UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

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MEETING: 467TH ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

U.S. Nuclear Regulatory Commission

11545 Rockville Pike

Room T-2B3

White Flint Building 2

Rockville, Maryland

Friday, November 5, 1999

The committee met, pursuant to notice, at 8:30 a.m.

MEMBERS PRESENT:

DANA A. POWERS, ACRS Chairman

GEORGE APOSTOLAKIS, ACRS Vice-Chairman

THOMAS S. KRESS, ACRS Member

MARIO V. BONACA, ACRS Member

JOHN J. BARTON, ACRS Member

ROBERT E. UHRIG, ACRS Member

WILLIAM J. SHACK, ACRS Member

JOHN D. SIEBER, ACRS Member

ROBERT L. SEALE, ACRS Member

GRAHAM B. WALLIS, ACRS Member

P R O C E E D I N G S

E/12

[8:30 a.m.]

DR. POWERS: The meeting will now come to order.

This is the second day of the 467th meeting of the Advisory Committee on Reactor Safeguards. During today's meeting the committee will consider the following -- proposed changes to the design control document associated with the AP600 design; spent fuel fire risk associated with decommissioning; status of resolution of issues associated with the design bases information; future ACRS activities; the report of the Planning and Procedures Subcommittee; reconciliation of the ACRS comments and recommendations as well as proposed ACRS reports.

This meeting is being conducted in accordance with the provisions of the Federal Advisory Committee Act. Mr. Sam Duraiswamy is the Designated Federal Official for the initial portion of the meeting.

We have received no written statements from members of the public regarding today's session. We have received requests for time to make oral statements from representatives of Nuclear Energy Institute, Northeast Utilities, as well as a member of the public regarding spent fuel fire risk associated with decommissioning.

A transcript of portions of the meeting is being kept and it is requested that speakers use one of the microphones, identify themselves and speak with sufficient clarity and volume so that they can be readily heard.

Do members have any comments they want before we get into the day's sessions?

float the debris

But after Barsebeck, we realized that the greater threat to plugging the screens was not so much how much coating or other kinds of debris that could be generated from the basic design, but rather, it was material control because of things like workers' suits and other larger objects that get left inside containment and float around. And for that reason, a lot of other countries are looking at backflow procedures so that they don't have to be concerned about whether or not they've accounted for every square inch of material

The modeling that I've seen of different debris kinds is, it's probably not even liberal arts engineering because you don't know how the paint's gonna break up. You don't -- you know, if the paint comes off in one large sheet, then no matter how low your approach velocity is, you potentially could wrap the suction screen. So for that reason, we tend to look at these things more as material control issues and emergency operating procedures, as opposed to trying to model the debris that's going towards the sump

MR. BARTON: Any other comments or questions? Hearing none, I'll turn it back to the Chairman.

DR. POWERS: Thank you. WE are now scheduled for a break, so why don't we recess until 10:15.

[Recess.]

DR. POWERS: Let's come back into session. Our next topic is the spent fuel fire risk associated with decommissioning. And Dr. Kress will lead us through this issue.

DR. KRESS: Thank you, Mr. Chairman. This subject of the fire risk to the spent fuel pools is going to be discussed by the staff, but I understand it's a work in progress, so it will mostly be a status report. We're not being asked at this time for a letter, but if we detect that they may be going in their wrong direction with the status report and we're going where they didn't. We'll find the right on.

DR. POWERS: I remind the members that our boss, the Commission, has explicitly for guidance on this particular topic.

DR. KRESS: We'll also hear, in addition to these presentations from the staff, we'll hear presentations from NEI to give us the industry report. And there are a couple of concerned, interested citizens that will make presentations also.

The issue is that spent fuel pool fires appear to be the dominant risk for permanently shut down plants, and the question is, how long do you have to be a caretaker for the spent fuel before you can pretty much decide the risk is at an acceptable level without much caretaking. And this caretaking involves cooling of the spent fuel pool and seeing whether or not it's drained out, or if the water's there. And this depends on the, things like the heat level, and if you lost cooling, how long would it take to heat up to temperatures that would cause a run-away oxidation, and then basically have the impetus to release a fission product. So those are the kind of issues we'll hear to day

And it's also a risk question. Just what actually is the risk and when, at what -- it's a risk that varies with time, which is

this risk low enough that we can start doing away with some caretaking provisions

With that introduction, I'll turn it over to John Hannon, who's the branch chief of the plant systems branch.

MR. HANNON: Thank you. Good morning. The staff appreciates the opportunity to come here this morning to brief the ACRS on our progress with the Technical Working Group on Decommissioning.

We are in month 8 of an approximate 12-month effort that's been supported by a multidisciplinary team, with members from all 3 of the technical branches in DSSA and with input from the Division of Engineering, Office of Research, and other specialty areas such as EP and Security

Diane Jackson works for me, and she is going to be giving the brief this morning. She's the lead engineer on the Technical Working Group, but she'll be supported by members on the team that are in the audience, as necessary. So let me turn it over to Diane now to conduct the briefing.

MS. JACKSON: Good morning

DR. POWERS: Good morning. We'll get you wired in.

MS. JACKSON: Good morning. Is that good?

DR. POWERS: You'll have to say something, so I --

MS. JACKSON: Oh, is that sufficient?

DR. POWERS: Is that good for the reporter?

MS. JACKSON: Can the reporter hear? Okay. Okay. As introduced, I am Diane Jackson. I'm a member of the Plant Systems

Branch and a Technical Working Group leader. Our presentation today is going to be on the Technical Working Group study. It's a broad-scope study that's looking at spent fuel pool accidents, and its associated risk at decommissioning plants.

We set out a plan at the beginning that we're following. Our work towards our final assessment is in progress at this time. At the same time of finishing our final technical work, we're also addressing stakeholder comments. And the results of this will fold into being incorporated into rulemaking

Just a short background on decommissioning. When plants began decommissioning, it was found that most of the operating reactor regulations were not developed considering the transition from operating power reaction operations to decommissioning, and that many of the regulations were not necessary for decommissioning plants that just had fuel in their spent fuel pool

The staff has been issuing exemptions on a case-by-case area, a case-by-case basis in many areas, such as emergency preparedness, safeguards, and indemnification. However, we found that this isn't a very efficient process for regulation. To remedy this, the Commission has directed the staff to issue rules specifically for decommissioning plants

At the time the Commission gave this direction, there were five rules in development. These rules were combined into one rulemaking package, and we were given direction to risk-inform to the extent possible the whole package

DR. KRESS: Is there, has differentiation been made between "decommissioning" and "decommissioned" past-tense? Are those two different things?

MS. JACKSON: Yes there are. Most -- plants that -- well, if you let me defer to the project side to give you a very good definition.

MR. HUFFMAN: This is Bill Huffman. I'm a project manager in NR. The process of decommissioning starts with a certification to permanently shut down and removal of fuel from the reactor.

DR. KRESS: This is what, five years?

MR. HUFFMAN: It actually starts when they send us the certification after the fuel's been permanently removed from the reactor. It can extend for many years depending on the financial situations and incentives for the licensee. They can be in safe-store. They can incrementally decommission, or they can actively decommission very rapidly, depending on availability of waste sites, finances, other plants on-site. So the question of decommissioning is the entire process. The end of the process is a license termination where they have basically restored the site and turned it over for commercial or public use.

DR. KRESS: Thank you.

MS. JACKSON: For the Technical Working Group consideration, we're only dealing with the decommissioning process

DR. KRESS: How many plants are currently going through that?

MS. JACKSON: I believe there's 18 in the decommissioning

process right now, at different phases of it

Just the last bullet on there. It was shortly after the Commission gave us this direction that the Technical Working Group was formed. And this was about March-April timeframe of this year. And we set off on a path to look at spent fuel pool accident risk

Our output from our activities is to provide a technical bases on spent fuel pool accident risk to help with the development of this integrative rulemaking, to provide guidance for interim exemption criteria during the rulemaking activities over the next several years --

DR. KRESS: And is the Working Group itself doing a risk assessment?

MS. JACKSON: Yes. Yes, and I'll -- that's coming up in a few minutes.

DR. KRESS: You're going to tell us who's on this working group? Who the members are.

MS. JACKSON: Oh, certainly. Would you like them to stand up as well?

DR. KRESS: No

[Laughter.]

DR. KRESS: I was just wondering what branches they come out of and what their expertise was at PRA.

MS. JACKSON: In the PRA area, we have from the DSSA branch of probability, we have Glen Kelly, Mike Cheok. We have advisory role of Gareth Parry.

DR. KRESS: Never mind. You've said enough.

MS. JACKSON: Okay.

[Laughter.]

MS. JACKSON: One of the other missions that the Technical Working Group was given was to identify any areas that came out of our study, that gave us, there was enough large uncertainty in that area that maybe we should consider additional work.

The expectation of the study is, would be that it would be able to generically applied to all plants such that site-specific analyses would not have to be done.

DR. SEALE: Excuse me. Could I ask --

MS. JACKSON: Certainly.

DR. SEALE: Specifically, who from Research is involved with your Working Group?

MS. JACKSON: In the Thermohydraulic area, it was Chris Boyd. And in the area of consequences, it was Jason Chaperall.

DR. SEALE: Okay.

MS. JACKSON: We have one other role for research, and we'll be talking about that in a minute. But we're having an independent review currently done of our draft report and our members of Research or contractors through Research who are performing that, and that would be Nathan Siu and Dr. Bob Kennedy.

DR. SEALE: There are no specifically Materials people involved?

MS. JACKSON: No. No. Gutan Bagchi is looking at the seismic area, and he's from the Division of Engineering

DR. SEALE: Yeah.

MS. JACKSON: And he provides support if there's any material questions.

DR. SEALE: Okay.

MS. JACKSON: We started out looking at existing information on spent fuel pool accidents and spent fuel pool risk, and we found that a comprehensive review of both areas didn't exist for decommissioning plants. The most extensive information that was done was in support of Generic Safety Issue 82, which was Severe Accidents in Spent Fuel Pools, which was done in the mid '80s.

DR. KRESS: And that was for operating?

MS. JACKSON: That was performed for operating plants, exactly. We found some very useful information out of those reports that could apply to decommissioning plants. However, we felt due to some of the operational changes since the '80s and also the different systems and different level of personnel that were at decommissioning plants that didn't quite apply directly to decommissioning plants, so we felt that there was a void in information.

Our preliminary study contained two key areas. One was a decay time estimation based on existing thermohydraulic coat analysis, and that was to give us the window of vulnerability for zirconium fire.

DR. POWERS: I guess I'm confused on what you mean -- the decay time based on thermohydraulic analysis.

MS. JACKSON: Okay. In Generic Safety Issue 82, they did a lot of studies using S fuel 1 at Sandia National Lab to look at how long

would have to be shut down so that your decay was sufficient enough that you wouldn't have enough decay heat to heat up your fuel in your cloud to reach zirconium oxidation. And they used thermohydraulic codes to look at air flows and to see what kind of cooling mechanisms you'd have if you only had cold fuel.

DR. KRESS: Natural convection v. transfer coefficient.

DR. POWERS: I presume that the zirconium oxidizes at any temperature above absolute zero.

MS. JACKSON: But there's a point at which, that the heat added from your decay, from your decay heat of your fuel, that it will start become very rapid and you won't be able to stop the temperature excursion. And that will take you to ignition. And that' the window we're looking at for thermohydraulic analysis. What does that window for temperature force the lower threshold for that?

DR. POWERS: I mean, what you're looking for is some point where the heat generated is exactly balanced by the heat removed?

MS. JACKSON: Yes

DR. POWERS: Okay.

MS. JACKSON: And that has to at some level that you can stop the temperature excursion from oxidation.

DR. POWERS: Okay.

DR. KRESS: That heat was coming from the oxidation process itself.

MS. JACKSON: Yes, it's an exothermic reaction.

DR. KRESS: But the decay heat is just a way to --

MS. JACKSON: To get you --

DR. KRESS: -- incrementally get that oxidation up to a level --

MS. JACKSON: Let me -- I have a back-up slide on this, and it seems like a good enough time to go to it.

If I can pass these around.

DR. SEALE: It's an igniter.

MS. JACKSON: This is a graph from NUREG-0694, which was one of the reports done in support of Generic Safety Issue 82 and it is showing us decay time versus maximum clad temperature. As decay heat goes down as time increases and so your maximum peak clad temperature goes down.

DR. POWERS: I am going to have to interrupt you.

MS. JACKSON: Sure.

DR. POWERS: Members should be aware that I am listed as an author on this particular document and though I can honestly say I don't remember a thing about it --

[Laughter.]

DR. POWERS: -- I had to look it up to make sure -- I am listed as an author on it.

MS. JACKSON: Okay. We have been reading a lot about this report.

DR. WALLIS: What does the word "minimum" mean in the axis there?

MS. JACKSON: Just given uncertainties -- I think it was

just a lower level of how much decay time that they thought you would get -- if you had this much decay time, this is the temperature you would get to, so given uncertainties that was your lower bound.

DR. WALLIS: So minimum is needed?

MS. JACKSON: Yes --

DR. WALLIS: Minimum is needed because it is a bounding calculation?

MS. JACKSON: Joe, would you want to, would you say it was a bounding calculation?

MR. STAUDENMEIER: I don't know why they listed it as minimum decay time. Joe Staudenmeier, Reactor Systems Branch, NRR.

I don't know why their choice of axis label, but it is -- to get to that temperature --

MS. JACKSON: Decay time --

DR. WALLIS: It takes a certain time. It's just --

MR. STAUDENMEIER: It's just decay time so I don't know why. I mean --

DR. WALLIS: Presumably the authors of the report put the word "minimum" there for some reason.

MS. JACKSON: Well, there is some uncertainty in the calculation --

MR. STAUDENMEIER: I don't think that was considered --

MS. JACKSON: You don't think --

MR. STAUDENMEIER: -- or why it was minimum.

MR. HOLAHAN: This is Gary Holahan of the Staff.

I suspect what it covers is things like how much fuel is in the pool. If there were a lot less fuel than, you know, or different configurations, so I think the analysis was done for a relatively conservative configuration and then other configurations would have had longer times.

DR. KRESS: That would affect just the heat transfer coefficient --

MR. HOLAHAN: Well, radiative --

DR. KRESS: -- fuel doesn't matter --

MR. HOLAHAN: Radiative heat transfer and stuff like that to adjacent fuel --

MR. THROM: My name is Ed Throm, with the Staff. I believe in that report what they were looking at is trying to develop a temperature criteria so if you said I wanted to maintain the temperature below, for example, 600 degrees celsius I would have to have a minimum decay time based on a certain racking configuration to assure that I would not exceed that temperature.

That was the temperature that Diane was alluding to a little earlier, and you can see from these curves that at about 800 degrees centigrade the oxidation process really takes off, so if you were to look at a temperature criteria, for example, this type of curve would tell you the minimum decay time you would need to assure yourself, if I could use that word, that you would not exceed a certain temperature, so that is kind of the simplicity of the terminology "minimum decay heat" from that particular report.

DR. KRESS: Could you tell us what these parameters are -- square 3 inch hole, cylinder 3 inch hole?

MS. JACKSON: Sure.

DR. APOSTOLAKIS: What does the curve mean, first of all? Can you explain the figure?

MS. JACKSON: Sure. We are looking at how much time you would need given that you want to keep your fuel below a certain temperature, and just from the general shape of the curve as you go up this, the solid line, is increase in temperature due to decay heat.

The dashed line is when you get more or a dominant effect for temperature increase due to oxidation, so you can see that somewhere around 600 to 800 degrees oxidation is taking over as your driver for temperature, and that you can't stop your temperature increase after a certain point.

The various lines are different --

DR. APOSTOLAKIS: Could you point to the screen?

MS. JACKSON: Oh, I'm sorry.

DR. APOSTOLAKIS: Thank you.

MS. JACKSON: Sure. The various lines show different spent fuel storage configurations -- the very old ones were open frame, later on they went to cylinders, then they went to squares and the hole is the, the hole in the orifice at the bottom, the orifice in the bottom that would allow air to go down and then come up to cool your spent fuel assembly, so that makes a difference in how much cooling air you would get if you lost all your fuel -- your water.

DR. POWERS: The authors of this document were looking at heat transfer versus an oxidation reaction apparently and the oxidation reaction they had in mind was the oxidation of zirconium clad on the fuel, which presumably had been exposed to a burnup of up to 33 gigawatt days per metric ton.

We now have fuel going into spent fuel pools at much higher than that, and whereas the zirconium hydride in 33 gigawatt day fuel is probably dispersed, we can have localized concentrations of zirconium hydrides in the higher burnup fuel. (1) [redacted]

Do we understand how that material reacts in an oxidizing environment?

MS. JACKSON: I don't think extensive or any studies have been done on that since Generic Safety Issue 82, but the higher burnup is one of the reasons that we feel that the conclusions that came out of there, the actual values for decay time that are acceptable don't exactly apply to the decommissioning plants or the plants that we believe -- the plants as they are configured in the future, so we think current spent fuel pools and future ones will be somewhere on this part given that they are a little higher density in racking and that their burnup is higher, so they are going to have to wait longer to get to a decay time.

DR. WALLIS: Are these calculations based on some sort of heat transfer coefficients and flow resistance coefficients and things like that?

MS. JACKSON: Yes.

DR. WALLIS: Typically there is a fair amount of error or uncertainty in the heat transfer correlations particularly if the exact geometry and range of groups and so on has not been investigated experimentally, so what sort of uncertainty are these predictions subject to?

MS. JACKSON: I don't know that particularly. I don't know if they put that in the report.

MR. STAUDENMEIER: Heat transfer and flow is laminar flow and heat transfer in the bundle so yes, heat transfer and flow coefficients probably have an uncertainty in the range of 10 percent. There is no real uncertainty analysis done on it at all, but I would say that is probably the smallest part of the uncertainty in the whole problem because you have this whole building temperature and ventilation problem that has a lot higher uncertainty in calculating that.

DR. APOSTOLAKIS: Now your previous slide said that you are determining the decay time, so would you tell us how you do that from this figure?

MS. JACKSON: Well, given if we want to say for this particular burnup and everything if we want to keep the temperature of the clad below where oxidation would take over, we would say, you know, it would be 600 --

DR. APOSTOLAKIS: Let's pick one curve and do that.

MS. JACKSON: Okay -- well, let's pick this one.

DR. APOSTOLAKIS: Okay.

MS. JACKSON: Since that is the closest one to what we

have --

DR. APOSTOLAKIS: Sure.

MS. JACKSON: -- today. We would want to keep temperatures below a certain level that oxidation wouldn't take over and we could --

DR. APOSTOLAKIS: Before the line becomes dashed.

MS. JACKSON: Right, that we could say you won't get the temperature excursion that will take you to a zirconium fire, so we would have to then go when you get to 600 and down here how many days does that take? And we would say that is your window of vulnerability to a zirconium fire. Okay?

DR. APOSTOLAKIS: Okay.

MS. JACKSON: But like I said before, today was somewhere --

DR. APOSTOLAKIS: And this time is fairly well known? There is no uncertainty about it?

MS. JACKSON: As Joe just mentioned, there is some uncertainty in it.

DR. APOSTOLAKIS: Some means it is minimal or --

DR. KRESS: It is uncertain.

DR. APOSTOLAKIS: Less than significant or --

DR. KRESS: That is the question. There's uncertainties in the reaction --

MR. BARTON: A couple days or a couple years --

DR. KRESS: -- rate. There's uncertainties in the heat transfer coefficient.

DR. APOSTOLAKIS: So if I read the figure, at 600 it is

about 800 days?

MS. JACKSON: Could be.

DR. APOSTOLAKIS: Now that could be -- 500 would be a thousand or it could be just a few days up and down? Do you have any idea what the order of magnitude is?

MS. JACKSON: Joe is going to have to answer.

MR. STAUDENMEIER: I think it is more in the range of years, like the timeframe of the uncertainty. It's just things on how you configure the fuel in the fuel pool if you concentrated all the hot bundles together in one spot like some plants have done. That is a lot worse than checkerboarding them with hot bundles next to like long decay bundles which have a lot less power.

A lot of these times are driven by the assumptions that you make, like these times are computed in a method that pretty much assumes the building is not there at all, that you get perfect ventilation from the outside, so that the uncertainty is in the range of years.

DR. APOSTOLAKIS: Actually that confuses me but -- 800 days is what? Two and a half years?

MR. BARTON: Something like that, yes.

DR. APOSTOLAKIS: And now you are saying the uncertainty is years? What does that mean?

MS. JACKSON: Yes. Given that these are --

DR. APOSTOLAKIS: It could be all the way down to zero?

MR. STAUDENMEIER: No.

MR. BARTON: It would go the other way.

DR. APOSTOLAKIS: It would be what, 10 years?

MS. JACKSON: Any maybe that is why they chose this to be a minimum one. They think it would be extended farther, probably not less, and this is one of the reasons that the Commission says we should risk inform this process -- to do a thorough hydraulic analysis for a generic spent fuel pool is difficult -- to be kind.

You know, it depends highly on how the fuels in the pool, how -- you know, Joe had mentioned how much spacing you have around the well, a lot of different things that it is hard to capture this in a generic area, and that is why we are looking at these types of analyses, just to give us a window to say, you know, when are we concerned about a zirconium fire, now let's see what type of initiating events and scenarios would affect the risk in that window.

DR. APOSTOLAKIS: But didn't you say earlier that you would like to resolve this in a generic way and now do plant-specific risk assessments? Isn't that contradicting what you just said -- that it is really plant specific.

MS. JACKSON: The whole study -- the whole study, yes, should apply generically and we not going to pin it down to a number of days for every plant. You know, there is a range that we are looking at and we're trying to estimate what that window of vulnerability is. Currently we think the window is somewhere in the order of three to five years.

So we will take -- we think within a five year period is

when you might be vulnerable zirconium fire. Given that five year window, what do we know in the risk area that could tell us something about what we -- how likely do we think a zirconium fire will really happen.

DR. APOSTOLAKIS: So if the figure tells me two-and-a-half years, then you will consider something like five to account for the uncertainty?

MS. JACKSON: And given different things like higher burnup, denser racking, things like that, yeah.

DR. SEALE: In a way, the reality of the situation is that concerns for things like housekeeping are going to be more dominant than anything else. A little bit of Saran Wrap that would interfere with the airflow getting into these fuel bundles is probably a bigger uncertainty in terms of what temperatures -- how much cooling you are going to get and what temperatures you are going to arrive at than these things even.

DR. WALLIS: These started off covered with water?

MS. JACKSON: Yes, spent fuel pools.

DR. WALLIS: And the waters were somehow lost?

MS. JACKSON: Yes.

DR. WALLIS: Then it takes some time for them to dry out and all that sort of thing. And this is way down the road, no one has put any more water in there, and it is just hanging there in the air?

MS. JACKSON: Right. Or it assumes a severe accident that would --

DR. WALLIS: Drain the pool.

MS. JACKSON: Drain your pool, and you wouldn't -- you might not be able to put water back into your pool.

DR. WALLIS: And this is a steady-state analysis, this happens pretty quickly after that?

MS. JACKSON: It depends on how far out that you have decay time. Once you drain your pool, you might, you know, if it is just after shutdown, you might have just a few hours. After a couple of years, you will have several hours for the decay heat to be able to heat up to that point.

DR. WALLIS: And you could put a fan in there and things like that?

MS. JACKSON: Theoretically, you could if you got a volunteer to put one in there

DR. KRESS: This fuel is stored in, is it --

MR. BARTON: Spent fuel pools.

DR. KRESS: Yeah, I know that. They are vertical and if they are BWRs, they are in the shroud that is around it, and if they are PWRs, --

MS. JACKSON: Right. And the Bs, they are in secondary containment, and PWRs, they are in an auxiliary building.

DR. KRESS: They are outside the containment.

DR. WALLIS: It sounds like they are inside containment of this dry fuel.

MS. JACKSON: For PWRs, they are not.

DR. KRESS: PWRs are outside.

MS. JACKSON: They are just in a building.

DR. WALLIS: So there is dry fuel hanging there, and you not sure because you have got uncertainties about whether it going catch fire or not, and someone says, what do we do? It sounds like a really interesting situation.

MS. JACKSON: And for areas such as emergency preparedness regulation, that you look at severe accidents, that is one of the reasons why we think the study is important to do.

DR. WALLIS: You can't flood it with non-combustible air, I mean gases?

MS. JACKSON: A spent fuel pool is about 40 feet deep, 40 feet wide, and 20 feet. So we are looking into those type of mitigation --

DR. POWERS: A big time leap.

MS. JACKSON: It is difficult to assure that that type of environment can be maintained.

DR. SEALE: I think housekeeping is the issue.

DR. WALLIS: Make sure it never happens.

MS. JACKSON: That is what we want. Okay. The other key area of our study is the risk assessment. Now, we started out with a broad set of initiating events. We did receive some initial criticism that all these events were not necessary to look at, but since this is a risk assessment, we wanted to start with all the initiating events, consider them all, and analysis should tell us which ones are significant and which ones aren't.

Since the beginning of the study, we have had significant stakeholder interest in it. We had planned on doing our independent review prior to the release -- or the staff work prior to the release of the study, but given that we had so much stakeholder interest, we did release our preliminary work as a draft study, which you were provided.

We also thought it could benefit the staff to release it early and that we could maybe gather comments from our stakeholders and perhaps get additional technical information from industry, given that, you know, they are the ones out there running their decommissioned plants every day, they could tell us what they are doing, and would be able to help refine our assessment a little better.

We have held several public meetings to meet with our stakeholders during the preliminary part of the study, and after the issuance of the draft, and that included a two day workshop that we had in July, during which we received a lot of comments and additional comments from subsequent teleconferences we have had and correspondence we have had.

In the workshop, we found that the major industry concern was that the risk analysis didn't give sufficient credit to operator actions and plant conditions. And we have been working to remedy that.

This list is a list of some of the top stakeholder comments we have gotten in many different areas.

DR. POWERS: Let me understand, you have in this, in your document you have created some event trees

MS. JACKSON: Yes.

DR. POWERS: And you have an event tree associated with seismic events, heavy load events, some loss of coolant, loss of heat sink kind of events.

MS. JACKSON: Yes.

DR. POWERS: Then you walk through the trees and they are like classic trees.

MS. JACKSON: Yes.

DR. POWERS: And you have some probabilities of each one of the nodes on these trees. Where do the probabilities come from?

MS. JACKSON: We tried to take them from -- there was NUREG-1275 that looked at spent fuel pool accidents at operating plants. We looked at them to try and find the ones that would apply to a decommissioning plant, not all of them would. We looked at additional, you know, what was the current standard for human response actions that was used in PRAs. Is there any other input you can --

DR. APOSTOLAKIS: Are you going to show any event trees?

MS. JACKSON: Today, no, we were not prepared to talk about them.

DR. KRESS: They are in the document, George.

MS. JACKSON: They are in the document. At this point, we released our draft study, but we are really beyond our draft study. We are trying to focus our concentration on finishing and refining that assessment and addressing our stakeholder concerns to finalize our whole assessment in the next month or two.

So, to look at some of those numbers, I think would be a

disservice at this point because they are changing. But we have gotten information from industry. We have gone out to other experts to try and refine that.

Okay. I do want to talk about several areas, though, that we have --

DR. APOSTOLAKIS: Some of them are pretty high, actually, some that you used.

MS. JACKSON: And we were kind of surprised by that as well. We thought, you know, maybe these numbers would all be low and that is what our assessment would show us and we would be done.

DR. APOSTOLAKIS: I am talking about the inputs. The operator recovery actions and so on. You are using probabilities of 1 in 10 that they will do the wrong thing, right? That is a pretty high number.

MS. JACKSON: Glenn, would you care to respond to that?

MR. KELLY: Well, I would have to know exactly -- my name is Glenn Kelly with the staff. When we did the risk assessment, some of the events that you are looking at there perhaps are ones that are included in the dependencies associated with previous things that had happened in the event tree. Without knowing specifically what it is that you are referring to, it is difficult for me to respond to that. But I think you will find that the -- where we tended to end up and where we were running into problems, we were in an area where the methodology and the data really didn't cover events that were taking multiple days to occur. And so we did the best with the kind of

information that we had available.

We have subsequently been working with some world class experts to attempt to expand in this area and to identify what things have to happen at the plant and with the utilities themselves in order for us to have confidence that the human error probabilities are low. We don't believe that it is valuable, or if we could come up with exact numbers, we would love to do that. I think that is extremely difficult for long-term events. We think it is much more profitable to go ahead and develop the criteria that are necessary for us to feel that the human probability is low without necessarily coming up with an exact number.

If we could come up with an exact number, we would, and we have been looking at that

DR. APOSTOLAKIS: I am not asking for exact numbers. Did you do an uncertainty analysis, do you have distributions? I don't see —

MR. KELLY: No, this entire risk assessment was performed in about two-and-a-half months. We had a very tight schedule and we had to do a lot of things in parallel rather than sequentially. And with that understanding, we went ahead and worked with point estimates rather than distributions of uncertainty.

MS. JACKSON: Okay.

DR. KRESS: What were the endpoints of your event trees?

MS. JACKSON: The endpoint was the frequency of fuel uncovery, so the top of the fuel. And although that is not quite

equivalent to initiation of a zirconium fire, we thought it was a good approximation for analyses point, that if you got that low, then --

DR. KRESS: Probably an hour away from --

MS. JACKSON: Right. You are going to most likely get there.

MR. KELLY: This is Glenn Kelly. You are more than an hour away from when you are -- the water is at the top of the fuel.

DR. KRESS: Before you boil off the water.

MS. JACKSON: Right.

MR. KELLY: Right. The reason why we made -- the assumption I made when we did this was that once you got below about three feet of water above the fuel, that you would be unable to effectively recover it from inside the reactor, the reactor building or the spent fuel pool cooling building because the dose rates would be so high that, effectively, you are not going to be able to send anybody in there.

We went ahead and had INEL perform a calculation to determine those kind of dose rates, and we found that if you had -- the fuel was entirely uncovered, that you are talking about dose rates in rem in the tens of thousands of R per hour. So we felt that that is probably not an area where we would want to be sending people in to make recovery.

DR. SEALE: That is not where you want to go.

MR. KELLY: Right.

DR. POWERS: There might be some specific people you would like to send in there.

[Laughter.]

MR. KELLY: So my assumption was that, you know, that recovery would not be effective. And I talked to people about whether, you know, we could stand off at a distance and just shoot a fire hose in there or something as the building is burning down, and they felt that that wouldn't necessarily be very effective, because once you start a zirconium fire, the dose rates could be considerable for anybody standing close by.

So, from our standpoint, although it is the timing and the numbers are not exact, we felt that it took so much time to get to -- to boil down to the point where you -- or to have the inventory be lost to the point where you were uncovering the fuel, that the additional credit that you could take in human reliability space was minimal compared, because it is relatively flat at this point, where you are talking about being days into the event, that we felt that additional credit you were going to take for the heatup time, or the additional time to get the fuel heated up was something that we felt was going to be in the noise compared to all the other things that were going on.

MR. HOLAHAN; This is Gary Holahan. I think Glenn expressed exactly how the analysis was done and the logic for it. However, I have asked them to go back and look at the difference between the two endpoints they have picked, just to be sure that, you know, we are not biasing our results by picking an endpoint of top of fuel versus zirc fire. And if we can get a little additional author our insights on that matter, I think we will cover that in between one way or another.

DR. POWERS: I think I would be very, very cautious about going farther on this top of the fuel uncovery, because you are going to get to a point that you have to go in and start arguing chemical kinetics, if you go farther than that. And I think you would have a very hard time persuading anybody with the current experimental database that you understand the kinetics, chemical kinetics that affect the fuel combustion here.

In your document, there is a lot of talk about what the ignition temperature is of zirconium and whatnot, and it really may not be zirconium ignition temperature you have to worry about. You may have to worry about nodules of zirconium hydride triggering the action, things like that. That may be put a demand on your for an experimental database that would be challenging to put together. (2)

MR. HOLAHAN: I understand that, but it seems to me that there is room in the analysis between top of fuel. Remember, when you get to top of fuel, you still have one-third of the water left in the spent fuel pool. Okay. And I think at that point, the fact is you may see additional signals to the people at the site that there is something going on, whether it is, you know, additional radiation indications or whatever, and, you know, I don't think we need to push it all the way to endpoint being 600 degree clad temperature. But there may be some more reasonable point. It may be, you know, bottom of the fuel, okay, uncovery. *

DR. POWERS: I think you start going down there, I would just caution to avoid getting to a point that you have to defend your

study based on your knowledge of chemical kinetics, because I think you are going to be very, very vulnerable there.

MR. HOLAHAN: We understand that, however, we also recognize that it puts a conservative ~~basis~~ bias in the analysis if you don't go further.

DR. POWERS: It sure does.

MR. HOLAHAN: And you need to in some way acknowledge or estimate, you know, what that means to the analysis.

DR. KRESS: It seems like your chemical kinetics would mostly be steam zirc oxidation under that period.

DR. POWERS: I am not persuaded at all that that would be the case. It mean be steam zirc hydride oxidation.

DR. KRESS: Oh, yeah, I'm sorry. I'm sorry, you are right.

DR. POWERS: And that is what causes your --

DR. KRESS: But it is not air, it is steam at this time.

DR. POWERS: Steam, air, anything, I am not sure I understand how hydride nodules are going to behave for high burnup fuels.

DR. KRESS: Should we consider then, in terms of risk acceptance, this endpoint to be basically equivalent to a LERF?

MS. JACKSON: We are going to -- I have a slide to address that later on.

MR. HOLAHAN: That is a very significant issue.

MS. JACKSON: And, yeah, it is, that is something we are looking at, because it is not quite a LERF, but I will get to that in

just a minute, if that is okay.

DR. KRESS: The other question I had was risk is varying with time.

MS. JACKSON: Yes.

DR. KRESS: And did you pick a time to do this study, like five years or three years, or did you vary that time?

MS. JACKSON: We varied the time. We looked at short timeframes of I think like 30 days from shutdown, but the main focus was on like one year after shutdown. And we had some existing information that we were able to use from Generic Safety Issue 82 that had inventories that we could use for fission products and stuff that were at the pool at one year. So that is where our long-term focus was.

Okay. I wanted to go over a couple of areas that we did have stakeholder comments in and one of the areas that was a significant concern was human reliability, as was already picked up.

It was felt that sufficient credit wasn't given to operator response to adverse plant conditions. In the decommissioning plants there are no automatically actuating systems like you would see for a reactor, so there is a heavy reliance on the personnel to identify and correct any conditions in the spent fuel pool area, and this had an influence in our PRA.

We took an action item at the workshop to solicit comments to outside experts in human reliability and to all our stakeholders to try to identify conditions that would support an assumption of high human reliability and those conditions were things like plant

procedures, alarms, training that would lead us to say, okay, yes the operators will identify adverse conditions.

We released our straw man in mid-August. To date right now we haven't received any technical comments from our stakeholders but we have gotten back our expert feedback and we are reassessing our assumptions for human reliability in our assessment and this work is ongoing, so we don't have any results for you at this time.

For the sake of the committee's time and perhaps the other speakers, I would like to move to one other area and that would be criticality.

That is two slides over. Criticality has been raised as a concern from a member of the public, that we didn't sufficiently address it in our draft study, so we are going back to look at the potential for criticality using an expanded scope of scenarios and a ranking or listing to look at what all has to happen in a sequence to get you to criticality. That work is currently ongoing now too.

DR. KRESS: Does the fuel have to relocate to go critical or are there other ways?

MS. JACKSON: Something has to relocate -- either the solid boral plates or the fuel --

DR. KRESS: Oh, the boral --

MS. JACKSON: You can try and -- even if you had all you borated water gone --

MR. SIEBER: And put fresh water --

MS. JACKSON: -- and put fresh water in, you would not get a

criticality, so something else has to occur, so we are trying to go through the whole sequence of what all has to happen to reach a criticality.

DR. POWERS: To do criticality analyses, what are the technical capabilities for doing it?

MS. JACKSON: I'm sorry?

DR. POWERS: What are the technical capabilities available to you for doing criticality analyses?

MS. JACKSON: Can I refer to the Staff? Larry Kopp.

MR. KOPP: Larry Kopp, NRR Staff. We do have some capabilities inhouse. We have the KENO code that a member of our staff has used to do some criticality analysis.

Of course, a lot of these are transients and really not steady state calculations, which are a little more difficult to analyze.

You have got feedback effects which come into play and it's sort of difficult to analyze a true transient because it is a slow approach and you don't really know the initiating factors that well.

DR. POWERS: Yes, but basically what you are going to do with KENO calculations -- fixed hypothesized positions.

MR. KOPP: There are basically two scenarios that we are looking at. One is a disruption of the fuel and the racks and the play of any associated poisons and to see whether that could cause some type of criticality concern. Right now we feel that there probably doesn't because we can't visualize any way for the UO2 pellets to conform by themselves into a critical mass without the structure

material and the rest of the poisons.

But the other scenario is something like gradual degradation of boroflex in the boiling water reactor where the fuel would remain intact, but there would be no boron in the pool of water to make up for the increase in reactivity due to the degradation, which is another slow approach but we are looking at that also.

DR. POWERS: Sure.

DR. SEALE: There's been a fair amount of experimental data for these kinds of arrays also, and they have been used to benchmark the KENO, so it is a pretty reliable calculation.

DR. POWERS: I would think it would be doable, but really the question is trying to add fuel to the concern I have that we are losing all our capabilities to do adventurous --

DR. SEALE: That's true.

DR. POWERS: -- criticality calculations, and I think we can end up having problems such as those taking place in Japan.

DR. SEALE: There are some recent experiments that the French have done at the Maraccas facility on higher burnups, simulated higher burnup effects and so on, not only for arrays like spent fuel but also shipping arrays and so on, and that should be useful for benchmarking in any higher burnup.

DR. POWERS: Yes, that sounds like real useful data.

DR. SEALE: Yes.

MS. JACKSON: Okay. In addition to addressing stakeholders' concerns, we have other activities in progress now to help finalize our

study. These would include additional technical work we are having performed to augment our original analyses, and this is mainly in the area of thermal hydraulics and in PRA.

There is an independent technical review which I mentioned earlier in progress on our draft report and our independent reviewers also got all the input from the stakeholders so they could balance their review on what others think of our draft report.

The independent review are people outside of the Technical Working Group and they are people from the Office of Research, from National Labs and from other contractors in specific areas of expertise

We are also in the process of applying the risk informed principles of Reg Guide 1.174.

This is where I hope to answer your question. For risk informed decision-making our study is supposed to be risk informed but not risk based so we want to look at all the principles for Reg Guide 1.174. One of the things we first discovered is that the spent fuel pool accident frequency and the consequences don't really line up with the CDF or LERF. Given that we have a release, it doesn't really match up with the CDF. Given that there is no iodine released from the spent fuel pool accident, it doesn't quite line up with the LERF.

DR. POWERS: What is your limiting isotope?

MS. JACKSON: It is usually Cesium-137. There's also another factor that you might have more than one core involved in this, so you'll have a larger inventory

DR. KRESS: Do you actually have a fission product release

model that you use here or do you use something like MELCOR?

MS. JACKSON: I think we used MACCS. Is that the correct --

DR. POWERS: MACCS is a consequence code.

MS. JACKSON: Okay, I'm sorry then.

DR. APOSTOLAKIS: Do you have a curve frequency versus release of --

MR. SCHAPEROW: Oh, excuse me. This is Jason Schaperow from the Office of Research. (4)

We used a release fraction of cesium of one based on some work that was done back in the early '80s by some Research staff and also Brookhaven.

DR. KRESS: What did you use for a release fraction for ruthenium?

MR. SCHAPEROW: My recollection is those release fractions were small, five percent or less.

DR. POWERS: And you can defend that in light of the Canadian work?

MR. SCHAPEROW: I am not intimately familiar with the Canadian work.

DR. POWERS: Well, they have a design basis accident that is a fuel bundle ejection and so they have been worrying about the release of ruthenium from fuel exposed to air.

DR. KRESS: It releases a lot faster than you might think.

MR. SCHAPEROW: We can take a look at that. Actually a lot of these sequences are steam environment. The only one that might be

air would be a seismic maybe where the bottom of the pool would rupture.

You are not going to keep this steam air free. — I did not say this.

DR. SEALE: Not when she dries out.

MS. JACKSON: It seems like something we are going to have to look into.

DR. APOSTOLAKIS: Let me understand the end states again? What are the end states?

DR. KRESS: Well, right now they mentioned it was top of fuel, uncovery to top of fuel and the question I had was is this equivalent to LERF? Well, probably not because LERF was derived from prompt fatality. Prompt fatality depends on the mix of fission products, so -- as well as atmospheric dispersion type things, so the mix of fission products will affect your feeling about what is a LERF and what isn't and what is an acceptable LERF.

DR. APOSTOLAKIS: Yes, but should it be just a scaler, that is my question. Shouldn't you have different frequencies for different kinds of releases -- I mean in a good study?

DR. KRESS: Yes, but you know, to get LERF you add those up.

DR. APOSTOLAKIS: But my point is LERF is not very meaningful here. I am going to the frequency consequence curves, okay?

DR. KRESS: If you have the right LERF it would be just as meaningful --

DR. APOSTOLAKIS: I mean it's yes/no right now? We are either uncovering the fuel or we are not?

MS. JACKSON: Well, you will either have a fire or you won't

have a fire.

DR. POWERS: Yes/no.

DR. APOSTOLAKIS: It is a binary model.

DR. SEALE: The end state though is -- has multiple answers to it because the end state in terms of whether or not you have a release accident may well be whether or not you get down to the top of the core or somewhere near there, but what gets released then depends on where you go from there. I mean again if you boil off all the water and so on, you have got an air fire now. That's very different.

DR. WALLIS: What is the end state after an air fire?

MS. JACKSON: After an air fire --

DR. SEALE: Well, a pile of oxide and a highly, a fairly large unpopulable area I would think.

DR. KRESS: You are driving off the volatile fission products --

DR. POWERS: More than that, you would be vaporizing fuel.

DR. KRESS: Yes.

DR. SEALE: Yes.

DR. POWERS: You would be manufacturing uranium trioxide like you wouldn't believe.

DR. APOSTOLAKIS: The question is would it make sense to have a curve that shows the amount curies released versus the frequency?

DR. KRESS: Of course it would.

DR. APOSTOLAKIS: And right now we are replacing that by a binary thing that says fuel is uncovered or it is not.

MS. JACKSON: Glenn Kelly?

MR. KELLY: This is Glenn Kelly from the Staff.

When we did the calculation it really is a binary event because you are either going to have a zirconium fire or you are not. If you don't have a zirconium fire there is nothing that is energetic there enough to take the fission produces offsite.

If we have a zirconium fire, we have made an assumption about how much zirconium is going to burn up.

DR. SEALE: Yes.

MR. KELLY: And given that, you basically burn down the building and it is released directly to the atmosphere and you are either doing that or you are not doing that.

Now one may quibble about whether we have got the numbers exactly right, but clearly what we did come up with was that the results weren't very good that happened, and so --

DR. KRESS: So you want the frequency of uncovery in the top of the core to be at an acceptable level?

MR. KELLY: That's correct.

DR. APOSTOLAKIS: So that plays the role of core damage --

DR. WALLIS: Well, how much burns? The fire starts in one place where it is most likely -- it spreads to the whole thing?

MR. KELLY: We assumed that it was configured in a manner such that you would be burning up approximately two cores.

MS. JACKSON: So that is your last offload plus like your last three refueling outages. After that you might not be able to get

propagation to the older fuel and heat it up to the point that it would get involved in the fire.

MR. SCHAPEROW: Jason Schaperow for Research. Actually it was three cores.

DR. POWERS: Okay.

MS. JACKSON: Okay.

DR. APOSTOLAKIS: You know, it is important though to have the supporting documentation because as I look at the numbers I get a lot of questions, and all it says is go to NUREG such-and-such or go to INEL such-and-such and find the answer.

For example, probability of recovery of offsite power from severe weather events and the numbers are different for Case 1 and Case 2. Now Case 2 is simply whether they put spent fuel there a month before the accident, right?

MS. JACKSON: I believe so.

DR. APOSTOLAKIS: Why does that have anything to do with recovery from offsite power? It is not clear to me. Does it have anything to do with it?

MS. JACKSON: Glenn?

MR. KELLY: It has to do with -- well, is Mike here to answer that one?

MS. JACKSON: Or whomever

MR. HOLAHAN: There is a good reason. We are still looking it up.

[Laughter.]

MR. HOLAHAN: I mean the big difference -- I can talk about one of the differences between the two is that with -- at one year you have significantly longer time available within which you want to get power back. When you are at one month you are draining down that much faster and you get in trouble that much more quickly, but I think there may be something else that Mike was thinking of in that number.

DR. APOSTOLAKIS: Oh, so the time available is different.

MS. JACKSON: Yes.

MR. HOLAHAN: Yes.

DR. SEALE: Very different.

DR. APOSTOLAKIS: And that takes a whole volume to explain?

DR. POWERS: Actually, in the text there is quite a little discussion of exactly that point.

DR. APOSTOLAKIS: In some places, not everywhere.

DR. POWERS: Not everywhere, I'll admit.

MR. KELLY: Again we apologize for only being able to do this in two and a half months but if we had had more time, we would have been happy to --

DR. SEALE: You would have had a shorter document.

MS. JACKSON: To continue on --

DR. APOSTOLAKIS: I have noticed though the eagerness with which Mike Cheok sat down.

[Laughter.]

DR. APOSTOLAKIS: He couldn't wait.

MR. CHEOK: This is Mike Cheok from the Staff -- from

NUREG-5496 they provide you with a recovery curve and I guess for the Case 2 you do have a shorter time to recover.

DR. APOSTOLAKIS: Okay, that was the reason.

MS. JACKSON: Okay. In looking at the CDF and the LERF we are trying to find an analogous criterion that we could use for spent fuel pool accidents at decommissioning plants. At the same time we are also looking at balancing defense-in-depth and safety margin and the ability to monitor performance.

DR. WALLIS: What does defense-in-depth mean in this context?

MS. JACKSON: That is one of the things we really struggle with. Obviously in every spent fuel pool you are only down to one of the three traditional barriers for fission product release. In decommissioning plants and spent fuel pools you don't have automatic system actuation and we are looking at reducing emergency preparedness, which is usually considered a defense-in-depth --

DR. WALLIS: There is no defense-in-depth, at least in the traditional sense.

MS. JACKSON: Not in the traditional sense, but we are also looking at balancing that to safety margin, which we believe there is an increase in safety margin given that you have a longer time to respond to accidents.

We are not talking minutes or maybe hours. We are talking hours to days now that you can actually do something to respond, and that gives you some margin.

DR. WALLIS: As long as there is something to do.

MS. JACKSON: That's true, but in many of the sequences there is something -- you can call the fire department and bring them in.

You also have increased safety margin in that your iodine has decayed away after a few months after shutdown, so you are not going to have the prompt fatality concerns that you would with an operating plant, so we are trying to balance these things to say what is an appropriate -- (5)

DR. KRESS: Yes, I think that is maybe an illusion there because you will have prompt fatalities from the ruthenium and other things and we are not real sure of what gets released in this kind of accident.

DR. SEALE: Yes.

MS. JACKSON: We did calculate some but they were a small amount. [redacted]

DR. KRESS: Yes, but they were release models that are not very relevant to the situation.

MS. JACKSON: Okay. That is something we will have to take into consideration. (5)

DR. WALLIS: Now a fire -- the release is dependent on the buoyancy of this plume, isn't it? A very hot fire --

DR. KRESS: Oh, it's plenty buoyant, believe me.

DR. WALLIS: Could spread a long way.

MS. JACKSON: Yes.

DR. WALLIS: Of usual magic numbers of miles distant may not apply anymore.

MS. JACKSON: For EPZ and everything -- yes, the study that Jason Schaperow did for us on consequences went far beyond the 10 mile EPZ to look at consequences.

DR. WALLIS: Yes, I think it would --

DR. KRESS: When you use a code like MACCS, you do actually input an energy function into it and it is factored into the dispersion model.

DR. WALLIS: Well, what sort of range are we talking about? Suppose that Maine Yankee has one of these? How far does the plume go?

DR. SHACK: Vermont.

[Laughter.]

DR. WALLIS: It's a Nor'easter.

DR. KRESS: It goes to Dartmouth.

MS. JACKSON: I can tell you in our analyses we looked at I believe 100 miles and 500 miles away.

DR. WALLIS: So you are talking hundreds of miles.

MS. JACKSON: Yes.

DR. WALLIS: That can get to some pretty populated areas.

MS. JACKSON: It's possible. It's possible, you know --

MR. KELLY: This is Glenn Kelly. When we did the calculation, we did not do it in 10 miles and in 20 miles and then 40 miles and then 100 miles so that we would know how much of the population was affected within each one of those circles. We do have

numbers for 100 miles and for 500 miles but to say what did that -- most of the dose was happening close in or far out I think would take a little bit more work on our part.

DR. WALLIS: You pray for rain or something.

MS. JACKSON: Yes.

MR. KELLY: As long as you are not under the rain.

DR. KRESS: That's right. Actually an energetic release is probably kind of good for you because it puts it up high and disperses it --

DR. WALLIS: Sends it to somebody else.

DR. KRESS: It gives a lot of cancers but it doesn't give as many prompt fatalities.

DR. APOSTOLAKIS: Is the quality of your risk assessment subject to the same criticism of incompleteness of the reactor risk assessments, do you think?

MS. JACKSON: I see Glenn shaking his head yes.

DR. APOSTOLAKIS: So what is it that you are leaving out?

MR. KELLY: Well, I mean one can always postulate something else and from that same standpoint we can always postulate something -- I mean we certainly didn't look at meteorites and there were a lot of other things that were not part of our evaluation, but we did look at a broader spectrum of initiating events than had been looked at in any previous study.

And we looked at them in we believe a sufficiently wide manner that were we looking at loss of inventory, loss of cooling, and

then rapid catastrophic events, --

DR. APOSTOLAKIS: Let me put in a different way then.

MR. KELLY: Sure.

DR. APOSTOLAKIS: You are familiar with the active PRAs, right?

MR. KELLY: Yes, I am.

DR. APOSTOLAKIS: Would you tend to rely more on the results of your risk assessment here than you would rely on reactor risk assessments to make decisions? Are you more confident that here your numbers are more representative of what can go wrong?

MR. KELLY: In this particular case, I would say that when we did this risk assessment, the basis of performing this initial risk assessment was to identify areas that we felt required additional effort on the staff's part to assure that they wouldn't be problem areas. We were not doing this on a basis of trying to find the right number, so to speak, the exact number.

DR. APOSTOLAKIS: Yeah, I am not really referring to this particular document which would perhaps you did under severe time constraints, but if you had the time to finish this.

MR. KELLY: Well, again, this is a very generic one because it was not built to a particular design.

DR. APOSTOLAKIS: Well, let me make the question different then.

MR. KELLY: Okay.

DR. APOSTOLAKIS: Is this a case where I really don't need

to go to all the principles of Regulatory Guide 1.174, I don't have to worry about defense-in-depth because I am fairly confident that my risk numbers and my PRA is giving me a sufficient information basis for making decisions. The reason why we have these principles in 1.174 is that we don't really trust the results of the PRA, that we know their holes, we know this, we know that.

Now, in this particular case, though, do I have to take all these principles and take them here and worry about defense-in-depth and safety margins and so on, or can it come closer to risk-based than risk-informed in this case?

DR. KRESS: It depends on the uncertainty in your final answer.

DR. APOSTOLAKIS: I know.

DR. KRESS: And I would guess that the uncertainty in this type of risk analysis ought to be far less than the one in the full power reactor, because it is a simpler system, much less can go wrong.

DR. APOSTOLAKIS: Exactly.

DR. KRESS: You ought to be able to say the uncertainty in this calculation, if you did it, is such that you ought not have to go to these 1.174 --

DR. APOSTOLAKIS: Right. That is what I am driving at. Is this --

DR. KRESS: But you ought to have that uncertainty done.

DR. APOSTOLAKIS: Sure.

DR. KRESS: And you ought to have some confidence level in

your result.

DR. APOSTOLAKIS: And that is why I said that, you know, they should be given the time to complete this analysis.

DR. SEALE: On the other hand, the great difference between the consequences of the two -- the binary nature of this accident is such that if you can find a magic silver bullet that will always assure you that you do not go to the fire case, as some kind of defense-in-depth, that would be a very attractive thing to have.

DR. APOSTOLAKIS: But the issue here is not whether I want to implement defense-in-depth. The issue here is, is defense-in-depth a principle or is it something that, for the measures that are equivalent to defense-in-depth, will flow naturally from my risk assessment? I may very well do this, Bob, but I may conclude that from the risk assessment, without involving a principle that can -- that will impose something on me independently of the risk numbers.

DR. SEALE: Clearly, the analysis will show that the first -- the lesser consequence is by far the more attractive.

DR. APOSTOLAKIS: Yes, I agree with Tom. It seems to me this is a good candidate for going the rationalist way.

DR. KRESS: A good candidate.

DR. SEALE: I think it is fine after someone else has done it.

DR. APOSTOLAKIS: Commissioner McGaffigan may know about it, by the way.

DR. SEALE: And maybe you have done two or three, but I

think you always have the completeness concern until you have gone at it a couple of times.

DR. APOSTOLAKIS: Right. And I understand that, that is why I asked the question. But is the completeness issue here of a similar magnitude as in -- and I don't think so. I don't think so.

DR. KRESS: Rich is going to speak to that.

MR. BARRETT: This is Richard Barrett with the NRR staff. I think I can agree with a lot of what has been said here in that to go into the five principles at the same level of detail that we might do for a full reactor PRA might not be justified. On the other hand, when we look at the risk analysis, we see a wide spectrum of sequences. Some of these sequences require -- involve many, many days to evolve. They involve the failure of equipment, the failure of support equipment, the failure of operator actions. And you can look at these calculations and have some confidence.

On the other hand, there are some scenarios in which a seismic event can occur and there is no opportunity in the model for recovery actions, or not with any high degree of confidence. So we believe that at least a look at the other principles, to examine, as Diane so aptly put it, the tradeoffs between the inherent margin that is built into this situation, and the defense-in-depth questions. But keep in mind, as a background, that the defense-in-depth that we are talking about here relates as well, we have operating reactors today with spent fuel pools. We have already made decisions about the tradeoff between margin and defense-in-depth, so we are not talking about a radical

departure from that, obviously.

DR. POWERS: I think I am going to have to plead for us to move on on this subject.

DR. KRESS: Yeah, I think we are running short on time. We probably are going to have to move on.

MS. JACKSON: Okay. I am just going to finish up. Based on all of our inputs, including the risk assessment, our stakeholder inputs, our industry commitments, our deterministic analyses, and applying our risk-informed principles, we think we can develop a realistic, risk-informed assessment that will provide technical bases for the development of rulemaking and for the development of interim exemption criteria

We think one of the keys to having a realistic assessment is industry commitments that we would be able to credit in our analyses. Our schedule for the remainder of the project is to release the draft for comment report in early January, have a public comment period and be able to release our final report at the beginning of April.

DR. APOSTOLAKIS: When are we going to see you again at the ACRS?

MS. JACKSON: At your leisure. When would you like to see us again?

MR. HOLAHAN: You haven't asked.

DR. POWERS: We have but to ask.

DR. KRESS: We will talk about it

DR. APOSTOLAKIS: We will talk about it.

MS. JACKSON: Whenever you would like, we will come.

DR. APOSTOLAKIS: What can I say?

MS. JACKSON: I would like to thank you all for you time this morning.

DR. APOSTOLAKIS: I must note, Mr. Chairman, that this confirms something that I always suspected, that we don't all mean the same thing by defense-in-depth.

DR. KRESS: That's right.

DR. APOSTOLAKIS: And this is an issue that has to be resolved.

DR. KRESS: Good comment. At this time we are scheduled to move on.

DR. APOSTOLAKIS: And I would also like to know how many hands Rich Barrett has. He used the expression "on the other hand" several times.

[Laughter.]

DR. KRESS: Let's move on. We are now scheduled to hear from the Nuclear Energy Institute, Alan Nelson I think is going to talk to us. No, I have got that wrong. Somebody is going to talk to us.

The Nuclear Energy Institute has reviewed this draft document and they have some positions and comments to make on it I think, so let's --

MS. HENDRICKS: Good morning. I'm Lynnette. I'm the director of -- Lynnette Hendricks, the director of plant support at NEI. My group has, among many other support-type issues, like radiation

protection and emergency preparedness. We have decommissioning and dry storage and low-level waste. So that's sort of where we come from.

I just wanted to make a few introductory remarks, and I'm going to turn over the discussion of the extensive work industry has put into this issue and the risk study, and I hope you've all been provided a copy of the Erin report we had -- Erin Engineering, who was doing a lot of the IPEs, prepare an analysis of the staff's report.

Just a couple of introductory remarks. Decommissioning is very important to the industry. We think it has -- if we're unable to proceed through it in a timely, efficient, safe manner, it has a lot of implications. Ironically, after the discussion today, decommissioning is generally referred to as relatively a low-risk endeavor, but I think we need to remember that it has the inability to proceed through it efficiently in a cost effective manner. It has impacts on the public and our rate payers and shareholders. The reason for that is if you get into decommissioning and lot of these major questions aren't answered, I don't think it gives the public a good impression if we can't proceed through effectively and efficiently and could also give them the impression that it's -- it's -- poses a lot more risks than maybe it really does.

DR. KRESS: Would, say a time frame of difference between three years and five years make much difference to you in terms of cost and burden and--

MS. HENDRICKS: It would make a considerable difference. What we -- the staff mentioned that this was a basis to look at certain

regulations applicable to decommissioning that are susceptible to risk-informing; many others aren't. Those would be EP, financial protection -- I think we've estimated at one point that the cost is about $5 million a year, a couple million in insurance requirements if you can't determine that you are out of a range where you can have the equivalent of large early release and the type of things that financial protection is intended for. Likewise, if you're required to keep a large staff of emergency preparedness to -- and that one's a little questionable, because of the latent effects, you don't have a large early release, so what is the reason for your off-site emergency preparedness plan. But, yes, it would -- it does have a significant effect if you assume three years versus five years.

I also as an introductory remark -- we're briefing the Commission, along with the staff, on Monday, as you probably know in decommissioning issues, and I just wanted to not get into our other issues at this point, because I think you're very appropriately focused on the risk study; but wanted to, as a place holder perhaps for further discussions with you, there are two other components to the decommissioning process that affect us very much. You risk inform the process initially, and then get out of requirements that are no longer applicable. You need to offload your spent fuel into dry casks. That is an issue that we've been very concerned, working with the staff, and also an issue that I think could very much benefit from a risk-informed approach.

~~And the third issue is when you actually get into the~~

And the third issue is when you actually get into the license termination plan -- what should you be providing at what phase, and there's some important issues there. But I don't want to digress into any of those, and at this point, I'd like to turn it over to Mike Meisner, who's, in addition to being president of Maine Yankee, is also the chairman of our decommissioning working group.

MR. MEISNER: Good morning. Can you hear me? Is this on? Pardon me?

DR. POWERS: There's a switch.

MR. MEISNER: Okay, how's that?

DR. POWERS: Better.

MR. MEISNER: Okay, you've heard a lot of the background from the staff this morning, so I'm going to be kind of selective in what I talk about. We've spent a lot of time looking at the staff's model. We think, in fact, that it's a -- it's a very good model from the point of view event trees, fault trees--that kind of stuff. The problem that we've had with what the staff has issued is the inputs to those models. And we think in virtually every case that the -- they've developed an extremely conservative PRA model here that generally goes to the worst case. You indicated very high numbers, for instance, for human error probabilities. That's the case. And as a result, we think that the information that you can derive from that model, from that conservative model is very skewed and doesn't give us much insight to operate our facilities by.

DR. WALLIS: What sort of factor -- is the contention about?

Is it a factor of ten or something in the estimated probabilities or what?

MR. MEISNER: We think they're high by several orders of magnitude.

DR. WALLIS: Orders of magnitude?

MR. MEISNER: I hope you all --

DR. WALLIS: Well, what do you appeal to in order to resolve this? I mean in the case of physical phenomena, you do an experiment. How do you -- what do you appeal to resolve in the factors -- in orders of magnitude?

MR. MEISNER: Well, let me give you few examples, okay, and then -- I hope you all have a copy of this report, and if you haven't gone through it--

DR. KRESS: We have it.

MR. MEISNER: Please do. It's a pretty detailed review of the staff's study and the areas of concern that we have. And I need to emphasize too that the -- what I'm going to be talking about today and on Monday with the Commission is based on that draft report the staff issued. And we've had a workshop with them and lot of discussions, but it's been four months since the workshop and we still have no additional information as to how the model's been changed. So I'm just going to be falling back on what the staff has already issued, in my discussions.

Let's talk about some examples where we think the model is particularly conservative. Human reliability is the key area. Human error dominates the results in the staff's study. And to get at the

issue, let me paint you a bit of picture, okay, and I'll use Maine Yankee as an example.

If you came up to Maine Yankee today, what you'd see is a new control room. And the control room is about a quarter of the size of this room. It's got a couple of indications in it--things like temperature and level. No other panels. We have two operators all the time. And all those two operators do is look at a couple of instruments and go out and walk through the spent fuel pool, doing their rounds.

All they have to look at is the spent fuel pool. Now, in that context what the staff is saying is that for the long-lasting -- long-acting events, these -- all events associated with the spent fuel pool that aren't instantaneous, like your catastrophic drain-down due to seismic -- all other events are -- take on the order of five to eight days to develop. So what the staff is saying in their model is that the operators on shift are going to fail to get water into the spent fuel pool, and then the next shift is going to fail, and the next shift, and the next shift going on five to eight days. And they've assigned a single failure probability to that likelihood such that -- and I -- it's generally on the order of ten to the minus fourth that is well in excess of anything, even IPEs used for similar kinds of events. And, as a result, the numbers that you see in the PRA analysis challenge IPEs--the core damage frequency numbers. It's very unrealistic to expect that shift after shift after shift someone is going to fail to do a very simple action, and that's get water into the pool.

DR. POWERS: You make that point in your review document at

-- how many shifts does this time period represent. But we've had other people make the point that things have happened in fuel pools that have gone on for days without people knowing -- acting on it or recognizing it. So, I mean, it's not beyond the pale, which you could have a large number of shifts with nobody catching something. And I think Brown might argue--

B: Browns Ferry went for three days, and the temperature went up and nobody knew it--recognized it.

DR. POWERS: Yes, we had these anecdotal accounts. In fact, it may well be the efforts go on for a few shifts, then it's almost guaranteed to keep going on for more shifts.

MR. MEISNER: Okay, well, let me address that.

DR. POWERS: (**Inaudible**) looking like it's normal.

MR. MEISNER: Yes, and what happened at Browns Ferry was the temperature went up 20 degrees or so, if I remember right. As an operating plant, let's fall back on simplicity. Those operators were running their facility, and weren't focused solely on the spent fuel pool. As the temperature went up, they eventually caught it, which I think proves the point within what a couple days, if I remember right.

MR. BARTON: Three.

MR. MEISNER: Three days. And that temperature hadn't even gotten up to the point of challenging tech spec limits, much less boiling and steaming. What happens in these pools is most events are self-revealing. If we start steaming in our pool and most pools, you're eventually going to get kind of a rain forest atmosphere in there. It's

impossible to miss -- well before any kind of an event could progress to the point where you'd have a concern, it's going to reveal itself. What do we have to do in all cases? Only one thing, and that's get water into the pools. We have multiple means to do that. Worst case, you know, with days and days to recover, we can set up a bucket brigade out to the bay to get water into the pool. The idea that somehow we're going to fail to do that one action, which is the only recovery action that the operators have, know, and are trained on and work to procedures on is just incredible to the industry. And when you -- when you assume those kinds of high probabilities for failure, I think you do a disservice to the purpose of the PRA. We want to get some risk insights out of this that will be useful for us in going forward.

DR. APOSTOLAKIS: It seems to me that part of the problem is the use of point values, and at some point that we should really see an uncertainty analysis, because I think it's easier to defend a curve and a point value. And then, of course, you may argue that the curve has shifted towards higher values, but I think a lot of the argument will go away, but certainly the human reliability part I'm very much interested in, and I would like to understand a little better. Maybe sending me -- by sending me the supporting documents, and I'd like to look at that.

DR. KRESS: Yes -- my question was going to be along those same lines, George, and I was going to also ask what is the basis for choosing any number. Don't you have to have some human factor studies that says under these circumstances, the chances are from here to here--in this range. I mean, I don't know -- I don't even know if that

exists.

DR. APOSTOLAKIS: The issue of several shifts -- I mean is -- you immediately ask questions like, you know, is the reason why they don't catch it something that is common to all the shifts? Or is it just that they don't pay attention? I mean, different probabilities for these things. By the way--

MR. MEISNER: On the other hand--

DR. POWERS: The speaker is correct that before you can get into trouble here, something has to be so bad that you -- it would be impossible to miss. I mean, you would have to -- the operators would have to be held away from this facility with -- by men with guns.

DR. APOSTOLAKIS: Yes.

DR. KRESS: Does that mean that human error is ten to the minus five or ten to the minus six? What number is put on it?

DR. APOSTOLAKIS: There are conditional errors in the event trees that are one, and I'd like to know why. I just saw one.

DR. KRESS: You just saw one as one.

DR. APOSTOLAKIS: One. And yet that tree has another branch, too. You might say this is a computer code, but it's one.

MR. MEISNER: Let me give a point of comparison.

DR. APOSTOLAKIS: It's fairly high.

MR. MEISNER: IPEs.

DR. APOSTOLAKIS: Yes.

MR. MEISNER: The general approach is IPEs is when an event continues, say, beyond 24 hours or 48 hours, you truncate that sequence

on the assumption that there's more than sufficient time to recover.

DR. APOSTOLAKIS: Yes.

MR. MEISNER: Let me ask you all, who are probably better at PRAs than I am, what the effect might be on IPEs if you took every truncated sequence out and never allowed, and always assigned a failure probability to that sequence. My guess is that you'd probably increase core damage frequencies across the board in order of magnitude.

DR. APOSTOLAKIS: Yes, and, you know--

MR. MEISNER: And our concern here is that the staff is departing from a consistent approach with IPEs or shutdown PRAs; that they're not taking a realistic view of decommissioning and folding that into a PRA. And fundamental to PRAs is the idea that you take a realistic approach. You don't take an excessively conservative one, else you're going to mask what the real contributors are to risk

DR. APOSTOLAKIS: Yes, I must say I looked at some of the numbers, and it says the operators have 132 hours to do these -- the probability they will not do it is 0.2. I would like to know the rationale behind that, or .02. I mean that's a pretty high number when you have a hundred and thirty-two hours.

DR. SEALE: Yes.

DR. APOSTOLAKIS: On the other hand, you know, I would knot invoke consistency with IPEs too much. I would just argue in terms of logic.

DR. SEALE: Yes.

DR. APOSTOLAKIS: Because the IPEs are not enjoying --

nothing. I will not complete the sentence.

[Laughter.]

DR. WALLIS: George? George?

MR. MEISNER: Let me give you another example that you -- excuse me.

DR. WALLIS: Okay, you make your example, and then I want to ask George something. Go ahead.

MR. MEISNER: Go ahead. Who? You talked earlier this morning about zirc ignition temperatures. Staff's using 800 degrees. If you look at the Erin report that we gave you, it provides some practical situations that demonstrate that that temperature isn't even close to what we should be using in our analysis.

DR. KRESS: Don't you lose a lot of credibility when you say that? Because you can look at the technical basis behind these curves they handed out, and it is 800 degrees.

MR. MEISNER: Okay, well, let me give you an example. When they make these tubes -- when they roll the tubes and forge them, it's at a temperature of 1,100 degrees Centigrade in the manufacturing process.

DR. KRESS: The trouble is ignition temperature is a function of geometries, heat transfer coefficients, reaction rates. It's not a fixed thing. It's a geometry-dependent thing, and this thing took those into consideration--the geometry. And it is -- I mean, you can look at this, and I believe it is 800 degrees. That's a good number to use, and to really use that as a argument against what they're doing

is I think a disservice, frankly. Well, wouldn't you expect that if you were going to manufacture these things at a temperature much higher than 800 degrees that you would have seen some kind of runaway oxidation reaction?

MS. HENDRICKS: We had some concerns in going through this and preparing our comments originally about the bases for -- behind that study that the fuel is sort of taken out and heated up. I wish I remember the particulars, but EPRI's (**check word**) been very involved in this, and if it would be of interest, we'll get back to you specifically on that comment.

MR. MEISNER: And consider, too, we're taking these fuel bundles out of the pools, and we're putting them in dry casks. We -- you know, as early as two years after shut down.

DR. KRESS: But maybe we ought to go back and look at that.

DR. WALLIS: The question I had for George. Is here still here, or has he gone away?

DR. KRESS: George is--

MR. HUFFMAN: I believe that the practice is five years. The regulations may allow you to do that earlier, but the tech specs for the certified casks that exist now -- this is Bill Huffman, by the way, in projects -- is five years or longer.

MR. MEISNER: Yes, that's right. But we were just talking yesterday about with EPRI, we were unloading some casks that have been loaded for 14 years, and the bundles were put in those casks two years after shutdown. There's a lot of real information out there that really

should be taken into consideration is my main point.

MS. HENDRICKS: And those bundles were set throughout the 14-year-old year period. No leakage was determined, and they have no indication that there's been a lot of oxidation. There's not a lot of finds or -- I think NRC's participating with EPRI on that, so that's information that's -- would be directly available from NRC's participation.

• oxidation
• hydride nodules

DR. POWERS: Have you looked at fuel with hydriding deposits on them?

(6)

MR. MEISNER: If we have, I'm not aware of it.

DR. POWERS: What do you suspect zirconium hydrides do when they're exposed to air? I know what uranium hydrides do. I don't have any idea what zirconium hydrides do.

MR. MEISNER: I couldn't answer your question. What I'm trying to say, though, is as a practical matter, I assume those hydrides exist in fuel that's sitting in casks. And, we've seen no adverse effects -- anything approaching a zirc oxidation reaction.

DR. POWERS: I suspect the hydrides you've got in existing fuels are distributed, and you don't have hydride nodules the way you will in fuel that's gone to burn ups and excess of 40 gigawatt days per ton.

MR. MEISNER: Good.

DR. POWERS: I mean, that's typically the precipitation levels.

DR. WALLIS: I had a question for George. George, you were

telling us earlier that this is a simpler problem; therefore, one ought to be able to rely on the PRA and might not need to--

DR. APOSTOLAKIS: I was asking.

DR. WALLIS: All the extra miles. And yet, now, we're hearing that this disagreements at the very sort of basic level of orders of magnitude in the probabilities. So how can you rely on something like that?

DR. APOSTOLAKIS: I was not saying that this is a simpler problem in the sense that the calculations will not be debatable. I think the fundamental reason why we went to risk-informed regulation is the issue of completeness. And I'm not sure that the issue of completeness here is as important as it is for reactors. Now, the fact that you will have large uncertainties will guide you to apply perhaps redundancy, diversity, and the usual defense and depth measures, but my point was that you didn't have to invoke any principles for that. But I -- I'm not surprised that the numbers, you know, are debatable.

DR. WALLIS: They're debatable by apparently large factors.

DR. APOSTOLAKIS: It's a very different -- yes, but it's a different philosophical approach to regulation.

DR. POWERS: Again, I think we're going to have to move along here.

DR. KRESS: Yes, we're running out of time.

MR. MEISNER: A comment on the end point. When you look at fuel uncovery, you do, in fact, mask the notion that there's a good deal more time for operators to do something in those kinds of situations.

And if you look at realistic heat up times and the end point being the actual oxidation reaction itself rather than the five days that the staff is using for recovery times, you have something approaching more like eight. And most of that time is valuable, available time without high radiation levels that we can use to get water back into the pool.

The industry has made a number of commitments to the staff as a result of their analysis so that they could have additional comfort in changing many of the assumptions in the study--things like having procedures to get water into the pool, training, some hardware changes such as ensuring that you have self-limiting seals, if you use seals in your -- around your pool. And we're waiting expectantly to see what credit that -- those commitments are going to give us in the staff's analysis.

We do think their study has to be revised significantly to use best estimates, as PRAs should, to remove conservatisms, because conservatisms are inappropriate in PRAs. And the most important thing we think is they need to be consistent with how PRAs have been done up to this point in things like truncating sequences beyond two days. And with all that done, a requantification of the model we think is going to show that the type of risk associated with zirconium fire is very low.

DR. WALLIS: What sort of numbers does your model show the risk to be?

MR. MEISNER: Down to ten to the minus seventh to ten to the minus eighth range, which, by the way, all previous NRC studies have shown as well. So, with a corrected study, we think we're going to

actually get some useful risk insights so that we can apply our resources to the right areas in managing these spent fuel pools. And we think, too, that that will then give the staff the basis to really risk-inform the regulations, provide a better transition period in the regulations for newly decommissioned plants. And we do have a concern, although you caution not to talk about it. But we do have a concern that with the staff proceeding as they are that the kinds of assumptions, approaches, and methodologies they use in this study will tend to undermine a lot of the work that's already been done in operating plants, both in IPEs and in shutdown PRAs. And the -- we're concerned that rather than risk-informing the process, we'll be taking a step backwards and setting a new standard for conservative PRAs versus realistic PRAs.

So, can I answer any questions?

MS. HENDRICKS: I'd like to actually add something. I'm wishing we would have brought some sort of a diagram to show what portion -- where the risk comes out on this. Basically, if you look at it in those terms, seismic is and was about ten to the minus six, one times ten to the minus six. We've recalculated that, as has NRC based on some Livermore results, and it's gone down I think by a factor of two--something like that. The remaining risk and I'm sure the staff will correct me if I'm oversimplifying off the top of my head, but a large part of the remaining risk where you could get a catastrophic pool rupture comes from heavy loads. Heavy loads was dispositioned in New Reg 1353 as not being a concern for operating plant spent fuel pools at

ten to the minus eighth. The requantification that the staff has done brings that back down also to ten to the minus six. And the remainder of the risks that -- in all fairness, it may have since been recalculated -- but the remainder of the risks that brings the overall risk up to ten to the minus five, which obviously is about an order of magnitude from the seismic plus the heavy load's ten to the minus six comes from these very long-term sequences, primarily where you have several days. The point I'd like to make is we've stated previously that this is human error driven, but I think if you put it in little -- you apportion it according to the total risk, you see just how much of it is human error driven.

And so -- I think it becomes almost a policy issue for the commission to say whether they will model these with current requirements taken care of and with credit for some of the commitments made going forward, with some assumptions that there will be a regulatory program in place that will affect what kind of numbers you end up assigning to these human reliability portions of the sequence.

Currently, they've taken a simplistic approach and just said, the whole sequence is ten to the minus four, which isn't too bad, except you add up a bunch of ten to the minus fours, and you get a -- you know -- you get a big number.

Another approach would have been to have gone through the sequence and given different human liability credit at different stages. For example, you have the stage where you've got a leak, and you haven't noticed--maybe comparable to the Browns Ferry situation. Okay, now,

it's gone down further, and you've got a rain forest. And then, again, you're still ignoring it. And you've gone down some more, and you get radiation alarms going off. I mean, you can kind of see how perhaps a more sophisticated approach to the human reliability analysis would just make a completely different outcome in terms of the bottom line.

And I'd like to emphasize I guess in closing that NEI was very concerned when this result came out, as indicating to the public in a (**inaudible**) that went to the Commission, although the results were preliminary -- what the public was told was that this decommissioning phase with fuel in the pool poses a greater risk in many cases than the operating plant itself. That's somewhat illogical, and I think it's probably -- wasn't a good practice to come up -- to put that before the Commission prior to finalizing the study with a little more peer review and a little more certainty on what that number really is more likely to be when it's refined.

DR. KRESS: Okay, with that we're now scheduled to hear from some members of the public. Did you want to--

MR. HUFFMAN: Bill Huffman, again, for projects. I'd like to just make a minor correction. The Commission probably was privy of the draft report where there might be implications that the risk could be comparable to operating reactors or much greater than previously suspected, but the SECY that posed the staff do this study never said that the risks were greater. We just characterized that they were different from what we had previously expected. So, the Commission was never told nor the public in formal SECY that the risks were greater.

MS. HENDRICKS: I believe the number was in the SECY, but Id' have to go back and check.

DR. KRESS: Okay. So I guess we'll hear from members of the public now. I think the next on the agenda is Mr. Pete Atherton, a member of the public, wishes to make some comments.

Come up front, please. We are running a little behind, so try to stick to the time limits if possible.

MR. ATHERTON: May name is Peter James Atherton.

DR. POWERS: Agree to wire yourself up.

DR. KRESS: Yes, we need to get the mike on you so that we can get you on the--

Hook it up close to the -- that's right. Very good.

MR. ATHERTON: My name is Peter James Atherton. I was -- is my voice audible? I serve -- recently, I've been serving as nuclear safety consult to members of the public. I've been representing their interests at nuclear power plants, primarily at public hearings. I have nuclear and electrical engineering degrees. I used to work for the Nuclear Regulatory Commission in the '70s. I am personally interested in what I started in 1978 concerning Safety Evaluation Report on the Power Protection Systems of the Maine Yankee Nuclear Plant, and I'm interested in continuing to follow that, which has thrust me into the decommissioning arena.

Surprisingly, you know, many of the subject matters that I wanted to talk about, you all have addressed in one way or another. And I would like to not repeat these unnecessarily, but to pose a question--

DR. APOSTOLAKIS: Did you say, surprisingly?

MR. ATHERTON: Well, I did not know that your concerns would have been -- would have paralleled some of the questions that I have addressing during the course of the -- of my participation with the hearings and the -- and my involvement with the working groups over the last six or eight months. So I too -- I was surprised. This is my first involvement with the ACRS. Again, so I'm not familiar with how you conduct your business, and so I've been listening attentively.

Getting to the PRA matter, I'd like to project an attitude, rather than get into technical details. And I'd like to say that my person interest is with Maine Yankee, but I'm representing the interests in the way that I'm able to interpret them from people in and around nuclear power plants from the Great Lakes region through the New England area primarily. And one of the concerns with some of these people is the risk assessment techniques that NRC is using. There is a concern that the risk assessment technique does not go to the benefits and the costs. They have an attitude -- I'm just going to basically summarize these -- they have an attitude that they would like to project that, and I'm quoting, "no risk is acceptable if it is avoidable."

And to the extent -- I'd like to move into the spent fuel pool arena and make some general comments. The spent fuel pool in PWRs is outside containment. There is no containment structure for this. If there's a catastrophe there, you can bet it's going to endanger the public. The conservative margin, which I tend to agree with NRC on, should be enhanced because of the lack of defense in depth for spent

fuel pools, as Ms. Jackson has addressed. And I would urge that you all err on the side of caution whenever there's a question with regard to conservatism or liberalism in the interpretation of criteria.

There is one other general concern. Many plants have been going through decommissioning within the last few years recently, and the -- there are people, especially people in the New England area and the Great Lakes area who are interested in what's happening. I would ask from a general overall approach without getting into the regulations that once a plant has decided to permanently shutdown that it's going to go through a decommissioning process. There are members of the public who would like to know -- who live in and around these plants -- who would like to know what's happening. Before the plant is dismantled, they would like to have some sort of input to provide comments, find out what's going on at the plant, and generally be permitted access to whatever is taking place rather than the current tendency which, at least in one instance at Yankee Row -- I mention that specifically -- there appears to be some antagonism, and some efforts to not involve the public in participation with what's happening at a plant that they live around. So that would be the second issue that I would like to address.

We do not talk about seismic concerns at all. Mr. Meisner has addressed issues concerning the drainage of the spent fuel pool and what would happen thereafter and the ability to refill it. There is some spent fuel pools -- different spent fuel pools are designed differently. Most of them have inner liners. Most of them have stainless steel inner liners. Some of them may not have a liner. Some

of the older ones may have a fiberglass liner. Some of the older ones leak, and so we already have leakage. The use, without getting to specifics, we have had plants in operation since the mid-'50s, with spent fuel pools in operation since then. I have not seen in any calculations conservatism taken into account for the degradation of the liner or the spent -- or the concrete structure of the spent fuel pool as a result of its aging and sitting and encountering the various environmental factors that it has encountered over time. I haven't seen a corrective margin for that, or I have not seen it addressed. I have seen people in a deterministic and very broad perspective try to avoid the issue. And I would like to urge NRC to address that. I understand they've hired a consultant for that specific issue.

I raise criticality concerns--going on to the next topic--with the NRC. The information that I've been provided in my off the record communications with them goes back to the '50s and '60s concerning testing and analyses that were done in that matter. I don't know what the fuel enrichment was back then. I don't know what type of cladding was used, whether it was stainless steel, whether it's zirconium, whether it was some other testing material that they were using. I don't know what, if anything, the criteria that was done some thirty, forty years ago, how that would apply today if they were going to use that. And I heard Mr. Kopp's presentation indicating he was looking into the criticality issues some more, and I have an obligation to consult with him separately, off the record, on this matter.

In one other instance, we have an inclination, at least

experimentally, to go to mixed oxide fuel for fuel cladding -- I mean, for fuel. I haven't seen how that added enrichment is going to be taken into account in spent fuel pools.

DR. POWERS: Well, I think that the move toward mixed oxide fuel has to be considered somewhat speculative right now, and it would be for a particular customer, the Department of Energy. So I think -- I think we don't want to make that generalization. It will be for specific plants at best. And it's a long ways down the pike here.

MR. ATHERTON: Okay, also the variation in the enrichment of the fuel - U-235 that is being used today.

We didn't talk much about terrorism, and I understand that's a topic that people do not wish to talk about on the record. However, I will address the fact that we don't have a containment around spent fuel pools, and if there was an attempt to do some damage maliciously, we could have a problem, and we're not looking into those consequences from that point of view that I'm aware of. I just wanted to raise that issue.

And, of course, as an electrical engineer, I have concerns about equipment qualification and single failure criteria for equipment that is actually being used to cool a spent fuel pool. It was never designed to meet the single failure criteria, or it was never designed to meet the Class 1E electrical requirements--basic, general safety grade requirements.

If we're going to have a spent fuel pool that is going to be used over a period of time to store fuel, in some cases over a period of

time beyond its originally designed capability to store fuel, I would like to suggest that equipment qualification could become an issue from one perspective. How are we going to know how reliable -- how are we going to get probability numbers for failure rates for this equipment if we don't have a known grade of equipment that we can develop these numbers for?

Ms. Jackson's already mentioned that we don't have an automatic protection system for the spent fuel pool area. From the safety perspective, we're relying upon operator performance. I would suggest to you, and as I understand it, Mr. Meisner has proposed at least at one of the meetings, that some specific parts of the spent fuel pool electrical systems are going to meet the Class 1E safety grade requirements. The specifics of that I do not know. But that was an industry proposal, which they should be commended for, in my opinion.

And I think I've used up my time, but let me just add one last point. This goes to the probabilities issue. Back in 1975, Stephen H. Hanauer was the technical advisor to the NRC. He also served as a member of the ACRS during the late '60s and early '70s. As a technical advisor, he received a draft of ANSI N-182, which was then dated November 2nd, 1974. He wrote a very brief memo, and he was notorious for doing this, to Guy Arlotta, who was assistant director for safety and materials protection and standards. Now, let me just read this for the record. It's two paragraphs.

The first paragraph reads: "It is my understanding that this is to be rewritten." This is an ANSI draft standard. "In view of

the Browns Ferry fire," which had occurred in March of 1975, and this memo was written May 6th, 1975, "and lessons forthcoming therefrom, I wonder whether it should be kept on ice for a while.

"The idea" -- second paragraph -- "the idea of a probabilistic evaluation that purports to show that the separation is not required leaves me absolutely cold. You can make probabilistic numbers prove anything, by which I mean that probabilistic numbers prove nothing. If this project is not to be put on ice pending the Browns Ferry fire lessons, I would like to comment further."

This was the attitude of some of our hierarchy at the NRC and the former AEC at the time concerning the use of probabilities. I -- it would appear to me that in view of this and my own personal knowledge of the skepticism that the use of probabilities was considered to be part of by members of the staff at the time, what are we doing to alleviate the fears of Mr. Hanauer. You can make probabilistic numbers prove anything, by which I mean the probabilistic numbers prove nothing. That's not a very complimentary message for that term, and it imports the feeling that the probability numbers, in this case trying to eliminate the need for separation--electrical and equipment separation criteria--that probabilistic numbers were being used to justify what deterministically and the commonsense perspective of the people of that era were using in order to avoid complying with safety criteria.

And with that, I would like to thank you for listening to me. And does anybody have any questions?

DR. KRESS: Are there any questions of Mr. Atherton? Well,

we thank you, and particularly thank you for helping us on our time. At this time, I -- we are scheduled to hear from another member of the public, Mr. Paul Blanch, an energy consultant.

MR. BLANCH: Good afternoon. I am Paul Blanch. I am a private consultant, and I'm not very popular. I'm cutting into your lunch hour. I've also got a plane to catch, and I'm limited to 10 minutes. I will try to make this as brief as possible.

As an opening statement, I'd just like to say that, you know, any views that I present here are those of -- my personal views don't represent anyone else's opinion necessarily, certainly not the opinions of Northeast Utilities, where I am an energy consultant for their management.

Over the past few years, I've had a lot of interaction with the NRC staff at many levels--in public meetings and private meetings with the NRC staff--about the decommissioning. And it's more than just the risk of zirc fire. I agree with Mr. Meisner, and also some of the staff, that the real risk there is seismic--catastrophic loss of water in the spent fuel pool is about the only issue in my mind that is realistic that could cause a loss of water. We've looked at it at Millstone or at Connecticut Yankee. We've analyzed the consequences of a loss of water in the spent fuel pool and the consequences, because the fuel has sat there for many years, the consequences are relatively insignificant. That analysis isn't available.

What I'd like to do is briefly touch the overall regulations governing decommissioning. I think in some respects we're losing the

forest through the trees, because there are many, many issues out there in addition to the possibility of a zirc fire. The staff has proposed, and it was alluded to earlier, the proposal on rule making under SECY 99-168, and I'm very supportive of this. I've made some comments at previous meetings. And SECY 99-168, if you haven't seen it, is rule making that covers all aspects of decommissioning for which there are very few rules. And in going through the development of the rules, we need to keep these NRC key messages in mind: to maintain safety, to enhance public confidence, to improve effectiveness and efficiency, and to reduce unnecessary regulatory burden. I'm very, very supportive of all these aspects, especially the one on enhancing public confidence, which we have not done a real good job.

The SECY 99-168, which is being considered -- and, by the way, I -- this is the identical presentation I will be giving to the Commission Monday afternoon -- has a five-year schedule. There are issues, additional issues, that need to be addressed within SECY 99-168. But the additional guidance provided will assist plants that are presently going through decommissioning.

There are many issues here that I am just going to have to glance over, but I'd be willing to discuss at a later time. Significant issues that are not addressed properly for these plants that are going through decommissioning. By the way, in the past two weeks, I've been to four decommissioning plant sites--Millstone, Connecticut Yankee, Yankee Row yesterday, and Maine Yankee last week, I think it was.

Issues that are not addressed that need to be addressed.

Site remediation criteria. The remediation criteria is 25 millirem by the NRC, and I think the EPA says 15 millirem, but it boils down to risk. I've looked at these numbers. I've received presentations from knowledgeable people. I find the site remediation criteria of the 25 millirem to be acceptable from a risk standpoint.

Design basis accidents. What design basis accidents do we have to consider. Peter Atherton mentioned criticality. He also mentioned terrorism. What's the basis for doing away with emergency planning. We need to define that.

Big issue here is the applicability of 10 CFR Part 50. If we look at 10 CFR Part 50, and if you ignore the general design criteria, the storage from high-level waste is not discussed; but, yet, people are decommissioning their plants under 10 CFR Part 50. I don't think it's totally appropriate. We need the regulations.

10 CFR Part 72 discusses the long-term storage of high-level waste. 10 CFR Part 72 is not even being applied--at least the site-specific regulations are not being applied to decommissioning plants. I can envision in the future the way the staff is going right now that we could have, for instance, Yankee Row 20 years from now still having a Part 50 license and the only thing that's on site are dry cask storage. It's just not appropriate. We need more definition.

We need consistent application of existing regulations. And after these four plants, all I can say is, totally inconsistent application of regulations in a security area; fitness for duty--applicable in some plants, not applicable in other plants; quality

assurance, Appendix B -- everyone has a different program. And I'm not saying anyone is doing it wrong, because I was impressed at the way these various plants were doing it. All I'm saying is there's inconsistency.

Emergency planning. Undefined. Fire protection. Applicability of codes and standards. And many other areas that are not defined.

We are regulating by exemption. We're taking parts of Part 50 and granting exemptions. I'm not saying it's wrong. We are applying certain sections of Part 72 to various plants. There is a -- some guidance out there. It's a NUREG. It's 6451. I right now couldn't even tell you who wrote it, but it's a document that was put out about two years ago. It does provide reasonable guidance for plants that are going through decommissioning.

We have competing, conflicting regulatory mandates that need to be resolved. We have the EPA's criteria and the NRC site remediation criteria. That difference needs to be resolved. And one of the issues that I'm bringing up is I think it's -- while the 25 millirem per year, based on the resident farmer, is acceptable from a risk standpoint, neither the EPA nor the NRC specify how much activity can be left on site, either in concentration or total curies. By the regulations right now, as long as I meet the 25 millirem three feet above the ground, I can leave the reactor vessel buried. We need to be more specific.

We need to define what can be disposed of on site. When I was at Maine Yankee, when I was at Yankee Row, there's a lot of clean

waste the staff has not been able to define what can be left on site, even though it's clean, however you define clean. Certainly, I'm a supporter of not going to additional expenses to dispose of clean waste at Barnwell or Envirocare, but we need to define this. Again, the NRC, EPA need to specify either average allowable concentrations or total activity on site.

We need rules for long-term storage of high-level waste, which are very clear in 10 CFR Part 72. We have the issue of a general versus a site-specific license under Part 72. Again, most utilities, although some of them have applied a site-specific license, most utilities are planning to go with a general license, and essentially store their high-level waste for God know's how long under a Part 50 license. Part 50, again, doesn't address high-level waste storage. And then some licensees are applying certain portions of Part 72.

I'm a little repetitive here, but the general license, which is being applied, 10 CFR Part 72, Subpart K, was really intended for the storage, dry cask storage, of those plants that are continuing to operate but yet have dry cask storage. The intent of that was never to allow decommissioned plants to store high-level waste in dry casks forever under a Part 50 license.

Alluded to before, all design basis accidents need to be addressed, not only just the uncovery of the spent fuel -- they need to be risk based. We do have to consider the zirconium fire, probably a very low risk, low consequence -- well, it's not a low consequence event, but it's a low risk event. We need, as Peter said, and some

other people alluded to, to address the potential for criticality. It's happened. You know, someone asked regulators over in Japan two months ago if it could happen, they would have said no. Stuff does happen. It could happen while you're loading dry casks. Miscalculations of burn up, et cetera. And we need to address are there other potential accidents out there. I'm not sure.

DR. APOSTOLAKIS: Would you explain your first bullet a little bit, please? What do you mean we need to be risk-based?

MR. BLANCH: What I'm saying here is that we need to look at all potential accidents, and determine both the probability of their occurrence, and the risk associated with -- or the consequences.

DR. APOSTOLAKIS: What you mean is that the risk assessment should be complete?

MR. BLANCH: A risk assessment, yes. I think that's a hint.

DR. KRESS: I have a little button over here.

DR. POWERS: You attribute more control to us than what we really have.

MR. BLANCH: I have some -- you can follow along here -- handouts. But let me go on in the interest of your time and my time. My recommendations are to provide some interim guidance for those plants that are undergoing decommissioning and NUREG 6451 does provide at least a starting point

Again, a recommendation to the Commission is to direct the staff to proceed with the rule making, as proposed by SECY 99-168; apply site-specific requirements of -- and I say, site-specific requirements

of Part 72 to decommissioning plants.

My final slide is evaluate all potential accidents. Establish clear site remediation criteria. Assure consistency, and establish predictability. Money means a lot to these contractors that are going into decommissioning. They want predictability. They want to know what the regulations are and to work closely with all stakeholders to enhance public confidence.

And I want to thank you for your time, and if I can respond to any questions, I'd like to try.

DR. KRESS: Are there any questions or are you?

MR. BARTON: I think it was a pretty clear presentation.

DR. KRESS: Yes, it was pretty good.

MR. BLANCH: Thank you.

DR. KRESS: Well, I certainly want to thank all the presenters and staff and the NEI for their presentations. At this time, I guess we'll turn it back over to you, Mr. Chairman.

DR. POWERS: I'm going to recess us until 1:15 p.m.

[Recess.]

DR. POWERS: Let's come back into session. We are now ready to turn to a subject that's going to be new to the Committee--the status of resolution of issues associated with the design basis information. And John Barton, you're going to take us through this subject, and tell us what we ought to know.

MR. BARTON: Thank you, Mr. Chairman. The purpose of the meeting is to continue our discussions with the staff and NEI on the