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1 UNITED STATES OF AMERICA

2 NUCLEAR REGULATORY COMMISSION

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4 ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

5 (ACRS)

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7 MATERIALS, METALLURGY, AND

8 REACTOR FUELS SUBCOMMITTEE

9 + + + + +

10 TUESDAY

11 NOVEMBER 19, 2013

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13 ROCKVILLE, MARYLAND

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15 The Subcommittee met at the Nuclear

16 Regulatory Commission, Two White Flint North, Room T2B1,

17 11545 Rockville Pike, at 8:30 a.m., J. Sam Armijo,

18 Chairman, presiding.

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1 COMMITTEE MEMBERS:

2 J. SAM ARMIJO, Chairman

3 RONALD G. BALLINGER, Member

4 SANJOY BANERJEE, Member

5 CHARLES H. BROWN, JR. Member

6 HAROLD B. RAY, Member

7 JOY REMPE, Member

8 PETER C. RICCARDELLA, Member

9 MICHAEL T. RYAN, Member

10 STEPHEN P. SCHULTZ, Member

11 GORDON R. SKILLMAN, Member

12 JOHN W. STETKAR, Member

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14 DESIGNATED FEDERAL OFFICIAL:

15 CHRISTOPHER L. BROWN

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2 ALSO PRESENT:

3 EDWIN M. HACKETT, Executive Director, ACRS

4 TIM MCGINTY, Division Director, NRR

5 RAJ AULUCK, NRR

6 STEVEN BAGGETT, COMM

7 ANDREW BARTO, NMSS

8 PATRICK CASTLEMAN, OCM

9 GREG CASTO, NRR

10 AMY CUBBAGE, OCM

11 HOSSEIN ESMAILI, RES

12 KATHY HALVEY GIBSON, RES

13 STEVEN JONES, NRR

14 IAN JUNG, OEDO

15 ED LYMAN, UCS*

16 JOSE PIRES, RES

17 BILL RECKLEY, NRR

18 FRED SCHOFER, NRR

19 ROBERT TAYLOR, NRR

20 BRIAN WAGNER, RES

21 KEVIN WITT, NRR

22 *Present via telephone

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3 T A B L E O F C O N T E N T S
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P R O C E E D I N G S

8:30 a.m.

CHAIRMAN ARMIJO: Good morning. The meeting will now come to order. This is a meeting of the Materials, Metallurgy and Reactor Fuels Subcommittee. I am Sam Armijo, Chairman of the Subcommittee.

ACRS members in attendance are Sanjoy Banerjee, Ron Ballinger, Harold Ray, Dick Skillman, Steve Schultz, John Stetkar, Mike Ryan, Charlie Brown and Joy Rempe.

I expect Pete Riccardella will show up, but he hasn't yet. Christopher Brown of the ACRS staff is the designated federal official for this meeting.

Today's meeting is open to the public. The purpose of the meeting is to receive a briefing from the Office of Nuclear Reactor Regulations on staff evaluation and recommendation for Japan lessons learned Tier 3 issues on expedited transfer of spent fuel.

The Subcommittee will gather information, analyze relevant issues and facts and formulate proposed positions and actions as appropriate for deliberation

1 by the full committee.

2 The full committee meeting on this topic

3 will be on December the 5th, 2013, and will also be open

4 to the public.

5 The rules for participation in today's

6 meeting were previously published in the Federal

7 Register.

8 We have received no written comments or

9 requests for time to make oral statements from members

10 of the public regarding today's meeting.

11 A transcript of the meeting is being kept

12 and will be made available as stated in the Federal

13 Register Notice.

14 Therefore, we request that participants in

15 this meeting use the microphones located throughout the

16 meeting room when addressing the Subcommittee.

17 Participants should first identify

18 themselves and speak with sufficient clarity and volume

19 so that they can be readily heard.

20 I'd like everyone to please silence their

21 cell phones at this time. And also, it is my

22 understanding that members of the public, Mr. Ed Lyman,

23 may be on the bridge line. And the bridge line will

24 be set in listen-only mode during the briefing. After

25 the briefing, we will open the bridge line for public

1 comments.

2 We will now proceed with the meeting and

3 I call on - I believe it says Tim McGinty. He will open

4 up the meeting for us and give a brief introduction.

5 MR. McGINTY: Thank you. Good morning. My

6 name is Ted McGinty, and I'm the director of the Division

7 of Safety Systems in the Office of Nuclear Reactor

8 Regulation at the NRC.

9 I would like to thank the Chairman and the

10 members of the ACRS for the opportunity to hear the

11 staff's presentation of the near-term task force Tier

12 3 action to recommend whether further regulatory action

13 is recommended or additional study would be warranted

14 regarding the expedited transfer of spent fuel from wet

15 to dry storage.

16 To determine whether regulatory action

17 might be warranted, we followed our regulatory

18 decision-making procedures to determine whether there

19 is a substantial safety enhancement.

20 Additionally, to provide information to the

21 Commission, the staff performed additional cost-benefit

22 analysis, as well as additional sensitivity studies for

23 cases beyond the current regulatory framework.

24 Based on the feedback that you provided in

25 your October 3rd full committee meeting on the draft

1 analysis, the staff has reviewed their earlier work and
2 made a number of improvements based on your comments.
3 The staff issued COMSECY-13-0030 to the Commission on
4 November 12th.
5 For our meeting with you today, Kevin Witt
6 will be covering the Tier 3 plan background and
7 evaluation process, Steve Jones will be covering the
8 Tier 3 analysis, and Fred Schofer will be supporting
9 the discussions on the cost-benefit analysis.
10 And with that said, I'll turn it over to
11 Kevin Witt.
12 MR. WITT: Thank you. As Tim said, my name
13 is Kevin Witt. I'm the project manager in the Japan
14 Lessons Learned Project Directorate. I was responsible
15 for coordinating the staff activities on this issue.
16 Today during our presentation, we'll be
17 going over these following items. I'll be giving a
18 brief background of this issue and talk about the process
19 that we went through on the evaluation of this.
20 And Steve is going to talk about the
21 regulatory analysis. And Fred will help us out in our
22 discussions.
23 A little bit of background on how we got
24 here. This issue was identified following the
25 Fukushima accident where there were stakeholder

1 concerns about spent fuel storage and spent fuel pools.
2 And the issue came up as to whether spent
3 fuel pools would be safer, and this has been an issue
4 that's been around for quite some time in terms of
5 whether spent fuel pools are safe in a high-density
6 configuration and whether they would be safer in a
7 low-density configuration.
8 So, what we did following the
9 identification of this issue following the Fukushima
10 incident, is we tried to determine what the best way
11 to determine whether regulatory action might be
12 warranted.
13 And we have a normal process for doing this
14 on our regulatory analysis guidelines that are outlined
15 in the NUREG/Brochure-0058. And so, this process kind
16 of lays out how we did this analysis.
17 So, during this analysis we utilized a lot
18 of previous information that we had about spent fuel
19 pools. There's been a broad history of studies on spent
20 fuel pool safety. There was a generic issue back in
21 the 1980s on high-density spent fuel pools.
22 We also had the Spent Fuel Pool study which
23 was started following Fukushima and we utilized
24 information from that study for our analysis.
25 So, what the purpose of the paper that we

1 just recently sent up to the Commission was a high-level
2 look at whether regulatory actions might be warranted.
3 And if our analysis showed that regulatory action might
4 be warranted, then we would do additional studies.
5 So, when we came up with the plan for this
6 issue, we split it up into three phases. And this first
7 phase is the one that we just recently completed the
8 Commission paper on. It's what we call "Phase 1."
9 And it's really a conservative analysis.
10 We picked all of our assumptions in a conservative
11 manner to try to maximize what the benefits would be
12 if you did indeed move the fuel out of the pools, move
13 from high-density to low-density spent fuel pools.
14 MEMBER BANERJEE: Was it a purely
15 conservative analysis, or did it have certain best
16 estimate elements?
17 MR. WITT: We tried to do it in a conservative
18 manner, but there were a number of places where we did
19 best estimate.
20 Steve, do you want to -
21 MEMBER BANERJEE: It seems that it was mixed,
22 right?
23 MR. JONES: Yes, it is a mix and we'll get
24 to it in detail, I guess, a little later on.
25 MR. WITT: Yeah, when we talk about all the

1 inputs that we used, we can see how - we'll talk about
2 how we picked those.
3 MEMBER BANERJEE: Why did you choose this
4 path instead of either doing something like a best
5 estimate or a very conservative? I mean, this is sort
6 of neither fish nor fowl in some of it.
7 MR. WITT: Well, really our objective with
8 this analysis was to try to skew it as much as possible
9 towards going further down the road and doing further
10 study on regulatory actions.
11 So, we tried to figure out whether it would
12 theoretically be possible to have a substantial safety
13 enhancement by having less fuel in the pool than it is
14 currently.
15 And so, in order to do that, we try to
16 maximize the benefits that we could get out or what type
17 of safety benefits there would be for moving from a high
18 to a low-density pool.
19 MEMBER BANERJEE: I think the reason is
20 clear. So, I don't want to belabor this, Mr. Chairman.
21 But on the other hand, it is confusing because of the
22 way - it's not clear which assumptions are which.
23 They're not pinned and justified in a way which is -
24 CHAIRMAN ARMIJO: I share your concern,
25 Sanjoy. The problem is when you're trying to maximize

1 a benefit of an alternative, the question is how far
2 can you go before you actually create an unrealistic
3 or unjustified benefit when it really isn't there.
4 And we have that problem with this type of
5 an analysis as opposed to a best estimate, plus some
6 uncertainties are higher and lower.
7 As you go through your presentation, you
8 just have to keep that in mind that's a concern.
9 MR. WITT: Right.
10 MEMBER BANERJEE: And so, if you look at your
11 detailed studies and so on, they were done in great depth
12 in some ways that I must compliment you in that work
13 as well. I think other people might feel that way, but
14 they looked more like in some ways best estimate
15 calculations that you've done if I recall all the
16 materials you put in those.
17 Now, you can say that maybe the incident
18 was shifted by an hour or two or whatever if you make
19 more conservative estimates, but that's sort of hand
20 waving, you know.
21 So, this mixture of best estimate and
22 conservative really continues to trouble me on this.
23 MR. JONES: I'll try to give you a good
24 explanation when we -
25 MR. WITT: Yeah, another viewpoint on that

1 is I think that if this analysis did indeed show that
2 there might be a benefit, then we would try to do more
3 of a best estimate analysis on the next phase, but -
4 MEMBER BANERJEE: Or either, I mean, be
5 conservative. That's fine. Okay. Thank you.
6 MR. WITT: So, this plan was provided to the
7 Commission back in May of 2013. It outlined the
8 three-phase process that we proposed to follow for this
9 issue.
10 In terms of stakeholder involvement in our
11 analysis of this issue, we did have two public meetings
12 this past summer. The first was on August 22nd, and
13 the next one was on September 18th.
14 The first public meeting mainly discussed
15 the Tier 3 issue of expedited transfer and we received
16 some feedback that stakeholders wanted to have some more
17 dialog on the spent fuel pool study. So, we had another
18 meeting on September 18th to talk about the spent fuel
19 pool study and the Tier 3 issue.
20 There has been a lot of feedback from
21 stakeholders. We received a number of letters on this
22 issue.
23 Most of the external stakeholder feedback
24 that we have received generally indicates their favor
25 for moving forward with expedited transfer of spent

1 fuel, but it also outlines a little bit of confusion
2 in terms of what the process we followed was.
3 We really tried to do our best in terms of
4 revising the document from the draft version to what
5 you have currently, what we sent up to the Commission
6 to lay down in a more logical manner.
7 The spent fuel pool study as I mentioned
8 several times before, was a major element of this
9 analysis.
10 We started really doing this analysis with
11 the spent fuel pool study and I'll talk about that in
12 another slide, but this was carried out by the Office
13 of Research. NRR was heavily involved with the conduct
14 of that study. So, there was a lot of collaboration
15 between Research and NRR in terms of how the study was
16 conducted and also on the Tier 3 analysis.
17 The spent fuel pool study was issued for
18 public comment in June 2013 and that was just recently
19 finalized and sent up to the Commission in October.
20 And the final version had the public comments they
21 received, as well as responses to those public comments.
22 In terms of the Tier 3 analysis, we did
23 release a draft version of that document before the ACRS
24 meeting which we had with you on October 2nd.
25 That document was released to support

1 stakeholder involvement in that meeting or some
2 stakeholders who presented at that meeting.
3 We did receive, like I said, we received
4 some feedback from individuals and from you about the
5 outline that we had in that document. So, we really
6 took that back and tried to do our best to respond to
7 those concerns or those comments that we received and
8 tried to lay this out in a more logical manner.
9 So, that's really what you'll see the
10 difference between what we released, what you had back
11 in October and what we just recently sent up to the
12 Commission.
13 We tried to reformat it to lay it out in
14 a more consistent format in terms of what the process
15 we followed was.
16 So, this slide gives an overview of the
17 steps that we took to get to this Tier 3 analysis. The
18 bottom level here is the spent fuel pool study. And
19 that was a study to identify the potential consequences
20 of a spent fuel pool accident at a representative plant.
21 It was really focused on one plant and
22 talked about one specific event that occurred. So, it
23 really went quite in-depth in terms of how the accident
24 progression can occur at a spent fuel pool.
25 So, subsequent to the completion of the

1 calculations and all that stuff, we went ahead and added
2 on an appendix to that study. It's Appendix D to the
3 spent fuel pool study. It was a regulatory analysis
4 of that representative spent fuel pool.
5 And what we did is we wanted to see how those
6 consequences would fit into our regulatory framework.
7 It was kind of like the first step towards getting
8 towards a generic regulatory analysis.
9 So, the appendix of that study outlined how
10 the consequences from that spent fuel pool study would
11 fit into our regulatory framework in terms of whether
12 there was a substantial safety benefit, and a
13 cost-benefit analysis as well in there.
14 There was an expanded set of scenarios that
15 that regulatory analysis considered in the spent fuel
16 pool study.
17 And then finally at the top of this which
18 we're talking about today is the Tier 3 analysis. And
19 that expands it out to all of the plants with the broad
20 side of initiating events that we considered in the
21 analysis.
22 MEMBER STETKAR: Are you going to talk a
23 little bit about that broad side of initiating events
24 that you considered?
25 MR. WITT: Yes.

1 MEMBER STETKAR: Okay.

2 MR. WITT: Yes.

3 MEMBER STETKAR: I'll hold my questions

4 until then.

5 MR. WITT: Yeah, there's a slide on that.

6 CHAIRMAN ARMIJO: Kevin, I don't remember

7 was it in Appendix D that you broadened the seismic from

8 a 0.7 g to a 1.2 g for the spent fuel pool study?

9 MR. WITT: Yes.

10 CHAIRMAN ARMIJO: It was in there?

11 MR. WITT: Right.

12 CHAIRMAN ARMIJO: And then you'll use that

13 same set of seismic events in the generic analysis.

14 MR. WITT: Correct.

15 CHAIRMAN ARMIJO: Okay. Somewhere along

16 the line if you could explain why you needed to increase

17 the seismic breadth of the plant over what was analyzed

18 in the spent fuel pool study itself, I mean, what was

19 the reason?

20 Because that was a very, you know, six times

21 the normal design basis.

22 MR. WITT: I think we can talk - we don't

23 really have a slide about the spent fuel pool study in

24 terms of what we did.

25 CHAIRMAN ARMIJO: No, we reviewed that. You

1 don't have to go into that again.

2 MR. WITT: Right.

3 CHAIRMAN ARMIJO: But then why did you feel

4 an obligation in the regulatory analysis to crank up

5 the seismic loading?

6 Was it arbitrary? Was it based on some

7 desire to maximize the -

8 MR. WITT: It is actually a conscious

9 decision. I believe -

10 CHAIRMAN ARMIJO: No, I understand it was

11 a -

12 (Simultaneous speaking.)

13 CHAIRMAN ARMIJO: No, I'm just saying I'm

14 trying to understand why did you do it?

15 MR. WITT: That did come out from the

16 formulation of the spent fuel pool study. Because when

17 they first started doing that, they were considering

18 what type of seismic events they were going to analyze

19 in there.

20 CHAIRMAN ARMIJO: Yeah.

21 MR. WITT: And so, they had to decide between

22 the Bin 3 and Bin 4 earthquakes. And I guess - I don't

23 know for what reason they chose the Bin 3, but they did

24 identify the Bin 4 in the - when they were starting that

25 study.

1 And so, we kind of took that from the study
2 itself in terms of how they discussed that Bin 4
3 earthquake in terms of it being a possibility.
4 MR. STETKAR: Kevin, maybe at the break you
5 guys can get together and assemble a little bit of
6 background material on this, because I have questions
7 different from what Dr. Armijo has, because your
8 analysis actually underestimates the seismic risk for
9 base case analysis, because you've limited only Bin 4,
10 which has a particular frequency and there's only a 50
11 percent probability that the two, three, four groups'
12 liner fails at that acceleration.
13 So, you have not accounted for frequencies
14 - when you convolute the frequency of higher
15 accelerations with the fragilities past the median
16 capacity, you've not accounted for that damage
17 frequency. You've not, you know.
18 So, you've arbitrarily truncated the upper
19 end at an acceleration that does not span the range of
20 fragilities of the Group 2, 3 and 4 pools.
21 So, I'd like to better understand why you
22 stopped at Bin 4, why you don't have a Bin 5, because
23 you don't have the frequency of those large earthquakes
24 for which the pools would fail.
25 CHAIRMAN ARMIJO: Well, John, you totally

1 confused me.

2 (Simultaneous speaking.)

3 MEMBER STETKAR: I do seismic analysis.

4 CHAIRMAN ARMIJO: Yeah, I understand.

5 MEMBER STETKAR: And risk analysis is just

6 selecting a couple of arbitrary bins. And what bothers

7 me is there are statements in there that says, well,

8 we assigned 1.2 g to Bin 4 based on PRA convention, and

9 that is not PRA convention.

10 That is a gross misrepresentation of what

11 is done in modern seismic risk assessments. And that's

12 on the record now.

13 So, I'd like to really understand why you

14 stopped where you stopped with Bin 4, and why you

15 characterized it the way you did it considering the

16 fragilities that you used for the Group 2, 3 and 4 pools.

17 Group 1 is fine, because it's guaranteed

18 to fail at Bin 4. Groups 2, 3 and 4, the fragilities

19 are only 0.5. It's a medium capacity of those liners.

20 They will fail at some higher acceleration.

21 You have not quantified the frequency of

22 that higher acceleration.

23 MR. WITT: Well, we can definitely have that

24 discussion.

25 MEMBER STETKAR: Okay. So, you know, maybe

1 at the break you can think about it a little bit.

2 MR. WITT: Yeah, unfortunately our seismic

3 expert isn't here yet.

4 MEMBER STETKAR: Well, that's too bad,

5 because all of this is seismic.

6 MR. WITT: Yeah, he's going to be here in

7 a little bit.

8 CHAIRMAN ARMIJO: I think, you know, I want

9 to understand that, you know, we obviously can make

10 anything fail if we crank up the seismic loading

11 sufficiently.

12 And the question I have is, where do you

13 stop and - to be realistic, these are, you know, we don't

14 want to have a - you find a situation where we just force

15 an answer being the only alternative is -

16 MEMBER STETKAR: If the frequency of failure

17 is small enough, then it's small enough. If the

18 frequency of failure is not small enough, then it's not

19 small enough. If you've not looked at it, you don't

20 know what the frequency of failure is.

21 CHAIRMAN ARMIJO: You're presuming it's -

22 MEMBER STETKAR: I'm not presuming anything.

23 I don't know, because it's not been evaluated.

24 I don't know the steepness of the assumed

25 seismic fragility curve, nor do I know the shape of the

1 - I do know the shapes of the seismic -

2 CHAIRMAN ARMIJO: If we have those curves

3 and we don't have to invent them on the fly, then I think

4 it's a good point. But if it's very high uncertainty,

5 I'm just -

6 MEMBER STETKAR: There's two issues. One

7 is uncertainty, one is completeness of the range of

8 accelerations in -

9 CHAIRMAN ARMIJO: You've got to educate some

10 of us that - your opening statement was very complex.

11 MEMBER STETKAR: It's not easy if you don't

12 - if you do seismic analysis, you know what I'm talking

13 about. If you don't do seismic analysis, you don't know

14 what I'm talking about.

15 CHAIRMAN ARMIJO: Okay. The staff knows

16 what John is talking about. Okay. Thank you. We'll

17 move on.

18 MEMBER BALLINGER: The seismic analysis is

19 not disconnected from the fragility and the assumptions

20 you've made there.

21 So, as you raise the - as you increase the

22 energy in the seismic event, you run up against the

23 conservatisms that you've made with respect to the

24 fragility, especially the pool mechanical properties

25 and those assumptions.

1 And so, they're not disconnected from one
2 another.
3 MEMBER STETKAR: No, they're not
4 disconnected. That's my point.
5 MEMBER BALLINGER: And we have to be sure
6 that we get them both right. Otherwise, we get hoisted
7 by our own petard here.
8 MR. WITT: I don't want to jump ahead, but
9 I just want to respond quickly that what our analysis
10 showed is that the dominant frequencies are - or what
11 we're talking about in terms of the safety enhancements
12 are really dominated by the event initiator frequencies.
13 So, that's one of the major contributors.
14 MR. SCHOFER: That's dominated by seismic.
15 (Simultaneous speaking.)
16 MR. WITT: We all agree it's dominated by
17 seismic. Now, the question is -
18 MEMBER BALLINGER: But it's the liner that
19 fails.
20 MR. WITT: Correct.
21 MEMBER BALLINGER: We'll get back to it.
22 MR. WITT: Yeah, we'll talk more about that.
23 CHAIRMAN ARMIJO: Okay.
24 MR. WITT: Okay. So, this is a little bit
25 more about how we did our analysis. We had a broader

1 set of initiating events in this Tier 3 analysis, as
2 well as the spent fuel pool studies talk about a more
3 severe earthquake, a Bin 4 earthquake, cask drop events,
4 loss of power, loss of coolant inventory.
5 The Two, Three analysis, as I said before,
6 covers all the reactors in the central and eastern.
7 We did have one caveat in the paper that we sent up to
8 the Commission in that we did not have updated seismic
9 hazard information for the west coast plants, which they
10 are currently working on updating as part of the Japan
11 Lessons Learned 2.1 activity, the seismic
12 reevaluations.
13 So, what we committed to the Commission is
14 that we're going to go back after the completion of those
15 reevaluations for the west coast plants and look to make
16 sure that they are consistent with the analysis that
17 we conducted in this Tier 3 evaluation.
18 We also did in our analysis, we covered new
19 reactors, the AP-1000s. That was one of the groups.
20 And then one of the issues that we've heard
21 about numerous times, a number of stakeholders have
22 brought this up, is security.
23 And we did have a statement in the paper
24 that we sent up to the Commission that security is not
25 considered in this analysis. It's handled through our

1 existing processes for security.

2 And we gave out - there was some effect of

3 security in this analysis in that in the alternative

4 we did consider the mitigating strategies, the B.5.B

5 or the 50.54(hh) equipment. So, that was included in

6 our analysis. We did credit that equipment, as well

7 as the security changes in the regulatory baseline.

8 So, we pretty much assumed that security

9 is going to be perfect in our analysis.

10 MEMBER SKILLMAN: Kevin, before you change

11 the slide, let me ask you about the western plants.

12 In the draft letter to the Commissioners - excuse me

13 - in the November 12th letter to the Commissioners,

14 Mark's comment on Page 8, Mark Satorius' comment is at

15 the completion of the NTTF recommendation 2.1 seismic

16 reevaluation, the staff will confirm that the seismic

17 risk for SFPs is consistent with that considered in the

18 enclosed analysis.

19 And I'm following up on the statement that

20 you made that this be revisited. It sounds to me like

21 the analysis is being closed out on a future promise.

22 MR. WITT: Well -

23 MEMBER SKILLMAN: And please explain to us

24 what's going to happen if as a result of the 2.1

25 evaluations the western plants don't conform with your

1 analysis.

2 MR. WITT: Well, I believe that it will be

3 handled through that process in terms of the 2.1

4 reevaluation process.

5 MEMBER SKILLMAN: What's that do to your

6 analysis, the risk analysis?

7 MR. JONES: I guess we're trying to - we are

8 following to a large degree past studies. And

9 NUREG-1738 and NUREG-1353 have the same issues with the

10 west coast plant seismic fragility or seismic hazard

11 information.

12 So, we are expecting to confirm the same

13 response or similar response as the west coast pools,

14 but there's a difference. And we certainly have to

15 consider that for plant-specific backup process or some

16 other action appropriate for that risk that's

17 identified.

18 MEMBER SKILLMAN: Okay. Thank you.

19 MEMBER REMPE: Are there any increases in

20 security costs if you have to expedite transfer because

21 you're going and building new ISFSIs and things like

22 that and there's more cameras and guards for these new

23 facilities, and were they considered?

24 MR. JONES: There's a discussion in the

25 regulatory analysis about operating costs. Most of the

existing reactors have ISFSIs and we're not assuming that they dramatically need to increase operational expenses.

There might be additional cost for expansion of an existing ISFSI by putting in a new pad or something.

On the other hand, for the new reactors, the Group 3 plants, there was consideration of additional operational costs beginning much earlier in the life of the plant, because there would be earlier transfer.

MEMBER REMPE: The judgment if you thought it was significant, you did consider it. But with the existing plants, you didn't think it was significant.

MR. JONES: The operational costs are - we didn't consider significant.

MR. WITT: Yeah, I would say just a general overarching plan that we had in mind was that we weren't going to try to make it more - I think something like that in terms of additional security would kind of make it more beneficial than cost more. the costs would go up.

So, what we are trying to do is we were not really considering the additional things like, for instance, the risks - additional risks associated with

1 expedited transfer in terms of loading more casks than
2 a plant would normally - we didn't include those risks
3 in our study to try to maximize the benefits that you
4 would get out of the expedited transfer.
5 And so, for something like the security
6 associated with expedited transfer, I think it was a
7 conscious decision to not add that in to try to see
8 whether the benefits would still surpass the costs.
9 MEMBER REMPE: Okay.
10 CHAIRMAN ARMIJO: You're going to talk about
11 your cost-benefit analysis later, right?
12 MR. WITT: Correct.
13 CHAIRMAN ARMIJO: Okay. I'll wait for it.
14 MR. WITT: Okay. This slide talks about the
15 process that we followed to evaluate this Tier 3 issue.
16 And this was a direct result of the ACRS meeting last
17 time where we kind of didn't really clearly lay out the
18 process that we followed.
19 So, what we did was we reformatted the
20 enclosure to the paper that we sent up to the Commission
21 to talk some more about the steps that we went through.
22 And this slide goes through those steps that we
23 followed.
24 The first step, and that's in Chapter 3 of
25 the enclosures, the safety goal screening evaluation,

1 and this is the step that we took a look at what the
2 safety benefit would be in terms of - what the difference
3 in safety would be from an expedited transfer to the
4 regulatory baseline.
5 And we compared that to the safety goal
6 policy statement or really the quantitative health
7 objectives, which are a surrogate of the safety goal
8 policy statement, to see whether it would pass the
9 threshold for pursuing or for getting to additional
10 analysis for potential regulatory action.
11 So, following that evaluation we did the
12 cost-benefit analysis. And really, the point here was
13 that even though the normal process would tell us to
14 stop if it doesn't pass the safety goal screening
15 criteria, we went ahead and did the cost-benefit to
16 provide that information to the Commission for their
17 consideration.
18 So, it's really additional information for
19 the Commission to consider in their discussions on this
20 issue.
21 MEMBER RAY: Well, let me just say at that
22 point, as John knows a great deal about seismic analysis,
23 I know a little bit about cost-benefit, and I don't
24 understand how - although I understand your goal was
25 to maximize the benefits as compared to the cost, on

1 the other hand, some reasonable estimate of the cost
2 needs to be assumed.
3 And how you did that for an environment
4 that's quite changed with regard to cost such as
5 acquisition of a lot of additional casks, how on earth
6 you could do that is beyond me.
7 So, if the answer simply is, well, we
8 assumed the existing cost of casks would continue even
9 though we doubled the - tripled, quadrupled the demand
10 for casks, if that's as far as it goes, then say that
11 at the appropriate point.
12 If on the other hand you made some
13 assumption about how the increased demand would affect
14 cost, make that more clear, because I can't find it.
15 MR. WITT: Well, we really didn't do a lot
16 of analysis - a new analysis in this study. We tried
17 to grab information from whatever sources we could find.
18 And for the costs that you're talking about
19 in terms of the casks and that type of thing, most of
20 that came from an EPRI report that was completed just
21 recently on expedited transfer.
22 MEMBER RAY: And it did assume a higher cost
23 as a result of increased demand?
24 MR. WITT: No.
25 MEMBER RAY: Okay. Because that - it may

1 be incidental to what you're doing, but it is an area
2 that I presume there will be some debate about
3 subsequently. And I just want to get clear as I can
4 whether or not there was any assumption made about how
5 costs would be affected by the change in the rate at
6 which this transfer would have to occur.
7 CHAIRMAN ARMIJO: Harold, Fred is - I haven't
8 read the EPRI report. Fred, I'm sure, has. Maybe you
9 could when we get to that point, you can just tell us,
10 you know, what assumptions they made and how the, you
11 know, cask cost goes up if you have to buy -
12 MEMBER RAY: Well, he just gave a very good
13 answer. The kind that we like. The answer was no.
14 (Laughter.)
15 CHAIRMAN ARMIJO: I thought he said yes, that
16 EPRI did take that into account.
17 MR. SCHOFER: No.
18 MEMBER RAY: No.
19 CHAIRMAN ARMIJO: He did not, okay. Well,
20 that clears that up.
21 (Laughter.)
22 CHAIRMAN ARMIJO: Then they should.
23 Somebody should.
24 MEMBER RAY: Well, I just - I don't want to
25 get into a debate about it now. I just want to get

1 clarity around it, because I couldn't figure it out.

2 CHAIRMAN ARMIJO: Okay. I'm glad that in

3 the rewrite that you put more emphasis on the safety

4 goal screening, because that's the fundamental reason

5 we're here and that's safety.

6 And I would appreciate if you would expand

7 on that. And once we're satisfied that we've really

8 got that nailed down, then we can go into the regulatory

9 analysis.

10 MR. WITT: Sure, yeah. Well, that's on the

11 next slide, but, I mean, really when it comes down to

12 it, the safety goal, the chapter that we talked about,

13 the screening, is only a few pages. And the

14 cost-benefit is -

15 CHAIRMAN ARMIJO: Well, that was a problem.

16 That was a problem. And if the decision basis really

17 is safety, then we needed to expand on that and

18 understand that.

19 And certainly the public needs to

20 understand that because, you know, it's easy to say,

21 gee, the problem is where they put all these hundreds

22 and hundreds of pages and that's where we should

23 concentrate our concerns.

24 Whereas the thing that really is - if you

25 have a safety goal and you meet that goal with margin,

1 then that should be clear to everyone.

2 And that's not saying that the regulatory

3 analysis is meaningless, but it just says it's

4 supplemental as opposed to the primary basis for the

5 decision.

6 MR. WITT: Exactly.

7 CHAIRMAN ARMIJO: Okay.

8 MEMBER RAY: But we can't tell how the

9 Commission will make a decision.

10 CHAIRMAN ARMIJO: No, no.

11 MEMBER RAY: They may rely on the

12 supplemental information and -

13 CHAIRMAN ARMIJO: They may, or they may not,

14 Harold. But I think that the main thing is that safety

15 goal screening isn't just a given. It was work and it's

16 quantitative rather than purely qualitative. And

17 there's an awful lot of qualitative stuff in the

18 regulatory analysis that concerns me.

19 MR. WITT: Yeah. And in addition to that

20 cost-benefit analysis we did add in - well, it was in

21 there previously, but there were sensitivity studies

22 done on that analysis.

23 And some of those factors include the dollar

24 per person-rem conversion factor and consequences

25 beyond 50 miles. So, there's a whole section on those

1 sensitivities that we can go through.

2 CHAIRMAN ARMIJO: Yeah.

3 MEMBER SKILLMAN: Let me ask a question here.

4 It's kind of - it's not seismic like John or finances

5 like Harold.

6 Have you guys ever handled fuel? Have you

7 ever picked them up, fuel assemblies, put them down,

8 tried to put them in a cask, move the cask around and

9 messed with an upender or moving the racks around to

10 make sure that the trolley and bridge are functioning

11 accurately?

12 Have you ever done that work?

13 MR. WITT: I've observed it through

14 inspections.

15 MEMBER SKILLMAN: Here's why I ask. I

16 recognize Phase 2 is the piece of this work that would

17 draw in that activity, but what I got a feel is absent

18 here is the recognition of what the plant staff needs

19 to do to achieve a different loading pattern and

20 particularly offload to a lighter thermal hydraulic

21 pattern, however you define that. Those activities are

22 not without physical risk, radiological risk.

23 I'm sure the operators would say, we're

24 macho, we can handle this. And they do a very good job,

25 but occasionally something goes wrong and those risks

1 can be significant. You can droop a fuel assembly, ruin
2 your handling equipment.
3 It just seems to me that what's missing in
4 this is, if you will, that practical understanding that
5 this is not free to the industry.
6 If one were to say, you know, it's a really
7 good idea to go ahead and lighten the footprint of the
8 fuel in addition to the cask issue that Harold
9 appropriately raises, there is a lot of work that these
10 plant operators have to do and it's masked here.
11 So, I'm just wondering is there a way to
12 embed at least a token flag that says we recognize that
13 this is not free? This is going to cost big time.
14 And if you've been near those pools, if
15 you've watched that activity, if you've done it
16 yourself, there's a recognition. This is hard work,
17 and it's work that takes a huge amount of safety focus.
18 And it takes an army of people to do it.
19 It takes your operators, RADCON, security.
20 If you're going to put this stuff in the cask or a truck,
21 you have another vary of security that now comes into
22 play.
23 It just seems that that piece that
24 recognizes the industry burden isn't fully recognized.
25 And if we say, well, we'll just do that in Phase 2,

1 we might not serve the Commissioners best by advising
2 them, hey, this is not free.
3 The people that run these plants are really
4 going to be put to the test if we go this way. So, I'd
5 ask you to consider that.
6 MEMBER SCHULTZ: And, Dick, I know that
7 you're considering this in that comment, but what we
8 are asking for expedited transfer, we would be asking
9 staff at the plants to be performing this task over a
10 concentrated period of time, but that concentrated
11 period of time is a long time.
12 In other words, this is not happening
13 overnight. It's going to be happening over --
14 MEMBER SKILLMAN: Five years.
15 MEMBER SCHULTZ: A few years. Five year's
16 assumption. This is diverting the attention of the
17 operations, the maintenance, the engineering staff of
18 the plant away from other things that they would normally
19 be doing.
20 That's also an impact on plant safety and
21 it can be evaluated directly with processes that we have
22 for looking at the way plants operate and the way
23 diversion of activity to a project like this could affect
24 overall plant safety.
25 So, I know there's an argument that says,

1 well, we're going to have to do this anyway over time.
2 You're going to have to unload the fuel, the casks or
3 to ultimate storage over time.
4 We're not asking you to do anything
5 differently. It's just unloading the pool, but doing
6 it in a concentrated fashion over a three to five-year
7 period is going to divert that attention and it will
8 have an impact on plant safety. It can be quantified.
9 MR. WITT: Yeah, another thing that I would
10 add in, too, and I was just looking to see where we talk
11 about this, I'm not sure if - we did indeed include a
12 discussion about the additional risks associated with
13 the movement - or more movement of the fuel in the spent
14 fuel pools.
15 Another thing we added in there was the
16 uncertainty of the final disposal of these canisters,
17 these casks. There's really no guarantee that if the
18 licensees put the fuel into these casks at this point,
19 that they won't have to repackage them at a later date.
20 MEMBER SKILLMAN: Again, yeah.
21 MR. WITT: And so, that's another factor
22 that I think the Commission has to consider on this issue
23 is do you want licensees to start doing this right now
24 when they may have - when a final disposal strategy
25 hasn't been set yet?

1 And so, we do have a little bit of a
2 discussion. The only problem was that you can't really
3 quantify this stuff. We didn't have the information
4 available to add in those risks associated with the
5 expedited movement.
6 So, I think if we were to do more work, if
7 this did show indeed that there may be a potential
8 benefit to doing this, then we would look at those
9 additional risks and uncertainty associated with the
10 final disposal.
11 MEMBER SKILLMAN: My point is that the burden
12 is placed on the operators and may not be fully
13 appreciated unless it's flagged so the Commissioners
14 say, hey, this is not free. If we move in this direction,
15 we're really relying heavy on the people that operate
16 these plants.
17 And like Dr. Schultz says, it's a diversion
18 of other - of resources to what could be a very slim
19 increase in safety, very huge risk in moving all of this
20 equipment, because it's complicated. Thank you.
21 MR. SCHOFER: This is Fred Schofer.
22 With regard to your comments, there was a
23 recognition that having these huge loading campaigns
24 would be a diversion and is complicated and does take
25 a lot of focus.

1 That was one of the reasons that in the paper
2 it was a five-year campaign to achieve that lower density
3 configuration recognizing that you can't do it much
4 faster than that.
5 With regard to, you know, there is no - I
6 would say there may not be, you know, sufficient other
7 consideration-type comments that would qualitatively
8 indicate, you know, the points that you're making, but
9 they were thought about when I redid the analysis.
10 CHAIRMAN ARMIJO: Well, you know, I would
11 expect a lot of these points should have been brought
12 up by the industry comments. And if they weren't
13 brought up, shame on them for missing the opportunity,
14 because they're the ones who know very well what they
15 would have to do.
16 And we, you know, our members have a lot
17 of experience as well and we're pointing out some of
18 the things we thought about. But as far as a systematic
19 compilation of all the qualitative as well as
20 quantitative concerns, should be put in some slides or
21 package or something so they aren't just buried here
22 and there throughout the report, because it's a
23 non-trivial exercise.
24 I've worried, you know, I'm just - don't
25 want to spend too much time on this. How many casks

1 would you need if you went through such an operation
2 on an annual basis, and is there a capacity with licensed
3 US casks to meet that need?
4 Would you have to be licensing casks from,
5 let's say, France or Germany or Japan or Korea? And
6 that would add cost and that would add uncertainty in
7 order to meet our arbitrary goal.
8 You said five years. Maybe it would turn
9 out to be ten years. Who knows? But somewhere in there
10 has got to be some little package that says, okay, here's
11 the alternative. It isn't perfect either. It's got
12 some real problems and it better have some really big
13 benefits before we enter into this exercise.
14 And I know you've got it throughout your
15 report, but I just have a hard time getting it all put
16 together.
17 MR. WITT: Okay. I'll go ahead and turn it
18 over to Steve now to talk about the safety goal
19 screening.
20 MR. JONES: Good morning, I'm Steve Jones
21 in the Office of Nuclear Reactor Regulation, Division
22 of Safety Systems. I'd just like to go over the safety
23 goal screening, and also the regulatory analysis.
24 To start with the safety goal screening,
25 we looked at the highest frequency derived from all the

1 different plant groupings and considering, in this case,
2 the highest estimate for the frequency which turned out
3 to be 3.46 times ten to the minus five per year. And
4 that considers, really, the Sequoyah site seismic hazard
5 curve and all the other contributing events.
6 Then we relied largely on the spent fuel
7 pool study which evaluated several bins of releases
8 consisting of cesium and short-term isotopes such as
9 iodine.
10 For the large release - excuse me - that
11 study determined a condition of probability of 4.4 times
12 10 to the minus four per release of a latent cancer
13 fatality risk to an individual within ten miles of the
14 plant site.
15 That number was relatively insensitive to
16 the magnitude of the release, however. So, because the
17 linear no-threshold model was used and protective
18 actions were assumed to be implemented. So, any release
19 that caused the type of actions to be implemented would,
20 you know, result in people being relocated and,
21 therefore, avoid additional dose.
22 Okay. With those considerations,
23 determined a calculated latent cancer fatality risk of
24 one in 66 million per year. And that's less than one
25 percent of the individual risk goal, which is based on

1 a routine probability of two cases per thousand people
2 per year. And then taking one-tenth of one percent of
3 that gives you two in a million per year.
4 MEMBER RYAN: Steve, are you going to do any
5 comparisons to actual cancer incidents? The average
6 latent cancer in the US is one in four to one in three.
7 So, it's striking against one in 66 million.
8 MR. JONES: Well -
9 MEMBER RYAN: It's an extremely low cancer
10 rate for -
11 MR. JONES: Right.
12 MEMBER RYAN: - an activity compared to the
13 background cancer rate. So, I don't know how you make
14 any sense out of that.
15 MR. JONES: Well, this is just not cancer,
16 but cancer progressing to a fatality within one year.
17 And then we're comparing it against the two in a million
18 or - which I guess in the same terms would be one in
19 500,000 per year is the goal. And that's one-tenth of
20 one percent of -
21 MEMBER RYAN: I guess what I'm trying to
22 address is that if you have very low cancer incidents
23 from something related to the activities we're talking
24 about, it would be impossible to distinguish that as
25 being caused by the activity of being a normal cancer

1 in the population from all other causes.

2 MR. JONES: That's true.

3 MEMBER RYAN: So, I'm kind of wondering what

4 we do with this. Do we interpret it to make judgments

5 and decisions on right and wrong?

6 MR. JONES: I guess we use this predominantly

7 as a screening. Right now the regulatory analysis

8 guidelines are more formatted to address reactor

9 accidents and focus on core damage frequency and large

10 early release frequencies.

11 MEMBER RYAN: Right.

12 MR. JONES: This, because it's a spent fuel

13 pool, the release is a different character, different

14 isotopes.

15 MEMBER RYAN: It relies not broadly on the

16 wind and all that.

17 MR. JONES: Well, there's certainly a

18 potential for it to go over long distances and affect

19 large areas, but it does not have the same risk of

20 immediate health effects on a population.

21 So, we're looking basically in a sense of

22 magnitude. If it was like ten percent of our goal, that

23 would definitely lead us to look closely at a

24 cost-benefit analysis.

25 When we're far less than one percent, it's

1 hard to make an argument that any action will be
2 substantially impact the health and safety of the
3 public.
4 MEMBER RYAN: To stress that kind of, you
5 know, decision-making as what you're driving at as
6 opposed to managing, you know, the risk of cancer from
7 some exposure, because you're using that as a metric
8 to something else.
9 MR. JONES: Right.
10 MEMBER RYAN: I'd put that in bold letters
11 somewhere so it doesn't get confused with the other kinds
12 of uses of that sort of parameter.
13 Does that make sense to you?
14 MR. JONES: I understand.
15 MEMBER RYAN: I can just see an awful lot
16 of confusion in trying to explain this versus that kind
17 of discussions with lots of different constituencies.
18 It might be hard to get it across. So, it's probably
19 best to try and get it explained right up front.
20 MR. JONES: Right. Okay.
21 CHAIRMAN ARMIJO: Kathy.
22 MS. GIBSON: Kathy Gibson. This is on
23 research. I just wanted to remind you that in the spent
24 fuel study we did look at some thresholds in addition
25 to the linear no-threshold. And one of those was

1 subtracting out the background radiation.

2 And of course any of the thresholds that

3 you use other than linear no-threshold just makes your

4 numbers lower. So, that is in the spent fuel study if

5 you wanted to see the difference that it makes if you

6 take the background into consideration.

7 MEMBER RYAN: No, I appreciate that, but I

8 think it very quickly dwarfs - background dwarfs any

9 of the 9:21:43 probability low-dose events.

10 So, there are different ways to handle it,

11 treat it, discus it. And I just think we ought to think

12 about the audience looking at different kinds of risks

13 from, you know, radiation exposures like releases, like,

14 you know, spent fuel accidents and make sure that we

15 don't confuse it more than we do help explain it.

16 CHAIRMAN ARMIJO: Well, most of this, the

17 dose that you're talking about, is from people returning

18 to a contaminated -

19 MEMBER RYAN: That's correct.

20 CHAIRMAN ARMIJO: - property.

21 MEMBER RYAN: Right.

22 CHAIRMAN ARMIJO: And so, yet, they can't

23 return unless they meet the habitability criteria.

24 MEMBER RYAN: Correct.

25 CHAIRMAN ARMIJO: Which from my point of

1 view, is effectively a threshold that says as far as
2 the NRC and EPA or whoever else controls this, they have
3 set a threshold, come back and live here indefinitely.
4 Yet, then we turn that okay situation into
5 a cancer risk calculation, which I would say, you know,
6 doesn't make a lot of sense.
7 If you think there's a real cancer risk and
8 you believe those numbers, you'd never - you might say
9 don't come back.
10 MEMBER RYAN: I think -
11 CHAIRMAN ARMIJO: Yeah, I think there is a
12 threshold built into the habitability criteria that is
13 not recognized in these calculations.
14 MEMBER RYAN: But the cancer risks that the
15 US population faces, a broad scope, to me, the way to
16 address it is to put that risk in context with other
17 risks, which are people are immune to any kind of
18 consideration that those risks are unacceptable such
19 as smoking.
20 CHAIRMAN ARMIJO: Well, I think we're in
21 agreement. I just have, you know, there's a lot of -
22 lot of concern when anybody challenges LNT as being
23 meaningful at very low doses.
24 And yet, regulators set habitability
25 criteria that, in fact, recognize there are safe levels

1 of radiation over and above background. Tiny, tiny
2 amounts are okay.
3 And yet, we don't - we still calculate
4 latent cancer fatalities based on doses that we allow
5 people to take.
6 Okay. That's confusing to me and it just
7 seems like - and it confuses the public, I'd like to
8 tell you. They say, well, is it safe, or isn't it safe?
9 You guys are saying there's this much cancer
10 fatality risk if we come back. Gee, that's terrible.
11 Why - so, you've got a communication problem.
12 MEMBER RYAN: You know, years ago I remember
13 a paper. I guess it was Bernie Cohen that wrote the
14 Catalog of Risks. Something along those lines. That
15 wasn't a bad attempt at the kind of structural, you know,
16 how risk plays out that might be helpful, but I think
17 that's what I'm struggling to understand.
18 And I think, Sam, that's kind of the same
19 thing you're looking at.
20 CHAIRMAN ARMIJO: Yeah.
21 MEMBER RYAN: How do you take one risk in
22 one situation and compare it to another risk in a
23 completely different situation? It's tough.
24 MEMBER STETKAR: You may want to be careful.
25 Watch 1400 tried to do this comparison of imposed risk,

1 if you will, with routinely accepted risk and daily -
2 and they were criticized wildly for that comparison,
3 you know.
4 So, the notion of comparing the cancer risk
5 from a fuel pool accident to the normal incidence of
6 cancer in the American population, one to three, one
7 to four or whatever it is, has not gone over very well.
8 On the other hand, the types of arguments
9 that Dr. Armijo is making, which is strictly limited
10 to this particular issue, repopulating an area under
11 acceptance criteria that are imposed for repopulating
12 for this, is, I think, a very useful type of discussion.
13 Because that divorces it from, you know, is it one in
14 three, one in four from all sources, you know, automobile
15 accidents and all that kind of stuff in terms of plant
16 fatalities.
17 And it really does focus on this notion of
18 what is a regulatory, whether it's state, federal,
19 acceptable level of risk from inhabiting - permanently
20 reinhabiting that area.
21 MS. GIBSON: Well, we have to be a little
22 careful, because it's actually the individual states
23 and local governments that make the decision on the
24 return criteria. And it's different from state to
25 state.

1 MEMBER STETKAR: Obviously there's
2 uncertainty.
3 MS. GIBSON: It's tough to get out and say
4 below this, you're safe, and above that it's -
5 MEMBER RYAN: And that compounds the problem
6 trying to explain it. Well, why across the state line
7 is it higher or lower?
8 MS. GIBSON: Which is why the linear
9 no-threshold serves our regulatory purpose, because
10 it's conservative.
11 CHAIRMAN ARMIJO: But it frightens the hell
12 out of people, I'll tell you. I talk to lots of groups
13 of people and there is a belief as long as the NRC says,
14 that no level of radiation exposure is safe no matter
15 how small.
16 By using the LNT, you voice that thought
17 in the mind of people and, in fact, it is not correct,
18 you know.
19 There is a safe level of radiation. What
20 it is, people can argue about, but, you know, there's
21 no such thing that, you know, so, there is a real problem
22 here and we keep telling people it's safe, but it's not
23 safe by the rules we use.
24 And we're going to be arguing about this
25 forever if we don't - if somebody doesn't step up to

1 the bar and says, hey, there's a level from a regulatory
2 point of view that it is safe to come back, here's the
3 numbers. At this level, we believe there's plenty of
4 margin there. And other states may have for political
5 reasons different thresholds, but there is a threshold.
6 And somewhere along the line that - because,
7 you know, otherwise you're left with this thing saying,
8 you know, we're letting you come back to an unsafe region
9 and - but it's safe, or it's not safe, you know. It's
10 very confusing.
11 MR. RECKLEY: This is Bill Reckley with NRR.
12 And just to acknowledge that that might be
13 a policy issue, but giving it back to what we were tasked
14 to do in this particular thing, you know, we're really
15 asking the Commission to make a decision if this issue
16 warrants additional study and we'll do research to do
17 investigations of added costs, added risks. And if
18 we were tasked to do, incorporate other policy issues
19 within that like LNT, but the bottom line when you look
20 through what we've done to date would be with those
21 conservatives in place using LNT without revisiting the
22 conservatisms in here and in that, ignoring the risks
23 of the transfer, ignoring any additional cost.
24 The staff's conclusion is, we don't need
25 to study this anymore. If we were to do more studies,

1 spend more time, more FTE, more dollars to get better
2 data, it is only going to reach the same conclusion,
3 in our view, that in the end we would be saying we don't
4 need a rule to require expedited transfer of spent fuel.
5 So, we acknowledge all of these
6 discussions, but we were really tasked to ask the
7 Commission to make a simple decision, A or B. And we
8 only went as far as we thought we needed to go in order
9 to support that decision.
10 And as Steve's going to get into as he starts
11 going through the assumptions, we made some
12 conservative, we made some out of convenience, but the
13 bottom line is in the end, in total, they're going to
14 support the recommendation we made to the Commission.
15 CHAIRMAN ARMIJO: Well, you know, we're all
16 engineers and we understand that, Bill. And we
17 understand these charts and we can interpret them in
18 a way that among ourselves we understand them. But,
19 you know, there's also the general public out there who
20 doesn't understand this thinking and the number can
21 really be misused.
22 So, even though your conclusion may be
23 right, the degree of conservatism that is in this
24 analysis, I see it, and maybe other people see it, but
25 I'm not sure that the general public sees it. So,

1 that's really our - part of our point.

2 The other thing is, and we'll get later in

3 this when we get into the assumptions, some of the

4 assumptions are trying to maximize a benefit of the

5 alternative, our really extremes. And we want - at

6 least a couple of us want to challenge the models. So,

7 let's move on.

8 MR. JONES: Okay. This slide goes over the

9 safety goal screening results. I've talked a lot about

10 this already, but no risk of fatalities due to the nature

11 of release. And the potential benefit is a very small

12 fraction of the latent cancer fatality goal.

13 Also, the risk was in, like I said,

14 insensitive to the magnitude of release. Events in the

15 spent fuel pool evolve relatively slowly and protective

16 actions would be effective.

17 We decided to proceed to the cost-benefit

18 analysis even though the process allows us to stop here

19 due to the margin from the quantitative health

20 objectives.

21 And next slide, please. Okay. Just real

22 quickly we talked about the cost-benefit analysis

23 before, but the other thing I have just one

24 alternative-expedited transfer. And we wrote looking

25 at that, basically to provide a maximum measure of the

1 benefit that could result from this action and
2 transferring - the alternative would involve transfer
3 of fuel with more than five years decay to dry casks
4 and store the remaining fuel in a low-density
5 configuration in existing racks. That would be the
6 hottest assemblies would be surrounded by four empty
7 slots on each face.
8 And then the baseline would be having fuel,
9 hot fuel surrounded by four colder assemblies on each
10 face.
11 The analysis is conducted for four groups
12 although seven groups were initially, you know,
13 determined. Seven groups based on the risk. Three
14 groups were not evaluated. And the four groups
15 representing the operating plants and one group for new
16 plants were evaluated.
17 Major assumptions, we separated it out in
18 a new table in Regulatory Analysis Table 2. And it
19 discusses, I believe, the assumptions and basis for
20 those assumptions.
21 The initiating event frequencies and
22 accident progressions is one section of that. And then
23 economic modeling, the costs and the benefits of
24 reverted dose, and also the timing of the cask transfer
25 or fuel transfer to dry casks.

1 MEMBER REMPE: I was afraid you were going
2 to leave the slide. On Table 2, I really liked it because
3 it does lay out the assumptions. But when I started
4 going from the assumptions listed in Table 2, for
5 example, like the liner fragility and then I started
6 looking other places in the report like Table 39, I found
7 it inconsistent.
8 Was that a typo, for example? Because when
9 I look at that like Group 1 -
10 MEMBER STETKAR: Go to your backup slide
11 number - Page 35 in the backup slides. That will
12 highlight - I'm sorry, 34.
13 MEMBER REMPE: Yeah.
14 MEMBER STETKAR: Those liner fragilities are
15 not what we used in the study.
16 MEMBER REMPE: Please say that, because it's
17 not listed in -
18 MEMBER STETKAR: I understand that. They
19 are not what they -
20 (Simultaneous speaking.)
21 MEMBER REMPE: And so, yeah, that was one
22 thing. And then this factor of 19 and when I compared
23 it, you only invoked it, I guess, for the low-density
24 cases and not the high-density.
25 MR. JONES: That's right.

1 MEMBER REMPE: So, there are a lot of
2 assumptions you made that either might be inconsistent
3 with things later in the report or the logic for invoking
4 those assumptions didn't seem very clear to me. And
5 I don't know when the best time to discuss this is.
6 MEMBER STETKAR: I think this is our only
7 shot at it.
8 (Simultaneous speaking.)
9 CHAIRMAN ARMIJO: Well, you know, I think
10 it would be very good to go through the assumptions by
11 table.
12 MEMBER REMPE: Uh-huh.
13 CHAIRMAN ARMIJO: Because, you know, I think
14 they are really important. And I know I had a lot of
15 questions that I was going to raise as we went along,
16 but it might be useful for the staff to go through the
17 assumptions one by one and give us the opportunity to
18 raise our concerns in one shot rather than -
19 MR. JONES: Okay.
20 CHAIRMAN ARMIJO: And I'll look up all my
21 comments and - but just go ahead, Steve, and we'll just
22 -
23 MR. JONES: I think on Slide 15 we'll get
24 to the - well, I'd like to progress through them, I guess,
25 until we get there.

1 CHAIRMAN ARMIJO: When we get there.

2 MR. JONES: We did establish a base case and
3 perform sensitivity studies around that. Then Slide
4 11. Okay. Thank you.

5 Okay. So, what we did at first to establish
6 the maximum benefit is really look at how we could
7 separate the low-density and high-density cases. And
8 that centered really on the release fractions we assumed
9 which came, to a large extent, from the spent fuel pool
10 study and the previous studies and the effectiveness
11 of mitigation.

12 And there are some issues, really, frankly,
13 with the implementation of mitigation and the
14 uncertainty that's involved in determining that
15 likelihood.

16 So, for the regulatory baseline we used high
17 cesium release fractions for this. For the BWRs for
18 the elevated pools, we relied on the spent fuel pool
19 study which had values of approximately 40 percent for
20 those releases in the high-density cases on mitigated.

21 And then for the remainder or the balance
22 of the plants where the pool is at-grade and we're less
23 certain of leak locations and things like that, we used
24 the value from NUREG-1738, a 75 percent release
25 fraction, and assumed ineffective mitigation.

1 That means that once the fuel heats up,
2 we're assuming that it progresses to a large release.
3 And that basically results in what we considered a
4 conservative outcome for the high-density case.
5 If we assumed full effective mitigation in
6 this case, you would result with a very small delta
7 between the two events, because essentially all cases
8 would be mitigated. There would be no release.
9 CHAIRMAN ARMIJO: But cesium isn't that
10 really, you know, this came up, you know, Bill Shack
11 isn't here, but he's our consultant on this thing. He
12 couldn't attend the meeting or be on the bridge line,
13 but he did send me his notes.
14 And the issue of assigning effective
15 mitigation only to the alternative and not to the base
16 case is, you know, his words were just plain wrong.
17 It's not conservative.
18 And his argument was that as for the pumps
19 whether it has a light loading or heavy loading in the
20 pool, the pumps still work.
21 Access to the ability to - to the equipment
22 to cool and measure and things like that is not affected
23 by the loading particularly with the new equipment that
24 the orders have imposed.
25 So, you know, it's either both of them have

1 effective mitigation, or both of them don't have
2 effective mitigation to present really a fair picture
3 of the benefits.
4 So, you know, either we're both - so,
5 that's, I think, a major, major thing. You can't just
6 - in trying to not undervalue the Alternative 2, you
7 can go overboard by giving it so many advantages and
8 depriving the base case advantage that are really there
9 that you just - you wind up creating a false impression
10 that the Alternative 2 is such a good thing at least
11 in some of the cases you analyze.
12 And then you say, well, that being the -
13 despite that, we don't think it's a good idea. So, you
14 know, somewhere along the line you've got to bring it
15 into - a little bit into balance especially in the high
16 cases and in the sensitivity studies.
17 If you look at the sensitivity studies and
18 the high cases, it seems like a slam dunk. You ought
19 to go and expedite fuel transfer. And yet, and I know
20 that's not what you believe is the right thing to do,
21 but somewhere along the line - I won't use the words
22 "painted yourself into a corner," but something like
23 that has happened that you've got a very difficult
24 explanation to make of how can you calculate these very
25 large benefits granted for sensitivity studies, but

1 still then say we don't want to do it. We don't think
2 it's worth pursuing.
3 So, that's kind of the heart of many of my
4 concerns. And this mitigation has got to be treated
5 a little equitably between the two cases. I just don't
6 think there's any justification, and I share Bill's
7 views on that, that there's any justification for having
8 just one alternative get the effective mitigation and
9 not the other.
10 MEMBER SCHULTZ: So, you're nodding your
11 heads as Sam went through his discussion related to
12 mitigation.
13 I just wanted to get on the record were there
14 engineering or analysis or operational rationale that
15 were identified that would have differentiated the
16 alternatives with regard to mitigation?
17 Because all I saw in the documentation both
18 now and what we have seen over the last several months
19 is that it, in fact, is an assumption in order to maximize
20 the benefit of going to the alternative of low-density
21 loading.
22 MR. JONES: Right.
23 MEMBER SCHULTZ: And I just want to emphasize
24 what Sam has said. To put that into a document and say
25 we are not going to credit mitigation for a case, for

1 the current case, but we will credit mitigation for the
2 case where we have low loading, can be read by anyone
3 to say that we believe that mitigation is not possible
4 for the current case, but it is possible for a
5 low-density loading, which is not the intent.
6 The intent is to say we have some
7 uncertainties in the evaluation where we have - we want
8 to credit the case of low-density loading in a fashion
9 to maximize the benefit. And, therefore, we're going
10 to incorporate a factor of 20 and see what happens.
11 But to attach it to an engineering rationale
12 that says, okay, say there is no mitigation possible,
13 for Case B there is large mitigation possible, it
14 presents the wrong impression, the wrong rationale, the
15 wrong reason for the difference.
16 And I think the same is somewhat true, at
17 least, for the assumptions that were used with regard
18 to the cesium release fractions.
19 Because you use - we'll use the high one
20 for this, we'll use the low one for this and there was
21 a difference, but one does not - one cannot attach that,
22 really, to high-density loading and low-density loading
23 in such a direct way as was done here.
24 There's also the rationale that we're doing
25 it because we want to maximize the difference that we

will see. And when we're all said and done, we will see that we still don't justify doing further study.

That's all well and good, but to present it as an engineering rationale that Case 1 is different than Case 2 in a real practical engineering and analysis way, presents the wrong information to scientists, as well as the public.

Some scientists are in the public. I don't -

(Laughter.)

MEMBER STETKAR: I'm just saying that the reader of the document can be misled.

MR. JONES: I guess I'd have to say that the mitigation is really turning out to be somewhat more of a distraction than a help, because really the dominant impact is the release fractions. That the assumptions that go into driving those using the highest case from the spent fuel pool study and using 75 percent from NUREG-1738 give you, you know, 30 to 50 times more, I guess, consequences, greater consequences from the baseline or high-density case than from the low-density case.

The additional factor of including mitigation is relatively small. It's just -

CHAIRMAN ARMIJO: Are you saying, Steve,

1 that even if you'd applied effective mitigation to the
2 high-density case, the release fraction would not have
3 been -
4 MR. JONES: Well, that would go the other
5 way. That would just result in basically no difference
6 or -
7 (Simultaneous speaking.)
8 CHAIRMAN ARMIJO: I think that should be made
9 clear that when you have effective mitigation in either
10 case, there's not much going on.
11 If you have ineffective mitigation in both
12 cases, low-density has an advantage.
13 MEMBER STETKAR: Let me try something. And
14 this follows up on a little bit of what Steve was saying.
15 We tend to talk about effective and
16 ineffective mitigation. And for whatever reason,
17 effective mitigation for this particular study is
18 assigned a 95 percent chance of being perfectly good,
19 and a five percent change of being perfectly bad.
20 CHAIRMAN ARMIJO: Okay.
21 MEMBER STETKAR: And I'm not going to argue
22 about 95 and five percents. What I heard Steve asking
23 and what I think would be very useful rather than saying,
24 well, suppose we assume 95 percent effectiveness for
25 the high-density loading case, you know, you're saying,

1 well, if we did that, there wouldn't be any difference.
2 At least that's what I'm hearing you say.
3 Is there anything, because you guys have
4 studied this a lot and understand it a lot better than
5 I did, that would say, well, there's a rationale to say
6 that we believe that the effectiveness for the
7 high-density case might be less than 95 percent, may
8 be 80 percent because the timing is a lot faster, because
9 I don't know, you know?
10 Don't focus on pumps, because the pump
11 doesn't care. The hose doesn't care. People do care,
12 you know, and that's this whole notion.
13 Is there - if there's no engineering
14 rationale to say that we don't believe high-density
15 loading versus low-density loading would result in a
16 difference, I don't care whether it's 95 percent
17 effectiveness or 50 percent effectiveness, if there's
18 no rationale to say that there would be any difference,
19 then it ought not to be included as a variable parameter.
20 If there is a rationale to say that there
21 would be a difference, that rationale ought to be
22 presented and perhaps you ought to take a shot at what
23 the difference might be.
24 CHAIRMAN ARMIJO: Okay.
25 MEMBER REMPE: Also -

1 MEMBER STETKAR: And if it's true that the
2 mitigation doesn't make a difference to the overall
3 conclusion, why are we having this discussion, you know?
4 Why is it given the prominence in the report that it
5 is getting?
6 CHAIRMAN ARMIJO: Well, I think it's given
7 prominence, because that's exactly what we want to do.
8 We want to mitigate.
9 MR. JONES: I think at the end of the cesium
10 case, we do rely on that somewhat for defense-in-depth
11 purposes, but we're not using it for the - to evaluate
12 whether we need to refine the cost-benefit analysis,
13 I guess, is the point.
14 CHAIRMAN ARMIJO: You know, I think - I just
15 want to read what Bill sent me, and I think he sent copies
16 to all the members, and relate it to the mitigation.
17 And it basically says it's technically
18 indefensible to just assign zero to one and a hundred
19 percent to the other.
20 So, his arguments are, you know, the pumps
21 either survive the event and are in place and operate,
22 or they don't. None of this is affected by loading
23 density in the spent fuel pool.
24 There may be, John, small differences in
25 time available, but the overall accident sequence is

1 long enough that this would have little affect.

2 And so, you know, basically you're saying,

3 well, if we want to compare the two alternatives, let's

4 do it apples and apples. Both of them get full

5 mitigation whether it's 95 percent or 50 percent, but

6 they both get the same, or they both get zero. And then

7 you can just compare them, but you can't just say, well,

8 we'll cripple this guy, and this guy who's not even

9 wounded, we'll give him help, you know. Something is

10 wrong here.

11 So, I guess maybe we've beat that to death.

12 MEMBER REMPE: Before you leave this slide,

13 though, on the cesium release fractions just is it

14 because you - where there's more certainty is why we

15 used higher values for Groups 2 through whatever, but

16 is there really a physical reason to say that we think

17 that Groups 2 through 4 have a higher release?

18 What is the physical reason? Is it because

19 you just don't have a MELCOR analysis you're not spending

20 a lot of time on it or -

21 MR. JONES: Well, it's predominantly because

22 we're talking about largely PWR fuel and it has higher

23 -

24 MEMBER REMPE: Mark III though.

25 MR. JONES: Yeah, that's true. The Mark III

1 BWRs are in there.

2 MEMBER REMPE: Uh-huh.

3 MR. JONES: They still have a little bit

4 higher power density, The PWRs have a lot higher power

5 density for the fuel.

6 MEMBER REMPE: Right.

7 MR. JONES: The past studies like, for

8 example, NUREG-1353 assumed a factor of four difference

9 between the probability of reaching a high enough

10 temperature in BWR fuel versus PWR fuel to ignite and

11 have a large release.

12 MEMBER REMPE: So, some of that logic it

13 would be helpful if it were included. You don't even

14 have NUREG-1738, I think, included in Table 2 in the

15 comments.

16 And the factor of 19 even is - you've got

17 to dig around in that table and it just seems like this

18 document if it's standing alone, would be helpful if

19 you put a little bit more beef and why you make certain

20 assumptions.

21 MEMBER SCHULTZ: So, I mean, the logic that

22 you just described, though, is it - in the first case

23 you have that the value of 75 percent was used for other

24 groups in the base case. And with the low-density

25 loading, the assumption has been three percent for all

1 groups in the base case.

2 So, it seems as if there are conservative

3 assumptions or biases, I would call them, associated

4 with the assumptions here as well.

5 In other words, the title of the slide is

6 completely right. They are assumptions to maximize the

7 calculated benefit. But, again, I'm concerned that

8 they also lead into conclusions - or could lead to

9 conclusions that there, in fact, is a real difference

10 between having a low-density loading and a high-density

11 loading. It is -

12 MR. JONES: We did have some problems there

13 resolving the release fraction for the low-density case,

14 because there is, I mean, the spent fuel pool studies

15 the first time that that's where we've been examining

16 in detail. So, we only have that three percent data

17 for BWR fuel. We don't have information like how a PWR

18 assembly might perform in the similar low-density

19 configurations.

20 So, and the previous studies are no help

21 at all, really, with respect to that.

22 MEMBER SCHULTZ: Right. But, again, what

23 has been done is to maximize the difference between the

24 two cases.

25 MR. JONES: Right.

1 MEMBER SCHULTZ: And there are rationales
2 going into the documentation both previous and here that
3 we're trying to account for uncertainties and we're
4 trying to maximize the difference.
5 But, again, my concern is that the
6 conclusion will be that there is a real difference
7 between this and, therefore, why are we saying we don't
8 need to do this?
9 It can cause confusion where it seems as
10 if it's based upon real scientific evaluation and
11 analysis, and it's really a result of some assumptions
12 to see whether we should go forward.
13 MR. ESMAILI: This is Hossein Esmaili.
14 There is some rationale to what for the
15 low-density cases we assumed lower release fractions.
16 It's the insight we got from the SFPS.
17 And in the low-density cases, generally we
18 didn't see any hydrogen combustion. So, the building
19 remained intact. And the same thing can be applied,
20 you know, sort of to the PWR that, you know, if you have
21 low-density cases, you are not going to produce a lot
22 of hydrogen, you probably are going to maintain.
23 And if you remember in the NUREG-1353, they
24 assumed a range of release fractions going from 10
25 percent to a hundred percent. At hundred percent meant

1 that it was a high-density case, you know, you have a
2 large release to the environment.
3 A ten percent case was for the case where
4 the building remained, you know, you have a
5 decontamination factor of ten. That means that the
6 building was retaining some of the fission product.
7 So, we are using that, you know, like about
8 ten percent for the case where it's a low-density case
9 that, you know, the building remains intact. So, even
10 though you get releases from the fuel, it's not all going
11 up.
12 These rationale have happened, you know,
13 kind of explained in the report, but, you know, there
14 is a rationale behind, you know, why we - and even the
15 low-density cases we don't see a large variation.
16 And if you remember from the SFPS when we
17 do high-density cases, you have large variations. You
18 can have, you know, a few percentage going all the way
19 to 60, 70 percent.
20 We didn't see these in the low-density
21 cases. So, we are a little bit more comfortable with
22 the type of releases that we are getting from the
23 low-density situation.
24 So, it is consistent with past studies and,
25 you know, insight.

1 MEMBER SCHULTZ: I understand that, but it
2 also, I mean, if you look at the numbers here, what has
3 been selected in order to maximize the calculated
4 benefit for the case of current spent fuel pool loading,
5 or high-density loading, some are not - some reactors
6 are not - fuel pools are not at a higher density loading,
7 but for those - for this study, the assumption is we're
8 going to use to maximize the benefit, the upper range
9 of what has been calculated in the past for cesium
10 release fractions. And then we're going to use the
11 better values that we have calculated for the
12 low-density case.
13 And I just think it can be taken in a wrong
14 fashion if one is reading this study to try to maximize
15 the difference and interpret it that it's a result of,
16 if you will, equivalent engineering analysis and
17 evaluation where, in fact, we are trying to maximize
18 to calculate that. It just needs to be presented very
19 clearly.
20 CHAIRMAN ARMIJO: Okay. Let's move on.
21 MR. JONES: Okay. For the base case
22 analysis, this discusses some of the assumptions we
23 have. And we considered the base cases appropriate for
24 the decision whether to conduct additional studies to
25 refine these numbers, or in some cases that would

1 involve, for example, studies on - in the scope of the
2 spent fuel pool study for other plant types to get a
3 better understanding of, for example, the structural
4 integrity of the pools or to refine the thermal hydraulic
5 response of PWR versus BWR assembly, things like that.
6 But to run through these real quick, the
7 initiating events we have used the USGS 2008 information
8 for the seismic hazard curves.
9 They're not refined. I guess the
10 completion of Generic Issue 199 will probably result
11 in better information for seismic hazard for the central
12 and eastern plants.
13 But we used the Peach Bottom site which was
14 selected, because that is among the highest seismic
15 hazard sites among the central and eastern US sites.
16 And then for other initiators such as
17 station blackout or conditions that lead to a partial
18 loss of cooling and then boiling of the pool, we've used
19 initiating frequencies from NUREG-1738 and NUREG-1353.
20 MEMBER STETKAR: Steve, be really careful
21 about your use of terminology and your sweeping
22 statements in this report.
23 The precision of the sum total of all other
24 initiating event frequencies that can - I've forgotten
25 the words and I won't take the time to look them up -

threaten or disrupt - I think the word is "disrupt" fuel pool cooling of 2.37 times 10 to the minus seven event per year, that's a very precise and very tiny number.

If I look at the frequency for a two-train plant of a complete station blackout, meaning loss of offsite power and destructive failure of any emergency power supply, it is considerably higher than 2.37 times 10 to the minus seven.

So, it's pretty doggone clear to me that that 2.37 times 10 to the minus seven is neither an initiating event frequency -

MR. JONES: Right.

MEMBER STETKAR: - and it is certainly not the cumulative initiating frequency of all initiators that can disrupt spent fuel pool cooling.

MR. JONES: Right.

MEMBER STETKAR: It must include some other assumptions and failures, et cetera. So, it's some surrogate for a large number of other event sequences that you feel have been adequately quantified by some other studies, I think.

MR. JONES: That's correct.

MEMBER STETKAR: Okay.

MR. JONES: It does -

MEMBER STETKAR: It's not an initiating

1 event frequency.

2 MR. JONES: Right.

3 MEMBER STETKAR: Okay.

4 CHAIRMAN ARMIJO: Steve, I have to go back

5 to release fractions again. I want to make sure I

6 understand it.

7 In your assumptions, you've summarized that

8 for spent fuel pool Groups 1, 2, 3 and 4 low-density

9 loading release fractions are 0.5 percent for the low

10 estimate case, three percent for the base case, and five

11 percent for the high estimate. And that is based on

12 a calculation that - or is it based on the assumption

13 that it is 95 percent mitigated or not?

14 So, this says if even unmitigated, release

15 fractions for the low-density case would be this low.

16 MR. JONES: That's correct.

17 CHAIRMAN ARMIJO: Okay. I just wanted to

18 -

19 MR. JONES: And the same for part of the

20 detail about that, but the building integrity plays a

21 large role in the assumed release fraction.

22 MR. ESMAILI: Yeah, this is Hossein Esmaili

23 again.

24 That's what I was saying before that for

25 the low-density cases even unmitigated you have very,

very - even though you have some releases, but because the - this is we are talking about environmental. Because the building for the most part remains intact, you have no releases to the environment.

CHAIRMAN ARMIJO: Right.

MR. ESMAILI: The cases in the high-density case that led to, you know, very high releases was because you had large releases, you have hydrogen explosions, you have - you brought in - if you remember, you brought in air and you lost the building. So, those were the cases that led to about 40 percent, 50 percent releases.

CHAIRMAN ARMIJO: But if you had allowed mitigation to be effective at some level, not zero, that 40 percent would be lower because the probability of getting to a hydrogen --

MR. ESMAILI: Right.

CHAIRMAN ARMIJO: - situation and big fire would be much lower. And the question is, you know, and that isn't even shown in the analysis, right?

You don't show the effect of what mitigation would do. You do in the - probably in the pool study, but you don't here for the high-density case.

MR. JONES: That's correct. We don't have the details to cover the variety of plants.

1 CHAIRMAN ARMIJO: So, the low-density case,
2 the big advantage of that is it doesn't require effective
3 mitigation. That's a legitimate conclusion that I
4 think you can draw to have relatively low release
5 fractions.
6 MR. JONES: Well, one of the big take-aways
7 from the spent fuel pool study is that the frequency
8 of release is essentially identical between low-density
9 and high-density cases.
10 The hot assemblies are - require
11 essentially the same amount of cooling. Very nearly
12 the same amount of cooling. And they will proceed to
13 an oxidation state with - at about the same frequency
14 under the same conditions. So, and mitigation for the
15 same reason, mitigation would be essentially equally
16 effective.
17 Any time mitigation would be deployed if
18 it's effective at deploying spray when spray is
19 required, then you would have no release for the majority
20 of the cases. That's the 19 out of 20.
21 CHAIRMAN ARMIJO: Okay. I just wanted to
22 make sure I understood that. Thank you.
23 MEMBER REMPE: Before you leave Slide 12,
24 a while ago we had a meeting and Dick brought up about
25 the fact that you were assuming Peach Bottom weather

1 for all of these cases, right?

2 MR. JONES: That's right.

3 MEMBER REMPE: And there was a question

4 raised about, well, what would happen if you - I know

5 it's too much work, but is there some weather for

6 particular plants where you actually can see some

7 difference if you went site-specific?

8 And I thought the answer we got from the

9 staff at that time is, we'll get back to you on it.

10 And I don't think we brought it up when we had the last

11 full committee meeting and have you looked at that at

12 all?

13 MR. JONES: Well, it does affect like what

14 populations - particularly when you're looking within

15 50 miles, what population groups might be affected, but

16 there is a sensitivity that addresses changes in

17 population density and the effects. And we'll talk

18 about that a little bit later.

19 When you go beyond 50 miles it's really not

20 so much of an affect, because eventually, you know, you

21 generally will get to a population center that will be

22 impacted by that weather.

23 MEMBER REMPE: Okay.

24 MR. JONES: You're looking at a long-term

25 release. So, there's a lot of wind shifts and things

1 that are -

2 MEMBER SKILLMAN: Well, clearly you used the

3 wind rose for Peach.

4 MR. JONES: Correct.

5 MEMBER SKILLMAN: And you had a prevailing

6 northwesterly that pushes all the isotopes down into

7 Baltimore.

8 If you take the wind rose at Cooper, you

9 probably would have said, golly, there are a lot of

10 cattle that are affected, but not many people.

11 So, the plant and the wind rose are

12 important to the conclusion particularly for the

13 downstream effect for a major event.

14 And so, to hang the conclusion on one plant

15 without wind rose really does maximize the benefit.

16 And as my colleagues have pointed out, you

17 need to be careful how to interpret that, because that

18 wind rose in that particular plant gives a stunning

19 benefit particularly at the increase to the alternative,

20 the dollars per man-rem.

21 So, there's a need just to toggle some of

22 these issues that communicates caution. One can't be

23 too accepting of the conclusions without understanding

24 what they really mean. Thank you.

25 MEMBER STETKAR: Steve, you also used - and

1 I don't know whether we raised this question earlier,
2 because I wasn't at one of the Subcommittee meetings,
3 but you also use the evacuation plans and evacuation
4 time estimates for Peach Bottom in your MACCS 2, right?
5 How would those be - how important are those
6 to the overall results? Let me ask you that. What I'm
7 concerned about is, I know the spent fuel pool scoping
8 study looked a lot - or SOARCA or somebody looked at
9 - everybody has looked at Peach Bottom. Everybody has
10 looked at bridges. Everybody has looked at roadways.
11 Everybody has looked at pathways and things like that
12 for that particular site.
13 We're talking about a really big seismic
14 event here and we're curious about how representative
15 the Peach Bottom evacuation time estimates and
16 evacuation plan is for the infrastructure surrounding
17 all the other sites in the country under this type of
18 very severe seismic event.
19 I know some sites, for example, that have
20 only two directions that you can leave, and one direction
21 might be throwing you over a bridge, for example.
22 But I don't have a sense - I didn't run
23 MACCS. So, I don't have a sense - and I don't have a
24 sense of the timing here of how important that might
25 be, but it definitely correlates with some of the other

1 comments that we've had on meteorology.

2 MR. JONES: Certainly I think the evacuation

3 assumptions would be more important if we were looking

4 at a reactor event like SOARCA was.

5 MEMBER STETKAR: Uh-huh.

6 MR. JONES: For the spent fuel pool study,

7 you do have a very long period of time -

8 MEMBER STETKAR: You're also looking at a

9 doggone big earthquake and something fell down. You're

10 not going to, you know, the Corps of Engineers isn't

11 going to come in and build a pontoon bridge in, you know,

12 a couple of days.

13 MR. JONES: That is another issue that we

14 would have to refine in more detail to proceed with,

15 you know, the next step analysis of this event.

16 But we thought that given the long time for

17 this scenario that using the Peach Bottom information

18 as readily available and thoroughly researched would

19 be a good approach to this screening.

20 MEMBER STETKAR: Well, but "long time" is

21 long compared to a power reactor core damage event, but

22 it's not long in terms of, you know, calendar time.

23 MR. JONES: Right. We're talking on the

24 order of one to two days.

25 MEMBER STETKAR: A couple of - yeah, a couple

of days. That's why I used a couple of days for building a pontoon bridge. It's not like months.

MR. JONES: Right.

MEMBER STETKAR: Okay.

MR. ESMAILI: This is Hossein Esmaili again.

I'm not a MACCS expert. But if you remember from SFPS, we did consider three EP models. And, you know, getting back to your question of how important it is, you know, they did model it and it was not that important precisely because of what Steve was saying that, you know, this is a very, very small event and sensitive to different EP models.

MEMBER STETKAR: But that was still for the - that site.

MR. ESMAILI: That's right. But we did look at, you know, the - yes. So, there is some sensitivity that we have considered.

CHAIRMAN ARMIJO: Okay. Just to let everybody know that I'm going to - somehow we didn't have time for a break in the agenda, but I'm going to shoot for somewhere around 10:30 for a 15-minute break. So, Steve, we'll try and not mess up your presentation.

(Laughter.)

(Discussion off the record.)

MEMBER BALLINGER: I have a question about

1 the line of fragility issue. You're talking about
2 assumptions.
3 MR. JONES: Okay, yes. We do have another
4 slide that gets a little bit more into that detail.
5 MR. WITT: Slide 14.
6 MR. JONES: Yeah, Slides 14 and 15.
7 MR. WITT: If we ever get there.
8 CHAIRMAN ARMIJO: We're on 13?
9 MR. JONES: No, we're not there yet.
10 CHAIRMAN ARMIJO: Okay, sorry.
11 MEMBER BALLINGER: Okay. Neither one of
12 those slides addressed my concerns.
13 MR. JONES: Okay.
14 MEMBER BALLINGER: I was onboarding at the
15 time of the spent fuel pool study. So, I'm sort of in
16 between, but have you guys gone back and looked at the
17 basis for the event that causes a ripping of the liner?
18 Because NUREG-6706, which is the basis -
19 is it - 6706? I actually remembered it. That's not
20 for stainless steel. That whole study was based on
21 carbon steel.
22 The properties of carbon steel are way
23 different than stainless steel. The toughness of
24 stainless steel is much higher than carbon steel.
25 So, we've been talking about releases and

1 all that kind of stuff, but I'm a little bit worried
2 that we're not adequately treating the thing that allows
3 for the release to start with and that a better treatment
4 of that - or not a better, but a more thorough treatment
5 of that might cut the head off of a snake, so to speak,
6 because the liner is so tough compared to the properties,
7 maybe a factor of two, that you were using.
8 So, anyway, it's just a, you know, I don't
9 know because I was in between, out and in on the ACRS,
10 I don't know how that was treated.
11 MR. JONES: Okay. I guess going back to the
12 spent fuel pool study, that event, there was pretty
13 minor, really, relative motion of the wall relative to
14 the floor, but there's enough to cause like I think it
15 was 20 percent of the strain that might normally be
16 associated with failure.
17 And for that reason, the spent fuel pool
18 study used a ten percent overall probability of liner
19 failure. And that was based on using those stainless
20 steel properties in that case.
21 MEMBER BALLINGER: I don't think so.
22 MR. PIRES: This is Jose Pires.
23 We were conservative on the failure strains
24 for the stainless steel, but also at the - when you get
25 to the very large crackings of the wall and you start

1 increasing the flow, you start seeing a very large
2 increase on the displacement.
3 If you keep increasing the load at that
4 stage, the displacements that open the crack would start
5 increasing in a very nonlinear manner.
6 So, if you - yes, it was a conservative
7 assumption on the various strains for the liner, but
8 you was changing those strains very rapidly at those
9 load levels.
10 MEMBER BALLINGER: Yeah, I understand that,
11 but the ductility of stainless steel is twice -- it's
12 -- 40 percent compared to carbon steel of 25 percent
13 or something like that.
14 And so, the whole basis for determining how
15 big this rip is, I just worry that we're not -
16 CHAIRMAN ARMIJO: Well, if, in fact, Ron has
17 it right that the mechanical properties of carbon steel
18 were used to determine the amount of strain, then that's
19 incorrect. It should have been the mechanical
20 properties of stainless steel including the ductility.
21 I missed that point in my view whether it
22 was - because it should have used the mechanical
23 properties of stainless steel.
24 And, Jose, do you know for sure that the
25 liner properties used in your analysis were for

1 stainless steel?

2 MR. PIRES: The greater strains we used on

3 carbon steel versus stainless steel. So, there is a

4 conservative assumption there, but we also have some

5 lack of knowledge on, for instance, not in this

6 particular pool, but in other pools what is the welding.

7 Is there the transition between the liner

8 of the wall to the floor? If there is a welding joint

9 there, that might have been degradation on the welding.

10 Not in the case of this pool. In this pool,

11 the detail was that in a different manner that was

12 better. So, also as I mentioned, you have displacements

13 at those load levels increasing very rapidly.

14 So, even if it is not safe that you get -

15 just a hypothetical number. If you don't get the very

16 large strains, let's say, at the 0.8 g or 0.9 g, you

17 will get that at probably 0.1 -

18 MEMBER BALLINGER: I'll grant you that.

19 It's just a matter of scale though. The same material

20 of steel will perform differently for the same set of

21 displacements than stainless steel.

22 CHAIRMAN ARMIJO: Right.

23 MEMBER STETKAR: The only comment I make is

24 that's certainly a valid concern. It certainly would

25 affect the absolute frequency of failure.

1 It would not affect a comparative analysis
2 here. Because if it fails under the earthquake for high
3 density, it's going to fail under the earthquake for
4 low density.
5 So, although the absolute magnitude of the
6 frequency of failure can be affected by the properties,
7 the difference between high density versus low density
8 for the purpose of this regulatory analysis wouldn't
9 be affected.
10 MEMBER BALLINGER: But I worry about a
11 failure at all.
12 (Simultaneous speaking.)
13 MEMBER STETKAR: At some loading, it will
14 fail.
15 MEMBER BALLINGER: Well, okay. If you
16 explode a nuclear device on the site, you will get
17 failure. You're right.
18 MR. PIRES: Well, as I said - I keep saying
19 that at the load levels where we used that to get the
20 large strains in the liner, those strains change very
21 rapidly with the load level.
22 You want to - at the very - at the region
23 where the stiffness of the bolt has degraded and you
24 have a rapid change on the strain. So, if you did
25 increase the load, but at larger loads, but will still

1 happen.

2 CHAIRMAN ARMIJO: But there is a profound

3 difference between the properties of stainless steel

4 and plain carbon steel. And the stainless steel is

5 tougher. It will work harden more. Even under greater

6 loads it's much more resistant. So, it will take an

7 awful lot more seismic loading before -

8 (Simultaneous speaking.)

9 CHAIRMAN ARMIJO: But the point is I think

10 maybe what Ron is saying, you say, look, these stainless

11 steel liners are incredibly tough. And if we use the

12 wrong properties in the spent fuel pool study, we ought

13 to correct it and just say, hey, look, there's much more

14 margin here.

15 MEMBER BALLINGER: NUREG-6706 is capacity

16 of steel and concrete containment vessels with corrosion

17 damage steel.

18 We have lots of data on casks that have been

19 dropped on, what do they call it, immovable objects from

20 a height of whatever it is, stainless steel casks where

21 they've undergone enormous amounts of deformation and

22 still not failed.

23 Okay. I just - my concern is -

24 MR. PIRES: The other thing -

25 MEMBER BALLINGER: That's it.

1 MR. PIRES: The other thing that you have
2 is also you may have different failure modes that can
3 - and I go back to the same thing is you might have some
4 failure modes where you could have the large strains
5 near the welding. Those are for the welding areas.
6 We were told that there may be degradation on those,
7 because there had been some cold forming of the steel
8 that could have - that also might reduce somewhat the
9 various strains of the liner.
10 In addition to that, as I said, the strains
11 when you start getting the very large failures, you have
12 very large increases in strains, but smaller increases
13 on the load.
14 MEMBER RICCARDELLA: That's assuming the
15 concrete is cracked?
16 CHAIRMAN ARMIJO: Oh, yeah. The concrete
17 always cracks.
18 (Simultaneous speaking.)
19 MEMBER RICCARDELLA: I mean, that's what
20 causes the large increases in strain?
21 CHAIRMAN ARMIJO: Yes.
22 MR. PIRES: I agree with you. It is a
23 conservative assumption on that.
24 CHAIRMAN ARMIJO: Well, it's kind of a hidden
25 conservative -

1 MEMBER STETKAR: By the way, my earlier
2 comment, this discussion doesn't affect the conclusion
3 in the regulatory analysis on high density versus low
4 density at least as far as I - it could be important,
5 though, in terms of presenting the results to the public,
6 because the absolute frequency, you know, of both could
7 be substantially reduced.
8 Substantially, factors of two are not
9 substantial to PRA people, but -
10 (Laughter.)
11 (Discussion off the record.)
12 MEMBER STETKAR: At some seismic
13 acceleration it will -
14 CHAIRMAN ARMIJO: Of course, John.
15 MEMBER STETKAR: That's the whole point of
16 looking at the frequency and the consequences is to
17 understand if what we're talking about potentially large
18 consequences and it's important to understand what the
19 frequency of those potentially large consequences may
20 be.
21 It's not just one or the other. I mean,
22 that's why the absolute frequency can make a difference
23 when you're presenting the results, because it will
24 scale both of them down.
25 MEMBER RICCARDELLA: Would the probability

of leakage under this 0.7 g earthquake change significantly if you use stainless steel -- in the stainless steel liner?

CHAIRMAN ARMIJO: Oh, yes.

(Simultaneous speaking.)

MR. PIRES: It's also in the base case analysis I understand that the more controlled results is what we call the Bin 4 - are the loads on the Bin 4, not the loads on the Bin 3.

In the Bin 4, you have much higher levels. So, it is - it's also - and that's back to the fact that the strains will decrease rapidly as the loads increase when you get to the Bin 4 pack acceleration.

MEMBER BALLINGER: And I'll just say it one more time. As a matter of scale, there's a point at which you get failure for carbon steel. There's a point at which you get failure for stainless steel. They're very different.

And so, the initial - the initial starting event is affected by those properties. And it is on a good nonlinear that stainless steel is very tough material.

MR. PIRES: And we have concerns. I mean, materials - people I talk to, they have concerns about - mostly about degradation of welds under water for 30

1 years, 40 years.

2 MEMBER BALLINGER: I'd be more worried about

3 carbon steel welds than I would be about stainless steel

4 welds.

5 MR. PIRES: I understand.

6 MEMBER BALLINGER: Okay, enough.

7 MEMBER RICCARDELLA: But neither addresses

8 the welds.

9 MR. PIRES: No.

10 CHAIRMAN ARMIJO: Okay. So, we've got a

11 materials issue on the table, but I share Ron's - both

12 of us being materials guys, you know, you're really -

13 and shame on me for missing the fact that it was carbon

14 steel properties used in the analysis as opposed to

15 stainless steel, but it's a hidden conservatism.

16 Probably not intended to be hidden, but it -

17 MEMBER BALLINGER: The report that they used

18 contained the methodology for determining the fragility

19 numbers.

20 The materials that they used were carbon

21 steel. So, the methodology -

22 CHAIRMAN ARMIJO: No, I have no problem with

23 the methodology. I thought that was good. In fact,

24 we said so in our letter, but it's the properties, the

25 stress strain curves of carbon steel and stainless steel

are very, very different. And at these temperatures, the stuff is really ductile and tough.

So, and that explains one of the reasons why the Fukushima plants and the Kashiwazaki plants subjected to these earthquakes that you point out in your study performed so well.

Okay. Go ahead, you know. You take a stopping point, Steve, whether it's this chart or the -

MR. JONES: Okay. We'll finish this slide and the next slide, I think, and then we'll -

CHAIRMAN ARMIJO: Okay.

MR. JONES: Okay. Just the last couple items here. Population density and economic activity were based on the Surry site as a mean.

It's higher than the median levels for economic costs, but lower than the upper bound sites. The high case, for instance, used Peach Bottom representative of the 90th percentile.

And then the industry implementation costs were just derived from the EPRI information. I forgot that before.

Next. The one assumption that we were, I guess, very constrained with was what we were just talking about. Really is to some extent, is liner

1 fragility where the liner might fail and the resultant
2 pool level and also what fuel distribution may exist
3 in the pool at the time of the event.
4 All those can affect the ability of the pool
5 to - or the ability of air cooling to provide adequate
6 heat removal.
7 Okay. That results in the dominant
8 initiating events generally - the assumptions we make
9 here is, for the most part, air cooling would be
10 insufficient. And that results in the dominant
11 initiating events progressing the fuel heat-up and if
12 there's no mitigation like for the high-density case
13 to a release.
14 This is conservative, because the spent
15 fuel pool study and other studies have identified
16 substantial potential for air cooling when the pool is
17 either fully drained or when the fuel is particularly
18 - has a particularly long decay time and is not
19 generating much heat.
20 We did make an exception for the Mark I and
21 II BWRs that were the focus of the spent fuel pool study.
22 In that case, we have a lot less uncertainty
23 and we used the eight percent value for just covering
24 the first part of the operating cycle where the fuel
25 is particularly hot and, therefore, would heat up to

1 a release potentially.

2 Okay. Next slide. I'll do this one and

3 then we'll stop.

4 CHAIRMAN ARMIJO: Okay.

5 MR. JONES: Okay. For seismic event

6 frequencies we used the Peach Bottom seismic hazard

7 which falls near the upper end for all the sites

8 considered in the central and eastern United States.

9 It's lower than the bounding site,

10 Sequoyah, by a factor of a little over three. And

11 Sequoyah is a Group 4 plant, which is the shared pool.

12 Okay. For population demographics, I

13 talked a little bit about this in the last slide. The

14 Surry population was used and it's above the median for

15 all sites.

16 There's a sensitivity evaluation in the

17 regulatory analysis that addresses the effect of looking

18 at higher population density sites and using Peach

19 Bottom within 50 miles would have increased the benefits

20 by about 28 percent compared to the Surry demographics.

21 Most of the other - the other assumptions

22 all have generally smaller affects. But added up I

23 guess when you look at the highest in the cases, a lot

24 of little factors adding up to a very large increase

25 in the potential benefits from the - in the alternative.

1 I guess before we get into the table, we
2 could -
3 CHAIRMAN ARMIJO: Yeah, I think --
4 MR. JONES: - take a break.
5 CHAIRMAN ARMIJO: I think it's a good time
6 for it. Why don't we take 15 minutes. So, let's be
7 back at 10:40.
8 (Whereupon, the proceedings went off the
9 record at 10:26 a.m. for a brief recess and went back
10 on the record at 10:43 a.m.)
11 CHAIRMAN ARMIJO: Okay. Go ahead, Steve.
12 MR. JONES: All right. Together this slide
13 is to basically demonstrate how the base case
14 frequencies for heat-up of the fuel and release might
15 occur for these - the different initiating events that
16 were considered here.
17 Okay. For Seismic Bin 3 we're looking at
18 a 0.7 PGA earthquake. That's somewhat higher than the
19 1.2 g, I mean, there's different measures for the seismic
20 acceleration. So, I do want to make clear that that's
21 different than the 1.2 g fragility that was assumed in
22 NUREG-1738, because that corresponds to 0.5 g PGA.
23 So, it's slightly less than the Bin 3
24 earthquake. So -
25 (Simultaneous speaking.)

1 MR. JONES: Anyway, Bin 3 earthquakes, what
2 we're looking at here at 0.7 peak ground acceleration
3 is more severe than what was generally considered in
4 the NUREG-1738 as a fragility point. A point at which
5 liner fragility would be a concern.
6 And the numbers are a little bit confusing,
7 because they kind of overlap. They have 1.2 showing
8 up in two different contexts if you look between the
9 two studies.
10 But anyway, for this case we looked at Peach
11 Bottom for the base case frequency. And taking
12 basically an average of the seismic hazard during - from
13 the 0.5 to 1 g realm you end up with a 0.7 peak ground
14 acceleration being the average. And the frequency
15 drawn off for that seismic hazard was 1.65 times ten
16 to the minus five.
17 For the liner fragilities for the elevated
18 pools, we're using what was assumed or essentially based
19 on current calculation from the spent fuel pool study
20 of ten percent for the liner fragility.
21 For the at-grade pools representing Groups
22 2 through 4 we used five percent. And then for the
23 inadequate cooling, and I mentioned this previously,
24 for the elevated pool again we're looking at eight
25 percent of the operating cycle where air cooling would

1 be ineffective.

2 CHAIRMAN ARMIJO: I just don't understand

3 the hundred percent inadequate cooling for the at-grade

4 pools when the liner fragility is half of the elevated

5 pools.

6 Could you explain why that -

7 MR. JONES: Okay. We're really trying to

8 encompass a lot of conditions that could affect the

9 adequacy of cooling.

10 One of the principal ones is the location

11 of the liner tear, because the pool is at or near grade

12 and you have different supporting structures around the

13 pool.

14 The potential for there being a shear

15 condition in the pool structure might be somewhere other

16 than at the bottom of the pool. And, therefore, you

17 have greater potential of blocking the natural

18 circulation air cooling.

19 And also, we don't have full publicly

20 available MELCOR analyses of the PWR assembly

21 performance under low decay heat cases with the partial

22 joint conditions.

23 CHAIRMAN ARMIJO: So, you just picked it as

24 a bounding situation to cover all of those

25 uncertainties.

1 MR. JONES: Right.

2 CHAIRMAN ARMIJO: Okay.

3 MEMBER RICCARDELLA: And why, again, is that

4 so much higher than the elevated pool?

5 CHAIRMAN ARMIJO: The elevated pool -

6 MR. JONES: The principal difference is the

7 - for elevated pools, the leakage location was

8 determined based on structural analysis for the Peach

9 Bottom plant to be at the bottom of the pool.

10 So, you have a full drainage of the pool

11 for most of the conditions that allows air circulation

12 to, you know, cool and to be drawn underneath the racks

13 and to go through the assemblies and provide adequate

14 cooling after a certain number of days have passed into

15 the operating cycle since the fuel was last used in the

16 reactor.

17 For the PWRs, we're saying we don't really

18 know where the most likely leak location would be. And

19 if you have a partially exposed fuel, there is potential

20 for the upper part of the fuel to heat up to the point

21 of release.

22 MEMBER RICCARDELLA: So, a partially drained

23 pool in some cases could be worse than a fully drained

24 pool.

25 MR. JONES: Right.

1 MEMBER RICCARDELA: I think that was one of
2 the comments from one of the other outside comments.
3 MR. JONES: That's a principal concern.
4 There's also issues with distribution of the fuel.
5 There may not be fully distributed in the assumed
6 configuration at all times during the operating cycle.
7 That hundred percent covers that as well.
8 MEMBER RICCARDELLA: So, these cases, the
9 0.7 g and the 1.2 g, are they combined into your overall,
10 you know, with the different probabilities that are
11 combined?
12 MR. JONES: We're adding the heat-up
13 frequency at the end to total an initiating event
14 frequency or for a release frequency, basically, for
15 the case of the high-density fuel storage.
16 MEMBER RICCARDELLA: But was there any look
17 at smaller, like, Bin 2 earthquakes or, you know,
18 combining those which might be higher frequency
19 recurrence, but lower fragility?
20 MR. JONES: No, we didn't - we based, in part,
21 on -
22 MEMBER RICCARDELLA: So, anything less than
23 the 0.7 you're saying you have a hundred percent -
24 MR. JONES: Well, the Bin 3 is meant to cover
25 0.5 g to 0.7 g.

1 MEMBER RICCARDELLA: Yeah.

2 MR. JONES: I mean, sorry, 1 g in the peak
3 ground acceleration and that goes above the fragility
4 limit.

5 What I was mentioning was for NUREG-1738
6 these was assumption of at 0.5 peak ground acceleration
7 - 0.5 g peak ground acceleration the pool would maintain
8 its integrity.

9 MEMBER RICCARDELLA: Zero probability.

10 MR. JONES: Zero probability of leakage.

11 MEMBER RICCARDELLA: For leakage, okay.

12 MR. JONES: And then going up to Bin 4, you
13 know, we really do have a pretty rough seismic input
14 coming from USGS studies for the 2008 values.

15 This is an estimate of the average frequency
16 for a very severe earthquake over 1 g. And from that,
17 we used a pool liner fragility of a hundred percent for
18 the elevated pools, and 50 percent for the at-grade
19 pools.

20 This predominantly comes from actually
21 earlier studies that looked at Vermont Yankee and
22 Robinson spent fuel pools and the relative fragilities
23 of those two pools.

24 We wanted to give some benefit for the PWR
25 pools that don't have the same level of amplification

1 due to higher elevation of the PWR pool.

2 MEMBER RICCARDELLA: Do you know if those

3 earlier studies you referred to assumed carbon steel

4 or stainless steel liner?

5 MR. SCHOFER: 1738 does.

6 MR. PIRES: This is Jose Pires.

7 Those studies did not really calculate

8 liner strains. They assumed that there will be a crack

9 on the concrete and that the crack on the concrete will

10 grow sufficiently large to cause failure of the liners.

11 They didn't go into detail on even trying

12 to estimate strains in the liners, but they considered

13 a crack that would be susceptible to growths. Very

14 large growths.

15 CHAIRMAN ARMIJO: So, the liner really

16 didn't play a role in the analysis. It was just assumed

17 to fail?

18 MR. PIRES: Yes, but they had a failure mode

19 on the concrete that was somewhat brittle. So, their

20 assumption was that the crack would grow quickly and

21 it would drag the liner with it.

22 CHAIRMAN ARMIJO: Okay.

23 MEMBER RICCARDELLA: Yeah, I mean, if you

24 get a significant amount of concrete cracking, it seems

25 to me that a factor of two difference in liner ductility

1 wouldn't make that much difference.

2 CHAIRMAN ARMIJO: You know, there's not much

3 strain in the concrete.

4 MEMBER RICCARDELLA: Well, once it cracks,

5 though, and if the liner is going -

6 CHAIRMAN ARMIJO: That opening is pretty

7 tiny.

8 MR. PIRES: Once the concrete cracks, it

9 depends on the characteristics of the load. Depends

10 on whether there is some ductile behavior or if the crack

11 spreads faster.

12 So, at that time the assumptions were made

13 in a very simple way that they assumed the crack would

14 grow large enough to strain the liner beyond this -

15 MEMBER RICCARDELLA: To strain regardless

16 of the -

17 MR. PIRES: Right.

18 MEMBER RICCARDELLA: - material ductility.

19 MR. PIRES: Those were the assumptions that

20 were made.

21 MEMBER RICCARDELLA: Okay. Thank you.

22 MEMBER REMPE: So, the values you have on

23 this slide are consistent with Table 39 of your report,

24 which is way back in an appendix, but Table 2 has

25 incorrect values.

1 Is there going to be an update or something
2 or revisions to what's been published or -
3 MR. JONES: I guess - we didn't recognize
4 this in advance. I think pointing it out, I think we'll
5 assess whether or not it's incurred enough to find a
6 route to the Commission, because it's already been
7 issued.
8 MEMBER STETKAR: Table 2 is wrong. These
9 are actually -
10 MR. JONES: Table 2 is wrong. That's
11 correct. For the liner fragilities, we have the wrong
12 values.
13 MR. WITT: Yeah, we'll see if we can get a
14 correction.
15 MR. JONES: Then for the cask drop, the two
16 to the minus seven value comes from NUREG-1738. And
17 in that case, that actually essentially considered liner
18 fragility in that analysis.
19 And there is - well, they're assuming an
20 inadequate cooling for that case also. And but I do
21 want to point out that cask drop is not really a credible
22 failure for all plants.
23 In many cases there are - the crane that
24 handles the cask is configured in such a way that it
25 can't pass over the spent fuel pool with a load or it

1 has some type of operating limits that prevent it from
2 going over the pool. And the cask loading area is
3 separate from the spent fuel pool structurally.
4 Okay. And then all the other initiators,
5 there's a wide variety that were considered in
6 NUREG-1738. Again, they include additional factors
7 beyond the initiating event. Like I mentioned,
8 initiators as station blackout is one. A pipe break
9 in the cooling system might be another.
10 And these would - then you'd have mitigative
11 activities that are simplified human error probability
12 analyses listed in NUREG-1738 that results in -
13 MEMBER STETKAR: So, for those other
14 initiators, both the high density and the low density
15 take full credit for all of those other mitigation for
16 -
17 MR. JONES: Right, but those are not - that's
18 not using the 50.54(hh) mitigation. That's strictly
19 existing firewater systems or maybe servicewater or
20 other makeup means that are available onsite.
21 It doesn't consider spray, which is the,
22 you know, predominant benefit of the B.5.B or the post
23 9/11 actions.
24 CHAIRMAN ARMIJO: So, none of these other
25 things, the cask drops, other initiators, they're not

1 station blackout conditions. They're just normal
2 operation.
3 MR. JONES: No, no, no. They are. They
4 are.
5 MEMBER STETKAR: That 2.37 times 10 to the
6 minus seven ostensibly includes the frequency of every
7 other possible initiating event other than the seismic
8 event and cask drop that could possibly happen at the
9 site with every possible event sequence that could be
10 developed that could result in loss of fuel pool cooling.
11 That's what they're claiming.
12 MR. JONES: A lot of these are very -
13 MEMBER STETKAR: And, again, those are
14 really small numbers and they're certainly really
15 precise.
16 I'm not at all clear that they're very
17 accurate. They're certainly very precise.
18 CHAIRMAN ARMIJO: Okay. Okay, good. Thank
19 you.
20 MR. JONES: Okay. And then from those
21 results we get the numbers at the bottom that were used
22 for the base case event frequencies.
23 CHAIRMAN ARMIJO: This is what you worry
24 about, this Bin 4.
25 MR. JONES: And about 90 percent of that is

1 a seismic contribution. And if you go looking up
2 further back up at Bin 4, Bin 4 is the dominant
3 contributor.
4 MEMBER RICCARDELLA: Yes. 88 percent Bin
5 4.
6 MR. JONES: Okay.
7 MEMBER RICCARDELLA: And these were applied
8 equally to both options, the low density and high
9 density?
10 MR. JONES: Right. Both low density and
11 high density. The only difference here, again, is the
12 application of mitigation would reduce the frequencies
13 for - of actually going to a release for the low-density
14 cases.
15 MEMBER RICCARDELLA: Okay.
16 CHAIRMAN ARMIJO: But would mitigation
17 affect the heat-up frequency?
18 MR. JONES: I guess it depends on when you
19 consider the - I was looking for a good word to describe
20 - we're in this intermediate state where the fuel is
21 heating up. And if you don't do anything else, it will
22 lead to a release.
23 CHAIRMAN ARMIJO: To me -
24 MR. JONES: For mitigation to be effective,
25 it does need to be deployed relatively early probably

before the floor is exposed unless you have a separate area.

CHAIRMAN ARMIJO: Yeah, I see mitigation as preventing fuel heat-up as opposed to -

MR. JONES: Bad word selection, yeah.

MR. WITT: This is really initiating event frequency. I mean, all these things considered multiplied by the consequences gets you the risk or the consequences.

MEMBER SCHULTZ: This would be it without mitigation. So, the low-density case gets mitigation.

CHAIRMAN ARMIJO: Yeah. So, this is without.

MEMBER SCHULTZ: The other case does not.

MEMBER RICCARDELLA: Yeah. And there's no difference in the heat-up - in the fuel heat-up rates for low density versus high density.

CHAIRMAN ARMIJO: Well, yeah.

MR. JONES: That's correct. The event progressions are basically the same given all the other external conditions are the same, because the - it's driven by the very hot assemblies which are present in both the low density and high density cases.

(Discussion off the record.)

MR. JONES: I have a results slide here, but

I'm not certain if we -

CHAIRMAN ARMIJO: We're not quite ready for that results slide.

MR. JONES: Okay. So, we have backup slides available that we can talk about Table 2 or look at some of the other progressions.

CHAIRMAN ARMIJO: Yeah, why don't we, you know, I have a couple of questions on Table 2 other people may have.

MEMBER STETKAR: Let me ask you before we get to that, Sam, I need some clarification. We don't have backup slides for this. So, you mentioned this in October offline, but I'm going to put it on the record now.

If I look at the report and I compare the base case results, and write these down, in Tables 4, 44, 54, 56, 60 and 64, okay, that will give you the scope of the things that I looked at and I'm only looking at base case now, I notice that there are distinct differences in the sense that those tables align in two, what I'll call, collections, because I want to avoid the word "groups."

Collection Number 1, and those are Tables 4, 56 and 64, gives me base case dose averted values for spent fuel pool Group 1 of 1740 person-rem. For

1 Group 2, 1630. Group 3, 3,020. And Group 4 is 1690.
2 Now, if I look at those qualitatively, I
3 don't care about the absolute values. It's - and if
4 I normalize them to Group 1, it says Group 2 is a little
5 bit lower, Group 3 is about 75 percent higher and Group
6 4 is about the same as Group 1. Okay.
7 Now, if I look at Tables 44, 54 and 60, Group
8 1 got corrected between October and today. So, it now
9 has a dose averted of 1739 person-rem. Group 2 has 2109.
10 Group 3 has 3616. And Group 4 has 2284.
11 Groups 2, 3 and 4 in that second collection
12 are much, much different than Groups 2, 3 and 4 in the
13 first collection as are the relative fractions when I
14 normalize it to Group 1.
15 Group 2 in the second collection is now
16 higher than Group 1. Group 3 is a factor of two higher.
17 And Group 4 is somewhere in between.
18 I did my own back-of-the-envelope
19 calculations and I don't do MACCS runs. I don't have
20 all of these sophisticated computer tools. All I have
21 is a spreadsheet.
22 The qualitative behavior of Groups 1, 2,
23 3 and 4 in my little calculation seem to behave more
24 like the second collection than the first collection.
25 In other words, if I normalize to Group 1,

1 Group 3 is the highest, Group 2 is a little - is between
2 Group 1 and 3, and Group 4 is between Groups 2 and Group
3 3.
4 So, I'm curious now if I look at those table
5 of results, why are they different? Why do we have these
6 two different collections for the base case?
7 Now, it used to be in October that the Group
8 1 was different between the two collections, but somehow
9 that got corrected. So, Group 1 is now consistent, but
10 Groups 2, 3 and 4 are different.
11 You probably can't do this realtime, but
12 there are differences. And if those differences are
13 used in the overall results of the study, and I maintain
14 that they are, I'm not clear now what the sensitivity
15 studies are telling me and which set is correct, if
16 either.
17 (Discussion off the record.)
18 CHAIRMAN ARMIJO: Well, these are all on the
19 same order of magnitude, right?
20 MEMBER STETKAR: They're on the same order
21 of magnitude, but the important thing is - I don't care
22 about the absolute values. The behavior is different
23 also.
24 CHAIRMAN ARMIJO: Right. Yeah, yeah.
25 MEMBER STETKAR: Whereas if I just compare

1 One and Two in Collection 1, Two is - Two gives me lower
2 releases than one. Whereas in the second collection,
3 Two gives me more releases than Group 1.
4 CHAIRMAN ARMIJO: Yeah, yeah. Same with
5 Three.
6 MEMBER STETKAR: You know, so something
7 fundamentally is different in those two collections the
8 way the model seems to be developed.
9 And it's not just a simple typo, I don't
10 think, because it propagates through all the costs.
11 I mean, it isn't one column and one table in the report,
12 because it propagates consistently through the cost
13 estimates.
14 MR. WITT: It seems like something we'd have
15 to go back and -
16 MEMBER STETKAR: You can't do it in real -
17 MR. WITT: - determine where these numbers
18 came from.
19 MEMBER STETKAR: Right.
20 CHAIRMAN ARMIJO: But, you know, whichever
21 is the right set of numbers, they should be throughout
22 the report and some explanation of -
23 MEMBER STETKAR: Anyway, I'll just -
24 CHAIRMAN ARMIJO: But for the -
25 MEMBER STETKAR: It's an observation. As

1 I said, I - my little back-of-the-envelope calculation
2 seems to be behaving more like what I call the second
3 collection, which is Tables 44, 54 and 60, than the first
4 collection, which is Four, 56 and 64.
5 The problem is that Table 4 is your base
6 case results that you highlight up front in the study.
7 CHAIRMAN ARMIJO: Yeah, yeah.
8 MEMBER STETKAR: And if that's wrong for some
9 reason, there could be a concern.
10 CHAIRMAN ARMIJO: So, the benefits or the
11 averted person-rems are greater for the plants in Groups
12 2, 3 and 4 than for Group 1? Is that -
13 MEMBER STETKAR: No, you can't -
14 CHAIRMAN ARMIJO: You can't come to that?
15 MEMBER STETKAR: Yeah, don't look at - don't
16 look at - these are just numbers getting out to -
17 MR. WITT: I see what you're saying in terms
18 of the differences in the tables, the -
19 MEMBER STETKAR: Well, the absolute values
20 are different. So, if I look at - if I just look at
21 averted person-rem in Group 2 in Collection 1, if you're
22 following me, the averted person-rem in Group 2 in
23 Collection 1 is 1630. In Collection 2 it's 2109.
24 MR. WITT: Which is higher than -
25 MEMBER STETKAR: Which is 470 some odd, you

1 know. And I don't know why that is different, because
2 I'm just comparing so-called base case values.
3 MR. WITT: Right.
4 MEMBER STETKAR: So, not only the absolute
5 value is different. But because the absolute values
6 are different, the relative ranking, if you will, of
7 those groups when I - if I normalize it to Group 1, if
8 I called Group 1 my normative condition, the relative
9 rankings of the groups become different also in terms
10 of what is - what gives me more releases versus less
11 releases than Group 1.
12 MR. WITT: Yeah, I think this is something
13 that we'll definitely have to investigate to see where
14 those numbers came from.
15 MEMBER STETKAR: Okay. I wanted to do it
16 here. I was waiting until we got here, because this
17 is the only place where you sort of talk about all of,
18 you know, the sensitivity study/cost-benefit analyses
19 in one place.
20 MR. JONES: Sure.
21 MEMBER STETKAR: And I think we've probably
22 sent enough time on that. We can now go to Table 2 where
23 Sam wanted to -
24 CHAIRMAN ARMIJO: Yeah, I wanted to get into
25 this health consequences part of the table.

1 You have a statement under - in the table
2 that says the LNT dose response model is used as the
3 base for reporting results. And that statement is the
4 dose truncation methodology introduced in SOARCA
5 analyses documented in 1935 is provided as a sensitivity
6 analysis.
7 It's not actually - you didn't actually do
8 a sensitivity analysis in this document, did you? Or
9 did you just say SOARCA did the sensitivity -
10 MR. SCHOFER: SOARCA did the sensitivity
11 analysis.
12 CHAIRMAN ARMIJO: Okay. Because I was
13 looking all over in the document for this sensitivity
14 analysis. And you're saying that if you really wanted
15 to know what benefit you could get, you'd have to go
16 look at SOARCA.
17 MR. SCHOFER: Correct.
18 CHAIRMAN ARMIJO: Okay. I understand what
19 you did then.
20 MR. SCHOFER: Yeah, you could either do that
21 or -
22 CHAIRMAN ARMIJO: I was looking for it,
23 because I was saying, great, now we'll have -
24 MS. GIBSON: For spent fuel pools you need
25 to look in the spent fuel study. For a reactor analysis,

1 it would be in SOARCA. We use the same truncation in
2 both SOARCA and the spent fuel study.
3 CHAIRMAN ARMIJO: Okay, but it's not - it's
4 nowhere really visible, but the effects of truncation
5 are in this report. At least I don't see numbers or
6 anything like that.
7 MEMBER SCHULTZ: It's a remarkable
8 difference or -
9 CHAIRMAN ARMIJO: It's a huge difference.
10 MEMBER SCHULTZ: - associated with in the
11 spent fuel study.
12 MR. SCHOFER: A couple thousand difference.
13 A factor of a thousand.
14 CHAIRMAN ARMIJO: Yeah, and that's - to me,
15 that's so important. And it's not really - doesn't get
16 much - it doesn't get any visibility particularly when
17 you're extending it to beyond 50 miles and huge
18 populations and habitability for 50 years and on and
19 on and on.
20 It just multiplies and accumulates and
21 seems to me it should get more visibility and that's
22 just an observation. So, I won't hold you up anymore
23 on that. I just wanted to see if I had any other
24 questions.
25 Okay. I don't have any other question

1 myself on that table. Anybody else? Keep going, Steve.
2 You're on a roll.
3 MR. JONES: Nothing else on Table 2. I guess
4 we can go back to the -
5 MEMBER REMPE: I think we've covered it at
6 other places, but again I guess I would really if you
7 are going to issue some sort of update with corrections,
8 I sure would like to see more explanation.
9 This report is getting a lot of visibility
10 and there's a lot of assumptions in here that - it's
11 coming from the spent fuel scoping study, but these
12 values are - the factor of 19 isn't identified in that
13 section or in that table. And, you know, these things
14 - we have these discussions here. I know where it's
15 coming from, but it's not obvious to the reader, I think.
16 And so, those kind of things, I think,
17 should be documented better.
18 CHAIRMAN ARMIJO: Well, you know, when the
19 Committee writes a letter, we may point that out, you
20 know, some things that could be improved or that would
21 be helpful.
22 MEMBER REMPE: Yeah.
23 MEMBER STETKAR: And a factor of 19 is just
24 the 95 percent mitigation.
25 CHAIRMAN ARMIJO: Well -

1 MEMBER REMPE: But isn't it coming from the
2 scoping study and the table in the scoping study where
3 they found that value and it's not clearly stated?
4 It just seems like, you know, it's something
5 that could be documented better.
6 CHAIRMAN ARMIJO: Bill calls it the
7 artificial factor of 19. If he was on the line, we could
8 ask him to expound.
9 MEMBER STETKAR: It's the 95 - I don't know
10 why you use 19, but it's 95 percent gets you 19 out of
11 20 if you want to think of it that way, of the stuff
12 recovered. Five percent is not recovered, which is like
13 120th.
14 MR. JONES: Right.
15 MEMBER STETKAR: It's not really a factor
16 of 19.
17 MEMBER REMPE: Isn't it coming from Table
18 33 of the scoping studies where you got that factor of
19 19?
20 MR. WITT: Is that the HRA? Do you remember
21 the -
22 MEMBER REMPE: The mitigation. And then -
23 MR. JONES: It's not coming from the HRA.
24 It's coming really from - it looks at the - the scoping
25 study had an assumed response for mitigation and it

1 relied on the rate of level decrease in the spent fuel
2 determined like what response whether it would be
3 mitigation by makeup or mitigation by spray.
4 And for one of 20 scenarios looked at for
5 the low density storage configuration, the level drop
6 would be occurring very slowly, because it's actually
7 very early in the outage when the reactors connect with
8 the spent fuel pool.
9 And that leads based on the methodology in
10 the study, the operators to determine makeup by just
11 additional water to the pool as the appropriate response
12 when spray is really necessary to effectively mitigate
13 the condition.
14 So, there's a failure and it's modeled in
15 the spent fuel pool study for that one out of 20 evaluated
16 cases. That's really the - did I cover that correctly,
17 Hossein?
18 MR. ESMAILI: Yes. So, in the spent fuel
19 pool scoping study we looked at medium - moderate leaks
20 and small leaks.
21 The small leaks were of no concern because
22 as soon as you got the mitigation, you were always
23 recovered. You never got any releases.
24 The case with the moderate leaks you could
25 not with the 500 gpm, you could not recover. So, there

1 was a period of time in OCP1 during the first week the
2 fuel is so hot.
3 So, whether you inject or you spray, you're
4 still going to get a release. And that constituted that
5 five percent of the time for half of the damage state,
6 you know.
7 So, only for moderate leak cases only during
8 the first week even with mitigation you get a release.
9 MEMBER REMPE: Okay. I think it ought to
10 be documented.
11 CHAIRMAN ARMIJO: Yeah, you either have to
12 expand that to make it easier to understand --
13 MEMBER REMPE: Yea.
14 CHAIRMAN ARMIJO: - or as, you know, some
15 of us believe, it would be so much better if you just
16 treat both alternatives; mitigated and unmitigated.
17 And the benefits of the Alternative 2 for
18 the unmitigated situation would be evident, but the
19 effectiveness of mitigation for the base case for the
20 Alternative 1 would be clear, too, so a decision-maker
21 isn't left hanging with just a big advantage on
22 Alternative 2 when it's without realizing the advantage
23 of Alternative 1.
24 Anyway, that's again consistent with some
25 of the things that Bill would have contributed if he

1 were here.

2 Okay. Keep going.

3 MR. JONES: Okay. I guess we can go back

4 to Slide 16.

5 (Discussion off the record.)

6 MR. JONES: So, we've talked about, I guess,

7 basically the overall assumptions. The benefits - or

8 excuse me, the base case costs outweigh the benefits

9 particularly when we're looking at within 50 miles and

10 $2,000 per person-rem, which is the standard regulatory

11 analysis approach. And the changes in discount rate

12 do not affect that result.

13 Sensitivity analyses for - address

14 commissions involving $4,000 per person-rem and

15 consequences extending beyond 50 miles from the plant.

16 In that case, there is margin benefits in some of the

17 cases.

18 The costs continue to outweigh the benefits

19 for Groups 1 and 2. And Groups 3 and 4, the benefits

20 marginally outweigh the costs.

21 The main difference driving that for Group

22 3 is, you know, there is a longer period of operational

23 life and really the costs are a little bit, I want to

24 say, lower, because the cask purchase is deferred later

25 in the life of the plant relative to the other cases

1 we're looking at.

2 For Case 4, that's the case where you have

3 a shared spent fuel pool and a higher inventory of cesium

4 present that really drives - so, there's additional

5 benefits from avoiding that release.

6 CHAIRMAN ARMIJO: Just to - and I'm asking

7 you to guess. If the - for Groups 3 and 4 where the

8 base case benefits currently marginally outweigh the

9 costs, if the costs for these casks and expedited process

10 were off by a factor of two from what you used, would

11 that still be the situation?

12 I've never been involved in a procurement

13 that hasn't been off by a factor of two.

14 (Laughter.)

15 CHAIRMAN ARMIJO: Even after we scrubbed it.

16 MR. JONES: Yeah, I think it came out cost

17 beneficial by a very small - by a fraction of the total

18 cost. So, I would expect that - and most of the costs

19 are the procurement of the casks.

20 MEMBER SCHULTZ: So, if you took Groups 3

21 and 4 and determined that for those groups it was

22 warranted to go to a further investigation, wouldn't

23 the first thing that you would do be to reevaluate the

24 conservative assumptions that have been used in this

25 analysis for the base case as compared to the low case,

1 which in many areas of assumption is the low case is
2 more conservative than what was derived in the spent
3 fuel pool study, which was the most - is the most recent
4 evaluation that we have done. And then these
5 conclusions would disappear associated and would
6 marginally outweigh the costs.
7 It would be clearly demonstrated that there
8 is no benefit for those groups as well doing anything
9 differently than what is currently done in the spent
10 fuel pools we have today.
11 Is that a fair evaluation?
12 MR. JONES: One thing -
13 MEMBER SCHULTZ: In other words, one of the
14 things we tend to do is we tend to make lots of
15 assumptions in order to create an evaluation technique
16 that can differentiate between one option and another.
17 And then we begin to apply it to other cases.
18 And when we do, we get a - as it's stated,
19 marginally outweigh costs. But, in fact, if one were
20 to go back and do something that was just not best
21 estimate, but just somewhere directed toward a more
22 reasonable evaluation, there would be no difference
23 demonstrated. And we begin to lose that when we draw
24 general conclusions like this.
25 MEMBER RAY: Well, at the very least a lot

1 of the comments around here have been to make more clear
2 to what assumptions were made.
3 I think a factor of two is way low. I had
4 to go off and build casks at one time in my life. I
5 know a little bit about it.
6 And if everybody is out trying to get casks
7 even over a five-year period or so, their costs are going
8 to be - and that was because at any price you couldn't
9 get them, period.
10 So, I just think it needs to be highlighted
11 if we're - and it looks to me like we're stuck in the
12 position that we're in just from the standpoint of what's
13 practical to do. I'm talking about the timing of this
14 phase that we're engaged in now.
15 It just needs to be more clear that, you
16 know, we really have no idea of what the cost of casks
17 will be when everybody is trying to do this. And to
18 just pick a number and say, well, conservative, assume
19 it's twice what it was, I don't even think that's good
20 enough.
21 CHAIRMAN ARMIJO: Well, it's better than
22 one.
23 MEMBER RAY: Well, yeah, but there's a sense
24 in which making things better you think you've made them
25 good enough and that's not necessarily true.

1 I just think we ought to make clear in a
2 footnote or somewhere that this assumes there's no
3 affect on the price of the cask.
4 MEMBER BALLINGER: In fact, I talked to
5 Transnuclear, Holtec - all three cask manufacturers,
6 because there's an estate program dealing with canister
7 life and NRC is involved in some of that, and asked them
8 the blank question, could you do it? And every one of
9 them said no, not possible to respond in time to build
10 enough casks.
11 MEMBER RAY: Well, you'd have to have new
12 -
13 MEMBER BALLINGER: Yeah.
14 MEMBER RAY: - capacity to build casks that
15 would be amortized over the period that this demand would
16 exist. And then after that you'd have a lesser demand
17 than what was the basis of the existing manufacturing
18 capability and so on.
19 So, it's a complex analysis and Sam
20 suggested maybe go overseas. Well, maybe you would.
21 CHAIRMAN ARMIJO: Well, that's what would
22 happen.
23 MEMBER RAY: There are some complications
24 associated with it. Rather than trying to sort them
25 out at this late date -

1 CHAIRMAN ARMIJO: Right.

2 MEMBER RAY: - I think it's best to simply

3 say we don't have any idea.

4 (Laughter.)

5 MEMBER RAY: Well, we don't. That's the

6 real, you know, we don't have any idea. And, like I

7 say, I couldn't buy them at any price when I needed them.

8 CHAIRMAN ARMIJO: Well, you know, what

9 bothers me is the base case would normally be what you

10 would use for a decision. And if your base case analysis

11 shows a benefit, you have a hard time saying we - it's

12 - we don't want to - we don't think it's worth doing

13 or pursuing further. And it just seems like there's

14 - somebody would sharpen their pencil and say, you know,

15 did we overdo our effort to maximize the benefit of the

16 alternative and wind up in a situation that we just don't

17 believe, you know, we just don't support? And but that's

18 where we are.

19 MEMBER REMPE: And so Table 2, it lists the

20 price per cask assumed and just points as a comment,

21 look at the EPRI study is a good place if you're updating

22 Table 2 to provide this footnote or this comment and

23 to say that there's a lot of uncertainty.

24 And I know I'm harping on Table 2 updates,

25 but it sure seems like a good place where you're listing

1 your assumptions to have additional caveats.

2 CHAIRMAN ARMIJO: Well, you know, the staff

3 has finished their report. And, you know, if the

4 Committee wants to make some points -

5 MEMBER REMPE: They're going to have to issue

6 a correction for Table 2.

7 CHAIRMAN ARMIJO: Yeah, certainly

8 corrections. The staff would do that without -

9 MEMBER RAY: On that point, Sam, I think at

10 another time we're going to have to discuss to what

11 extent we have been going from the cost-benefit. That's

12 normally not something - we engage in the benefit side,

13 but the cost side we normally don't do.

14 But on the other hand if you're talking

15 about cost-benefit of necessity, one of the factors is

16 cost and I would think we could observe that there's

17 no basis for the assumption that was made here.

18 CHAIRMAN ARMIJO: Weaknesses, yeah.

19 MR. WITT: One point on this slide that I

20 think is important to bring up is that the top bullet

21 here which talks about the costs outweighing the

22 benefits, that's for all the cases that we evaluated,

23 base case.

24 All the groups that we evaluated were the

25 costs outweigh the benefits utilizing the current

1 regulatory policies and guidance that we have in place.
2 Now, when we did the sensitivity analyses
3 where we up these factors like the dollar per person-rem
4 and the consequences beyond 50 miles, that's when you
5 start to get into some cases where the benefits may
6 outweigh the costs.
7 And I would think that if the Commission
8 decides to tell us that based on these sensitivities
9 that they want us to do additional research, I would
10 hope that we get additional guidance on how we should
11 consider these things like consequences beyond 50 miles,
12 because they are not a part of our current regulatory
13 policies where we make regulatory decisions on those.
14 CHAIRMAN ARMIJO: But if you for that case,
15 a sensitivity analysis where you increase the dollars
16 per person-rem, because that's likely the direction
17 where you're going, everything costs more, so everybody
18 understands that, and beyond 50 miles you create a much
19 larger population, but then you admit that the dose that
20 these guys get is because they return consistent with
21 habitability criteria which are deemed safe enough by
22 whatever regulatory authority exists and you still -
23 but you still put in the cost, dollars per person-rem,
24 for a large number of people that are presumed safe.
25 Safe enough.

1 So, if you took out all those costs, would
2 you still be in the situation? I don't think so. I
3 think you would have no benefit. So, you can't have
4 it both ways.
5 I think you can't charge $4,000 per
6 person-rem for a huge population for a situation in which
7 they've been allowed to return based on a judgment that
8 it's safe.
9 So, somewhere along the line I think that
10 there isn't a base case benefit even for the sensitivity
11 analysis.
12 MEMBER RICCARDELLA: Could I ask a question?
13 In your judgement if you credited
14 mitigation equally to both options, either you credit
15 it in both cases, or you don't credit it in both cases,
16 would that conclusion about the marginally outweighing
17 the costs, would that change?
18 CHAIRMAN ARMIJO: Yeah.
19 MR. SCHOFER: Well, there's enough of them,
20 in fact, to get - yeah, probably if you don't credit
21 it for either case, then I would guess that that margin
22 - the marginal benefit would go away and it would be
23 non-cost beneficial for all of them.
24 MR. JONES: If you looked at the case where
25 mitigation was effective in both cases, yeah, definitely

1 the costs would -

2 CHAIRMAN ARMIJO: Disappear.

3 MR. JONES: I mean, the costs would far

4 outweigh any potential kind of -

5 CHAIRMAN ARMIJO: There would essentially

6 be no -

7 MEMBER BALLINGER: Is that not a more

8 internally consistent way to do things?

9 MEMBER RICCARDELLA: I think, you know, a

10 lot of the comments from the Committee have to do with

11 these apples and oranges comparisons.

12 I mean, the real benefit of these types of

13 probabilistic analysis is not the absolute. It's the

14 relative.

15 And when you make inconsistent assumptions,

16 you're biasing that relative benefit.

17 MR. RECKLEY: This is Bill Reckley again.

18 And we're doing that on purpose.

19 (Laughter.)

20 MR. RECKLEY: But, again, I'm going to just

21 ask everyone to come back to what the staff is asking

22 the Commission to decide in this particular case and

23 we look much more targeted in terms of the decision that

24 we're asking them to make, which is whether to direct

25 us to go do more study of this issue, or whether they

1 agree with us that more study would likely show what
2 we think we're already demonstrating here that the
3 combination of the safety test, the risk test and the
4 cost-benefit would show that we are unlikely to proceed
5 to develop a rule to require this particular action.
6 So, that it really comes down to all we're
7 asking the Commission to decide is tell us to either
8 do more study, in which case as Steve was mentioning
9 we're going to go in and we're going to revise the
10 conservative assumptions, and if there's only group that
11 might show cost beneficial, we'll focus to make sure
12 we're not being overly conservative for that particular
13 group, to reach that point of whether to go into
14 rulemaking or not.
15 And so, yes, we were inconsistent. We look
16 at it from a couple points of view, right? Every time
17 we make a conservative assumption, we were also thinking
18 if we don't make a conservative assumption, somebody
19 else will say you didn't make a conservative assumption
20 and, therefore, biased it in the other direction, which
21 was what we primarily wanted to avoid.
22 And so, yes, we were by and large when we
23 faced the choice of A or B, we would pick the one that
24 biased it towards being beneficial to move.
25 (Simultaneous speaking.)

1 CHAIRMAN ARMIJO: That's why we have a
2 probability. If you just say, hey, I'll apply the same
3 assumptions to both alternatives across the board, you
4 wind up with, in certain cases, one alternative on its
5 own will be - will have a benefit that the other one
6 doesn't have even though they've all been -
7 MR. RECKLEY: I understand.
8 CHAIRMAN ARMIJO: And so, I think you're
9 making the Commission's job a little bit harder than
10 it needs to be with call it a bias or a tilt to - that
11 exaggerates the benefits of Alternative 2 where at least
12 I don't see them.
13 MR. RECKLEY: And the unintended consequence
14 of doing it the way we did it.
15 The other thing I'd point out is whenever
16 we're talking about the cost-benefits here and even in
17 the cases where we would say with the sensitivities some
18 of them are marginally cost effective, is never consider
19 that in isolation from the first test of the actual risk
20 reduction against the QHOs which still would not pass.
21 And so, the way we do regulations it's not
22 just - it's not one way or the other. It has to be both.
23 And you have to get by the QHO test first.
24 And so, this is just a little additional
25 information for the decision-makers, but not to focus

1 too heavily on the fact that there's a marginal cost
2 benefit in some of the calculations.
3 We can always come up with cases where
4 there's marginal cost benefits. We don't pursue them,
5 because they don't have the corresponding safety benefit
6 to warrant doing the ruling.
7 MEMBER RAY: But, Bill, you normally aren't
8 dealing with the kind of issue that this -
9 MR. RECKLEY: No, I understand the politics
10 of it.
11 MEMBER RAY: All right. Then you should be
12 sympathetic to the comments.
13 MR. RECKLEY: No, I do. I do. Then, again,
14 I say that might be an unintended consequence of the
15 way we chose to do this, but -
16 CHAIRMAN ARMIJO: Okay, let's keep going -
17 oh, I did have a question on Table 3, and that is
18 replacement energy cost. And I have to confess I didn't
19 go into the details of how it was calculated, but you
20 project - is this years into the future or - and how
21 do you come up with the replacement cost?
22 Probably Harold can answer it for me, but
23 seems like there's so much uncertainty on that. That
24 could be a huge variable whether it was now low-cost
25 gas or high-cost windmills or something like that.

1 MR. SCHOFER: This is Fred Schofer.

2 We actually had a study performed for us

3 where we looked at all the generating facilities within

4 the US as well as the forecast for new generation and

5 retirement of facilities over ten years to, you know,

6 model each region.

7 And then looked at economic dispatch for

8 each of the regions within the country to come up with

9 values both at the hourly, daily and annual rates.

10 That's how we came up with that.

11 That is part of the - as we're revising our

12 reg analysis guidelines, we wanted to update the cost

13 of replacement power, because a lot has changed since

14 the original reports came out particularly with emergent

15 plans and deregulation. So, that's why we went to a

16 dispatch model.

17 MR. JONES: And I think it's important to

18 note this didn't really have a - play a role in this

19 particular analysis, because we're not talking about

20 -

21 MR. SCHOFER: And of course included in that

22 is a forecast for natural gas and solar and hydro and

23 so forth.

24 CHAIRMAN ARMIJO: All right. Thank you.

25 MR. JONES: Just a few more slides to go

1 through. I wanted to put this in a safety perspective,
2 I guess.
3 Basically, confirm the pools provide
4 adequate protection and we feel they have a substantial
5 defense-in-depth.
6 The overall frequency of damage to spent
7 fuel even with these relatively low or conservative
8 assumptions is just a few times in a million years.
9 And these frequencies exclude the effective deployment
10 of mitigation, which is the subject of past regulatory
11 action and orders that are in place to expand that
12 mitigation capability.
13 We think the spent fuel pool has
14 defense-in-depth, because there are several layers
15 involved here.
16 Predominantly the pool itself was so robust
17 that, you know, we're getting into pretty extreme
18 earthquakes to even have any substantial damage. So,
19 variable frequency of an initiator requires any
20 mitigation whatsoever.
21 The ones that do require mitigation, we have
22 capabilities now especially with these new orders that
23 provides good mitigation capability to address those
24 situations. That's all I have for that.
25 I want to acknowledge that there is some

1 issues with the use of quantitative health objectives
2 for screening. As we mentioned earlier, they were
3 developed or intended for reactor accidents. And we
4 recognize that the spent fuel pool accidents could
5 affect large areas and populations.
6 And while we could develop alternative
7 societal measures, we feel we have appropriate safety
8 levels based on the defense-in-depth and the ability
9 to meet the quantitative health objectives.
10 CHAIRMAN ARMIJO: What is it that would make
11 you feel that the QHOs aren't suitable for spent fuel
12 pool accidents? I mean, it's -
13 MR. JONES: Well, they're an individual risk
14 measure. That's the predominant problem. It doesn't
15 integrate, I guess, all the effects that could go into
16 population.
17 That's one of the main reasons I guess to
18 go onto a cost-benefit analysis is that it does more
19 fully capture all the impacts, because we are, for
20 instance, the evacuations change the health effects,
21 but it costs money to move people around.
22 So, when you factor that into the
23 cost-benefit analysis, I think you see a little bit -
24 a fuller picture of the societal impacts that are also
25 part of the -

1 CHAIRMAN ARMIJO: So, that's an added
2 benefit of the regulatory analysis. It fills that gap
3 in some way.
4 MR. JONES: Somewhat, right.
5 CHAIRMAN ARMIJO: Yeah.
6 MEMBER SCHULTZ: At the same time when you
7 did the evaluation for the QHO calculations, and I'm
8 expecting this is done routinely, very conservative
9 assumptions were made associated with the frequency of
10 the event and the fragility of the pool.
11 It was, you know, essentially we're going
12 to have an event and if the pool fails, then let's see
13 what the consequences would be.
14 And the highest, not the mean and not the
15 base case, but the highest frequency was chosen to
16 represent the conclusion that the QHO was met.
17 So, yes, they were used, but - and they may
18 not be particularly applicable in the case of spent fuel
19 pool, but they were evaluated in the high case with
20 conservative assumptions and so forth.
21 So, you can suggest that in that particular
22 approach, you've taken care of a concern that we
23 shouldn't be using these for the evaluation or some,
24 you know, something else could certainly be better, but
25 -

1 MR. WITT: Well, what we said is that we think
2 that the QHOs are appropriate, because we feel confident
3 with the measures that we have in place for spent fuel
4 pools, but there may be some issues that people have
5 with the way we did this. And we acknowledge those
6 issues.
7 MEMBER SCHULTZ: If we were to move forward
8 and look further at approach that would be applicable
9 to spent fuel pool, it seems to open up the book
10 associated with as we've talked about here.
11 Another level of technical evaluation that
12 I think we would be prepared for, but it would get into
13 issues like application of LNT and - versus thresholds
14 associated with application of dose impact and so forth.
15 And that's just one thing.
16 There are the other things that would
17 certainly come into evaluation also.
18 MR. WITT: And another thing with all these
19 issues is that there are much broader policy issues than
20 just this one specific aspect of spent fuel pools.
21 I think it applies to all the regulatory
22 activities that the NRC conducts.
23 MR. WITT: And other agencies as well in
24 protecting the public.
25 CHAIRMAN ARMIJO: I had - are you finished

1 with your slide, Steve? Other alternatives. Okay,
2 there you are. That's the one I anted to get to.
3 MR. JONES: All right. There were other
4 alternatives. Alternative loading patterns, for
5 example, going to a less dense configuration than even
6 the current regulations or requirements called for.
7 However, there are limits to that as far
8 as available pool storage space. Not all plants can
9 get to much lower density configurations or - I'm sorry,
10 fuller distribution of the hot fuel among the colder
11 fuel due to limits on the storage space.
12 Direct offload of fuel into more - into the
13 required patterns is also an area that might potentially
14 have benefits, but there is effects then on reactor
15 conditions during refueling particularly.
16 And then, finally, enhancement of
17 mitigation strategies, we think the existing mitigation
18 orders have established quite a robust capability to
19 provide mitigation for spent fuel pool accidents and
20 not much areas for further improvement there.
21 So, overall we considered these changes,
22 but determined that they wouldn't for the same reasons,
23 really, as the expedited transfer of fuel, wouldn't
24 provide a substantial safety enhancement such that
25 further study and regulatory action would be warranted.

1 CHAIRMAN ARMIJO: In the spent fuel pool
2 study, the Peach Bottom loading pattern of the one by
3 eight -
4 MR. JONES: Right.
5 CHAIRMAN ARMIJO: - seemed to have a really
6 powerful effect in reducing the likelihood of getting
7 into a problem. And, you know, certainly if it could
8 be done, would be very low cost compared to cask loading
9 and expedited and things like that.
10 It's something that could - and maybe it's
11 only limited to BWR 4's spent fuel pools. I don't know.
12 But in the cost-benefit analysis, that would come out
13 very favorable, I suspect, if it worked for maybe just
14 only one set, one group of pools.
15 Did you look any further than that? You
16 know, the cost of that can't be very much. Of course
17 nothing is cheap in this business, but -
18 MR. JONES: We didn't do a strip cost-benefit
19 analysis. However, there are several pools that can't
20 quite reach that due to absolute limits on the storage
21 capacity, as I mentioned.
22 Other things come into play with regard to
23 how the existing storage locations are used. The
24 technical specifications may include, you know, storage
25 locations that aren't suitable for fuel or that are

needed for other equipment storage that's not really, you know, addressed directly, but, you know, highly activated components are routinely stored in the spent fuel pool and they take up some of the space that might otherwise be available for fuel storage.

CHAIRMAN ARMIJO: But if you weren't limited by those kinds of concerns, wouldn't that be just something of good practice? It's really low probability, but it doesn't cost very much.

MR. JONES: I think it's something that I think we have addressed.

MR. WITT: Yeah, we did have that in the COMSECY. We did identify to the Commission that we would communicate this to the industry and they could pursue it.

There may be benefits, but we just don't feel that this would pass our regulatory thresholds in terms of a substantial safety enhancement to warrant regulatory action.

So, we thought the best step was to identify this to the industry and let them figure out if they want to do it or not.

CHAIRMAN ARMIJO: Okay. Next slide.

MR. JONES: Conclusions. Okay. Just real briefly again the safety goal screening using the

1 quantitative health objectives determined that the
2 potential benefits were a very small fraction of the
3 safety goals. And, therefore, it wouldn't be justified
4 to continue with the regulatory action.
5 And the cost-benefit analysis determined
6 that there's only, if any - for the most part, the costs
7 outweigh the benefits. But if there are any cases where
8 the benefits outweigh the costs, they're very marginal
9 and might be overcome by, as we mentioned, changes in
10 the assumptions and other factors not fully evaluated
11 yet, but we think that will change based on further,
12 more detailed analysis of some of our input assumptions.
13 Based on the generic assessment of the
14 cost-benefit analysis, we don't feel that additional
15 studies are necessary to evaluate spent fuel pool
16 transfer and the potential added risks involved with
17 that storage situation in addition to further refining
18 some of the input assumptions we've already considered
19 here. And, therefore, we also recommend no further
20 regulatory action on this issue.
21 And that's it.
22 MR. WITT: We do have this slide on upcoming
23 activities. As I'm sure you are aware, there is an ACRS
24 full committee meeting.
25 CHAIRMAN ARMIJO: We're aware of that.

1 (Laughter.)

2 MR. WITT: And the Commission originally

3 planned to have a meeting on this next week, but that

4 did get postponed to early January. So, that will be

5 happening in early January.

6 CHAIRMAN ARMIJO: Excellent. With that, if

7 you're finished, let's go to comments from the committee

8 members.

9 Joy.

10 MEMBER REMPE: They've done a lot of work,

11 but I have brought up a couple of places where Table

12 2 needs to be updated, assumptions, I think, should be

13 more clearly documented and John's comments about the

14 tables where values seem to be inconsistent.

15 And so, clearly by the December meeting I

16 hope some of those issues are identified or clarified

17 for us.

18 And I don't know how to deal with some of

19 these other issues that it's already gone to the

20 Commission and if there's an errata sheet or I don't

21 know how that can be resolved.

22 CHAIRMAN ARMIJO: I'm sure the staff has ways

23 to say, hey, look, there's an error here. But if those

24 things were sorted out before our December meeting,

25 which would, you know, they're solved, we don't have

1 to comment on that.

2 MR. WITT: Yeah, we'll definitely

3 investigate how to pursue that.

4 MEMBER REMPE: If we could see the corrected

5 tables before our December meeting, it would be nice

6 so we're not just trying to think on the fly at the

7 meeting. That would be helpful.

8 MR. WITT: Sure.

9 MEMBER STETKAR: That would be next week,

10 and Thanksgiving is next Thursday. Just keep that in

11 mind.

12 (Laughter.)

13 (Discussion off the record.)

14 MEMBER STETKAR: Perspective on time is

15 important often.

16 MEMBER REMPE: Yeah.

17 CHAIRMAN ARMIJO: Yeah, we can forget.

18 All right, Charlie.

19 MEMBER BROWN: Since I'm not an expert on

20 all these fragilities and other goodies that you all

21 were tossing around, I did enjoy and learned a lot from

22 a bunch of the questions you all did ask relative to

23 this on the diversity of assumptions and the bias that

24 we use to come to the conclusions.

25 And I really rogered up mostly to, I guess,

1 Pete's comment about seeing a set of the two
2 alternatives, you know, do you do it or do you not do
3 it, evaluated with the same assumptions with no biases
4 in there, the same, you know, relative uncertainties
5 and stuff being the same and then doing your variations.
6 So, if I was a decision-maker, that's what
7 - the way I thought about it. That's what I would have
8 liked to have seen. In whole, I thought that was an
9 excellent comment relative to it's hard to tell with
10 all these different biases thrown in.
11 I understand the basis for what you all were
12 doing and what you were aiming at, but I think that,
13 to me, that was the missing piece. That sounds like
14 the train has left the station and the piece of paper
15 is out, so - but that's what I reckon I'll pass on to
16 Mike.
17 MEMBER RYAN: I don't have anything else to
18 add to the comments made already. Thank you.
19 CHAIRMAN ARMIJO: John.
20 MEMBER STETKAR: Couple of things. First
21 of all, I like the fact that you've kind of pulled the
22 QHO stuff and the safety perspective into, you know,
23 a little bit better focus in this version compared to
24 the draft that we saw. I think that helps a lot.
25 It's short and sweet, but it at least draws

1 people's attention to it. And I guess I don't have
2 anything else.
3 I do understand, you know, my kind of
4 engineering hat notwithstanding, I do understand the
5 reasons that the staff made the assumptions to try to
6 bias things toward the alternative. I understand that
7 as an engineer. I don't like to work that way, but I
8 get it.
9 Whether the report makes it so glaringly
10 obvious that the deck was stacked that way, I think,
11 remains to be seen when you have people who are not
12 involved in this long drawn out process, you know,
13 reading this report.
14 And I don't think the staff can read it
15 objectively, because you know what you did. And, quite
16 honestly, we've been involved with it long enough that
17 we can't read it with a fresh set of eyes either. And
18 I think I'll just leave my comments at that.
19 CHAIRMAN ARMIJO: Okay, Steve.
20 MEMBER STETKAR: We've had a good discussion
21 here today. I did want to take this time to remark about
22 how well I feel the work that has been done in this area
23 over the past few years including, of course, the spent
24 fuel pool study being developed and then used as the
25 basis for a lot of the work in this evaluation, how well

1 that work has been done, how much effort has gone into
2 it, how much engineering evaluation has been done.
3 I was - and with regard to that, I was a
4 little disappointed in the evaluation that was done
5 here, in fact, going back and pulling in work that was
6 done, 15, 20, 25 years ago to try to assure that
7 conclusions that were reached way back when, when we
8 didn't have the analysis capability that we do today,
9 that even those evaluations and analyses and results
10 were kind of pulled in to make sure everything was
11 covered and that we used conservative assumptions to
12 bound things that were concluded many, many years ago.
13 I'm not sure that was - from one
14 perspective, it was a good thing to do. But in terms
15 of doing a strict and detailed engineering evaluation,
16 one could have used what was developed for the spent
17 fuel pool study.
18 And, again, if you had done that, you would
19 have demonstrated even more clearly that there's no
20 differentiation between Alternative 1 and 2.
21 With regard to the discussions we've had
22 today as we said in several different ways, making
23 assumptions about what will be applicable to Alternative
24 1 versus Alternative 2 based upon different engineering
25 assumptions, if you will call it that, which are not,

1 in fact, practically real, creates a situation wherein
2 the results may be taken improperly out of context.
3 And as we've said, one may attribute to
4 Alternative 1 that you can't mitigate the accident.
5 Where, in fact, as we discussed, either event can be
6 mitigated.
7 So, I think going forward we need to
8 continue to realize what assumptions we've made here
9 for the purposes of performing the analysis we've done,
10 but we need to - we need to retain the knowledge that
11 we made those assumptions for a particular purpose that
12 is documented here. And those assumptions should not
13 be taken forward to presume that the risk associated
14 with spent fuel pool accidents is documented in this
15 study.
16 It's documented in the spent fuel pool study
17 very nicely. And when you rack up all of the
18 conservatisms that are in that study and take them out,
19 you see an extremely low likelihood of event and
20 extremely low consequence.
21 It's almost difficult to describe
22 associated with the risk of spent fuel pool accident
23 and consequence.
24 CHAIRMAN ARMIJO: Dick.
25 MEMBER SKILLMAN: Thank you for your

1 presentation. I would like to suggest that what you've
2 included in your regulatory analysis in Section C3,
3 implementation assumptions, deserves some
4 accreditation in your conclusions specifically what it
5 takes for plant staff to move all of that fuel, the risks
6 associated with dropping a fuel assembly versus dropping
7 a cask or both.
8 Those are real risks. And if one were to
9 simply glance at this study and say, well, the cost
10 benefit shows that it really is not beneficial to do
11 all these moves, it seems the Commissioners ought to
12 realize if they were to move to want early transfer,
13 there is a whole other side of risk associated with it.
14 It seems to me that that's mighty important, because
15 of people like us that do this work.
16 The second thing I'll let Harold touch on
17 as he wishes to with the issue of the number of casks
18 and what it would take to obtain all of those casks,
19 but those two items are the objective of your C3 writeup.
20 And it seems like a piece of each of those should be
21 flagged in your conclusions. Thank you.
22 CHAIRMAN ARMIJO: Okay, Harold.
23 MEMBER RAY: Okay. I just want to say that
24 I think that we are over - we may be overrelying on the
25 idea that the quantitative health objectives are the

1 principal criterion for something of this kind.

2 And that because others may not see that

3 as clearly, the fact - and for reasons Steve himself

4 mentioned, the claims benefit is relevant and not just

5 something that can be easily dismissed, because the QHOs

6 are what they are.

7 We've all said it, I've said it, there isn't

8 alternative but to, I guess, reiterate the importance

9 now of making clear that the cost benefit was what it

10 is, but I'll just say I'm concerned - the principal

11 concern is that we are too prepared to say, oh, well,

12 look at the QHOs. That's what you've got to do first.

13 And if that isn't met, then the rest doesn't matter.

14 And in any case, it's, in our judgment, doesn't justify

15 doing anything further.

16 I don't think it's fair to ask others to

17 look at things that way. And for that reason, how the

18 cost benefit is presented becomes, I think, more

19 important than we've treated it here probably

20 inadvertently, but for other reasons, I mean, than that

21 it was definitive or dispositive of what should be done.

22 But it is what it is, like I say. And,

23 therefore, I'm concerned going forward that it will

24 assume a life that it wasn't intended to have, but that

25 there won't be anything then we can do about it and it

1 will just have to be worked through on the basis that
2 people are inclined to believe that there is sufficient
3 benefit to warrant the cost. And that would be a very
4 unfortunate conclusion. That's it.
5 CHAIRMAN ARMIJO: Ron.
6 MEMBER BALLINGER: I'd like to just go over
7 what Steve has said. There's an awful lot of work that's
8 been done.
9 With respect to this document, though, I'm
10 concerned that the original goal was to sort of find
11 out or demonstrate that there was no benefit.
12 I think what we may have done is to just
13 show the opposite in the sense that he said no further
14 work needs to be done.
15 I think maybe what the sort of
16 cherry-picking of assumptions, if you want to use it
17 that way, different things, what we've really done is
18 to make an argument for further work.
19 And in this environment that we live in,
20 I guess the horse is out of the barn, the report is issued
21 and all that stuff, but I just don't think it's going
22 to end there. And so, I don't think we've heard the
23 last of it. I think we're going to - we have not.
24 CHAIRMAN ARMIJO: Okay, Dr. Banerjee.
25 MEMBER BANERJEE: Sam, are we going to write

a letter on this?

CHAIRMAN ARMIJO: I can't help it. Absolutely, we are going to have to write a letter. I think we have an SRM that -

MEMBER BANERJEE: Well, we are going to -

CHAIRMAN ARMIJO: Typically, we would write a letter.

MEMBER BANERJEE: We need to, I guess, separate the spent fuel pool study from this study, right?

CHAIRMAN ARMIJO: Sure.

MEMBER BANERJEE: So, in some ways I have the same concerns as Ron has. I don't think that this has come to an end here.

And part of it is because there's enough grounds to demand more work be done to quantify the benefits. And I can understand as John said, why you went about doing things the way you did, which was to give the best shot to, you know, moving fuel into casks and quantifying those benefits as large as they seemed feasible in some way.

But in doing that, I think you've opened up some issues which we probably need to get addressed. So, we really need to think about how to address this.

CHAIRMAN ARMIJO: Yeah, in our letter.

1 MEMBER BANERJEE: Yes, this is really -

2 CHAIRMAN ARMIJO: It will be up to the

3 Committee what direction they want to take.

4 MEMBER BANERJEE: Yeah. So, I think it's

5 going to probably remain an open issue for a while.

6 Anyway, that's my -

7 CHAIRMAN ARMIJO: Pete.

8 MEMBER RICCARDELLA: I don't have anything

9 to add that wouldn't be redundant to what my colleagues

10 have already said.

11 CHAIRMAN ARMIJO: Okay. Well, on behalf of

12 the Subcommittee, first of all, we may have given you

13 a very hard time, but that's just -

14 PARTICIPANT: I'm sure it was intentional.

15 (Laughter.)

16 CHAIRMAN ARMIJO: And I'm sure you enjoyed

17 it, but I'd like to say you've done a ton of work. We

18 know it was on a tough time schedule and this new version

19 is a definite improvement over the draft that we saw

20 earlier. There are still some matters.

21 And before I open it up for public comment,

22 I want to just summarize just two points that I had that

23 kind of a little bit repeats what everybody else has

24 said.

25 The philosophy of trying to maximize the

1 benefits of Alternative 2, you know, I guess I see some
2 art, some value in that, but I think what really the
3 analysis philosophy should be, to show what is the
4 inherent advantage of the alternative. What's built
5 into it?
6 And when you start dicing it with
7 assumptions that favor one advantage, one alternative
8 versus the other, you lose the inherent advantage of
9 the option.
10 And there could be some situations where
11 Alternative 2 has built in without any crutches or favors
12 of built in advantage, but I don't think it's there,
13 but it could be.
14 So, I kept looking for analyses that show
15 inherent advantage, and that's when - the way you get
16 that is by just same assumptions for either case where
17 it's appropriate.
18 Then the other point I made is in the
19 sensitivity studies and even in the basic studies, I
20 just don't see the - how one can count the person-rem
21 costs of - that are accumulated by people who are living
22 in an area that meets habitability criteria. I don't
23 think you can have it both ways.
24 If there's a person-rem cost that you really
25 believe should be maybe people shouldn't be living

1 there, something is wrong here. You can't have it both
2 ways. So, anyway, I leave it at that.
3 I should have probably earlier asked for
4 a comment from members of the public. I know Dr. Lyman
5 was going to be on the bridge line. I hope he's still
6 on.
7 Maybe we could open up the bridge line and
8 see if he cares to make some comments. And is there
9 anyone in the room that would like to make a comment?
10 There's no one in the room. So -
11 MR. LYMAN: Yes, I am on the bridge line.
12 Can you hear me?
13 CHAIRMAN ARMIJO: Okay. Yes, please go
14 ahead.
15 MR. LYMAN: Thanks. Well, we've already
16 gone on the record with regard to our views on this issue.
17 I'm not going to go over that.
18 But I would like to address the issue that
19 Dr. Armijo has raised repeatedly, and that's the issue
20 of accounting for the dose for people who return to their
21 home.
22 And the confusion here is that the
23 habitability criteria are based on limiting individual
24 risks. So, what you're talking about here is an
25 assessment of the societal risk, the cumulative risk.

1 So, even though individual decisions to
2 return are based on an incremental individual risk which
3 society judges to be acceptable on an individual basis,
4 that the cumulative impact of all those people who are
5 allowed to return because their individual risks are
6 limited, that that cumulative impact could be
7 considerable and that's what you're evaluating here.
8 So, there is a mismatch between the criteria
9 that are used to determine habitability and those that
10 would be used to evaluate whether the cumulative
11 societal impact is unacceptable. So, that's the issue.
12 And putting aside whether there's a
13 threshold or not, because I - well, I think, I mean,
14 there is no - well, I don't want to get into that
15 argument.
16 (Laughter.)
17 CHAIRMAN ARMIJO: Yeah, look, I appreciate
18 that point. And I got to think about it some more, but
19 I appreciate you bringing it up.
20 MR. LYMAN: Yeah. And you have to look at
21 the societal impact of what has happened with a much
22 smaller cesium release from Fukushima and the decisions
23 that those people have to make, because the Government
24 judges if they can return to their homes, it's safe for
25 them to return.

1 Plus the dose, you know, if you're talking
2 about a 20 millisievert per year or something, that is
3 a considerable additional risk of dose background.
4 So, they have to make these decisions based
5 on whether to return to their home if they're not going
6 to be compensated, because the Government says it's
7 safe. And so, that's an additional layer that's just
8 not present.
9 The other thing I wanted to say was if you're
10 going to start looking at things like the - a factor
11 of two difference in the cross-side of the equation,
12 then you need to look at uncertainties that lead to
13 significant differences and benefits as well.
14 And there are assumptions built in, I'd be
15 happy to show them to the Committee, that would lead
16 to a factor of ten or more increase in benefits depending
17 on additional sensitivities other than what the staff
18 has looked at.
19 So, there are additional uncertainties of
20 both sides, and I'll stop there. Thank you.
21 CHAIRMAN ARMIJO: Okay. Thank you, Dr.
22 Lyman. I think unless we have any other comments -
23 staff, nothing more? We've certainly made our
24 comments.
25 Again, thank you very much. We're about

1 ten minutes behind schedule, but good job. We're
2 adjourned.
3 (Whereupon, at 12:10 o'clock p.m. the
4 meeting was adjourned.)
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U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Japan Lessons Learned Tier 3 Issue: Expedited Transfer of Spent Fuel to Dry Cask Storage

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ACRS Subcommittee Briefing

November 19, 2013

Agenda

- Background
- Tier 3 Evaluation Process
- Regulatory Analysis Modeling, Assumptions, and Results
- Upcoming Meetings

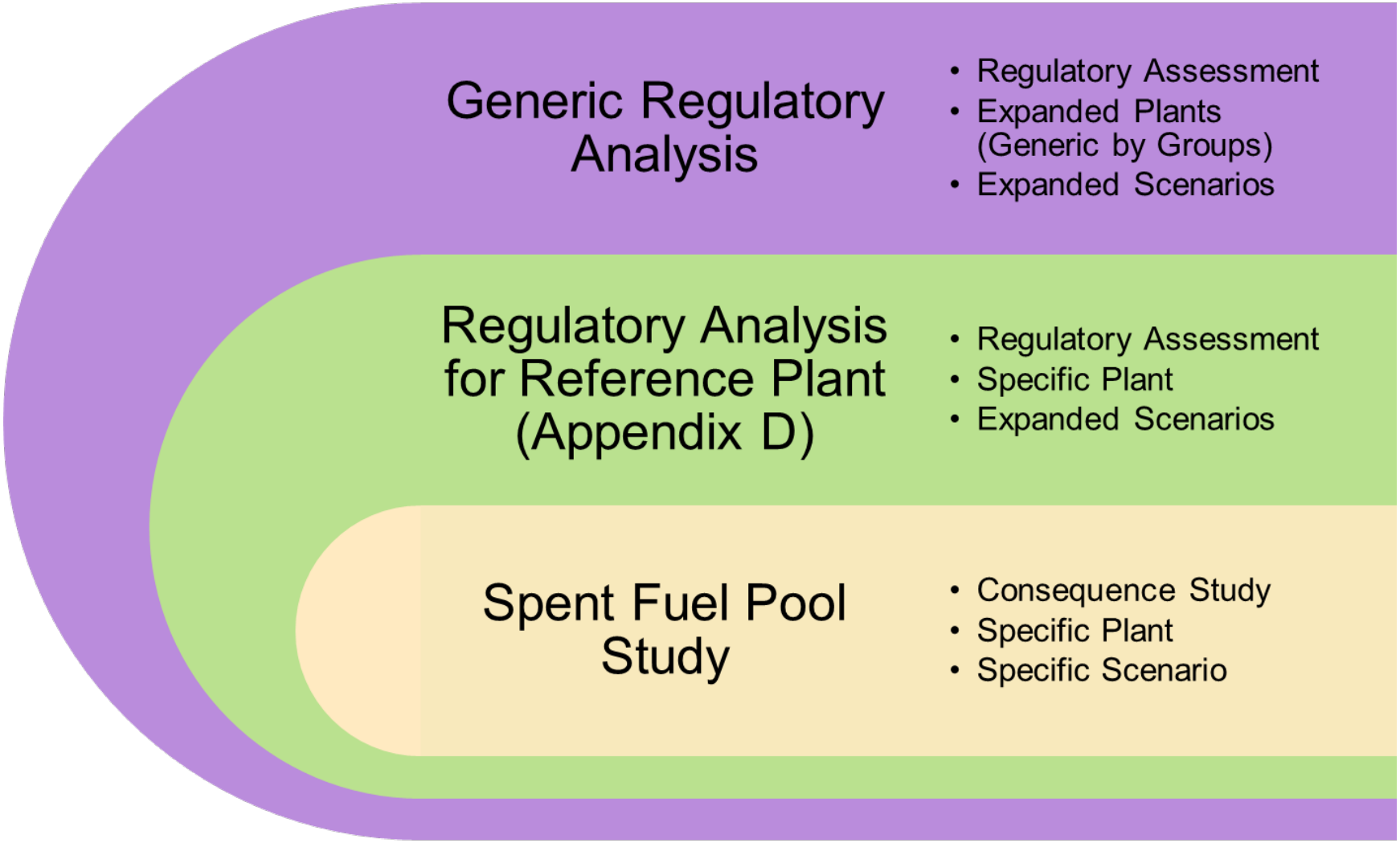
Background

- Tier 3 Project Plan:
  - Determine whether the NRC should consider expedited transfer of spent fuel to dry casks
    - » Follows normal regulatory process utilizing Regulatory Analysis Guidelines (NUREG/BR-0058)
    - » Utilizes information from past SFP evaluations and the SFPS
  - Current phase evaluates whether additional studies are necessary to determine if regulatory action might be warranted
    - » Conservative analysis that maximizes calculated benefits of expedited transfer (i.e., not best-estimate risk study)
    - » Provides information for decision regarding further research
  - May 2013 Memo provided updated plan to Commission

Stakeholder Interactions

- Two public meetings held (August 22 and September 18)
  - Questions involving both SFPS and Expedited Fuel Transfer
  - Responding to letters received from stakeholders
- Spent Fuel Pool Study
  - Draft issued for public comment - June 2013
  - Written comments addressed in final report - October 2013
- Expedited Transfer Memorandum and Regulatory Analysis
  - Draft issued for public review - September 2013
  - ACRS Presentation – October 2013
  - Non-concurrence from NRC staff
  - In response to stakeholder feedback, the staff provided additional detail addressing specific issues and reformatted analysis for clarity

Overview


Generic Regulatory Analysis
• Regulatory Assessment
• Expanded Plants (Generic by Groups)
• Expanded Scenarios
Regulatory Analysis for Reference Plant (Appendix D)
• Regulatory Assessment
• Specific Plant
• Expanded Scenarios
Spent Fuel Pool Study
• Consequence Study
• Specific Plant
• Specific Scenario

Generic Regulatory Analysis

- **Spent Fuel Pool Study (Appendix D) and Tier 3 Regulatory Analysis consider initiating events beyond the event in SFPS:**
  - more severe earthquake
  - cask drop
  - loss of power/loss of coolant inventory events
- **Tier 3 Regulatory Analysis covers all SFP designs used with operating reactors in the Eastern and Central U.S.**
  - PWRs and BWRs with Mark III containments (spent fuel stored in at-grade pool separate from reactor building)
  - Western plants to be revisited following seismic re-evaluations
  - new reactors (AP-1000)
- **Assessment of security events handled separately**
  - regulatory changes implemented (e.g., 10 CFR 50.54(hh))
  - effect of security changes reflected in regulatory baseline

Tier 3 Evaluation Process

- Safety Goal Screening Evaluation
  - Based on the Commission Safety Goal Policy Statement
  - Used the Quantitative Health Objectives to evaluate achievement of the safety goals
- Cost/Benefit Analysis
  - Intended to identify maximum potential benefit
  - Analyzes costs and benefits for representative pool design groups
- Sensitivity Studies
  - Evaluates key factors to illustrate their effect on the final result

Safety Goal Screening

Bounding Release Frequency

- Bounding frequency of SFP release about 1 in 29,000 years (3.46×10^{-5} per year)
- Regulatory Analysis Table 43, High Estimate for Group 4 (highest total release frequency)

Conditional Probability of Fatal Cancer

- Conditional probability of an individual developing a fatal latent cancer within a ten-mile radius calculated to be 4.4×10^{-4} given a large SFP release from high-density pool (SFPS Table 34)
- Linear – no-threshold model with protective actions implemented

Individual Latent Cancer Fatality Risk

- Conservative latent cancer fatality risk estimate to an average individual within ten miles of 1 in 66 million (1.52×10^{-8} per year)
- Less than one percent of the individual risk goal of less than one-tenth of one percent of the average chance of developing a fatal cancer in the U.S. (2×10^{-6} per year)

Safety Goal Screening Results

- Marginal safety benefit based on comparison with QHOs
  - No risk of fatalities due to nature of release
  - Potential benefit is a very small fraction (0.76%) of latent cancer goal
  - Cancer risk relatively insensitive to magnitude of release due to slow accident progression and effective protective actions (SFPS)
- Proceeded to cost/benefit analysis even though process allows stopping when evaluation shows safety benefit below threshold of safety goal screening

Cost-Benefit Analysis Overview

- Evaluated one alternative - Expedited Transfer
  - Transfer fuel with more than 5 years decay to dry casks
  - Store remaining fuel in low-density configuration in existing racks
- Established Seven SFP Groups
  - Three groups not evaluated due to low risk
  - Four groups evaluated representing operating and new plants
- Major Assumptions (Regulatory Analysis Table 2)
  - Initiating SFP Event Frequencies and Accident Progression
  - Economic modeling (e.g., definition of representative plants, future spent fuel discharge projections, etc.)
  - Timing (e.g., dry cask storage loading, occupational dose, etc.)
- Established a base case
- Performed sensitivity studies

Assumptions to Maximize Calculated Benefit

- Release fraction and mitigation effectiveness assumptions provide conservative estimate of potential benefit
- Regulatory Baseline – Maintain the Existing Spent Fuel Storage Requirements
  - High cesium release fractions (SFPS value of ~40% for Elevated Pools and NUREG-1738 value of 75% for other groups in base case)
  - Ineffective mitigation (all fuel heat-up events lead to large release)
- Expedited Transfer Alternative - Low-density Spent Fuel Pool Storage
  - Low cesium release fractions (SFPS value of 3% for all groups in base case)
  - Effective mitigation (19 of 20 fuel heat-up events result in no release due to effective mitigation)

Base Case Analysis

- Staff considers base case appropriate for decision whether to pursue additional studies to refine assumptions
- Base case includes appropriately conservative assumptions, but not bounding values, for the following:
  - Initiating Events (USGS 2008 information for Peach Bottom seismic hazard, and NUREG-1738 and NUREG-1353 for other initiators)
  - Seismic liner fragilities (based on results of SFPS and NUREG-1738)
  - Cesium inventories for each group (based on SFP capacity, reactor power, and fuel burnup for reactors in group)
  - Plume dispersion (uses MAACS2 and Peach Bottom Meteorology)
  - Population density and economic activity (used data for Surry)
  - Industry implementation costs (EPRI information modified for representative site)

Base Case Analysis (Continued)

- Uncertainty regarding spent fuel pool conditions (i.e., pool water level, fuel distribution, and location of liner tears)
  - Generally make bounding assumption of inadequate heat removal if fuel is uncovered for base case
  - Results in dominant initiating events progressing to fuel heat-up
  - Conservative because SFPS and other studies indicate substantial potential for air cooling when pool is drained or decay heat is low
  - Exception for Mark I and II BWRs
    - SFPS reduces uncertainty for specific scenario evaluated
    - Used SFPS information of 8% inadequate cooling for 0.7g PGA quake

Effect of Assumptions

- Seismic event frequencies
  - Peach Bottom frequencies used, which falls close to the upper end of all sites evaluated
  - Lower than bounding site (Sequoyah) by factor of ~3.4
- Population Demographics
  - Surry population demographics used
  - About mean population density (above median) of all plant sites evaluated
  - Use of 90th percentile demographics would increase benefits within 50 miles by about 28 percent
- Other assumptions have smaller impacts

Base Case Frequencies

Event	Base Case Frequency	Pool Liner Fragility	Inadequate Cooling	Fuel Heat-up Frequency	Comments
Seismic Bin 3 (0.7g PGA)	Peach Bottom				
Elevated Pool	1.65×10^{-5}	10%	8%	1.35×10^{-7}	SFPS result
At-Grade Pool	1.65×10^{-5}	5%	100%	8.25×10^{-7}	
Seismic Bin 4 (1.2g PGA)	Peach Bottom				
Elevated Pool	4.90×10^{-6}	100%	100%	4.90×10^{-6}	
At-Grade Pool	4.90×10^{-6}	50%	100%	2.45×10^{-6}	
Cask Drop All Pools	2.0×10^{-7}	100%	100%	2.0×10^{-7}	Not always credible
Other Initiators					
Elevated Pool	2.37×10^{-7}	Not Applicable	100%	2.37×10^{-7}	
At-Grade Pool	2.67×10^{-7}		100%	2.67×10^{-7}	
Total					About 90% seismic contribution
Elevated Pool				5.47×10^{-6}	
At-Grade Pool				3.74×10^{-6}	

Cost-Benefit Analysis Results

- Base case costs outweigh benefits
  - Benefits based on $2000/person-rem within 50 miles
  - Changes in discount rate do not change result
- Sensitivity Analyses ($4000/person-rem and analysis beyond 50 miles) produce marginal benefits
  - Base case costs outweigh benefits for Groups 1 & 2
  - Base case benefits marginally outweigh costs for Groups 3 & 4
- The staff considers the base case an appropriately conservative analysis for use as the primary basis for the staff's recommendation that additional studies not be pursued and Tier 3 issue be closed.

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Safety Perspectives

- Pools provide adequate protection and defense-in-depth
- Overall estimated frequency of damage to stored fuel is low
  - Base case release frequencies for existing pools are on the order of a few times in a million years
  - These frequencies exclude effective deployment of mitigation capability and generally exclude consideration of air cooling (SFPS)
- Spent Fuel Pool Maintains Defense-in-Depth
  - Defense-in-depth consists of layers of protection with reliability of each layer commensurate with the frequency of challenges
  - SFP designed to prevent coolant inventory loss under accident conditions, which results in a low frequency of coolant inventory loss
  - Fuel dispersal, coolant makeup, and spray capability have reliability commensurate with the low frequency of coolant inventory loss

Use of QHOs for Screening

- Acknowledge that current safety goal screening, including QHOs, developed for reactor accidents
- Recognize that SFP accidents could result in larger affected areas and populations
- Could develop alternate societal measures but with continued focus on public health and safety (SRM for SECY-12-0110)

Other Alternatives

- Examples include:
  - Alternative loading patterns
  - Direct offload of fuel into more coolable patterns
  - Enhancement of mitigation strategies
- Staff has considered these possible changes but determined that they do not provide a substantial safety enhancement such that generic regulatory action would be warranted

Conclusion

- The safety goal screening evaluation concludes that SFP accidents contributes less than 1% to the overall risks for public health and safety. Enhancements to SFP designs or operations or would therefore provide only minor or limited safety benefit.

- The staff conducted a cost-benefit analysis, which finds that the added costs involved with expedited transfer of spent fuel to dry cask storage to achieve the low-density SFP storage alternative are not warranted in light of the marginal safety benefits from such an action.

Conclusion (Continued)

- Based on the generic assessment and the other considerations detailed in this paper, the staff finds that additional studies are not needed to reasonably conclude that the expedited transfer of spent fuel to dry cask storage would provide only a marginal increase in the overall protection of public health and safety, and would not be warranted due to the expected implementation costs

- **No further regulatory action is recommended for the resolution of this issue**

Upcoming Meetings

- Final COMSECY-13-0030
  - Signed November 12, 2013
- ACRS Meeting
  - Full Committee in December
- Commission Meeting on Spent Fuel Safety
  - January 2014

Backup Slides

Groups

1. BWR Mark I / II with non-shared spent fuel pool (SFP) located well above grade (Excluding Western U.S. Reactor - Columbia)
2. PWR & BWR Mark III with non-shared SFP located at grade with at least one exposed side (Excluding Western U.S. Reactors – Diablo Canyon and Palo Verde)
3. Combined Operating License Holder SFPs (AP-1000)
4. PWRs with Shared SFPs
5. SFPs located below grade with backfill on all sides (low probability of inventory loss, but evaluated with Group 2)
6. SFPs at decommissioned plants (fuel in pool) (not evaluated based on low decay heat rate)
7. Sites where fuel is in dry casks

Release Sequence of Events

Initiating Events
- Bin 3 Seismic Event (0.7g PGA)
- Bin 4 Seismic Event (1.2g PGA)
- Cask Drop

AC Power Fragility
- Reflects unreliability of both AC power and installed makeup systems for event mitigation
- Installed makeup systems often inadequate to mitigate significant damage even if AC power available

Liner Fragility
- Reflects likelihood of coolant inventory loss that uncovers the fuel given the initiating event
- Uncertainty in seismic response of pool liner to events well beyond design basis; near certainty for cask drop

No Air Cooling
- Reflects likelihood that air circulation inadequately cools fuel given fuel has been uncovered
- Inadequate cooling could result from: recently discharged fuel, non-dispersed configuration, and partial drainage states

Fuel Heat-up
- Product of values of above items plus other initiators that involve evaporative loss of coolant inventory
- Values for frequencies of other initiators drawn from prior studies (i.e., NUREG-1738 and NUREG-1353)

Mitigation Failure
- Applied to maximize benefit of expedited transfer
- Reduces frequency of release for low-density storage states by a factor of 19; high density release frequency unaffected

Release
- Combined with estimated consequences of release to obtain risk metrics
- Consistent with past studies, seismic events continue to dominate release frequency

Consequence Analysis

Cesium Inventory

- Calculated for representative plants based on licensed power, licensed inventory and burnup
- Selected from plants within each group
  - Base case used inventory representative of average inventory of plants in group

Release Fraction

- High-density base case uses 40% for Group 1 (SFPS) and 75% for other groups
- Low-density base case uses 3% (SFPS result for low-density unmitigated scenario)

Release Plume

- MAACS2 Model using Peach Bottom Meteorology
- Plume characteristics based on MELCOR release information from SFPS

Health and Economic Effects

- Relocation Based on Protective Action Limits
  - Base Case used 2 rem first year / 500 mrem thereafter
- Linear – No-Threshold Dose-Response Model
- Population Density and Economic Activity based on mean site (Surry) for base case

Accident Progression – Group 1

Parameter	Base Case	High Est.	Notes
Site seismic hazard • Bin 3 (0.7g PGA) • Bin 4 (1.2g PGA)	Peach Bottom 1.65×10^{-5} 4.90×10^{-6}	Limerick 2.24×10^{-5} 7.09×10^{-6}	Limerick is Group 1 site with highest seismic hazard
Liner fragility • Bin 3 (SFPS) • Bin 4 • Cask Drop	 10% 100% (bounding) 100%	 100% (bounding) 100% (bounding) 100%	For high estimate, specified initiators always result in coolant inventory leak
Insufficient nat. circ • Bin 3 • Bin 4 • Cask Drop • Other Initiators	 8% 100% (bounding) 100% (bounding) 100% (bounding)	 100% (bounding) 100% (bounding) 100% (bounding) 100% (bounding)	High est. never air coolable – bounds: • uniform dist. • partial drain • closed cell racks
Release Fraction • Alternative 1 • Alternative 2	 40% 3%	 90% 5%	Alternative 2 models successful mitigation - additional factor of 19 reduction

Accident Progression – Groups2- 4

Parameter	Base Case	High Est.	Notes
Site seismic hazard • Bin 3 (0.7g PGA) • Bin 4 (1.2g PGA)	Peach Bottom 1.65×10^{-5} 4.90×10^{-6}	[Highest in Group] 2.9×10^{-5} to 5.6×10^{-5} 9.1×10^{-6} to 2.0×10^{-5}	Highest Hazard Sites: Gr. 2: Watts Bar Gr. 3: Summer Gr. 4: Sequoyah
Liner fragility • Bin 3 • Bin 4 • Cask Drop	 5% 50% 100%	 25% 100% (bounding) 100%	Bin 4 Earthquake and cask drop always result in loss of coolant inventory
Insufficient nat. circ • Bin 3 • Bin 4 • Cask Drop • Other Initiators	 100% (bounding) 100% (bounding) 100% (bounding) 100% (bounding)	 100% (bounding) 100% (bounding) 100% (bounding) 100% (bounding)	Base & High case not air coolable – bounds: • uniform dist. • partial drain • closed cell racks
Release Fraction • Alternative 1 • Alternative 2	 75% 3%	 90% 5%	Alternative 2 models successful mitigation - additional factor of 19 reduction

Source Term (MCi Cesium)

Group	Low Est.	Base Case	High Est.
Source term	**Alt 1/Alt 2**	**Alt 1/Alt 2**	**Alt 1/ Alt 2**
Group 1 (BWR)	40.6 / 19.8	52.7 / 22.0	63.3 / 26.4
Group 2 (PWR)	57.4 / 15.7	67.9 / 17.4	78.2 / 20.9
Group 3 (New)	33.7 / 15.7	44.4 / 17.4	54.2 / 20.9
Group 4 (Shared)	63.6 / 31.4	101.1 / 34.8	142.2 / 41.8

Regulatory Analysis Inputs

Parameter	Low Est.	Base Case	High Est.
Dose Consequence Analysis			
Population density & demographics	169 people/sq.mi. (Palisades)	**317 people/sq.mi. (Surry)**	722 people/sq.mi. (Peach Bottom)
Weather conditions & modeling	Same as SFPS (Peach Bottom)	**Same as SFPS (Peach Bottom)**	Same as SFPS (Peach Bottom)
Habitability Limit & health effects	500 mrem annual - LNT	**2 rem first year, 500 mrem thereafter - LNT**	2 rem annual - LNT
Evacuation assumptions & modeling	Same as SFPS (Peach Bottom)	**Same as SFPS (Peach Bottom)**	Same as SFPS (Peach Bottom)
Offsite Property Analysis			
Economic data	Site specific using SECPOP2000) (Palisades)	**Site specific using SECPOP2000) (Surry)**	Site specific using SECPOP2000) (Peach Bottom)

COMSECY-13-0030 Encl 1 Regulatory Analysis

- **Revised Format**

EXECUTIVE SUMMARY
1. INTRODUCTION
2. ANALYSIS OF IDENTIFIED ALTERNATIVE
3. SAFETY GOAL SCREENING EVALUATION
4. COST-BENEFIT ANALYSIS
5. CONCLUSION
6. REFERENCES

APPENDIX A: SPENT FUEL POOL CHARACTERISTICS
APPENDIX B: SPENT FUEL STORAGE STRATEGIES
APPENDIX C: ANALYSIS MODEL INFORMATION
APPENDIX D: SENSITIVITY ANALYSIS INFORMATION
APPENDIX E: INDUSTRY IMPLEMENTATION MODEL OF MOVING SPENT FUEL TO DRY CASK STORAGE
APPENDIX F: SPENT FUEL DATA AND TABLES
APPENDIX G: QUESTIONS RAISED BY THE PUBLIC

COMSECY-13-0030 Encl 1 - Table 2

Topical Area	Major Assumption	Comment
Overall Approach	The fleet of U.S. reactor SFPs were classified in the following groups: 1. BWRs with elevated pools 2. PWRs and BWRs with dedicated pools near grade 3. New AP1000 reactors 4. PWRs that share a single pool 5. PWRs with pools that cannot rapidly drain 6. Decommissioning reactors For the first four groups, representative characteristics of the spent fuel and SFP loading conditions that were conservative with respect to the majority of SFPs within each group were selected. The remaining two groups were not evaluated due to the much lower potential for runaway zirconium oxidation.	The configuration of the plant is considered in determining potential bounding conditions regarding the potential drainage paths from the pools and the potential for natural circulation air cooling. The inventory of fuel, reactor thermal power, and fuel burn-up at reactors within each group are considered in determining the representative inventory of radioactive material present in the pool. Plant characteristics and accident progression for BWRs with elevated pools were drawn from the SFPS. Remaining plant characteristics and accident progression assumptions are drawn from NUREG-1353 and NUREG-1738.
Regulatory Baseline Condition	High-density loading configuration with one full core reserve capacity during which mitigation capability is assumed to be ineffective.	This loading configuration approximates the maximum fuel inventory normally maintained in the SFP. The assumption of ineffective mitigation maximizes the potential release frequency.

COMSECY-13-0030 Encl 1 - Table 2

Topical Area	Major Assumption	Comment
Alternative Condition	Low-density loading configuration with fuel decayed more than five years removed from the SFP and mitigation 95% effective.	This loading configuration approximates the minimum fuel inventory for an operating reactor SFP. The assumption of 95% effective mitigation minimizes the frequency of potential releases.
Seismic Hazard Characterization	Seismic hazard models – this analysis used the USGS 2008 model instead of the model currently under development in an ongoing regulatory program. While the USGS (2008) hazard model is not sufficiently detailed for regulatory decisions, it is appropriate to use for this analysis because it was the most recent and readily available hazard model for the central and eastern U.S. plant sites. Hazards for the western sites will be evaluated when the updated model is complete.	A new probabilistic seismic hazard model is currently being developed and will consist of two parts: (1) a seismic source zone characterization and (2) a ground motion prediction equation (GMPE) model. Although part (1) is now complete (Ref. 16), it was not available at the start of this analysis. In addition, the GMPE update is still in progress. Furthermore, the NRC is currently developing an independent probabilistic seismic hazard assessment (PSHA) computer code to incorporate part (1) and part (2) when complete.
Earthquake Frequency	Earthquake frequencies are based on hazard curves developed from 2008 USGS data for two bins having peak ground accelerations of 0.7g and 1.2g, respectively. Large earthquakes with frequencies on the order of a few occurrences every 100,000 years to once every 1,000,000 years have the potential to damage the SFP structure.	The USGS data provides a consistent method of quantifying earthquake frequency east of the Rockies. The low and base cases use the seismic hazard estimate for the SFPS reference plant, which results in higher earthquake frequency estimates than the USGS model for most plants. The high case uses the USGS model results for the site within each group with the highest earthquake frequency.

COMSECY-13-0030 Encl 1 - Table 2

Topical Area	Major Assumption	Comment
Cask Drop Frequency	A cask drop frequency of $2x10^{-7}$ per year is used for each SFP.	This value is drawn from an evaluation in NUREG-1738 and represents the potential for cask drops during routine transfer activities to maintain assumed SFP storage inventory. Additional cask movements associated with achieving low-density SFP storage are conservatively not evaluated.
AC Power Fragility	AC power is conservatively assumed to fail during earthquake and cask drop initiators to reflect loss of installed forced cooling and coolant makeup systems.	This assumption results in loss of forced cooling and other minor coolant leaks progressing to uncover the stored fuel unless mitigation is effectively deployed.
Liner Fragility	The values conservatively selected for the base case are: • 10% (SFPS) – 0.7g earthquake for BWRs with elevated pools • 25% (NUREG-1353) – 0.7g earthquake for all other groups • 100% for the 1.2g earthquake • 100% for the cask drop event	Liner Fragility represents the conditional probability of leakage from the SFP at locations that uncover the stored fuel, given an earthquake or cask drop occurs. The high case uses 100% for all initiators.
Other Initiating Event Frequencies	Loss of forced cooling and loss of coolant inventory events are conservatively represented by a total initiating event frequency of $2.37x10^{-7}$ per year.	Individual initiating events affecting loss of forced cooling, loss of AC power, loss of coolant inventory, and seal failures were drawn from NUREG-1738 and NUREG-1353.

COMSECY-13-0030 Encl 1 - Table 2

Topical Area	Major Assumption	Comment
Unavailability of Natural Circulation Air Cooling – Partial Drain Conditions	The conservative values selected for the base case are: • 8% – 0.7g earthquake for BWRs with elevated pools (SFPS) • 100% – 0.7g earthquake for all other groups • 100% for the 1.2g earthquake • 100% for the cask drop event • 100% for all other initiators	Unavailability of natural circulation air cooling reflects various conditions that could lead to inadequate heat removal and progression to runaway zirconium cladding oxidation. Conditions bounded by this result include: • fuel with high decay heat • recently discharged fuel in a contiguous pattern rather than distributed pattern • partial drain conditions with racks that block air cooling The high case uses 100% for all initiators.
Mitigation	Effective deployment of mitigation is conservatively assumed to reduce the frequency of release for low-density storage cases by a factor of 19.	Conservative assumption to maximize difference in release frequency between low-density and high-density storage configurations.
Release Frequency Determination	The release frequencies are calculated as the product of the frequency fuel becomes uncovered and the unavailability of air cooling. The frequency fuel becomes uncovered is the product of the initiating event frequency, ac power fragility, and liner fragility for the seismic and cask drop initiators. For all other initiators, the initiating event frequency is the frequency fuel becomes uncovered. For low-density storage configurations, the release frequency is reduced by a factor of 19 to reflect mitigation.	The earthquake and cask drop initiators dominate the events potentially leading to inadequate cooling of the fuel because these events are most likely to cause a leak from the pool at or below the elevation of the stored fuel. Other initiators are conservatively assumed to progress such that the coolant inventory does not adequately cool the stored fuel because of uncertainties in the accident progression.

COMSECY-13-0030 Encl 1 - Table 2

Topical Area	Major Assumption	Comment
Cs-137 Release fraction	The SFP Group 1 high-density loading release fractions are: • 3% for the low estimate • 40% for the base case • 90% for the high estimate	The SFPS (Table 27) shows that for the high-density scenarios involving a leak without mitigation measures, the maximum release is approximately 40%, which was used for the base case. A 90% release fraction is used for the high estimate to account for SFP variations within the group and uncertainties in the accident progression.
	The SFP Groups 2, 3 and 4 high-density loading release fractions used are: • 10% for the low estimate • 75% for the base case • 90% for the high estimate	These release fractions are consistent with the range of release fractions used in previous SFP studies.
	The SFP Group 1, 2, 3, and 4 low-density loading release fractions are: • 0.5% for the low estimate • 3% for the base case • 5% for the high estimate	The SFPS (Table 28) shows that for the low-density scenarios involving a leak without mitigation measures, the maximum release is approximately 3%, which was used for the base case. A 5% release fraction is used for the high estimate to account for SFP variations within the group and uncertainties in the accident progression. The release fractions are the same for all groups because only the most recently discharged fuel is expected to be involved.

COMSECY-13-0030 Encl 1 - Table 2

Topical Area	Major Assumption	Comment
Radionuclide Source Term	A source term calculated by the MELCOR code based on the cesium release fraction.	The MELCOR code models the fuel damage state, radionuclide release, and holdup of aerosols.
Atmospheric Modeling and Meteorology	The atmospheric transport and dispersion model used in this analysis is based on the MACCS2 model developed using weather data for the Peach Bottom site, which is described in Section 7.1.2 of the SFPS.	A straight-line Gaussian plume segment dispersion model is used for the atmospheric transport.
Population and Economic Data	Representative site demographics are selected to represent the 90th percentile, the mean, the median, and the 20th percentiles. For each representative site, the site population and economic data is established for use in the consequence analysis.	Representative sites for the 90th percentile, the mean, the median, and the 20th percentile are Peach Bottom, Surry, Palisades, and Point Beach, respectively. To identify the specific effect of these values, the staff performed sensitivity studies where only one parameter was varied from a low to high value. Section 4 discusses this sensitivity study in more detail.
Emergency Response Model	The site-specific emergency response model from the SFPS is used to model evacuation timing and speed within the emergency planning zone.	The conditional individual risk measures near the site are expected to be relatively insensitive to site-specific characteristics (i.e., emergency response measures). This is because the predicted releases allow time for effective protective actions to limit exposures to the public.

COMSECY-13-0030 Encl 1 - Table 2

Topical Area	Major Assumption	Comment
Long-Term Habitability Criteria	The long-term phase is modeled for 50 years to calculate the consequences of exposure to the average person assuming habitation is limited to areas where annual dose is within the criteria. The base case uses habitability criteria of 2 rem in the first year and 500 mrem each year thereafter. The high case uses a criterion of 2 rem annually.	The selected habitability criteria affect the values of offsite property damage used in this analysis. Certain metrics such as offsite property damage, the number of displaced individuals (either temporarily or permanently) and the extents to which such actions may be needed are inversely proportional to changes in collective dose resulting from changes in habitability criteria.
Accident Occupational Exposure	Occupational exposures related to accident mitigation and recovery are estimated based on actual worker doses collected for the Fukushima Dai-ichi site.	The assumed accident period extends for one year and involves a work force of 3,700 people.
Health Consequences	The Linear No Threshold (LNT) dose-response model is used as the base for reporting results. The dose truncation methodology, introduced in the SOARCA analyses documented in NUREG-1935, is provided as a sensitivity analysis.	For large populations exposed to low annual doses, which is the case for some of the SFP accident scenarios, the health effects to populations in habitable zones dominate the health effects when the LNT model is used.

COMSECY-13-0030 Encl 1 - Table 2

Topical Area	Major Assumption	Comment
Implementation Cost Approach and Timing of Cask Loading	For the regulatory baseline, the plant is expected to load the required number of dry storage casks each refueling cycle to retain sufficient space in the SFP to discharge one full core of fuel. For the low-density storage alternative in Groups 1, 2, and 4, the plant is assumed to transfer all fuel that has greater than 5 years decay within a 5 year period and then continue loading dry storage casks each refueling cycle as necessary to maintain a full core reserve. For the low-density storage alternative in Group 3, the plant is expected to begin loading dry storage casks once the pool reaches the allowed capacity in a low-density (1x4) configuration.	Group dry storage cask loading is based on a representative plant selected within each group. The total number of dry storage casks necessary for the low-density storage alternative is higher than for the regulatory baseline because fuel assemblies that have decayed for shorter periods have higher decay heat levels, and the higher decay heat per assembly reduces the allowed capacity below its nominal capacity.
Occupational Dose	For the low-density storage alternative, each cask loaded in addition to the number required by the regulatory baseline is estimated to result in an incremental 400 person-mrem dose.	This radiation dose is consistent with the exposure value used in EPRI TR-1021049 (Ref. 17) and in EPRI TR-1018058 (Ref. 18), which analyzed worker impacts associated with loading spent fuel for transport to the proposed Yucca Mountain repository.
Incremental Upfront Cost of ISFSI Capacity	Each additional dry storage cask is expected to require engineering, design and construction costs of $657,700 in 2012 dollars.	Each of these cost components are further described in EPRI TR-1021048, “Industry Spent Fuel Storage Handbook.”

COMSECY-13-0030 Encl 1 - Table 2

Topical Area	Major Assumption	Comment
Incremental Cost of Additional Cask purchase and Loading	The base cost for purchase and loading of a dry storage cask is assumed to be $1,300,000. When only 5-year decayed, high-burnup fuel is available for loading, additional shielding; engineering, licensing, and operational expenses are assumed to increase the cost to $1,466,400 per cask.	These cost estimates are based on the DSC unit costs that EPRI used for a generic interim storage facility and documented in EPRI TR-1025206.
Incremental Annual ISFSI Operating Costs	The majority of reactor sites in Groups 1, 2, and 4, have operational ISFSIs, and the incremental operating cost for increased capacity is considered negligible for these groups. For Group 3, maintenance of low-density storage is expected to require early operation at an incremental cost of $1.1 million per year.	EPRI reports a wide variability in published estimates of annual ISFSI operating costs that range from $212,000 to $2 million per year in 2012 dollars and reported their estimate of $1.1 million per year for an ISFSI at an operating nuclear power plant site.

COMSECY-13-0030 Encl 1 - Table 10

Net Monetary Savings (or Costs) – Total Present Value	Sensitivity Studies	Qualitative Benefits and (Costs)
Expedited Transfer Alternative – Low-density Spent Fuel Pool Storage		
Group 1 – BWR Mark I and Mark II with non-shared SFPs		
Group 1 Industry (Costs): **Base case** **($52 million) using a 7% discount rate** **NRC (Costs):** **Not calculated** **Benefits:** **Base case** **$8.6 million using a 7% discount rate** **Group 1 Net Benefit = Benefits + (Costs)** **Base case: $8.6M + ($52M) = ($43.4M)** **Conclusion: Not cost beneficial**	Group 1 Sensitivity Studies Industry (Costs) Sensitivity Studies ($53 million) using a 2% discount rate ($55 million) using a 3% discount rate Benefit Sensitivity Studies Low estimate $0.2 million using a 2% discount rate $0.2 million using a 3% discount rate $0.1 million using a 7% discount rate High estimate $123 million using a 2% discount rate $109 million using a 3% discount rate $73 million using a 7% discount rate Net Benefit Sensitivity Studies Low estimate ($52.8M) using a 2% discount rate ($54.8M) using a 3% discount rate ($51.9M) using a 7% discount rate High estimate $70 million using a 2% discount rate $54 million using a 3% discount rate $21 million using a 7% discount rate	Qualitative Benefits and (Costs) Qualitative (Costs): Cost Uncertainties (Repackaging Costs) Qualitative Benefits: Modeling Uncertainties. (Cask Handling Risk) Mitigating Strategies

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Group 2 – PWR and BWR Mark III with non-shared SFPs		
Group 2 Industry (Costs): **Base case** **($51 million) using a 7% discount rate** **NRC (Costs):** **Not calculated** **Benefits:** **Base case** **$7.9 million using a 7% discount rate** **Group 2 Net Benefit = Benefits + (Costs)** **Base case: $7.9M + ($51M) = ($43.1M)** **Conclusion: Not cost beneficial**	Group 2 Sensitivity Studies Industry (Costs) Sensitivity Studies ($51 million) using a 2% discount rate ($54 million) using a 3% discount rate Benefit Sensitivity Studies Low estimate $0.3 million using a 2% discount rate $0.3 million using a 3% discount rate $0.2 million using a 7% discount rate High estimate $137 million using a 2% discount rate $121 million using a 3% discount rate $77 million using a 7% discount rate Net Benefit Sensitivity Studies Low estimate ($50.7M) using a 2% discount rate ($53.7M) using a 3% discount rate ($50.8M) using a 7% discount rate High estimate $86 million using a 2% discount rate $67 million using a 3% discount rate $26 million using a 7% discount rate	Qualitative Benefits and (Costs) Qualitative (Costs): Cost Uncertainties (Repackaging Costs) Qualitative Benefits: Modeling Uncertainties. (Cask Handling Risk) Mitigating Strategies

COMSECY-13-0030 Encl 1 - Table 10

Group 3 – New reactor SFPs		
Group 3 Industry (Costs): **Base case** **($17 million) using a 7% discount rate** **NRC (Costs):** **Not calculated** **Benefits:** **Base case** **$5.6 million using a 7% discount rate** **Group 3 Net Benefit = Benefits + (Costs)** **Base case: $5.6M + ($17M) = ($11.4M)** **Conclusion: Not cost beneficial**	Group 3 Sensitivity Studies Industry (Costs) Sensitivity Studies ($42 million) using a 2% discount rate ($36 million) using a 3% discount rate Benefit Sensitivity Studies Low estimate $0.3 million using a 2% discount rate $0.3 million using a 3% discount rate $0.1 million using a 7% discount rate High estimate $108 million using a 2% discount rate $81 million using a 3% discount rate $34 million using a 7% discount rate Net Benefit Sensitivity Studies Low estimate ($41.7M) using a 2% discount rate ($35.7M) using a 3% discount rate ($16.9M) using a 7% discount rate High estimate $66 million using a 2% discount rate $45 million using a 3% discount rate $17 million using a 7% discount rate	Qualitative Benefits and (Costs) Qualitative (Costs): Cost Uncertainties (Repackaging Costs) Qualitative Benefits: Modeling Uncertainties. (Cask Handling Risk) Mitigating Strategies

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Group 4 – Reactor units with shard SFPs		
Group 4 Industry (Costs): **Base case** **($46 million) using a 7% discount rate** **NRC (Costs):** **Not calculated** **Benefits:** **Base case** **$8.9 million using a 7% discount rate** **Group 4 Net Benefit = Benefits + (Costs)** **Base case: $8.9M + ($46M) = ($37.1M)** **Conclusion: Not cost beneficial**	Group 4 Sensitivity Studies Industry (Costs) Sensitivity Studies ($49 million) using a 2% discount rate ($50 million) using a 3% discount rate Benefit Sensitivity Studies Low estimate $0.3 million using a 2% discount rate $0.3 million using a 3% discount rate $0.2 million using a 7% discount rate High estimate $205 million using a 2% discount rate $182 million using a 3% discount rate $120 million using a 7% discount rate Net Benefit Sensitivity Studies Low estimate ($48.7M) using a 2% discount rate ($49.7M) using a 3% discount rate ($48.8M) using a 7% discount rate High estimate $156 million using a 2% discount rate $132 million using a 3% discount rate $74 million using a 7% discount rate	Qualitative Benefits and (Costs) Qualitative (Costs): Cost Uncertainties (Repackaging Costs) Qualitative Benefits: Modeling Uncertainties. (Cask Handling Risk) Mitigating Strategies

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Figure 9 Comparison of annual PGA exceedance frequencies for U.S. BWR Mark I and Mark II reactors (USGS 2008 model)

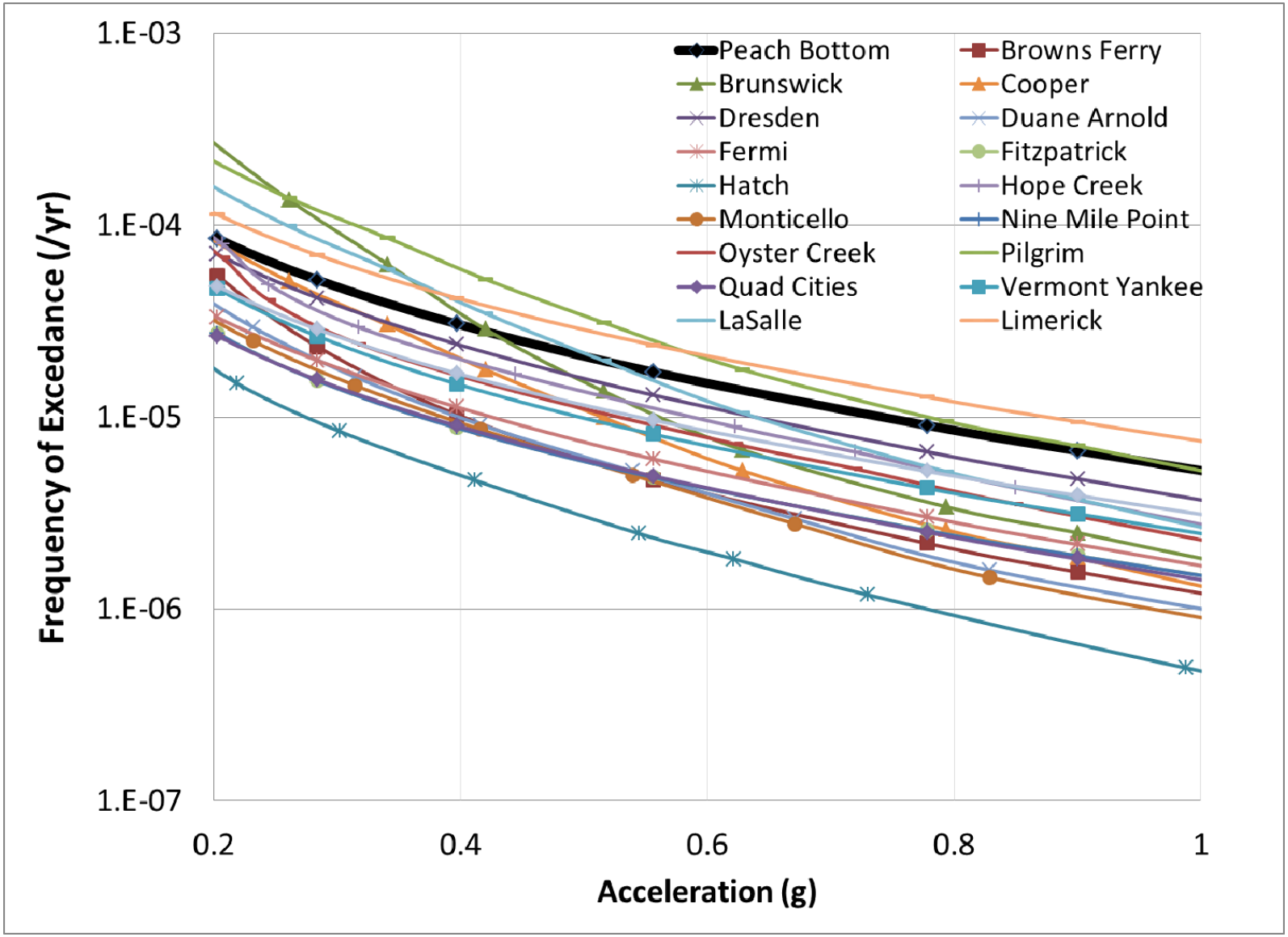

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Figure 10 Comparison of annual PGA exceedance frequencies for U.S. PWR and BWR Mark III reactors (USGS 2008 model)

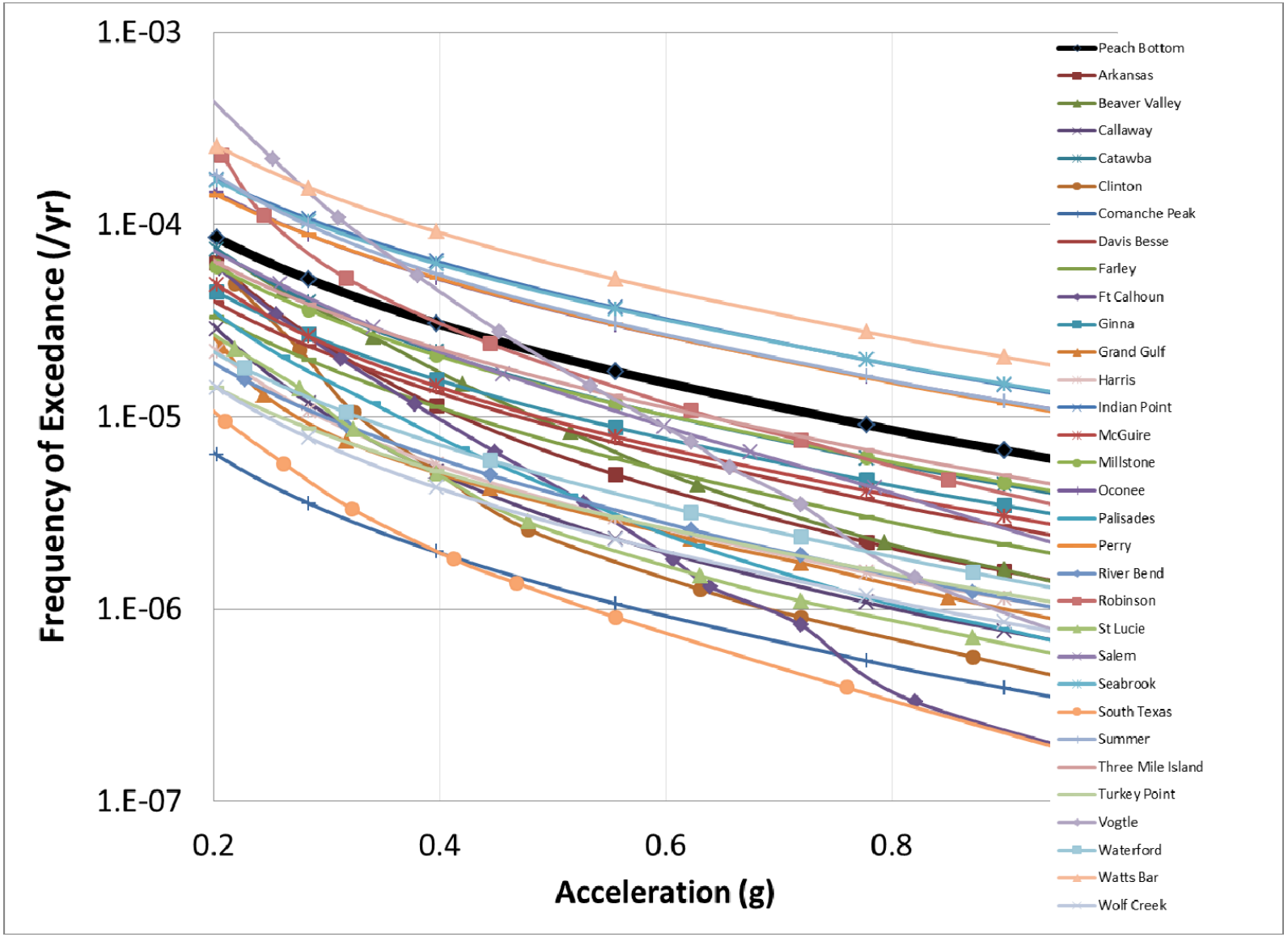

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Figure 11 Comparison of annual PGA exceedance frequencies for new U.S. reactors (USGS 2008 model)

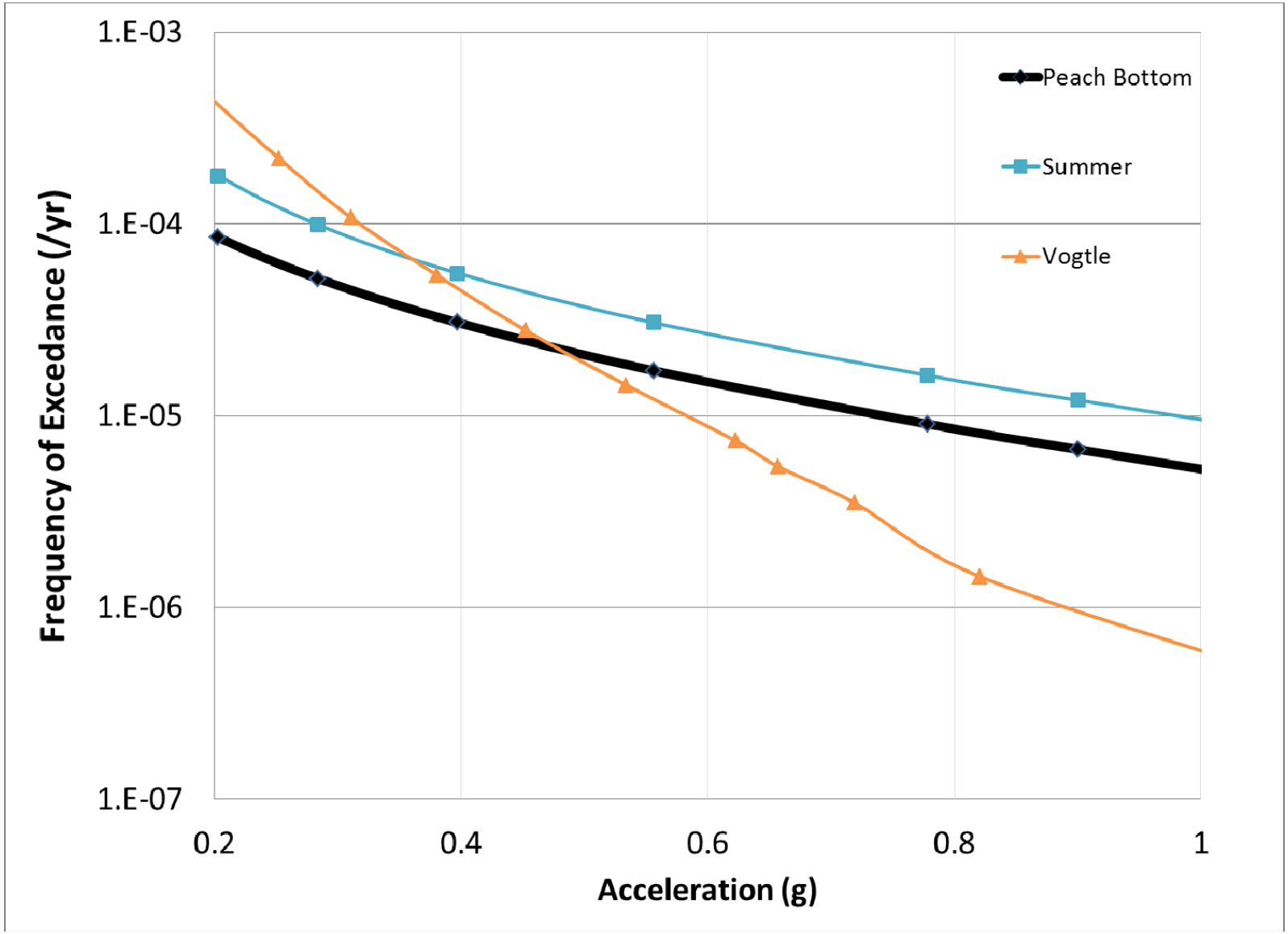

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Figure 12 Comparison of annual PGA exceedance frequencies for U.S. reactors with a shared spent fuel pool (USGS 2008 model)