your Honor.

CHAIRMAN FARRAR: Okay.

MR. TURK: I would ask that we distribute some pages from NUREG 1536. And I would ask that this be marked as Staff Exhibit 58 for identification.

(Whereupon, the above-referenced to document was marked as Staff Exhibit No. 58 for identification.)

MR. TURK: And, for the record, let me indicate that this document is entitled: Standard Review Plan for Dry Cask Storage Systems, NUREG 1536. And I've attached, to the cover sheet, three pages; specifically page XI, XIII, and 11-2.

BY MR. TURK:

Q Mr. Waters, are you familiar with this document?

A Yes, I am.

Q Is this a regulatory guidance document that applies to the Staff's review of spent fuel storage casks?

A Yes, it is the guidance document for Staff.

Q And I would ask you to look at page XI, there is a definition of design basis. Do you see that?

A Yes.

Q It states: "The extreme level of an event or condition for which there is a specified resistance limit of response, and requirement for a given of continuing capability, for instance, compares with design events 3 and 4 as described in the ANSI 57.9."

Is that your understanding of how design basis is defined for use in evaluating dry cask storage systems?

A Yes.

Q Also on the next page that I've attached here, page XIII, you see there is a definition of normal and off-normal?

A Yes, I do.

Q I won't read those into the record, I would just ask you to read them, and then tell us whether that is consistent with your understanding of NRC Regulatory Guidance with respect to dry cask storage system, definition of normal and off-normal events.

(Witness reviews document.)

THE WITNESS: Yes, it is.

BY MR. TURK:

Q Under off-normal do you notice that there is a reference to the design event 2 of the ANSI-ANS standard?

A Yes.

Q Is it safe to say, then, that when the regulation in 10CFR72.104 speaks of normal operations, and anticipated occurrences, that is a reference to events that are bounded by design events 1 and 2 under the ANSI Standard?

A Yes.

Q And also, if you would, take a look at page 11-2, under acceptance criteria, there are dose limits provided for off-normal events, and for design basis accidents; do you see that?

A Yes.

Q And is it -- you will notice for under

off-normal events, the following statement appears: "During normal operations, and anticipated occurrences, requirements specified in 10CFR part 20, must be met. In addition the annual dose equivalent to any individual located beyond the controlled area must not exceed 25 milli-REM to the whole body, 75 milli-REM to the thyroid, and 25 milli-REM to any other organ as a result of exposure to the following sources."

And you notice that item B, there, is direct radiation from operation of the ISFSI?

A Yes.

Q That is consistent with your understanding of 10CFR72.104 as it applies to normal operations and anticipated occurrences?

A Yes, it is.

Q Also take a look at the dose limit for design basis accidents paragraph, which has the following statement:

"Any individual located at, or beyond, the nearest controlled area boundary, must not receive a dose greater than 5 REM to a whole body, or any organ in any design basis accident."

Do you see that statement?

A Yes, I do.

Q Is it your understanding that that is the 10CFR72.106b standard for accidents?

A Yes, it is.

Q And that would apply to design events 3 and 4 under the ANSI standard?

A Yes, it would.

Q Which would include natural phenomena such as earthquakes?

A Yes.

MR. TURK: Your Honor, I would ask that Staff Exhibit 58 be admitted at this time.

MR. GAUKLER: No objection, Your Honor.

MS. CHANCELLOR: No objection, Your Honor.

CHAIRMAN FARRAR: All right, 58 will also be admitted.

(The document referred to, having been previously marked for identification as Staff Exhibit 58 was received in evidence.)

BY MR. TURK:

Q Mr. Waters, did you have any role in evaluating the HI-STORM storage cask application for a certificate of compliance?

A Yes, I was the primary radiation

protection and general reviewer for the Staff's evaluation for a certificate of compliance.

MS. CHANCELLOR: Your Honor, I'm a little confused as to what part of the testimony we are up to.

MR. TURK: We are establishing the regulatory criteria. And once I finish with this one small piece, I will be done.

MS. CHANCELLOR: Your Honor, this is not part of his direct testimony.

MR. TURK: That is correct, this is the supplementation that I indicated I would do in order to refer appropriate regulatory criteria.

CHAIRMAN FARRAR: It seems to fit, Ms. Chancellor. I mean, if we don't do it now, we do it later. This puts everything in front of us.

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

CHAIRMAN FARRAR: All right, go ahead.

MR. TURK: Your Honor, as I've placed in front of the witness a copy of a document that until now has only been marked for identification, and it was ruled out as being essentially a legal document, and that is what was marked for identification as Staff Exhibit 54, the Statement of Consideration that accompanied the COC for the HI-STORM 100 cask, and

this was Federal Register 65, volume 65 of the Federal Register, at page 25241, published on May 1, 2000.

CHAIRMAN FARRAR: All right.

MR. TURK: And I'm going to ask him two questions, or two short lines.

BY MR. TURK:

Q Mr. Waters, you indicated that you were the primary radiation protection reviewer?

MS. CHANCELLOR: Objection, Your Honor.

MR. TURK: I haven't asked the question.

CHAIRMAN FARRAR: Let him finish the question.

MS. CHANCELLOR: Okay.

BY MR. TURK:

Q You indicated that you were the primary radiation protection reviewer for the HI-STORM 100 cask COC, correct?

A Yes.

Q In evaluating the accident doses for the HI-STORM 100 cask with respect to the COC, did you utilize a 30 day period of time for the individual located at the OCA boundary, as being the appropriate period of time for exposure in that calculation?

A Yes, we used 30 days as a standard for determining exposure.

CHAIRMAN FARRAR: You got about 6 inches from the microphone, speak louder, we can't hear you. Go ahead.

BY MR. TURK:

Q You said you used the 30 days as the appropriate standard for the dose calculation?

A Yes.

Q Okay. And that is consistent with NRC regulatory practice?

A Yes, it is.

Q Did the COC application include any calculation of direct radiation doses?

A Yes, it did, for normal conditions, and I believe for accident conditions from the HI-TRAC transfer cask.

Q And did it include a calculation of direct radiation for things such as a cask tipover of the HI-STORM 100 storage cask?

A No, it did not.

Q And did you reach a finding, at that time, that that was not necessary?

A Yes, I did.

Q And that position was adopted by the Commission?

A Yes.

MS. CHANCELLOR: Objection, Your Honor.

MR. TURK: Well, it is self-evident in the Statement of Consideration.

MS. CHANCELLOR: Mr. Turk is trying to weasel his way -- I beg your pardon. Mr. Turk is trying to manipulate his -- is trying to navigate, that is the word I want, navigate his way into getting back to NRC exhibit 54.

This is a legal document, we can all use it in our findings and conclusions, for whatever it says.

MR. TURK: I won't move the admission of the document, Your Honor, that has been ruled upon already. My boat is sort of like the one that Thor used to get to America, 1000 years ago, it is leaky rigs.

But I think I'm just about done. The only question I asked, I believe, has been answered by the witness.

CHAIRMAN FARRAR: Let's move on.

MR. TURK: And with that, Your Honor, I'm done with my direct examination, and with the supplementation based upon Regulatory Guidance documents.

The witness is available for examination.

CHAIRMAN FARRAR: Mr. Gaukler?

MR. GAUKLER: No questions, Your Honor.

CHAIRMAN FARRAR: Ms. Chancellor, how much time do you think you will want?

MS. CHANCELLOR: I was hoping to get done today. I may be able to, but I'm just not sure, Your Honor.

CHAIRMAN FARRAR: Okay.

MS. CHANCELLOR: I had planned -- I'm just not sure if I can do it in an hour, it may take a little longer.

CHAIRMAN FARRAR: If we are ahead of schedule, and there is no sense going too late tonight. I mean, if you want to -- don't feel like going any more, just let us know, and we will come back in the morning.

MS. CHANCELLOR: I quit right now.

(Laughter.)

CHAIRMAN FARRAR: I take it we are ahead of schedule making sure we fit -- I mean, our goal is we are finishing seismic this week?

MR. GAUKLER: That is correct, Your Honor. The goal is to finish radiation dose consequences by Wednesday noon. I think we are on schedule for that.

CHAIRMAN FARRAR: Then, Ms. Chancellor,

I learned many years ago, from a federal district judge that I clerked for, that when people are half-joking, they are also half-serious. He always said that was a good way to get a message across.

If you would really like to quit now and focus, use the extra time to prepare, and sharpen things up, and start first thing in the morning, we've gone overtime enough nights in the last nine weeks, so there is no reason not to quit early, if that would help you. It is up to you.

MS. CHANCELLOR: I think given Mr. Trudeau's additional questions to the witness that I wasn't expecting, it would be helpful to just try and put it all together tonight, and then come back first thing in the morning.

With your indulgence that would be nice.

CHAIRMAN FARRAR: Why don't we do that whole line -- just a minute.

(Pause.)

CHAIRMAN FARRAR: Why don't we, then, we just have a question or two from the Board, and you also have that in front of you for the evening.

JUDGE LAM: Mr. Waters, is it true the analysis result that you have performed are really key to one observation, that if the cask tips over,

nothing happened in terms of structural degradation, thermal degradation, or fuel melting?

THE WITNESS: Yes, in respect to radiological protection.

JUDGE LAM: So if any one of these assumptions turn out to be incorrect, then the results would be very different?

THE WITNESS: Would you repeat which assumptions you are talking about?

JUDGE LAM: If the cask tips over, the multi-purpose would not break; that is assumption number one. There will be no thermal degradation, nor structural damages to the cask; that is assumption number two. Assumption number 3 would be there will be no fuel melting if there is any blockages of the air ventilation passages.

So if any one of these three assumptions turn out to be incorrect, then your results would be very different?

THE WITNESS: Yes, certainly if the MPC did not maintain its confinement there would be, likely, some release of radioactive material.

JUDGE LAM: And in your analysis you also examined the effects of special orientation of the cask?

THE WITNESS: Yes, I did.

JUDGE LAM: How many of them had their bottom facing the fence when you were doing that analysis?

THE WITNESS: My assumption was, basically, 50 facing in the north direction, and 80 facing in the east-west direction, and a similar configuration if they were upright, basically they are upright, then you turn them on their sides, neglecting the dimensional -- the dimension which probably makes that impossible, in my mind.

So I'm assuming the side of all 4,000 casks, as is laid out under normal conditions, the bottoms of all 4,000 casks, as they would be placed in that same array.

JUDGE LAM: So these configurations were consistent with what Dr. Resnikoff was advocating?

THE WITNESS: Yes.

JUDGE LAM: Thank you.

MR. TURK: I have one follow-on, Your Honor.

CHAIRMAN FARRAR: Okay.

MR. TURK: Dr. Lam asked you if there was no structural damage to the cask, and I believe your answer was that your assumption is that there is none.

Do you mean to say no significant structural damage, or would even localized damage, such as the Applicant talks about, cause you to change your conclusion?

What do you assume with respect to structural damage when you do your calculation?

A Let me clarify. I consider structural damage and shielding damage to be the same, they are two different purposes. I consider structural damage as something that would affect the MPC, which primary function is to contain the spent fuel.

To look at Judge Lam's question in, I guess, a different light, if there were more damage to the shield, it is not my belief that there will be a significant change to my results presented in my written testimony.

May I add, because as long as mass is maintained within the shield, there will be no significant changes in dose rates.

Q In your calculations do you assume that there could be some localized damage, some flattening of the steel, or packing within the concrete inside the shell of the cask?

A Not in my calculations for reorientation, or thermal degradation, but my discussion regarding impact damage after tipover, I do consider these

possibilities.

Q And with respect to thermal degradation, there again, you are talking about the thermal condition within the MPC, rather than the concrete in the outer shell?

A No, the thermal condition of the concrete.

Q Your analyses do look at the potential for delta in the thermal, in the temperature of the concrete?

A Yes, we calculated very conservative temperatures, assuming all set of four vents are blocked. We took those increased temperatures, we used data for other concrete with known hydrogen content density at these temperatures, and modeled that new, those new densities in our shielding model to calculate increases in doses.

Q You did consider thermal increases inside the concrete?

A Yes, we did.

MR. TURK: That is all I have.

CHAIRMAN FARRAR: All right, if we finish Dr. Resnikoff tomorrow, what are we doing Wednesday morning?

MS. CHANCELLOR: Try to fit in Dr. Stematakos, and Dr. Arabasz. The next thing that

happens after the Stematakos rebuttal is Dr. Bartlett's direct testimony, and Dr. Bartlett does not arrive until Wednesday late afternoon, so he will be available for first thing Thursday morning.

CHAIRMAN FARRAR: But you can't do Dr. Stematakos without Dr. Arabasz on hand, I thought?

MS. CHANCELLOR: That is correct.

CHAIRMAN FARRAR: So would we have Wednesday morning off, or would we --

MR. GAUKLER: We may have some rebuttal. Well, we do have some rebuttal, I don't know if we get it on Tuesday, or not.

CHAIRMAN FARRAR: Rebuttal on this issue?

MR. GAUKLER: Yes, very limited.

CHAIRMAN FARRAR: Okay.

MR. GAUKLER: I did mention that at the beginning of my direct examination.

MS. CHANCELLOR: And then the only other witness, I believe, in the que so to speak, is Dr. Cornell as rebuttal to Dr. Bartlett on the DOE standard.

So we basically have to do Dr. Bartlett, then Dr. Cornell.

CHAIRMAN FARRAR: On Thursday and Friday?

MR. GAUKLER: On Thursday and Friday, that

is correct, Your Honor.

CHAIRMAN FARRAR: All right. Then we will see you at 9 o'clock tomorrow morning.

(Whereupon, at 4:42 p.m. the above-entitled matter was adjourned, to be resumed at 9 o'clock Tuesday, June 25th, 2002.)

CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of:

Name of Proceeding:	Private Fuel Storage, LLC
Docket Number:	Docket No. 72-22-ISFSI
	ASLBP No. 97-732-02-ISFSI
Location:	Rockville, Maryland

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission taken by me and, thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings.

/s/ John Mongoven
John Mongoven
Official Reporter
Neal R. Gross & Co., Inc.