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NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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FUTURE PLANT DESIGNS SUBCOMMITTEE

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WEDNESDAY

OCTOBER 2, 2019

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ROCKVILLE, MARYLAND

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The Subcommittee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2D10, 11545 Rockville Pike, at 8:30 a.m., Dennis Bley, Chairman, presiding.

COMMITTEE MEMBERS:

DENNIS BLEY, Chairman

CHARLES H. BROWN, JR. Member

WALTER L. KIRCHNER, Member

JOSE MARCH-LEUBA, Member

DAVID PETTI, Member

JOY L. REMPE, Member

PETER RICCARDELLA, Member

ACRS CONSULTANT:

MICHAEL L. CORRADINI*

DESIGNATED FEDERAL OFFICIAL:

DEREK WIDMAYER

ALSO PRESENT:

VICTORIA ANDERSON, NEI

BOB BUDNITZ, JCNRM*

AMY CUBBAGE, NRO

KARL N. FLEMING, JCNRM

ANDERS GILBERTSON, RES

FELIX GONZALEZ, RES

MICHELLE GONZALEZ, RES

HANH PHAN, NRO

MARTIN STUTZKE, NRO

*Present via telephone

P R O C E E D I N G S

8:31 a.m.

CHAIRMAN BLEY: Good morning. The meeting will now come to order.

This is a meeting of the Advisory Committee on Reactor Safeguards' Subcommittee on Future Plant Designs. I am Dennis Bley, chairman of the subcommittee.

ACRS members in attendance are Joy Rempe, Charlie Brown, Walt Kirchner, Dave Petti, and Jose March-Leuba. Am I missing anything? Oh, and Pete Riccardella. He's on my other list here.

Mike Corradini, our consultant, has joined us by telephone. We may have Member Ron Ballinger coming in by Skype to participate.

Derek Widmayer of the ACRS staff is the designated federal official for this meeting. The purpose of today's meeting is to discuss the staff's review of the ANS/ASME standard on PRA -- standard for PRAs for non-LWR nuclear power plants and the staff's plans for future actions on the standard.

The subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions as appropriate. This matter will be presented to the subcommittee again at

a later date after the staff has taken the planned actions to be discussed.

The ACRS was established by statute and is governed by the Federal Advisory Committee Act -- FACA. The committee can only speak through its published letter reports. We hold meetings to gather information and perform preparatory work that will support our deliberations at a full committee meeting.

The rules for participation in ACRS meetings are included in -- I am sorry, including today's meeting were announced in the Federal Register on June 13th of this year.

The ACRS section at the U.S. NRC public website provides our charter, bylaws, agenda, letter reports and full transcripts of all full and subcommittee meetings including the slides presented.

The meeting notice and agenda for this meeting were posted there. As stated in the Federal Register notice and in the public meeting notice posted to the website, members of the public who desire to provide written or oral input to the subcommittee may do so and should contact the designated federal official five days prior to the meeting as practicable.

Today's meeting is open to public

attendance and we have received no written statements or requests to make an oral comment.

We have also set aside 10 minutes in the agenda for spontaneous comments from members of the public attending or listening to our meetings.

Today's meeting is being held with a telephone bridge line, allowing participation of the public over the phone. A transcript of today's meeting is being kept. Therefore, we request that meeting participants on the bridge line identify themselves when they speak and to speak with sufficient clarity and volume so that they can be readily heard.

Participants at the meeting -- in the meeting room should use the microphones located throughout the room when addressing the subcommittee.

At this time, I ask that all attendees in the room please silence all cell phones and other devices that make noise to minimize disruptions.

I remind the speakers up front to turn on their microphones, indicated by this little green light and you push down here very close to you where it says push, and then turn off your phones when you're done speaking. Otherwise, we get too much noise on the phone line.

We will now proceed with the meeting and I call on Hanh Phan, acting chief for the Advanced Reactor Technical Branch to make introductory remarks.

Hanh, please go ahead.

MR. PHAN: Thank you, Dr. Bley. Good morning. My name is Hanh Phan. I am the acting chief for the Advanced Reactor Technical Branch in NRO.

So in this briefing, sitting next to my left is Mr. Marty Stutzke from NRO and on my right is Mr. Anders Gilbertson from the Office of Research. And at the end of this table is Mr. Karl Fleming from the JCNRM, and also inspecting today is Ms. Michelle Gonzalez from the Office of Research.

So, first, I would like to thank the ACRS for this meeting and any comments you have on the staff plans to review and endorse the ASME/ANS non-LWR PRA standard.

We look forward to your feedback on our presentation. So next slide, please. Slide number two.

So to provide you a big picture, first, I will go over the background in the plan to endorse the standard, and next, Marty will provide the staff perspective on the PRA acceptability for non-LWR. Mr. Fleming from JCNRM will discuss the standard

development and the lessons learned from the pilot. And last, Anders and Michelle will detail the staff items to perform the reviews and the endorsement.

CHAIRMAN BLEY: Phan, let me ask you a question.

MR. PHAN: Yes.

CHAIRMAN BLEY: The standard has been out there for some time and I know we are going to hear later of some of the pilot studies that have been run.

Will the staff be waiting until that standard is revised following the pilot studies before you do an endorsement or are those two things running separately?

MR. PHAN: At this point, the staff plans to endorse the trial use standard 2013 and we are aware of the next revision of this standard. We would, because of that, include it in our presentation.

Next, please. Slide 4. So many previous staff presentations we identified the regulations attending to DC applicants, COL's applicants and COL's holders on the PRA.

So these regulations require that the applicants must include their PRA, the descriptions, and the results of their PRA in their application in

the FSAR.

And, furthermore, the staff guidance states that the applicants should justify the PRA acceptability in their submittal for any PRA used during the designs, contraction, and operation stage.

Next slide, please.

CHAIRMAN BLEY: Let me stop you again with a procedural question. My understanding is this is an introductory session for us to bring us up to speed with the standard and where you're headed.

MR. PHAN: Yes.

CHAIRMAN BLEY: And that you intend to come back to us at some point in time with your final recommendations and request for a letter. Do you have any idea when you expect that to be?

MR. PHAN: Would you please describe the letter?

CHAIRMAN BLEY: Your schedule. I am sorry?

MR. PHAN: Which letter do you mention there?

CHAIRMAN BLEY: Wait. You don't -- do not want a letter today.

MR. PHAN: Yes. Not yet. Not at this point.

CHAIRMAN BLEY: So you will be coming back and the question was when --

MR. PHAN: We will come back.

CHAIRMAN BLEY: Do you know when you'll be coming back?

MR. PHAN: Yes. So later in our slide we will show you how the staff will communicate with ACRS. Our plans need to include four briefings to you.

CHAIRMAN BLEY: Really? Okay.

MR. PHAN: One this year. This is the first one. Twice next year and then one in 2021 when we issue -- before we issue the final draft.

CHAIRMAN BLEY: And last question on this line. Do you have any idea when they plan to come out with a revision to this draft standard?

MR. PHAN: Based on the existing information, 2021. That's the date they plan for the ANSI standard.

CHAIRMAN BLEY: Okay. So about the time you'd be finishing your work on endorsing this one. Okay. Thank you.

MEMBER KIRCHNER: Dennis, may I ask a quick question? I note that this slide number -- yeah, four -- you're talking about DCs and COLs. You

make no mention of going the 10 CFR 50 path of construction permit and an operating license.

So the presumption here -- where would the PRA fit in if the applicant chose to go the -- that route?

CHAIRMAN BLEY: Before you answer, that was a question I was going to get to later because the standard is silent on this point as well. So --

MEMBER KIRCHNER: But are they --

CHAIRMAN BLEY: No, it's silent. The standard says we are looking at design certs. It doesn't say anything about Part 50. Please, whoever is going to answer that speak up.

MR. PHAN: For other applications besides the DC and the COLs that's up to the applicants to use the PRA. No regulation at this point say that they have to submit any PRA to us.

Amy?

MS. CUBBAGE: Is it on? Yeah.

Amy Cubbage, NRO. So we have a rulemaking undergoing right now to make sure that Part 50 has the same requirements to submit PRA information in the design cert -- well, it would be a construction permit OL stage that we provide a similar level of information to what's required in Part 52.

That said, the level of PRA information that would be available at the construction permit stage would be expected to be different than what would be available at the OL stage.

So we may need to look at guidance on how to handle the construction permit phase. I don't know if that answers your question, but we are looking to make sure that the regulations are consistent, at a minimum. But the standard itself is silent on what type of application.

CHAIRMAN BLEY: No, it isn't silent. It says it's for design certs and --

MS. CUBBAGE: Well, it should be silent.

CHAIRMAN BLEY: -- and it combined licenses. So Karl, you were going to say something.

MR. FLEMING: Yes. The standard is actually intended for both pathways.

CHAIRMAN BLEY: Okay. You know it doesn't say so now?

MR. FLEMING: Well, you'll have to point out where we messed up there. We --

CHAIRMAN BLEY: Just do a search for design cert and you'll find it.

MR. FLEMING: We intended it to handle both pathways.

MS. CUBBAGE: So I think that's a great comment and, you know --

MR. FLEMING: Maybe we could make that clearer. That would be --

MS. CUBBAGE: -- I think you're referring to the trial use standard that was developed many years ago and now we have more of an interest in the Part 50 pathway than was in the past.

So as you go forward with the next version definitely keep that in mind.

MEMBER REMPE: So while we are interrupting you with things that we saw in the standard that might now be fully inclusive of the designs coming through, when you think about the micro reactors where you have a fully loaded core and you're transferring it to the site and installing it, are those types of events that might occur during those types of activities, which are part of its operating cycle, considered by the standard as where you might have initiating events?

MR. FLEMING: The standard was written basically to cover all the sources of radionuclides that were selected by the user to be in the scope of the PRA.

When the trial use standard went out there

was a concern that there wasn't enough work on spent fuel pool PRAs for light water reactors to do that. So there's caveats in there to clarify that.

But in the next edition of the standard we need to be able to cover off-gas system in molten salt reactors and other sources of radionuclides that are outside the reactor core.

So in the next edition standard our intent is to broaden it to include all sources of radionuclides selected by the user for its application.

There has been a limited scope pilot study done on the eVinci micro reactor, which I talk about here.

MEMBER REMPE: Yeah. I saw that was coming in your slides, although I didn't have that before this meeting.

But I note that in another LWR type of activity that the type of activities that might occur as you install the unit and you're moving it back and forth for refueling that that was something that they did consider and I think it's something that does need to be considered here.

CONSULTANT CORRADINI: Can I ask a question?

CHAIRMAN BLEY: Yeah, Mike. Go ahead.

CONSULTANT CORRADINI: So what -- if the standard were used today what reactors is it supposed to apply to?

MR. FLEMING: It's supposed to apply to all advanced non-light water reactors including micro reactors, molten salt reactors, liquid metal, liquid lead, high-temperature gas, fluoride salt high-temperature reactors.

CONSULTANT CORRADINI: Okay.

MR. FLEMING: It's intended to cover the whole spectrum.

CONSULTANT CORRADINI: Right. But your answer to Member Rempe's question implies that certain things are missing. So what does it complete -- at this point what does it complete so that it apply to? Gas-cooled reactors? Sodium reactors?

MR. FLEMING: It's actually applicable to all reactors. Now, there was -- the JCNRM wanted us to restrict or clarify that the PRA practice for light water reactors was limited outside the reactor systems and so there's some caveats in the standard.

But the way the standard was originally drafted it covers all sources of radioactive material and for all types of reactors.

CHAIRMAN BLEY: But Mike --

CONSULTANT CORRADINI: Okay.

CHAIRMAN BLEY: Mike, part of this discussion has to do with the fact that the standard specifically says some things and doesn't say others. So Karl was clarifying, I guess, that the next version won't have those things missing from it. But they think the content is adequate to cover these other cases.

MEMBER KIRCHNER: Dennis, may I make a -- Dennis, may I make a comment in the form of a question? I am puzzled with this advanced non-LWR. If anything that we use in our tool set to me would be technology inclusive it should be the methodology of doing a PRA.

So if it embraces all reactor types, I don't know why in the standard it says non-LWR. So that's my comment, and I'll be educated as I listen.

CHAIRMAN BLEY: If you have -- if you want to do this later that's fine. If you want to address it now that's fine, too.

MR. FLEMING: Well, just very briefly, technically it's a technology neutral, technology inclusive standard. So technically it applies to all reactors.

That label was put on there basically to clarify that this was not intended for the existing operating reactors. There was a -- there was a concern that the scope of risk-informed applications could be greatly increased for the operating reactors. So from an administrative standpoint the JCNRM wanted to have that label on there.

Technically, and as a matter of fact, as I understand it NuScale is looking into applying, you know, parts of that for their reactor as well.

CHAIRMAN BLEY: The standard does mention, as Walt said, a working group on advanced LWRs, and is -- have they produced anything? Are they going to just say this standard is good for them too? Do you know what's happening?

MR. FLEMING: No, they are working on a separate standard and they are --

CHAIRMAN BLEY: Why? That was the question.

MEMBER KIRCHNER: I find this -- but I'll be enlightened as we go through this but, again, my sense of PRA is this non-LWR moniker advanced, throw out the advanced, would just be non-LWR. I would hope that you test the standard against the LWRs where you have the largest database. End of comment.

CONSULTANT CORRADINI: So if I might just -- I think I was looking to find Dennis's worry about it being to design certification there seems to be a sentence that's repeated everywhere that basically says, for example, meeting the SR capability Category II for design certification may not apply to the same scope, et cetera, et cetera.

That's everywhere in the document but it really doesn't narrow it to design certs. It says what it might be not as detailed and given the design cert.

MR. FLEMING: Yeah, I think that was -- it was unintentional to come across that it was only intended for design certs. If you look at the hazard sections for seismic and other external hazards, the standard clearly can support either a site specific external hazards PRA or a external hazards PRA for a range of sites using the site parameter envelope and that's very clear in that -- this letter.

CONSULTANT CORRADINI: Thank you.

CHAIRMAN BLEY: If we are silent you guys just take off and keep going.

MR. PHAN: So in addition to the regulations last year, December, Congress passed the NEIMA where under Title I Section 103 it states that

the NRC cert collaborates with standard-setting organizations and provides assistance to ensure the new and updated standards are developed and finalized in a timely fashion and also incorporate the consensus standard into the regulatory framework.

So with all these -- next slide, please -- early this year the staff sent ASME and ANS a letter that defines the importance of this standard and in the letter the NRC considered completion of the standard to be high priority.

So with that --

CHAIRMAN BLEY: I am sorry. I couldn't -- say that sentence again.

MR. PHAN: So the NRC considered completion of this standard should be a height priority compared to the other activity currently performing by the stations like low power and shutdown PRA or level three PRA for light water reactors.

CHAIRMAN BLEY: Okay.

MR. PHAN: So there are multiple activities that currently performs for investigations by the JCNRM including the next revision of the LWR PRA standard, the low power and shutdown PRA standard, the level three and level two PRA standard.

So the staff -- in the letter the staff

itemized those activities and we rank them according to the use of those standards for future activities.

CHAIRMAN BLEY: You bring up something there that I wanted to ask and I don't know if you ought to do this one or Karl.

In this standard, and it might be because of the date the standard was written, you do a comparison of -- comparison of PRA standards but for the standards the only one you focus on is the one for licensed and operating power plants for the full power plant operating state only.

You don't acknowledge there's a shutdown standard and I don't know if the date timing on this. You know, maybe it wasn't there when this draft came out.

MR. FLEMING: When the -- when the 2013 standard was published there hadn't even been a trial use standard issued for low power shutdown level two and level three.

Those were a work in process. We actually used draft materials from those standards to support ours but now I'll get into the evolution, you know, since then. So that's what --

CHAIRMAN BLEY: Okay. That's good.

MR. FLEMING: It's the date -- the dates

gave.

MR. PHAN: So at the same time we developed the exit plans to endorse the standard and we also developed a detailed guidance for the reviewers to perform the reviews and endorsements of this standard.

A number of risk-informed activities have been undertaken and a number of documents have been written by multiple staff in the industry that provides guidance on how to use the PRA information, and some of those including the three I mentioned on this slide -- first, of course, that the PRA standard for non-LWR on the next revision would be 2021.

We hope that the ANSI standard. And then the NEI's 18-04 that would be sent to you in the past would ask the applicant to use PRA information to select -- for selections of LBE set the classification of SSCs, identification of function and determination of defense in depth, and now the document, the Draft Guide 1353, which endorsed the NEI's 18-04.

Next.

CHAIRMAN BLEY: Before you go on -- I think it was on the previous slide -- wherever you were talking about the law requiring you to do this, were you telling us that work on -- NRC's work on this

standard has put the level three PRA work aside? That's what I thought I heard you say. Or put it at much lower priority so that it's maybe going to be delayed longer than we thought.

MR. PHAN: So in front of me is the letter. I'll let you have the numbers for you in case if you'd like to go over the letters. The ML numbers --

CHAIRMAN BLEY: Yeah, please, because I --

MS. CUBBAGE: So it's my understanding, and Research can correct me if I am wrong, that the priority for this project did not have any impact on any level three PRA project -- with level three PRA project, any delays or its schedule it's on and its own path, and please correct me if I am wrong.

CHAIRMAN BLEY: Thank you.

MR. GONZALEZ: Good morning. This is Felix Gonzalez, branch chief of the Performance and Reliability Branch and what Amy said is correct. This shouldn't have any effect on the priority of the other project. So yes, that shouldn't have --

CHAIRMAN BLEY: Okay.

MR. GONZALEZ: -- shouldn't be affected by these duties.

CHAIRMAN BLEY: I appreciate that. Thank

you, and I must have misunderstood. Go ahead.

MR. FLEMING: I think the -- what Hanh is referring to is that the NRC asked the JCNRM to set their priorities up such that the non-light water reactor standard comes to the top and the standards for level two and level three PRA becomes a lower priority. Priorities for the JCNRM, not the NRC. That's my understanding.

CHAIRMAN BLEY: The reason I am kind of staring off in the distance is this standard appears to include level two and three.

MR. FLEMING: Yes and no. Now, I'll get into that.

CHAIRMAN BLEY: You'll get to that. Okay. You and -- well, when you get to that let us know when you -- if you envision further standards because it seems to go soup to nuts here on the whole PRA.

MR. PHAN: Thank you. We understand your concerns the correlations between this standard and any other standards and we will get to that later.

So this slide, slide seven, the objective of the staff action plans is to identify the tasks that are needed to review and endorse the standard. The plan describes the approach and what activities that are needed to achieve the purpose of this

project.

Moreover, the plans also includes the proposed schedule along with the needed resources to implement the plan. In the past, the staff has reviewed and endorsed the LWR PRA standard including internal events, internal floodings, internal fires, external events, seismic, high winds. So reviews and endorsing this standard is not new to us.

However, because this standard is more comprehensive including information in level one, level two and level three standards -- LWR standard -- and including all initiated internals and externals and all operating modes.

So because of the complexity of this standard we decided to develop a detail plan which includes seven major tasks. From task one, supporting development of the standard; task two, preparation for review of the standard; task three, reviewing the standard; task four, maintenance of standard; task five, development of schedule; task six, identification of resources; and task seven, development of the communication plans.

So in this presentation I will briefly go over task two, three, four, five, and seven. Next, please. Page 8.

So task two, preparation for review of the standard, this task is divided into six sub-tasks, to perform the reviews and endorsement in an efficient and effective manner. The staff needs to understand of how the non-LWR standard has been developed.

So in task 2-1 determines the scope of regulatory risk-informed activities. The objective of this task is to identify any application and associated activities that will be supported by this standard.

For its application identifies the capabilities were also identified. That is whether the supporting requirements in the standard need to be Capability I or II.

Subtask 2-2, compare the non-LWR standard to the LWR standard. The purpose of this task is to understand the differences and the similarities between the two standards.

Subtask 2-3, identify the needed technical expertise to review the standard. This task will assist the staff in determining where there is the adequate technical expertise is available to perform the reviews and endorsements within the staff.

Next slide. Page 9 subtask 2-4 -- develop staff positions for an acceptable non-LWR PRA. The

efforts of this subtask includes establishing the technical basis for reviewing and endorsing the non-LWR standard and developing the staff position of acceptable peer review process including team qualification and documentation.

Subtask 2-5, identify and resolve technical and policy issue. The objective of this task is to identify technical and policy issues that may need to be resolved and also to understand how they are addressed in the non-LWR PRA standard.

And last one, subtask 2-6, guidance for the staff reviews and knowledge for non-LWR PRA standards. So the objective of this task is to develop a guidance on how to approach the reviews and establish the criteria for determining staff abilities. So later in this presentation Michelle and Anders will detail this guidance.

Next, Page 10 --

MEMBER KIRCHNER: Just for clarification, would you make the distinction in this PRA standard between policy and technical? I am just curious what policy issues you have seen the standard address.

I can see applicability is -- would be a reflection of what regulations exist. That's more in the policy realm.

But could you clarify, please?

MR. PHAN: Yes. So in 10 CFR 52.47(a)(27) and 52.79(a)(26), those regulations requires the DC and COL applicants to include the encryptions in the results of the PRA in the FSAR. But in the staff guidance in preparation that has to provide the CDF to the staff.

However, for advanced non-LWR designs there's no such core damage. So we have to look into those guidance to see what to be used for the risk metric difference than the exhibiting LWR.

Next, please. So task 3, review and endorsement of the standard, the objective of this task is to review and --

CHAIRMAN BLEY: When you go through all that stuff I hope you don't forget that you've already addressed many of these issues back when the technology-neutral framework -- what is it, 18-60 -- was done.

Don't do it all over again. This is sounding more and more bureaucratic and far from transformational. It's going to take you forever.

Go ahead.

MEMBER KIRCHNER: It may turn out that there's a 10 CFR 53. So one would hope the standard

still works. So if you embed a lot of things in the standard that are about the regulatory process, that's not a very technology inclusive approach to me. You're getting mired into the wrong part of the process.

MR. PHAN: So on Page 10, task 3, the objective of this task is to review and develop a staff position on the standard. So this would include three subtasks.

The first subtask is to develop the draft regulatory guidance. This new guidance will be a standalone document similar to Reg. Guide 1.200, which endorsed the existing LWR standard.

The second task is to perform the review and provide the staff positions on its supporting requirements in the standard. The staff position on its requirements is to be stated as no objection or no objection with clarification or no objections subject to the following qualification.

And the last subtask is to finalize the draft guide to issue the Reg. Guide for public review and comments and addressing public comments.

Next, please. Page 11. Subtask 4 and 5. Task 4 is to -- is an ongoing task to ensure that lessons learned from using the non-LWR PRA standards

and eventually the LWR PRA standard are incorporated into both standard itself and the staff endorsement.

And in task 5 we developed the schedule for each task. So next page, Page 12, we show you our tentative schedule. So at the bottom we show you how we'd like to brief you regarding this process including this briefing twice next year and once in 2021.

So later we will go back to discuss more about this schedule. Subtask --

CHAIRMAN BLEY: I am a little curious on your top line up there.

MR. PHAN: Yes.

CHAIRMAN BLEY: That applies to the standards development people, not the NRC? Or is that the NRC's task one?

MR. PHAN: The first applies that the non -- that the activities for JCNRM to complete the standard.

CHAIRMAN BLEY: So they are going to finish -- and it looks like by this schedule they are going to finish a new draft of the standard essentially on the day that you endorse the current version of the standard. That's right?

MR. PHAN: Yes, that is correct. That is

the plans. So we --

CHAIRMAN BLEY: I'll tell you, if they are that close together and you're working with them, it seems you could close on the new standard so that we don't have NRC's guidance pointing to something that's now an old standard, which we have all over the place and you have an opportunity to be finishing essentially with them. It seems like a very inefficient way to close this out.

MR. PHAN: The reason for us to come up with this schedule we have no controls on the standards. We cannot predict when the next ANSI standard to be applicably available.

CHAIRMAN BLEY: Well, you can predict but you might not be right. But if things go according to plan, you're not independent of them. You have people working on a group.

MR. PHAN: Yes.

CHAIRMAN BLEY: You'll know where it's standing. So if they are lagging behind maybe it makes sense to close it out at that point. If they are on schedule and you're happy with where it's going, it seems to me you could close on the same document at the same time. So think about that.

MR. PHAN: Karl, would you like to talk a

little bit just about the schedule of the standard?

MR. FLEMING: I'll address it.

MR. PHAN: Okay. Thank you. So we will go back and thank you for your comment. We will take it back and consider how to adjust the milestones that we don't have to perform the work twice.

MR. FLEMING: I will give you a little bit of a preview on something. The schedule that Hanh shows for the next edition of the non-light water reactor standard was based on the latest one that was published by JCNRM and it was largely based on an assumption about things that we would wait for while the light water reactor standard is done.

There's going to be -- there's been a change in that assumption which points to the possibility of accelerating the non-light water reactor standard, not that --

CHAIRMAN BLEY: That makes sense. That would be great. Of course, when you get to the consensus balloting it might stretch out forever. That's happened before.

MR. FLEMING: That's right. We can't predict --

CHAIRMAN BLEY: That one you cannot predict very well.

Okay. Hanh, go ahead.

MR. PHAN: Yes. Thanks. Thank you.

So slide 13. So task 7 is the communication plans. The staff will hold several public meetings to share and solicit input. So far the internal stakeholders we plan to brief you four times, as I mentioned -- one this year, twice next years and one in 2021.

CHAIRMAN BLEY: Those will just be status briefings or do you see -- it seems like a lot of briefings. That's why I am asking you this. But the next briefing you have planned will be after you've, I guess, finished your review of the standard and the trial use.

MR. PHAN: Yes.

CHAIRMAN BLEY: So you should know what you're doing at that point pretty well.

MR. PHAN: Yes. So the purpose for the next briefing is to update you on any initial findings based on our review and asking for your input.

CHAIRMAN BLEY: Okay. And that could be either very brief, that everything looks great, or it could be you have a number of issues where you would be diverging from the standard?

MR. PHAN: Yeah, possibility.

CHAIRMAN BLEY: Okay. Go ahead.

MR. PHAN: Anders, do you --

MR. GILBERTSON: This is Anders Gilbertson. I just want to add that some of those briefings are aligned with the NRC's Reg. Guide development process. So, for example, you know, the draft guide issuance -- one of our requirements is that we need to solicit ACRS for feedback.

CHAIRMAN BLEY: Exactly.

MR. GILBERTSON: They -- you know, ACRS may grant a waiver for a review of the draft guide and wait until after the public review and comment period.

But I think even if that was the case we would -- you know, we would probably seek to have at least a status update.

CHAIRMAN BLEY: Yeah. No, that makes sense and I -- you know, if you bring us a draft guide at that point we might also say just let us look at what happens after that and maybe we won't need another meeting. That happens quite often. Okay.

MR. PHAN: So Page 14. So this slide shows you where we are as of today. So we have a draft action plan. We also publish the draft -- the items and three weeks ago we had kickoff meetings with the technical reviewers. Since the ANSI standard will

not be publicly available until 2021 based on the extra things scheduled -- JCNRM schedule.

So we propose to start the reviews and endorse the trial use 2013 versions.

CHAIRMAN BLEY: Your action plan and your review guidance documents are actually drafted? You have drafts of those? That's what it says.

MR. PHAN: Would you please repeat that?

CHAIRMAN BLEY: Your first two bullets --

MR. PHAN: Yes.

CHAIRMAN BLEY: -- imply to me that you know have draft versions of the action plan and your review guidance. That's true?

MR. PHAN: Yes, that -- that is true.

CHAIRMAN BLEY: And you have not shared those with us.

MR. PHAN: At the draft version what we finalize that will be sent to you. Thank you.

So that's the end of my opening presentation. Do you have any questions?

CHAIRMAN BLEY: When do you expect to finalize those two?

MR. PHAN: We -- right now we don't have a plan yet, but because many things going on at this time we hope that within a few months we would have

that finalized -- one or two months.

CHAIRMAN BLEY: One or two months from now? You already have people using it though, right?

MR. PHAN: Just for discussion. We have not started any reviews yes.

CHAIRMAN BLEY: Okay.

MR. PHAN: We just are looking to the standard and try to understand what's in the draft guidance.

CHAIRMAN BLEY: Okay. Thanks. Last thing for this -- how many people from NRC are participating in the -- in the standard development, you know, with the JCNRM?

MR. PHAN: I am the NRC representative for that working group and only me working. Only myself participating.

CHAIRMAN BLEY: Okay.

MR. PHAN: However, we have the National Lab to participate in the developments as well.

CHAIRMAN BLEY: As your contractors?

MR. PHAN: Yes, our contractors.

CHAIRMAN BLEY: Okay. Thanks.

CONSULTANT CORRADINI: Can I -- can I ask a question at this point, Dennis, before we switch speakers?

CHAIRMAN BLEY: Yeah.

CONSULTANT CORRADINI: So my -- are there particular vendors or designs that have begun using the standard? Maybe -- I thought Dennis asked that but I didn't hear exactly an answer.

MR. FLEMING: This is Karl Fleming. I'll cover that in my presentation quite a bit.

CONSULTANT CORRADINI: Okay. Okay. Thank you, Karl.

MR. PHAN: So with that, I will turn over to Marty Stutzke to talk about the staff perspective on PRA acceptability for non-LWR.

MR. STUTZKE: Yeah. Good morning. I am Marty Stutzke. I am the senior technical advisor for probabilistic risk assessment in the Office of New Reactors, and as Hanh said, I want to give you a little perspective.

You know, PRAs of non-light water reactors have been developed and reviewed by the NRC since the early 1980s. I'll point way back to the Clinch River breeder reactor. That was issued in 1983. There's a staff SER on it. There was a PRA done. I know this because I did it.

[Laughter.]

MR. STUTZKE: In fact, the seismic PRA was

the subject of my Master's dissertation at the University of Tennessee, like this. So maybe that's some effort of how the quality of it -- like that.

But I'll point out that that was done before there was an advance reactor policy statement. It was done before the safety goal policy statement was issued.

Later on there was a host of non-light water reactors -- MHGTR, PRISM, SFR. All of those have NUREGs that document the staff's review including the PRA. The CANDU 3 was picked up. About that time Part 52 was issued as we know it, like this.

Of course, MHGTR is the ancestor of LMP. You can go way back to the late 80s or 1980 documents and you'll see the frequency consequence curve and the strategy basically the way that you see it now. The points on then curve --

CHAIRMAN BLEY: More than that. You'll see almost everything that looks the same, yeah.

MR. STUTZKE: Yeah. You know, so what's old is new again like that.

MEMBER REMPE: Wasn't there the AIPA, which I am sure Karl was well aware of, before the Clinch River one, too? The accident?

MR. STUTZKE: Yeah.

CHAIRMAN BLEY: 1975.

MEMBER REMPE: Yeah.

MR. STUTZKE: So, you know, my point is that we have rather a rich legacy of looking at non-light water reactors. At least some of us do, like that.

In addition, we also have all of the hard work that Mary Drouin provided us on PRA acceptability. As you know, Mary recently passed away. She was actually the author of these plans that we were discussing earlier, like that.

So we have a lot to build on here, like that. Slide 16, please. I would also point out that until very recently, like, several days ago, all of our preapplication reviews are addressing non--light water reactors.

There's not a single light water reactor in the pipeline. So we are talking about things like that.

So anyway, I wanted to, again, looks like I've duplicated Hanh's discussion of regulatory requirements like that. I'll talk about what the current SRP says about PRA acceptability and staff guidance -- interim staff guidance like this and then some challenges to actually developing PRAs.

Slide 17. As Hanh had discussed before, Part 52 has a variety of licensing options, design certifications, combined licenses, standard design approvals, manufacturing licenses.

We are engaged in preapplication reviews where the designers -- each one of them is interested in the different one of these options, like that. We have some that are coming in for what's known as a custom combined license.

Remember, the original model of a combined license was you would have an early site permit and you would have a design certification and then you would marry those together for a combined license.

A custom COL says, no, you just start from scratch.

CONSULTANT CORRADINI: Marty?

MR. STUTZKE: Yes.

CONSULTANT CORRADING: Has there ever been a standard design approval without it being in combination with a design certification? I know AP1400 are together but I am not aware of anything that they are separated. I am not aware of any SDA that's been -- not DC.

MR. STUTZKE: Yeah. Yeah. I don't believe there's ever been a standalone SDA, although

recently I heard it come up in the context of NuScale for power upright be an SDA type of thing, like that.

CONSULTANT CORRADINI: Okay. All right. Thank you.

MR. STUTZKE: In addition, as we had discussed before, there's an ongoing rulemaking Amy pointed out that would align the PRA. Part of the rulemaking would align the PRA requirements under Part 50 to look like Part 52 and I provided the various SECYs and the SRMs and stats, like that.

Slide 18, please. So when you look at the current standard review plan, of course, this is oriented towards light water reactors and, specifically, design certification and combined licenses, like that.

In addition to discussing the PRA and the uses of the PRA, it addresses the deterministic evaluation of severe accident features, like this.

And there are various acceptance criteria in that SRP that are derived from a host of commission policy statements and staff requirements.

So the basic concept is when you look at the SRP acceptance criteria, they tend to be technology neutral or technology inclusive. PRA is a PRA is a PRA and it doesn't matter what the style or

the design of the reactor that's being assessed against that.

So it seems like a reasonable starting point. That being said, you have to realize that there may be things in this guidance and in the SRP that are still LWR centric that we would have to revise and adjust.

So I am not saying use them as is. I am just saying it's a good starting point at this point in time.

Okay. Slide 19. Okay. The next series of slides are actually quotes from the SRP.

Yes, sir?

CHAIRMAN BLEY: Suppose the vision for this review and endorsement should occur as that by the time you finished you would have also updated the existing guidance -- staff guidance so that you could proceed with the process?

MR. STUTZKE: Ideally, when we endorse the non-LWR standard there will be a new Reg. Guide. It won't be Reg. Guide 1.200. And that Reg. Guide would incorporate all of the existing guidance as well as endorsing the standard. So it would become its own separate document.

CHAIRMAN BLEY: Okay. So that's part of

the plan?

MR. STUTZKE: That's the master plan.

CHAIRMAN BLEY: Okay.

MR. STUTZKE: We will see how close we get to it.

I mean, the original idea was that ISGs could be written and issued quickly. That has not been the case. They are as onerous to issue as regulatory guides. So we might as well try to get it all in there.

Okay. So anyway, starting on slides 19, these are the actual language out of the current LWR SRP and that I pulled out that talks to the issue of PRA acceptability like this, and I've tried to highlight some points that I want to make. One is that the PRAs are not done under a formal Appendix B quality assurance program because they are not considered part of the design basis information or whether they are supportive of that and that's discussed at some length inside the statement of consideration back in 2007 when we revised Part 52, like that.

That being said, we have four elements down here to help us ensure the PRA is of adequate quality. You know, the use of qualified personnel,

the use of procedures -- project analysis guidelines we usually call them -- maintenance of records including archival as well as what is submitted and corrective action, the feedback and things like that.

So these are kind of the essence of what we look at for PRA acceptability.

MEMBER KIRCHNER: As you go forward and you depend on the PRA for selecting the design basis events and other events, doesn't it de facto as you go to a more risk-informed licensing approach and regulatory framework it would seem to me then the PRA would become part of -- would come under the quality assurance requirements like 10 CFR 50 Appendix B?

MR. STUTZKE: Yeah. That would actually require elevating the PRA to become Tier 2 information, is my understanding. That would be a pretty radical departure from how we currently --

MEMBER KIRCHNER: But yet, we are going ahead and saying we are going to a risk-informed approach. So it seems to me a contradiction.

MR. STUTZKE: Yeah. We will look into it.

MEMBER KIRCHNER: And that PRA is much more mature than 20 or more years ago in terms of its application and its quality of the actual material.

So it seems to me if you make a

determination that this is a design basis event, using the PRA, not just selecting them -- I shouldn't say at random but the old process -- then de facto the PRA becomes part of the design basis and then de facto one would expect that the more rigorous quality assurance would apply.

MR. STUTZKE: Well, currently it's --

MEMBER KIRCHNER: You're going to still require it of -- let's pick on someone -- thermohydraulic codes or neutronic codes. So why not the PRA?

MEMBER MARCH-LEUBA: I wanted to second what Walt is saying. I mean, without naming names, we have unit reactors now that rely heavily on the design -- on the PRA and saying that the PRA -- we know of examples where modifications through instrumentation get done at the last minute and you don't know if those have been incorporated to the PRA or not and I'm pretty sure they are not.

So it really -- I mean, on these new reactors very important decisions like am I going to have a containment or not having to have a containment are based on this PRA analysis. I don't see how the PRA cannot be quality control.

MR. STUTZKE: Yeah, I appreciate that.

One of the other arguments that has been posed is that Appendix B of itself doesn't provide the level of detail that one would want in order to assure PRA acceptability and hence --

MEMBER KIRCHNER: Well, it doesn't for a steam generator design either. It does it through the formality of an ASME standard, actually, and it's 18 parts, and that includes design control.

So it seems to me that design control becomes extraordinarily important in PRA space, especially when arguments will be made, and we are going to see them and we have seen them already with one application we are considering, that PRA in effect is being used to determine whether it's risk significant or not.

CHAIRMAN BLEY: And it's also been used --

MEMBER KIRCHNER: And then that impacts the reactivity to control systems, as an example, without getting into technology-specific examples.

MEMBER MARCH-LEUBA: The PRA is used today to define the area of exclusion around the plant we have to protect. I mean, nothing could be more important to the safety of the public around the plant than that area.

CHAIRMAN BLEY: I am a little confused in

that in the DCD we have a chapter on the PRA, which I thought was part of Tier Two, given its area, and you said it's not part of Tier Two, which surprises me.

The standard, both for the current light water reactors and this standard, have a peer review process that was developed to help fill in the gaps you talked about, Marty, in Appendix B and it seems you're on the path there. So if you can give me some clarification on those two issues it would be helpful.

MR. STUTZKE: I'll defer to Amy.

MS. CUBBAGE: I just wanted to provide a little bit of clarity. The prior Part 52 rule required that applicants submitted their PRA on the docket. So the ESBWR in prior designs, and so there was a rule change in 2007 where that wasn't required anymore but they have to provide a summary in risk insights, which is in Tier Two as you said.

So I think the question is what level of information is needed to support a future application that's more risk informed that's something we are taking a look at, going forward.

But as it stands today, the PRA is not required to be submitted. The summary is required to be submitted in Tier Two.

MEMBER MARCH-LEUBA: What we are arguing

-- what we are discussing is the quality control and keeping the PRA up to date after there are some modifications over the life of the plant -- over the life of the design.

So I just cannot comprehend that -- the PRA, clearly, is used to define the source term that defines this crucial area because that defines which design basis events we are going to consider for source terms.

MS. CUBBAGE: So the actual source term that would be comparative in its regulatory limits that would be an Appendix B calculation. That would be a deterministic output. The actual PRA is not currently proposed to be --

MEMBER MARCH-LEUBA: The PRA defines what design basis events you consider.

MS. CUBBAGE: What the sequences are, yes.

MEMBER MARCH-LEUBA: So it, clearly, fits into where I pull my facts.

MS. CUBBAGE: I think we will have to take that back as something to think about.

MEMBER MARCH-LEUBA: I mean, and I am sure they used some quality control as to Appendix B or something special. But --

MR. STUTZKE: The other thing I would

offer is that not every non-light water reactor application we get will be implementing LMP.

Right. In fact we already know somebody that's intending not to use LMP like this. So we still -- they still need to meet the requirement to submit a description of the PRA and its results.

MEMBER MARCH-LEUBA: Yeah. I don't want to be --

MR. STUTZKE: So I appreciate the concern.

MEMBER MARCH-LEUBA: I want to be reassured that if -- in the middle of the design or in the middle of construction they just have to make a change on an instrumentation, for example, and that includes a new sequence of events, is there a requirement that that will be -- modify the PRA and everything will be run again?

CHAIRMAN BLEY: Karl, go ahead.

MR. FLEMING: Marty, I wanted to add something. So in considering this discussion about what's subject to Appendix B and what's not and how does the PRA fit into that, the draft guide 1353 is endorsing LMP as one possible -- one acceptable way to propose your licensing basis events and so forth. But that's not the only path forward.

If someone doesn't use LMP or risk-

informed process to do that, there's nothing in the regulations that endorses a methodology to select your licensing basis events for a new reactor.

So the applicant could just propose, okay, here's what I propose to be my licensing-based event and that could be negotiated with the staff. Here's my safety-related SSCs or whatever.

And, you know, it sort of -- it could devolve into an ad hoc process. So whatever the ruling is or whatever the decision is on this risk-informed pathway on Appendix B, you have to consider that's only one -- that's only one possible pathway.

And then I am not sure how you put Appendix B on the --

MEMBER KIRCHNER: Yeah, but in that case, let me -- let me argue that, say, I am a micro reactor applicant or some small reactor. I could just go back to the old means of just define, you know, the hazard be a bounding hazard and an accident and go from there. That's fine.

But it seems to me you're working on a standard -- it seems to me this should stand pretty much clear that if someone goes down the route, LMP notwithstanding, of using PRA to select design-basis events then it becomes part of the design basis for

the -- for the plant.

And that has nothing to do with the alternative regulations. It has everything to do with using the PRA as part of a risk-informed application.

MR. PHAN: Thank you for your advice. 10 CFR 71(h)(1) requires the applicant or COL holders to update and upgrade the PRA every four years. But for any PRA application like NEI 18-04 there is just no specific guidance regarding quality control.

So the staff will take your advice and look deeper into that. Thank you.

MR. STUTZKE: So on slide 20 the general expectation is that the applicant's PRA submittal will be consistent with prevailing standards guidance good practices and it specifically calls out Reg. Guide 1.200.

As I've said before, when we endorse the non-light water standard it will be a different Reg. Guide than 1.200. You know, and as Hanh had alluded to before, there's no specific regulatory requirements pertaining directly to PRA quality. But I would also acknowledge when 52 was written it wasn't necessarily envisioned the extent to which PRA would be wrapped up into the finding of justifying the licensing basis.

So the conversation is good. I've

actually done several PRAs under the Appendix B program. I even managed to make money on one of them.

[Laughter.]

MR. STUTZKE: It was tough. It was eye opening.

MEMBER KIRCHNER: Since you volunteered let's pull the string. So why was it eye opening, Marty? Was it the -- was using Appendix B, did it push you to another level?

MR. STUTZKE: It may have been with the way that we managed our PRA project where we had analysts from all over the country involved in the project and they would each individually go to the licensee to obtain drawings or procedures.

They would come back and write their part of the PRA and they would never tell me they had a suitcase full of documents. So here comes the QA inspector and he's going, I am looking at your controlled files -- where is this drawing? You referenced it in your report. It was that sort of thing, you know, this configuration control.

MEMBER MARCH-LEUBA: You're describing a nightmare scenario.

MR. STUTZKE: Of course.

MEMBER MARCH-LEUBA: -- not on your part,

on my part and believing that the problem that you come up with is, okay, even though we don't like to use that word. I mean, if you have a bunch of flu cases in Oregon and a bunch of flu cases in Alabama and nobody knows about anything else --

MR. STUTZKE: Mm-hmm. Yeah, it was a challenge.

MEMBER MARCH-LEUBA: You guys, you all know by now that I am not a big PRA fan and my primary concern is what is missing on your analysis and it's designed with a quality control and by independent people that don't talk to each other --

MR. STUTZKE: I appreciate the problem. Anyway, slide 21. The general guidance is that a PRA that meets Capability Category I would generally be acceptable for design certification and combined licenses like that.

To refresh your memory, the idea of the Capability Categories in the PRA standard is as the category increases the realism should increase.

Originally, when the PRA standards were written there was three Capability Categories. Now they are being reduced by JCNRM down to only two categories like this.

CHAIRMAN BLEY: They haven't made it yet.

MR. STUTZKE: I've seen bits and pieces of it.

CHAIRMAN BLEY: You know, when the first draft of the first standard came out there wasn't -- there were no Capability Categories.

MR. STUTZKE: Right.

CHAIRMAN BLEY: And there was a political need, similar to the one we heard here, for people who had PRAs that wouldn't meet the standard to at least be able to say they have a PRA, and that's where Capability Category I came from.

There was an effort some years ago -- I know Mary brought it to us, I am not sure if you did -- where 1.200 was going to be revised to say, at least for design certs, you had to be at least Category II unless there was a clear reason you couldn't and you should explain that.

That disappeared somewhere along the line and we reverted to the guidance -- staff guidance that Capability Category I was appropriate for a design cert, which has bothered this committee some.

Now, most of the people who have submitted are closer to Category II than they are to Category I. So they haven't leaned on that too much.

MR. STUTZKE: Well, and a couple of things

come to mind. First of all, this applies to the base PRA, not any applications such as LMP.

CHAIRMAN BLEY: That's true.

MR. STUTZKE: Okay. This is the description of the PRA and its results like that. The other thing that I would point out is that the standard itself contains provisions where users of the standard should decide what Capability Category is appropriate for their application -- this process that they would go down.

And we will certainly have a look at that when we are writing -- when we are endorsing the standard. The other thing I would point out is that to a certain extent when you read the standard the requirement is the same for Category I or Category II.

CHAIRMAN BLEY: In many cases -- in many cases 2 and 3 are identical. Yeah.

MR. STUTZKE: Right. I actually did an analysis of the old standard, trying to count them up. It's, like, what's the real difference and the answer is not much, like this.

So anyway, it's an area that I intend to pay attention to. So it's what we need to do here.

Okay. Moving to slide 22, what is interesting about this is I've highlighted Item B here

and it's kind of a fundamental staff philosophy.

The technical acceptability scope level of detail, the adequacy, the plant representation has to be adequate to support the intended uses. These use the phrase it's commensurate with the role the PRA plays in the decision making process.

And so we will be paying extra attention to that. Under Item C here -- Item Charlie here -- it talks about using or justifying methods that are not covered by endorsed standards yet.

So it would actually allow a licensee or an applicant to use the non-light water standard even if we are not endorsing it yet. That is likely to be the case.

As you know, we have an applicant that intends to submit by the end of this calendar year and we, clearly, won't be able to endorse the standard, like that. So we will use what guidance we have as they will, like that, to determine the technical adequacy.

It will be a challenge. The other thing that I would point out here -- I guess this is as good as any -- is I have -- let's flip to slide 23 first where it talks about the independent peer review process.

Okay. Currently, under the ISG -- ISG 028 -- it does not require the independent peer for review for the design certification initial application. Rather, it defers it until the fuel load PRA required by 50 71(h), like that.

The problem that the staff finds itself in for considering non-light water reactors is -- especially ones where LMP is being utilized to establish the licensing basis is you want to make darn certain that PRA is up to snuff, okay, because the application itself -- the FSAR that the licensee submits to us may be tailored around what the results of the PRA. For example, Chapter 10 on power conversion system may simply be missing. It's not relevant, and it's based on the PRA result.

So we need to ensure that the PRA has adequate capability to support this thing. Meanwhile, our current processes allows the staff -- grants the staff one month to do the acceptance review of an application.

That's not a lot of time for the staff to review --

MEMBER MARCH-LEUBA: Can you repeat that?

MR. STUTZKE: Our current acceptance process, so an applicant submits -- you know, please

give us a license -- we have one month, basically, to turn it around and say we accept your application.

In other words, we consider that it has enough material in it to all the staff --

MEMBER MARCH-LEUBA: It's sent in for review and then the review staff is --

MR. STUTZKE: Right. Okay.

MEMBER MARCH-LEUBA: Okay. That's why I asked you to repeat.

MR. STUTZKE: Right. That is --

MEMBER MARCH-LEUBA: Typically, we never take less than 18 months and very easy to go to 36.

MR. STUTZKE: Yeah. Well, that doesn't give Hanh's branch a lot of time to decide whether that PRA is up to snuff, okay, like that, particularly, if that PRA is being heavily used, for example, to implement LMP.

So we have been entertaining the idea that we should require the independent peer review prior to submittal of an application.

The problem there is he's a qualified peer reviewer. It's a very small community of non-LWR experts and, certainly, non-LWR PRA experts.

MEMBER MARCH-LEUBA: You want independent to it --

MR. STUTZKE: Right. I think Karl's going to be very busy if we -- if we impose that. Moreover, there are issues -- you know, control of proprietary information.

Designers don't want the other designers to come in and look and see what they are doing, like this. So it details the need to be worked out. I am still a big personal advocate of this need for peer review prior to the original submittal to the staff.

I think that will likely impact our review.

CHAIRMAN BLEY: Sounds pretty reasonable to me, given where we are headed with the use of these.

MR. STUTZKE: Right.

MEMBER KIRCHNER: Marty, for the record, could you just clarify what you said earlier about the one-month? I think what you're saying is that you have one month to docket the application.

MR. STUTZKE: Correct.

MEMBER KIRCHNER: I just want that on the record. You don't have one month to review it.

MR. STUTZKE: No. The acceptance --

MEMBER KIRCHNER: Your looking at acceptance for completeness.

MR. STUTZKE: Correct. Correct.

CHAIRMAN BLEY: But there have been cases where you've not accepted applications.

MR. STUTZKE: That's true.

CHAIRMAN BLEY: So it's a --

MR. STUTZKE: It puts us between a rock and a hard space, you know, because some people are getting money from other parts of the government and now you're going -- it's a tough problem.

Okay. And --

CHAIRMAN BLEY: Have you discussed this issue of independent peer review before submittal in open meetings with the stakeholders and -- what have you heard?

MR. STUTZKE: Not yet.

CHAIRMAN BLEY: Okay.

MR. STUTZKE: Not yet. We have our next stakeholders meeting -- it's next week.

CHAIRMAN BLEY: Oh, okay.

MEMBER KIRCHNER: Would this be a topic to discuss with the DOE who is a proponent of some of these applications for --

MR. STUTZKE: That's good advice.

MEMBER REMPE: I am also thinking of examples from other applications where there was a

peer review and they were pushing the envelope, and the peer reviewer said, well, you pushed the envelope -- you ought to discuss this in a broader community, and it didn't go anywhere.

And you're going to see a lot of that with the non-LWRs, especially with this transportation of the loaded reactor to the site and things like that.

I am just kind of wondering if you have these discussions with DOE and some of the stakeholders. It's just -- are you going to let other folks get away with that just to say, well, we didn't want to push the envelope -- we did something -- see you later?

[Laughter.]

MEMBER REMPE: That's not really dispositioning their findings, in my opinion, and --

MR. STUTZKE: I agree, well, and it's a good segue into the this point echo here on the slide about dispositioning the FNS for the comments. You know, NEI Guide 17-07 provides that process that's being issued and there's no reason why it could not be adopted to the non-light water reactors.

What bothers me personally is the need -- as you say, people are going to push the envelope here on PRA techniques. One of the issues that goes around

in the PRA acceptability community has to do with the review of newly-defined methods like this.

But we already have a non-light water applicant that's using dynamic PRA. Okay. That's -- so dynamic PRA is a simulation technique, basically, a thermohydraulics or neutronics simulation where the failures are injected stochastically into the model and then you watch the plant behavior.

And, presumably, if you run enough simulations you'll cover the state space and understand how the reactor behaves. That sort of thing.

CHAIRMAN BLEY: But such an approach has to have an overlay of the logic model of the plant.

MR. STUTZKE: Yes. The point is it's a method that we have never endorsed before. It's not been used by any risk-informed applications in NRR or NRO.

So what to do? And the standard nominally would address its review. But I'll say, nominally, if you don't know what you're looking for the standard is not of much help, in my opinion.

So, you know, these things are troublesome issues that need to be worked out.

Okay. Briefly on ISG 28, starting on

slide 24, again, it was issued pretty recently -- November of 2016. By way of contrast, okay, that's right at the time when the NuScale application came in -- formally came in.

So a lot of the previous work, whether it's the AP 1000, the ESBWR, those were submitted before ISG-28 had actually hit the streets, like this.

And, again, it applies to LWR's design certs and combined licenses. The recognition here, let's say, is that at the design cert and the combined license stage, you can't even achieve Capability Category I for certain requirements inside the standard and I will elaborate those in detail on a future slide, like that.

And recognizing that the PRA standards -- the level one plus LERF standard evolved from the current operating fleet -- may not be specific to advanced light water reactors and certainly not to non-light water reactors.

So that being said, I am looking at ISG-28 for guidance as a building block. But it's not the end all and be all of what we need to do in here, like this.

So, for example, on slide 25 these challenges are identified specifically in ISG-28. The

lack of site-specific information -- for example, seismic hazard curves, level three consequence input models, like what site. So what's the population? What's the meteorology that you intend to use in a code like that?

The PRA standard itself includes various screening criteria. It says if you can show that the frequency of something is below X you don't need to include it in your model and this criteria may not be applicable to advanced light water designs and certainly not to non-light water designs where the sequence frequencies could be well below any of the screening criteria, like this.

Again, you don't know the actual routing or layout of equipments necessarily. The lack of plant operating experience or relevant other operating experience like this would force PRA developers to use expert elicitation and these types of techniques, like this.

So I'll relay a little joke that I learned from George Apostolakis, a long-term member of this committee, and he would tell me, gee, Marty, if I provide you a number that's my expert opinion. If you provide the number you're just guessing.

[Laughter.]

MR. STUTZKE: So, hopefully, to avoid bogus numbers we would use some more formal technique. But it is an issue, the extrapolation of operating experience from one reactor to the other, like this.

The --

MEMBER MARCH-LEUBA: Let me reinforce that. That's extremely important for new reactors in which there is no operating experience.

MR. STUTZKE: Yes.

MEMBER MARCH-LEUBA: Because with light water reactors we have a thousand reactor years -- thousands of reactor years. Almost everything that was going to happen has already happened. You get a new reactor --

CHAIRMAN BLEY: Except the worst things that we consider.

MEMBER MARCH-LEUBA: It's the seven sigma. But --

MR. STUTZKE: Well, you know, for example, the check valves inside the NuScale design. We have been building check valves for a hundred years. We still can't show you these things. You know, there's an issue there, like that.

So slide 26, the lack of operating guidance. You know there might be no procedures

written on things like this. That's what HRA analysts revel in, come up with their -- no operation staff. Nobody you can ask, how does this actually work and what would you do if this or that or whatever like this. You can't walk down the plant to confirm the information.

That being said, I've actually seen virtual reality depiction of one of these advance reactors -- non--light water reactors like that. But it's only good -- you know, it only contains what the programmer put into it. It doesn't show you how it's actually built -- things like that.

And then last but not least is the recognition of the uncertainty bands because of this lack of plant-specific information may be broader than -- than for the current fleet like this and that can, in fact, inform applications such as the LMP where the decision of what's risk significant uses the 95th percentiles and if those percentiles get bigger then so it should be some forgiven.

Again, slide 27 --

MEMBER KIRCHNER: I can't let you go quickly over uncertainties. I think this is a much bigger matter than people appreciate. At least for me it seems -- now, my background isn't PRA. My

background is thermohydraulics.

So we have developed techniques for quantifying uncertainty using best estimate models and so on and have reasonable confidence now, because we have so many separate effects tests and integrated effects tests, et cetera, et cetera.

Here, with a new design where you have no little operating experience or none and many of these concepts, if people are diligent and go back and look at the literature, have actually been prototyped in one way or another.

And I note that we conveniently seem to leave out those adverse operating experiences with those prototypical concepts for whatever reason.

So I am interested in how you, the staff, are going to look at this question of uncertainty. How are you going to -- particularly if the applicant wants to do the LIM approach. How will you deal with this, with the seven points that precede number eight, considerably?

How -- is there a structural way that you see dealing with this matter? Because they will come to you and say, look, I am going to exclude all these potential events because they are 10 to the minus eighth or they are equivalent with a meteor strike or

something.

So, you know, and it seems to me when you get down to such low numbers they are almost -- it's hard to see how you, as the regulator, are going to deal with it and, hence, the question of uncertainty as they do a risk consequence curve kind of selection of events for their design basis.

MR. STUTZKE: Yeah. Structurally, you know, I would refer back to NUREG 1855, which is the staff's tome on the treatment of uncertainty and --

MEMBER KIRCHNER: Uh-huh.

MR. STUTZKE: -- decision making process, and in fact where Anders might comment on it, we are in the process of getting ready to update that type of document.

MEMBER KIRCHNER: Fifty-five, you say?

MR. STUTZKE: 1855. But --

CHAIRMAN BLEY: That's a KM, right? Knowledge management?

MR. STUTZKE: I think it's a NUREG.

CHAIRMAN BLEY: It's a NUREG -- well, NUREG KM, right? No?

MR. STUTZKE: No, it's just a NUREG.

CHAIRMAN BLEY: Okay.

MR. STUTZKE: Staff document. But your

comments reminded me, a number of years ago I was doing risk assessment on the Space Shuttle, and you looked at how NASA would treat its various test data. So they'd put the rocket engine on a test stand and it would fail and the argument was what we learned from that failure so it'll never happen again.

And so every failure caused an increase in the reliability curve. That just bothers me.

CHAIRMAN BLEY: Walt brought up something that I don't know if you folks have looked into but you ought to. Steve Hanauer used to give a lecture at the MIT safety course where he would go through many of the disastrous events at the lab facilities and it was very interesting.

But some of those failures with designs similar to things we are seeing now must be documented in DOE reports and maybe even in NRC reports from the past.

I hope somebody is digging up that history because that would be very useful.

Yeah, Karl?

MR. FLEMING: I just wanted to -- the standard has hundreds of requirements and I am just -- I'll give you a guess. I don't have the actual number, but on the order of 20 to 25 percent of the

requirements have to do with identifying and documenting your treatment of uncertainty.

Whether the source of uncertainty -- you know, what's the basis for failure rate data and so on and so forth. So there's a lot.

To meet the requirements you have to really put a lot out there on the uncertainty cycles.

MR. STUTZKE: The other thing I would offer is that I know that laboratories -- National Labs are compiling what they call the operating experience from, like, the EBRT and the molten salt reactor experiment down at Oak Ridge.

What I don't know is are those just the results of experiments, you know, the neutronics, the fueling, or if I could go in there and I'll actually get a database of incident reports, failure equipment, things like that.

CHAIRMAN BLEY: I think --

MR. STUTZKE: It'll at least be a start.

CHAIRMAN BLEY: Some of those probably predate computer files of these events.

MR. STUTZKE: I am certain.

CHAIRMAN BLEY: So finding some old timers at all the labs they might -- they might be a big help in pointing you in the right direction.

MR. STUTZKE: Yeah, like that.

CONSULTANT CORRADINI: So, Marty --

MR. STUTZKE: Yes?

CONSULTANT CORRADINI: -- I guess this discussion leads me to -- my comment would be that not all advance reactors are created equal.

So there are some of them that have no experience. So I would assume that the staff, regardless of the PRA, would expect some sort of power ascension -- a unique power ascension and testing program of the first of these as almost a prototype. Has that been considered as a way to gather information in terms of reliability? Because I can't imagine -- I don't want to identify which are which but it just strikes me that you're not going to treat them all the same relative to even allowing them to come up to power. And some of these would be essentially a prototype in the making.

MR. STUTZKE: Yeah, it's not -- I would expect that, you know, there would be a very cautious well laid out startup test program. It's not my field of expertise.

CONSULTANT CORRADINI: But I think -- I took what Walt was saying and what Jose and others were saying it would just -- that it's nice you might

have some sort of estimate about the risk.

But until you gather experience and the only experience for some of these unique designs would essentially be requiring it to be the prototype or demonstration to watch it and as it -- as it rises in power.

MR. STUTZKE: May well be.

CONSULTANT CORRADINI: All right.

MR. STUTZKE: Okay. Slide 27 is our assessment of addressing the challenges like this. So I've tried to lay out the challenges and to indicate where when we endorse the standard should we provide a clarification or qualification versus expecting that that requirement would be met as written, like that.

That's not so simple to understand. For example, the lack of site-specific information applies if you're submitting a design cert and SDA -- you know, a main factoring license. Not if you have a COL or a construction permit because you know where the site is. So there's no excuse not to collect the data like that.

Certainly, by the time fuel load -- I mean, you know where you're going to build it by that time. So no excuse like that.

The screening criteria would seem to be

problematic. It's not differentiated by the phase and the design process and the construction, so forth and so on.

So that's what I am trying to indicate down here in this table like that. But, again, to point out to this lack of operating experience, item number four, you know, what it says is after four years of operation then you would update and have plant-specific data. That may not be a broad enough database to do anything for you. Even a Bayesian framework, it won't even tickle the posterior distribution very well. Even if you had multiple reactors, you know, a fleet that you're all piling information into like this.

A little bit off topic, but one of the things that's been proposed in LMP and actually external is through removal or the replacement of single failure criteria with a reliability target. How do you demonstrate you meet a reliability target when you have very limited amounts of operating data like that? Statistically, that's a problem. Then, even worse --

CHAIRMAN BLEY: And when you have that kind of problem, as Mike was talking about power ascension, you need some kind of a program to really

respond quickly when you find these things.

MR. STUTZKE: But even worse, how do you write a tech spec now? So if I get one failure it's okay to continue operating the plant. If I have two failures maybe I have an issue because now my reliability is -- I am not meeting the stated target.

Suppose the failure didn't occur in my plant but it occurred in some other fellow's plant. Same design. These issues need to be thought about carefully and it's not clear to me that -- I mean, statistics will be supportive but that's not the full answer. Something else -- some engineering, it's got to go on here. So we are just beginning to think about those sorts of things.

MEMBER MARCH-LEUBA: Now is the time to think about those because the decision will have tremendous economic consequence.

MR. STUTZKE: Yes.

MEMBER MARCH-LEUBA: And if you don't have the rules ahead of time to rely on, the answer is going to be keep going.

MR. STUTZKE: Yes. I agree.

MEMBER MARCH-LEUBA: And if you look at the example -- for example, with aviation it took two accidents that killed 500 people before somebody would

do something. So if you really -- I mean, you guys are thinking about this. Make the rules now with a cool head on a logical position instead of waiting for the moment when it's needed.

MR. STUTZKE: I don't disagree and my response is there's only so many hours in the day.

[Laughter.]

MR. STUTZKE: Anyway, do you have --

MEMBER MARCH-LEUBA: It's important to prioritize.

MR. STUTZKE: Yeah. Further questions?

MEMBER MARCH-LEUBA: That has high priority.

MR. STUTZKE: I should risk inform it.

CHAIRMAN BLEY: No, but I will say the level of detail you've gone into, Marty, is very helpful and it tells me we are not just being bureaucratic here. We are digging into the essential meat of what we should be doing.

MR. STUTZKE: I appreciate that.

CHAIRMAN BLEY: We are behind for 40 minutes. But we scheduled extra time at the end. I think we are okay.

I am going to limit the break to only 10 minutes, though, and I don't -- you know, Karl's talk

may go over. Anders, I don't know about yours. Yours is probably going to be pretty tight. So we should be okay. In fact, let's do a 15-minute break. Be back here -- we are going to start promptly at 25 after 10:00.

We are in recess.

[Recess.]

CHAIRMAN BLEY: We are back in session.

Karl, you're up.

MR. FLEMING: Yeah, thank you, Dennis.

I am speaking to you today -- the hat on my head is I am the chairman of the Working Group responsible for the non-light water reactor standard. If we could have the next slide, please.

All these slides have been reviewed by my colleagues on the JCNRM. They've empowered me to provide information on the background in developing the non-light water reactor standard and to show you some ideas on where we are headed to come up with the next edition of our standard.

But I am not empowered to make any formal commitments which would require all kinds of board approvals and so forth. Next slide, please.

So what I -- I'll give you a little bit of background on how we came up with the idea of having

this standard to start with. I'll go into what's in the 2013 trial use standard, offer some comparisons with some of the supporting light water reactor standards and then go in to tell you about the pilot studies we have had and some of the lessons learned we got from those.

I'll wrap up by giving you some insight as to what we are doing to address the insights from pilot studies and the path we are going down to propose changes to the standard and what'll come up in the -- I am calling it the 2020 version of the standard.

And we will talk a little bit about the schedule to complete that augments a little bit, just a little bit, the schedule that Hanh showed you earlier.

Going on to slide four, this provides the background. In 2006, this was before ASME and ANS joined forces for the PRA standards. This was under the ASME.

The Board of Nuclear Codes and Standards directed the CNRM to initiate PRA standards for advanced light water reactors and non-light water reactors. So two separate working groups were set up. So we set up the working groups so that the chairman

of each group was on the other group to facilitate cross-fertilization of the two groups.

The applications that were intended -- that are listed --

CHAIRMAN BLEY: Who's chairing that other group?

MR. FLEMING: Right now it's Sara Bristol from NuScale.

CHAIRMAN BLEY: Have they got a draft out?

MR. FLEMING: They are about ready to issue a trial use standard.

CHAIRMAN BLEY: Okay.

MR. FLEMING: The only issue hanging that standard up is coming up with an agreeable definition of large release frequency, having already come out of the large early release frequency legacy. So that -- they are about ready to issue a ballot for their trial use standard.

CHAIRMAN BLEY: Is there -- you've seen them both. You're involved in both. Is there any chance they will merge into one in the next round?

MR. FLEMING: Well, the real big -- the big point of departure is the fact that the ALWR standard is using the same risk metrics -- core damage frequency, large release, large early release.

CHAIRMAN BLEY: Oh, okay.

MR. FLEMING: So it's -- they are going down the path of writing a appendix to the existing light water reactor standard on how you would adjust the requirements if you're doing a design stage or preoperational stage.

CHAIRMAN BLEY: Okay.

MR. FLEMING: So their risk metric set is different.

MEMBER REMPE: So maybe I should have asked this earlier. But when I was looking at your Table 1.9-2 in your standard it talks about the success criteria basis and it talks about the earlier one from the ASME and it does talk about large early release.

And I didn't see -- in this standard it says user-defined end states and radioactive material release from each model barrier. I didn't see timing in there and I didn't see timing anywhere else in what I looked through.

Of course, this thing was 500 pages so maybe I missed it. But are you going to have something that characterizes early versus late at all at these advanced reactors?

MR. FLEMING: We are not -- we are not --

we don't find it necessary to use large early release. But the mechanistic source term component of our standard does get into the need to identify the time-dependent aspects of any kind of release.

Let me -- let me back up here a little bit on the background, and Dennis and I worked together for many years prior to the evolution of this concept of using core damage frequency and large early release frequency.

The original 10, 15 years of light water reactor PRA work was all level three PRAs, all the way out to health effects, and we build in external hazards along the way as we knew how to do them and so forth.

And it was only after this body of work with level three PRAs that there was some research done to be able to show that the core damage frequency for light water reactors correlates pretty well with latent health effects.

And this large early release frequency metric pretty much captures the family of scenarios that can give you early health effects. So it was after that point that we -- you know, there was a lot of focus on, well, we can do a lot of applications without doing a full level three PRA.

That body of work doesn't exist for advanced non-light water reactors and if -- well, to the extent that it exists, it exists in different stages and different degrees for different variants of non-light water reactors.

So in order to achieve a technology-inclusive approach that would cover all the reactors, we decided to write our standards that would take the scenarios all the way out to source terms and radiological consequences without trying to gin up a generic definition of core damage, which many people have tried. In fact, there's ACRS letters that I've participated, going back and forth on attempts to do that which have all failed.

So that's -- if you go into the mechanistic source term and radiological consequences, the time dependence -- the importance of the time dependency releases is stressed in those requirements.

We don't try to define large or early. We don't find it to be helpful in our application.

MEMBER REMPE: I get that you could get it with the mechanistic source term, obviously. I am wondering if we are making it more difficult for some of these plants that don't have the data to support a mechanistic source term because I know some of them

are -- if they have that extra time before anything comes out and they can demonstrate that enough, I mean, I am just -- I'll have to think about it some more. But I am wondering if it's making it a bit hard for them because they've got to go through and try and justify it.

MR. FLEMING: Yes, but if we were going to try to come up with a definition of large early -- you know, if you look at what's happening in the light water reactor world, this ALWR standard has been held up for some time now because the level two people and the light water reactor community were struggling with how do you define large early release -- relative large early release and the problem we have is that you have -- you have 50 megawatt cores at NuScale. You have 3,000 megawatt cores out there and they are reluctant to come out with, you know, sieverts and becquerels and things like that that define these things.

MS. CUBBAGE: I'd just like to --

MR. FLEMING: So we wanted to avoid -- since that issue wasn't being resolved in a readily fashion even for light water reactors, we didn't want to hold up our standards.

MS. CUBBAGE: Yeah. I just wanted to add

that for large -- new large light water reactors we already have come away from LERF and we use LRF, large release frequency. We don't do early.

MEMBER REMPE: But there is something that gives you -- I don't know. I just -- I think that the timing thing and giving appropriate credit for timing is needed and trying to go through a mechanistic source term may be difficult.

MR. FLEMING: It is -- it is covered in the mechanistic source term.

MEMBER REMPE: Yeah.

MS. CUBBAGE: The timing is considered ultimately when we compare against different regulatory criteria, whether it be, at worst, two hours, whether it be 72 hours, whether it be 30 days.

MEMBER REMPE: Yeah. This is -- they are going to have to do a lot of work with it, and then some people don't want to do a big PRA. They just want to use a maximum credible hazard, which might be an early release. But that'll be the consequences they have to take with the licensing.

MR. FLEMING: So in the front matter of the standard the applications that were envisioned for the standard include the kinds of things that came up in the LMP process and that goes back to the fact that

the original sponsors of the non-light water reactor standards primarily came out of the HTGR, NGNP, the Pebble Bed Reactor Project in South Africa as well as a lot of developers in the sodium-cooled fast reactor community.

So these kinds of applications were envisioned a long time ago and they were specifically envisioned for this standard.

We wanted to come up with a technology inclusive approach that covers all the different types of reactors and we were given very sort of administrative reasons why we had to put the non-LWR label on our standard and it was to avoid upsetting or bothering the existing fleet, I believe, is what the policy was.

But, technically, there's no reason why you couldn't apply this to any kind of reactor.

We did coordinate with the ALWR Working Group because we both shared a common mission and that is how do you write a standard for a design stage or preoperational stage PRAs, and we shared common approaches up to the point in which we published our standard.

Now, the ALWR folks, I think lacking any near-term users, have delayed their work on their

standard.

We were able to issue a trial use or, I mean, a review and comment ballot in 2008 and we got about 600 comments back. I think about half of them came from the NRC staff review and lots of other comments as well.

And up until that time, nobody at ASME had seen that many comments come in on even a review and comment ballot and, unfortunately, my name has been attached to the unit of 600 comments equals one Fleming of comments.

So now at all the standards meetings, you know, how many -- how many Flemings did you get on your standards. So I'll never live that down. I am not proud of it but, anyway, I am stuck with it.

Now, I want to also mention something. Mary Drouin, I think -- well, she was always the point person in presenting the NRC comments, and we had a little bit of a conundrum because the purpose of a standard was to codify industry practice and the industry practice was strong in some types of reactors and weak in others and so forth, and how are we going to get everybody to approve this thing as an ANSI.

It was actually Mary Drouin's suggestion that we issue this for trial use and get this thing

rolling and get it out there for people to use it.

And since then, that's been adopted as almost a standard operating procedure in the JCNRM. All the -- all the standards that haven't been released yet have to go through a trial use phase, get pilot studies to get feedback and then go forward from there.

So we were the guinea pig on that. Since then, the standard's been used in many pilot applications, which I'll talk to in a second on slide five.

You know, if you -- as, I think, Marty and others have said, you know, if a lawyer can indict a ham sandwich, you know, PRA analysts can do a PRA on a ham sandwich. It's been done on many different types of things.

And a lot of the requirements for doing a light water reactor PRA and a non-light water reactor PRA are pretty common. When you look at our standard, I think -- and this isn't a scientific -- I didn't actually count this. It's just a rough estimate.

I'd say about 80 percent of the requirements in our standard are common to the light water reactor standard. One of the big deviations is that we don't use core damage frequency and we don't

use large early release frequency as a risk metric.

So everywhere you see those words appear in the light water reactor standard, you'll see things like event sequence families and release categories and quantitative health objectives and things like that.

We were -- we were required by the JCNRM to keep our standard as consistent with the light water reactor standards as applicable and deviate only when it's needed for, you know, the specific applications or for -- to be able to handle the technology-inclusive aspects.

And we were beat -- in the balloting process we were beat up pretty badly on trying to put in improvements, you know, in our standard that really were common to all kinds of reactors. So we have been constrained to try to --

CHAIRMAN BLEY: So where do those come up then if they really are improvements? Does there have to be --

MR. FLEMING: Well, they get passed over -- they get passed over to the groups working on the light water reactor standard.

CHAIRMAN BLEY: Well, yeah, but if you didn't include them here and they aren't over there

but eventually a consensus thinks they ought to be everywhere, how does that happen?

MR. FLEMING: Well --

CHAIRMAN BLEY: If one can't move forward if everybody --

MR. FLEMING: The only way -- well, you'd have to dig into the records of the balloting process where somebody says, you know, you're doing this but light water reactors can do that, too. So that's taken -- you know, taken out of the process.

There's lots of good ideas that people come up with that we then have to just refer these generic improvements over to the light water reactor groups to have them work on it.

CHAIRMAN BLEY: Okay.

MR. FLEMING: So 80 percent are pretty much common. Twenty percent are specialized. We have quite a few comments that don't even appear. They have no parallels in the light water reactor standard and I'll try to give you some examples of those.

Go on to slide six, please. The scope of our standard -- you know, first of all, all the things that drive our standard are driven by the stakeholders who participate on the -- on the working group, primarily. In the early days, it was mostly HTGR and

sodium-cooled fast reactor folks supporting this as well as NRC and some of the National Laboratories.

But, over time, it's grown to include other types of reactors including molten salts and so forth. So we want to capture multiple plant operating states and shutdown states.

We take our event sequences all the way out to having end states either with stable plant conditions or a release with a mechanistic source term and radiological consequences.

And there's options on consequences to simply do site boundary dose calculations or a full max type level three calculations.

The way we have done our end states is that we have user-defined event sequences, event sequence families, and release categories.

I might want to make a comment here is that the way licensing basis events are defined in the LMP documents we refer to the definition of event sequence family.

The event sequence family is simply a grouping of event sequences with comparable initiating event challenge to the plant, plant response, and mechanistic source term if there is a release.

The reason for having this requirement is

that none of the -- even the light water reactor stands have never standardized the level of detail of defining event sequences.

So the family provides a way to normalize things so we can make apples and apples, you know, type comparisons.

We have -- we include within our requirements requirements for mechanistic source terms and radiological doses and health effects. There's options for the user to provide his own intermediate end states.

For example, the sodium-cooled fast reactors like to use a end state called sodium boiling, which is a good precursor, you know, to challenging the fuel in the sodium-cooled fast reactor.

Those are not required but if you have them there's requirements in there on how you have to clearly specify how they are used and how they connect into the -- with dependencies into the ultimate technology-inclusive metrics.

From the get-go, we have embraced the idea of a evolving multiple reactor event sequences, going all the way back to the MHTGR days when this -- when the predecessors of the LMP processes were defined.

The MHTGR did a floor module PRA that included event sequences where all floor modules were involved. We have -- we have put in requirements for how you deal with PRAs done at preoperational design stages.

So what to do, for example, in lieu of walk downs. If you can't do a walk down there's alternatives -- parallel requirements that you can do to get the functional concern about walk downs.

So you can go from as-built as-operated plants to as-designed and as intended to be operated type of fidelity.

As I mentioned earlier, there's lots of requirements to address uncertainties. We import the -- all the uncertainty requirements from a light water reactor standard and we expand on those to recognize additional unique sources of uncertainty for these advance non-lights.

And as I mentioned, we are held to a standard and try to maintain consistency when it's appropriate and we can always justify deviating from that if we have a good case.

CHAIRMAN BLEY: Karl, before you go ahead, having looked through your slides, there's a few questions I'd like to get on the table now --

MR. FLEMING: Sure.

CHAIRMAN BLEY: -- and then we can talk about them later. Early on the in the standard when you were talking about Capability Categories, the standard says -- it makes a strong point that with increasing Capability Category realism increases, and that seems reasonable.

It also makes a strong point that doesn't sit as well with me -- there's a strong point made that Capability Categories are not based on the level of conservatism in the analysis.

The level of conservatism may decrease as Capability Category increases and more detailed -- and more realism are introduced in the analysis. However, this is not true for all requirements and should not be assumed.

What I would wish were in here is if -- that there ought to at least be a qualitative description of cases where moving up in Capability Category could result in higher risk.

If -- you know, if what you've done in Category I has left out a lot of stuff that could raise the risk it ought to be noted somewhere. I mean, it just gives a wrong impression that Capability Category I is kind of a broad -- you know, we have

given thought to everything that could happen.

It bothers me that that sense of conservatism isn't embedded in the process.

MR. FLEMING: Yeah. I am going to have to go back and take a look at that particular sentence to find out what's --

CHAIRMAN BLEY: Okay.

MR. FLEMING: -- what they are trying to get at. There were three sort of qualities considered in the Capability Category. One is realism, one is the fidelity of the models to the thing you're analyzing, and the case of an existing standard for light water reactors it's the as-built for the plant. In our case, it's -- if it's preoperational PRA it's the as-designed as-intended to be operated plant. And the third is the level of detail.

And I can tell you from the standpoint of how the -- how the requirements were written is that if there's a difference between Capability Category I and Capability Category II, it's always -- I can't think of any exceptions -- it's always the case that the Capability Category I will accept conservatism and simplicity and -- simplicity and conservatism --

CHAIRMAN BLEY: That's my way of thinking about it.

MR. FLEMING: In Capability Category II, it's still okay to use that simplicity and conservatism but only to the extent that it doesn't get you in the way of identifying your significant risk events.

CHAIRMAN BLEY: The implication here is just the opposite.

MR. FLEMING: That's --

CHAIRMAN BLEY: So if you take a look at that section I think it would be worthwhile.

MR. FLEMING: Yeah. I can't tell you what that -- what that's all about. I'll take a note and get back to you on that.

CHAIRMAN BLEY: There's a page on that stuff and it's right in there.

I have two comments on your acronyms and definitions. We do have core damage frequency, CDF. But nowhere do we have a definition of core damage, which seems odd.

And then there's a circular one that bothers me because it jumps out because I really don't like the word conservative. So there's one on demonstratively conservative analysis and the definition is that the outcome will be conservative. So it's circular. So you might think about that.

And I had -- go ahead.

MR. FLEMING: Yeah. So on the first one, it shows up in the acronym -- it shows up in the acronym list because it's talked about why core damage frequency is not used in the text.

The only terms that are included in the definition list are terms used in the requirements.

CHAIRMAN BLEY: Okay.

MR. FLEMING: We don't have any requirements for core damage frequency. That's why you don't show them in the definition, and that's -- I mean, that should be the --

CHAIRMAN BLEY: And you use CDF somewhere in a description so that's why it --

MR. FLEMING: Yeah, we use CDF in the text to say that we are not using it. So that's --

CHAIRMAN BLEY: Okay. Are you going to talk some about mechanistic source terms at some point? I didn't see it quite in your list of things. It's a thing where we have been concerned about that in a lot of the guidance that's coming out for new applicants there isn't much that gives them a lot of help on how to develop their mechanistic source terms. And I am not completely sure the standard goes quite far enough to be really helpful.

MR. FLEMING: Right. Okay. Let me see if I can address that. Can we go on to the next slide and I'll see if I can talk to that.

The one area of improvement that we got permission to deviate from and that is we didn't want to follow the part one, part two, part three model that was used for the light water reactor standard. It was too cumbersome and in fact, I will -- I just want to mention on the -- working on the light water reactor side of JCNRM, I was given a task.

Whenever ANS came forward with separate standards on low power shut -- or external hazards and the ASME just had the internal events of core power when low-power shutdown came, I was tasked with coming up with how are we going to put these together. And I made a proposal very similar to this that we'd come up with one integrated standard and everybody says yeah, that's a great idea -- let's do that.

And then -- and then somebody came up with -- tried to develop a project plan and said, oh, this is too hard. It'll be easier if we just have a part one, part two, part three approach. And I have to also say with the benefit of hindsight -- I just got to get this dig in to my light water reactor colleagues -- the last two cycles of improvements on

light water reactor standard have largely been to clear up inconsistencies between how issues were treated in part one, part two, part three, part four.

So what we decided to do is to have one integrated standard that treats all the hazards.

CHAIRMAN BLEY: And as you do this, the one thing that doesn't jump out at somebody reading this the first time only because of my background, I suppose, is that where we used to have level one event trees and we had containment event trees, all of that's embedded in the event sequence analysis phase.

MR. FLEMING: That's right. That's right. That's right.

CHAIRMAN BLEY: But this does go all the way through.

MR. FLEMING: Yeah. The event sequence analysis has the equivalent of the events -- active and sequence event trees going to core damage and what some people refer to is the accident progression event sequences that go through both.

CHAIRMAN BLEY: So it has both a systems part and a phenomenological part?

MR. FLEMING: Yeah. And the reason for simplifying that or squeezing that together is that it goes to the simplicity of these light water reactor --

these non-light water reactor designs. So very simple, relying more on passive and inherent features, different arrangement of barriers, relying on -- more on fuel in some cases, for example. In some cases, they dissolve the fuel in coolant like the molten salt reactors.

So if you look at the pilot PRAs that we have done, they are fairly simple event trees that go all the way to source terms. So it wasn't necessary to break them up.

And also, the history behind breaking up those event trees, I remember working with Dennis and others on the PRA procedures guide back in the 1980s, NUREG CR-2300, which is one of the first PRA procedures guides that was written.

That's when the level one, two, three concept was introduced into the light water reactor PRAs, and the idea was back in those days with the computer tools and the complexity of the designs, it was decided that we can break the problem up into more adjustable pieces by having level one PRAs, level two PRAs, and level three PRAs.

But a lot of that was driven by, first of all, the state of computer technology at the time and also the complexity of the large light water reactor

plants.

So the simplicity sort of justified collapsing all the event sequence development into event sequence analysis.

So if you go through the standard requirements, some of those are parallel to the light water reactor level one standard. Some of those are parallel to what you'll find in the level two standard.

So it's one integrated set of requirements and the one thing we have at the end, which is -- I just -- it may be covered somewhere in some of the light water reactor standards called risk integration. That's where we bring together the scenarios, the frequencies, the consequences and come up with an assessment of the overall risk facility.

So that's the structure we have on our standard and then each one of those has a section of requirements, with high level requirements and supporting requirements.

Just a comment on the Capability Categories. The origin for the three Capability Categories really came from the industry peer review process that predated the standards.

Before the standard -- the first standard

was even out the door, first of all, the BWR Owners Group and the other -- PWR Owners Groups adopted a peer review process that had a four-level grading system where grade one was simply the minimum necessary for an IPE submittal and then two, three, and four were various levels of detail and quality above that, so --

CHAIRMAN BLEY: Which were already complete at that time?

MR. FLEMING: Yeah, and nobody wanted to claim that they -- at the IPE level at that time. So actually the first three Capability Categories in alignment with grades two, three, and four in the industry peer review process.

That's how -- that's how the three got in there, and as it's already been noted, Capability Category III is being -- in the process of being eliminated. So the future standards will just have two Capability Categories.

CHAIRMAN BLEY: I had one last thing that I'd spotted that I wanted to ask you about and it's in the human reliability section of the standard.

We have got this language of -- more language I don't like. Errors of omission, errors of commission, which are really figments of the analysts'

imagination, I think.

But the standard very specifically is focused on errors of omission. It's doing the things that are called out in the procedures or other places, and it bothers me that that's true for Capability Category III, which is kind of out beyond what some would call current state of the art, although I don't personally believe it is.

With very curious and unusual designs -- well, with LWRs if you go back and look at bad events, many of the worst events we have had have had so-called error of commission -- somebody doing something you didn't expect them to do.

And if, in Capability Category III, the kind of events looking at PRA we don't even acknowledge such things exist. How can we get the risk right? I think you ought to rethink that. I think the staff ought to think about that quite a bit because --

MR. FLEMING: Yeah. To be very frank, we did not try to push the envelope on human reliability. So everything you see in there on human reliability is pretty much what we imported from a light water --

CHAIRMAN BLEY: Yeah. And I guess I can kind of live with that for Capability Category II.

But when you're saying where could we be or what could we be doing better, that strikes me as one that really ought to be there because it's showing up. It's been a problem in bad events and we don't even acknowledge such a thing exists in the standard.

MR. FLEMING: I totally agree. But the state -- our state of standards practice is pretty much in alignment with what the light water reactors have done in the --

CHAIRMAN BLEY: Pretty much. But, you know, these have been examined in a couple of NRC projects --

MR. FLEMING: Oh, yes.

CHAIRMAN BLEY: -- and in methodology development work for pushing 20 years now.

MR. FLEMING: Right. Point well taken.

The one thing that we did import was that the -- in the low-power shutdown standard -- well, in the operating light water reactor standard they sort of separate things into pre-initiator and post-initiator human reliability.

And the low-power shutdown introduced the at-power so you can keep track of dependencies of the human-caused initiating event that can show up in the dependency analysis later on.

Unfortunately, that's become quite controversial. But many people and the light water reactor people don't like that. So --

CHAIRMAN BLEY: They should have been thinking about it all along. So yeah.

MR. FLEMING: I know. Yeah. We liked it so we incorporated that.

MEMBER REMPE: On another topic, what would you do for a advance non-LWR that has part -- as part of the package a hydrogen production facility? Would that come under other hazards? Is it --

MR. FLEMING: Oh, yes. Oh, yeah.

MEMBER REMPE: Because when I looked through it, again, I may have missed it, but other hazards were usually external hazards. I didn't see anything about another co-located facility. But that is going to be in the 2020 version if it's not in this version?

MR. FLEMING: No, it's actually considered to be in this part of it.

MEMBER REMPE: Okay. So if I look through the 500 pages I'd find something about that?

MR. FLEMING: Any hazard -- any hazard that -- any hazard that's not specifically laid out in this slide right here is intended to be covered by

other hazards.

MEMBER REMPE: Okay.

MR. FLEMING: So, you know, hydrogen facilities process -- nearby process plants and so forth.

MEMBER REMPE: But I didn't see it in the standard specifically saying that that's what you expected for other hazards when I looked for it.

MR. FLEMING: Well, that's -- yeah.

MEMBER REMPE: But it should be there?

MR. FLEMING: That's something we can make more clear.

MEMBER REMPE: Okay.

MR. FLEMING: That's something we should make more clear. I am going to take a note of that.

If we can go on to the next slide, please, in slide eight.

CHAIRMAN BLEY: As you begin on that, you asked me earlier to point out where you had excluded the Part 50 kind of process and I'll give you that you say examples of PRA scopes.

But in Section 3.3.3 you list conceptual design, design certification and combined operating license. But there's no mention of construction permits or operating licenses.

MR. FLEMING: Oh, okay. Good feedback. It was never intended to exclude any of those applications. So we will try to make that more clear.

CHAIRMAN BLEY: And one could argue that it doesn't but it sure reads that way to somebody reading it.

MR. FLEMING: Okay. Yeah. That wasn't intended but good feedback.

We were very pleased at the amount of pilot study activity we were able to get. The -- actually the first pilot study was a real pilot study. This was the licensing of the HTR-PM in China, and they actually started to -- they had to submit their -- they had to submit a PRA as part of their PSAR application.

I don't know that much about the Chinese regulatory process but it looks a lot like Part 50 from my perspective. So they had to submit a PRA for the PSAR and then an FSA -- another upgrade for the FSAR.

When they submitted the PRA for the PSAR, they were actually using a draft of this trial use standard that hadn't even been published yet because the timing -- and then they completed a more comprehensive PRA as part of their operating license

and I believe they are operating today.

So they were actually the first out the door to actually use it in a regulatory application in another country. And I also wanted to take this opportunity to point out that all these JCNRM standards are intended to be international standards. So we have to be careful not to completely wire in the U.S. context, although it's heavily influenced by U.S. considerations because that's where the resources are coming from to develop it. But we have to be careful. It's an international standard.

CHAIRMAN BLEY: Karl, one thing that would have been helpful for me on this slide, and I'd like to hear about it sometime -- if not today, maybe in a later meeting. I am certain -- I could be wrong -- that not all of these PRAs exercised all parts of the standard.

MR. FLEMING: I was going to get to that.

CHAIRMAN BLEY: It would be interesting to see which ones did which, and you have a slide a few later about LMP demonstration projects that used the standard as well and not all of those are on this list, I don't think.

MR. FLEMING: Yeah.

CHAIRMAN BLEY: So --

MR. FLEMING: Okay. So we will try to -- we will try to get to that.

CHAIRMAN BLEY: Okay.

MR. FLEMING: The HTR-PM and the PRISM is the next -- the next -- probably the most important one on this slide is the PRISM PRA.

A couple of years ago, you know, the PRISM -- there was a PRISM PRA done for the 1980s vintage submittal that Marty referred to earlier and they got a grant from the Department of Energy a couple of years ago to modernize their PRA and also to pilot the standard, and they addressed almost all the requirements.

Between those two -- the sodium-cooled -- the PRISM and the HTR-PM, they exercise all the requirements in the standard to some -- to some level of detail, not necessarily all the Capability Category II or III but at least in Capability Category I.

The other -- the other pilot studies listed on here are less full scope type applications. Getting to the mechanistic source term, we had requirements for mechanistic source term and what we did there is that we looked at the level two PRA requirements having to do with the source term part of that and we had to generalize those requirements. So

we eliminated specific issues that are important for light water reactors and tried to write them in a more general way.

The best probably demonstration of that was for the PRISM reactor. So Argonne National Laboratory did all the thermal hydraulic and mechanistic source term work for the PRISM PRA.

And by the way, that same team of General Electric and Argonne National Laboratory is picking up on that work that was done in the past and they are applying that to the versatile test reactor that's being designed for the neutron source at the -- at Idaho National Laboratory.

And so the VTR thing on the bottom is sort of an extension of what was done in the PRISM PRA. But there's actually some technical papers out there that David Grabaskas has authored on how he's exercised the PRISM -- the mechanistic source term requirements for that particular PRA.

And, of course, that's also an example of the mature -- relatively mature advance reactor technology.

CHAIRMAN BLEY: If you could give some of those papers as references to Derek it would helpful for the committee.

MR. FLEMING: Okay, good.

CHAIRMAN BLEY: We'd like to see them. If that's possible.

MR. FLEMING: Yeah.

CHAIRMAN BLEY: Or if the staff has them.

MR. FLEMING: Yeah. And while I have Argonne on my mind here and David Grabaskas on my mind, another thing we have done in our standard is to try to beef up the requirements to be able to address things like passive safety features in reactor designs.

And the approach we have taken there is that in our success criteria requirements there's requirements in there to basically do an uncertainty analysis on the phenomena that you're relying on to perform your passive heat removal capabilities.

So that's another area where the PRISM folks have done some really excellent where they took their -- they have a passive decay removal system -- reactor cavity cooling system. I can't remember what they call it. But it's a natural convection, a DRAC system. Yeah, a DRAC system. And so what the -- there's a separate paper I can -- I can provide to you that meeting that they wrote on how they probabilistically evaluated the uncertainties in the

success criteria for performance.

So it's not just like we assumed it's perfect. You know, there's a probabilistic analysis of the uncertainty that backs up the passive --

CHAIRMAN BLEY: And I don't know if you'll know the answer to this. In the cases where people exercised the part of the standard that are looking at uncertainty, did they go back to their PIRTs and make sure they covered all the identified and important phenomena that ought to be considered?

MR. FLEMING: The best evidence that I have on that is what PRISM did. PRISM -- there is a public -- there is a public domain report on the PRISM PRA upgrade that was done a couple years ago, which is -- which has been made available to the -- our working group and I think it's also been made available to the NRC, which would provide some description of that.

And I think when the VTR project gets further along, they plan on publishing some additional not only feedback on the standard but feedback on the LMP process, which they are also trying to employ.

The other -- the other examples on this, you know, PBMR -- the PBMR project in South Africa they actually funded -- the only reason why we were able to get as far as we have gotten on this non-light

water reactor standard is because, you know, they are typically volunteer type efforts to put together -- is because between PBMR and the NGNP project they provided something like four to five person years of funding for us to work on the standard, you know, back in the early stages of this process.

So, you know, on the low-power shutdown standard they just came out with a trial use standard recently but they were working on that -- some of the standards for 15 years and that's typically what you'll see in the volunteer effort type process.

But this standard, there was so much need for it there was quite a bit of funding provided to help put it all together.

All of the -- all of the tabletop exercises have done limited scope, in some cases, preconceptual design, in some cases conceptual design level PRAs that focus on full-power operation and internal events.

The PRISM PRA did not look at external hazards but the VTR variant of that is looking at seismic events and other external hazards.

If we could go on to the next slide.

MEMBER REMPE: Karl, before you go on, the eVinci micro reactor discarded in 2019 so maybe it's

not very far along. But if I look back a couple of slides where you talk about how you're going to have -- consider offsite radiological consequences and they have to consider transport to the site and removal, what are they going to assume for the -- who the dose is going to?

MR. FLEMING: Nobody's actually done that transport on and offsite yet. So we don't have --

MEMBER REMPE: So that'll be something kind of hard to think about with transportation and highways and --

MR. FLEMING: That hasn't been tackled yet. But, you know, it's coming down the road.

MEMBER REMPE: Okay.

MEMBER PETTI: When you look at this list, I mean, you're really hitting a lot of the frontier, right, I mean, in terms of technology types, sizes of the reactors. You know, were there any big surprises that was completely missed somewhere along the line as you moved from one technology to another where, you know, oh, we never bumped into this because it wasn't part of the technology?

MR. FLEMING: There was no surprises in the context of every different type of reactor that has tried this process found that the way we

structured our event sequence analysis to go from initiating and then to source terms was not a problem. Everybody was able to do that. Everybody was able to come up with at least estimates of what the source terms would be.

Only PRISM and -- I can't speak too much to the HTR-PM because they didn't give us the whole PRA that they did. They gave us, you know, summary level information.

So but on the PRISM case they actually did all that work. So I am sort of losing track of your question now. Oh, yeah. So surprises in terms of the technical approach taken. No, not.

But there was a -- there's a big important insight we got from the pilot study that led to something that we didn't think through very carefully and that is how we were treating risk significance and I'll get to that in a second.

So that -- how we were treating the concept of how you define risk significance, we were copying what the light water reactor folks were doing without thinking clearly, and I'll have a couple of slides on that.

That was the big -- that was the big technical insight we got. In most cases -- let's go

on to the next slide because it's summarized there -- everybody who tried it said that it was a useful process going through the requirements to establishing the PRA technical adequacy.

In one case -- well, in the case of TerraPower, TerraPower actually did a peer review. They did -- they took the NEI peer review process and they adapted it to their traveling wave reactor and they brought in industry experts in PRA and performed a peer review. And we have asked Brian Johnson to give us a public domain document that tells us -- gives us some feedback on those experiences.

As I mentioned, as far as, like, tangible feedback that will influence how we write the next edition of our standard, the most important feedback came from PRISM, the HTR--PM, and the traveling wave reactor PRA because -- partly because Brian Johnson from TerraPower has been very active in -- on the working group and has provided us a lot of good written feedback. And we have a process in the JCNRM to post all the feedback and we have requirements to -- before we go out for ballot we have to justify to the -- in something called a readiness review process that we have addressed all the peer review feedback that we had.

CHAIRMAN BLEY: Is that a private website or is that a public one?

MR. FLEMING: It's a -- it's a website that everybody on the JCNRM has access to including members of the NRC. And there's nothing proprietary. All the information there is public domain information. But just getting the access -- if you have membership on one of the working groups and Anders and many NRC people and National Lab people can access it.

CHAIRMAN BLEY: Okay.

MR. FLEMING: The most -- you know, we got a lot of comments, which you would expect, that, you know, need more clarification on what was meant by this requirement.

I think that, like I said earlier, a lot of the work that's been done in the last 20 years -- we started working on the light water reactor standard 20 years ago and a lot of the work we have been doing on revising things to 2008, 2009, 2013 and now is to provide better clarification on what was the intent of the requirement. Very little new requirements are coming along. We are reexplaining the original requirements that we wrote 20 years ago.

So we have a lot of that as well, as you

would expect. So the most significant technical issue -- the number-one most significant issue was how we were treating risk significance and I'll talk more about what that's all about.

The other -- you know, they'd like to see more guidance on how you deal with and report very, very low levels of frequency, very low levels of dose, very low levels of risk.

And I don't know if we have a solution to that yet but we are contemplating offering up some de minimis levels that we can put in the standard such that when you calculate you have some cut set that calculates 10 to the minus 24 frequency or whatever that you can, you know, put your pencil down and say less than some de minimis value rather than take a number like that seriously because we know that when we calculate a low number we know that the results down at that low level of frequency are dominated by things that we don't have enough --

CHAIRMAN BLEY: My memory is that in the LWR standard, and I could be wrong about this, the current version anyway, there was a warning on that kind of truncation that you need to look -- at least retain some of that information for looking at raws because they can disappear through that process where

they link together a bunch of things that would be very tiny contributors but when you have them all linked together, what if this thing fails? All of a sudden it becomes important.

Is there such a warning in here? I didn't read carefully enough to find that.

MR. FLEMING: No, you won't see that. But we are trying to think about ways to deal with that in the next edition. We don't have a solution to that but that's on our plate to address.

CHAIRMAN BLEY: Good.

MR. FLEMING: And, of course, the other thing that has really come out more from the LMP process, and also some experiences with the design certification on the ESBWR is to rethink the roles of relative and absolute risk importance measures.

The LMP has included some absolute-based risk metrics for risk-significant SSCs and risk-significant licensing-based events and we are thinking about the best way to roll that into the standard.

The light water reactor standard and the next edition of the light water reactor standard seems to be still sticking with the relative only risk measures and we are contemplating introducing absolute risk measures, which I'll talk about in the next

slide.

We believe that we have sufficient experience already with the pilot applications to justify moving forward with an ANSI version of the standard.

Now, that's the position of our writing group. It remains to be seen whether it goes through the ballot process with that. So that's our -- that's our little working group technical position that we think we are ready to move forward.

Lessons learned from the pilots -- oh, we had that. So next slide, on slide 10 -- risk significance.

What we had done on the 2013 version of the standard is that we kind of copied what was being done for the light water reactors. The risk significance is defined in the light water reactors based on a -- normalized against your baseline core damage frequency and large early release frequencies.

So a risk-significant basic event or a risk-significant accident sequence is defined relative to what your floating baseline level of risk is and that's just the -- that's the way it was.

And we kind of with -- I think with benefit of hindsight we kind of naively extrapolated

that to release categories, which is one way to capture the sequences coming out of the back end of the event sequence process.

And that we should have -- I think when I look back at this I thought we were kind of -- we kind of missed -- we didn't think this through very well because the feedback we got PRISM tried to apply that. They had 40 release categories so they had 40 sets of risk importance measures.

What do you do with that? I mean, how do you get insights from that? And, of course, the failure that we made in the standard is that we weren't taking advantage of the fact we were calculating consequences.

So we weren't bringing the consequence -- the relative consequences of the release categories into the picture.

So anyway, that's -- that was the big feedback we got from that, and if you look at -- we have now drafted -- we have in our working group we actually have a draft of the next edition of our standard from soup to nuts, all the -- we have gone through the whole process.

The vast majority of the changes that you'll see relative to what's out there now is simply

changes to get in better alignment with the evolving light water reactor standards because we are required to be consistent.

The other area where we are -- where we will be different or we will show changes relative to the last time is how we are defining risk significance and how we are using risk significance in the requirements.

So that's the -- those are the big areas, and I have another slide -- it's slide 11 -- that elaborates on that a little bit. You want to do slide 11? Yeah.

No, I guess we are -- it's slide 12 but I'll get to it. LMP insights for the standard -- the standard was used at least for limited scope early design stage PRAs on six different pilot studies.

The Xe-100 Pebble Bed rector, the GE-PRISM case -- the molten salt reactor experiment, which is work that Vanderbilt did doing a PRA on that actual molten salt reactor, the Kairos fluoride salt high-temperature reactor, the eVinci reactor, and I -- there's another one done by Oklo, and I don't -- I am not exactly sure how Oklo used the standard. So I didn't include it on this list. But that was the sixth demonstration project.

I believe the reports for all of these LMP demonstrations are now on the NRC website. If I am wrong on that, Amy, maybe you can correct me.

MR. PHAN: So if you get into the NRC advance reactor website there are six reports in there. The best way you get to it is Google.

MR. FLEMING: So as I mentioned, LMP has proposed absolute risk significance criteria for event sequences, you know, for licensing-based event spaces for event sequence families, SSCs and, of course, you can easily see how that can be extrapolated to the underlying basic events that's supported in SSC.

So how one -- you know, so the question then comes what's the role of absolute metrics versus relative risk metrics, which we are working on and I'll get to the slide.

Slide 12. We need to -- you know, as I mentioned earlier, we originally wrote the requirements to cover all sources of radioactivity.

The JCNRM wanted us to put some caveats, you know, on the standard to say that, you know, because there was lack of experience in doing things like spent fuel pool PRAs and so forth, they asked us to put some caveats in the standard to sort of focus on reactors and reactor systems and things like that.

But especially for the molten salt reactors, we really need to expand the scope outside the reactor because in some of these molten salt reactor PRAs most of the hazards are outside the reactor. The fission products, the actinides, you know, the -- so and the off-gas systems -- qualitatively, there's a belief that off-gas systems may be the most important risk contributor in some of these molten salt reactor designs.

So we have to expand the scope of systems in this version. Again, that's subject to balloting, which hasn't been done yet. There's more clarification needed on some technical elements.

How we deal with the preoperational aspects, which were already addressed in 2013, we need to beef that up a little bit in the next edition.

And on the peer review process, as mentioned earlier, it's just not realistic to assume that you're going to bring in a sufficient cadre of peer reviewers that, A, know PRA technology and B, know your technology.

So we already have in our Section 6 in this standard, and we are going to beef this up in the next version, is that the nature of these peer reviews is going to change a little bit because we are going

to put on the scope of the peer review what the peer reviewers who probably don't understand the reactor technology that well to review the question how does this reactor technology influence the way in which this PRA was developed and how it might differ from how -- you know, a light water reactor PRA.

That type of a scope is not normally covered in peer reviews. But we intend to -- we have already identified this in 2013 and we want to beef that up a little bit in the next edition.

If we go on to the next, slide 12, the risk significant approach is -- we have drafted a new risk significant approach in our current working documents and since we -- since we know that this is going to be a major point of departure from the light water reactor standard because we are going to introduce the absolute risk metrics we are going to retain relative risk measures. We are not getting rid of them. We are going to introduce absolute risk metrics and we are going to be defining them based on not only the frequencies but also the consequences of the -- of the event sequences, which is a new wrinkle compared to the way light water reactors do it.

We are going to -- we are going to prepare a ballot just on this risk significance approach.

Bite that off as a separate issue and we are going to run that up the flagpole on the JCNRM and get clarification on and agreement on how we are going to do that because it's -- that approach is going to be implemented in every single requirement, especially when you get into Capability Category II you'll have to know what kind of risk significance you're going to use.

So and, you know, the thought here -- one thought is that absolute criteria as advocated in the LMP process are really criteria that are used to come up with requirements -- design requirements and regulatory requirements -- for the design and the plant and the SSCs.

So that -- there's a basis for why you would do it that way for that application. But we still need to retain some element of relative risk significance for things like screening, screening out low-risk contributors and identifying how to meet the Capability Category II requirements for realism.

We need to know what the relative impact of various things are to do some of those things. So we are still working on our process for dealing with this and we are going to run -- you know, probably early in 2020 we will be running this up the flagpole

to get some buy-in on this so we can -- it doesn't bog down the future balloting process.

So and then this also ties into screening criteria, to how do you use the risk importance metrics to -- and the risk significance criteria to screen out parts of the PRA model.

And some developers have come to us with statements, for example, that they believe they can design out entire hazards like internal fires. They are not going to have any cables that do anything important, so on and so forth.

So we are going to entertain the idea of expanding the domain of what you can screen out of your -- and how you would demonstrate, you know, that -- using risk significance criteria on how to do that.

Next slide, please. I am calling this the 2020 version of the -- of the standard. The major task to complete, and this was before some recent developments on the JCNRM, we need to demonstrate we have alignment with the supporting light water reactor standards.

Now, we are already in alignment in our draft materials with the February 2019 version, sort of draft version of the next edition the light water reactor standard.

There's already published trial use standards for low-power shutdown level two and level three, and that's all we are going for on this next edition, to be consistent with those trial use standards for low-power shut down level two and level three.

But we have recently been decoupled from future changes to the light water reactor standard, which is still in a state of progress right now.

We need to make sure our final risk significance and screening approaches after we run it up the flagpole and we have to get that settled into our standard. Questions about these low numbers still have to be dealt with.

We need to, you know, make sure that we have confirmed all the feedback from the pilots has been adequately addressed. We have to cross -- we farmed out sections of our standard to different authors.

Sandia, for example, has a lot of the external hazard sections, and different members have different sections and we have to get together and make sure that internally we are consistent across the various sections.

There's a readiness review process, which

is a process-oriented thing that we have to go through before we go off for ballot.

It's not a technical review but it's just to make sure that we can check off the boxes that we have addressed the comments from the pilots and all the consistency, format, style guide, guidelines and things like that have been met.

And we expect to be able to get this thing out for ballot anywhere from early to mid-2020, and I'll take off that last sentence because this caveat on the next -- the completion of the LWR next edition has been removed from this, as shown on the next slide.

So based on the level of consistency we already have with the supporting standards, subject, of course, to ballot review, the JCNRM decided to decouple our schedule from the completion of the light water reactor edition, which may go out for ballot at the end of this year and who knows how long that'll take to get through their ballot.

There was a lot of discussion at the JCNRM meeting about NRC's plans to endorse the standard. Concerns were raised about endorsing a trial use standard. JCNRM seemed to believe that there was earlier agreement with the NRC that trial use

standards could be let out and trial used and not endorsed, and they were concerned about this setting a precedent that it might inhibit future trial use standards if it's going to be subject to an NRC endorsement.

So a letter is being prepared that will be sent to the NRC staff basically making a pitch for endorsing the next edition versus this one.

That's really -- and I think we have one more slide. That's it.

CHAIRMAN BLEY: Thank you, Karl. Without objection, we will go ahead to Anders and maybe we will be quiet and let you zip through this because we will get another chance to dig into this material later.

MR. GILBERTSON: All right.

CHAIRMAN BLEY: But maybe not.

MR. GILBERTSON: We have got 12 slides and, you know, I think we can -- we can sort of speed things up here. I think the -- really, the intent of talking about the review guidance is just to convey that we have been -- we have been thinking about how we want the staff to frame their review of a non-LWR PRA standard, particularly given that following the passage of NEIMA we recognized that we had a

relatively short time frame to kind of turn things around.

And I would point out that previous to the passage of NEIMA we were not planning to endorse a non-LWR PRA standard. So we sat down together with NRO, Research and NRO, earlier this year and really started to work on the development of the action plan and the review guidance, which, as you may have already guessed and has been mentioned, was led by Mary Drouin. So a lot of is a product of her experience and expertise.

So the next slide. I won't spend too much time on this. I put this on here just because I wanted to just lay out the notion, the paradigm, that the NRC follows for -- with regard to PRA acceptability and we have already talked about this to a large extent but I'll just go over it quickly.

So the NRC regulatory position describes the staff's position and how we endorse requirements that are developed in consensus standards as well as the requirements developed in the peer review process.

Peer reviews are, obviously, performed on PRAs that are -- that are developed using the requirements and the consensus standards. And so the NRC is looking at the results of the peer review to

help ensure that the requirements have been met, that there are no issues that have been identified, and that an appropriate peer review process was followed. So both of those as endorsed by the NRC.

Next slide, please. So the main point here is really that when we started thinking about having to endorse the standard we wanted to ensure that the staff that were reviewing the document would have a structured approach to looking at the requirements in a structured way of thinking about requirements and what that means for PRA acceptability for the NRC.

So we sat down, and Michelle will actually talk about this in a little more detail. I'll just over it a high level. But we sat down and we really thought about what are the questions that a reviewer needs to ask when they are looking at a given requirement and that ranges from the overall technical -- I am sorry, the overall review of the standard in terms of usability, the structure of the organization, and then also going down into the specific technical requirements and whether things are - they make sense, they are supportable, they are explainable, et cetera.

So the review guidance, it's more of a, I

would say, a general review guidance. There are aspects of it -- because we were focused on a non-LWR PRA standard, there are aspects that focus on that and, for example, we do talk about the notion that we are reviewing these requirements with respect to different parts of the licensing process whereas if we are talking about the LWR PRA standard you're really just talking about operating reactors. So there's a different -- a different scope there.

Next slide, please. So slide 31 here, when developing the guidance we were looking to ensure consistency with the ASME guidelines for a valid code and standard, and those general guidelines, you know, they talk about things that the standards should be repetitive for -- it can be used repetitively. It's enforceable, authoritative, clear, complete -- those sorts of things.

So there's just a high-level guidance, things that reviewers should be keeping in mind as they are going through looking at the requirements.

We also sought to adhere to some consistency criteria that were developed for the PRA standard by the JCNRM. These were actually voted on in a consensus ballot by the JCNRM members. So things that everybody agreed to that a PRA standard should

follow regarding structure, organization, usage of terms, consistent usage of terms, the use of capability categories and how those are apportioned across a requirement, coordinating between different parts, making sure that referencing from one part to another is consistent, et cetera, and, of course, documentation requirements, which is one of the most important parts of the PRA.

And, of course, the review guidance also covers the endorsement of the peer review guidance and that generally follows the paradigms that we have done for previous endorsements of review guidance. The NEI -- there are at least four documents -- 00-02, 05-04, 07-12, and I think 12-13 is the last one. Of course, those will be superseded by the upcoming NEI 17-07.

Next slide, please. So as we have talked about before, the scope of review for the non-LWR PRA standard is going to include the entire scope of that standard. So we will be looking at all hazards, all modes of operations, looking at all levels of analysis, going from the very beginning to consequences and the source terms, and all stages of the licensing process.

So we have been thinking about this and writing down guidance that will help the reviewers

understand how they need to think about different portions of the licensing process, other things like differences between the LWR and the non-LWR requirements such as the fact that the non-LWR period standard it's not calling out CDF or LERF as risk metrics. And so reviewers need to be able to have a handle on how to think about that as they are developing the staff position.

Next slide, please. So the approach that was developed is really -- it's a multi-tiered approach and it's using two different types of reviews.

So it was recognized that to ensure that we have consistency across the parts, there needs to be an overall review and so, in general, a PRA generalist is going to look at that to ensure that those consistency items are satisfied and also look at other nontechnical element specific requirements such as requirements relating to configuration control, PRA maintenance, peer review requirements, et cetera.

And then, of course, on the other side the technical experts are going to go into much more detail. They are going to look at the requirements in -- at a much more detailed level to ensure the technical feasibility and acceptability.

So with that, I'll turn it over to Michelle Gonzalez.

CHAIRMAN BLEY: Before you leave that one --

MR. GILBERTSON: Yes?

CHAIRMAN BLEY: -- I have a little concern. These are just PRA people. You really need to have your -- at least some others, engineers and scientists, involved in this.

I was just thinking about the discussion we had a few minutes ago about source terms -- that there are other areas where the folks in NRO developing the computer code priorities are -- can be a big help and they are going to have to be involved in these reviews. I am surprised you don't show anybody outside of the PRA specialty.

MR. GILBERTSON: Yes. So, in fact, those types of folks are really included with the technical experts. So the scheme that we have developed is that we have really -- we have identified a number of leads for the different technical areas.

And so those technical leads have autonomy to go out and seek input from other technical experts within the agency to help ensure they have a diverse set of inputs.

CHAIRMAN BLEY: Good. Maybe some of your previous operators are on the staff, too.

MR. GILBERTSON: Yes, absolutely. Yes.

Okay. Michelle?

MS. GONZALEZ: Thanks, Anders. So I will be discussing in more details the expectations and responsibilities of the reviewers of the standards.

Both the PRA generalist -- I am sorry, if you can turn it to 34. Slide 34. Both the PRA generalist and the technical expert will review the standard to ensure that it conforms with the ASME guidelines.

As Anders said before, this guidance states that the standards should be suitable for repetitive use, should be enforceable, realistic, complete, clear, and consistent.

The PRA generalist will review the entire standard including all of the sections including production definitions, risk assessment application process, risk assessment technical requirements, configuration control, and peer review.

This review will determine whether the requirements are consistent and cohesive across the standard. It will determine if the standard as a whole makes sense.

The generalist will make sure that the definitions provided are appropriate and the terms used -- and the terms are used in a consistent manner throughout the standard.

They will look at the configuration control requirements to make sure that requirements address how to maintain and upgrade a PRA over time.

They will also make sure screening criteria issues are treated and defined in a consistent manner across the standard.

The generalist will also be reviewing the peer review requirements. Next slide, please.

So the technical expert will do a more in-depth analysis of their specific areas of expertise. The technical experts are either associated with various hazards like fire, seismic, or flooding, or associated with a specific technical area addressed by the PRA like HRA, thermal hydraulics or data.

The primary focus of the technical expert is to determine whether the requirements in the standard for their specific area are technically sound and clearly stated.

The technical expert will review for consistency between objectives, high-level requirements and supporting requirements. They will

verify whether the high-level requirement matches the objectives for each technical element.

They will also review for consistent use of terminology. They will make sure that there is appropriate referencing to other requirements and since the standard is meant to be technology neutral the technical expert will verify that the standard will be able to support any non-light water reactor technology.

Next slide, please.

MEMBER KIRCHNER: Michelle, clarification. I got distracted for a moment. You're talking about the review of the actual PRA, not -- that the applicant submits, not the -- not the standard, right?

MS. GONZALEZ: No. The review of the standard.

MEMBER KIRCHNER: The review --

MS. GONZALEZ: Yes.

MEMBER KIRCHNER: -- review of the standard. Okay. Thank you.

MS. GONZALEZ: So review of -- PRA review requirements. So to determine the standard has been correctly implemented, a peer review of the PRA model is needed. So the standard provide requirements for an acceptable peer review. It provides requirements

for the process, peer review qualifications and documentation.

The PRA generalist will review the standard to determine that requirements of the process, team qualifications, and documentation are adequate.

These requirements should be consistent with existing LWR PRA standards. The technical expert will look at the PRA review requirements for the specific area of expertise. They will review to make sure any special qualifications needed for peer reviewers is identified under the standard, identify the needed scope and level of detail of the review.

Next slide. So the PRA review process is documented in our peer review guidance. This guidance has not been completed or developed yet but NEI is planning on developing it. This guidance is set to mimic the existing guidance for LWR PRA peer reviews.

Again, both generalists and experts will be reviewing the guidance to ensure the needed attributes of an acceptable PRA -- I am sorry.

So they will be reviewing the guidance to ensure the needed attributes for an acceptable peer review have been identified. The review will be consistent with reviews of existing PRA peer review

guidance.

Next slide, please. So overall, the overall objectives of the reviewers is to determining the standard and peer review is acceptable. The reviewer will determine whether the language is acceptable or not acceptable. Acceptable means that the staff has no objections to how a sentence or a statement is stated, meaning that the sentence is clear and correct.

These sections or sentences will be noted as no objections. Not acceptable means the staff has an objection or a concern with how the statement is stated.

If the statement is not clear, the reviewer can deem it no objection subject to the following clarification. If the sentence is not technically sound and the acceptability of the PRA might be affected, it will be deemed an objection and the reviewer will provide a rewrite of the sentence to resolve the objection.

So the reviewer will document all of these comments in sort of a table, providing pretty much what the issue is, the section where they had the specific issue. They will say they have an objection or they do not have an objection, and then they will

provide additional comments or clarification as needed.

This will be done for all of the sections across the standard.

Next slide. So I pretty much just covered this one so if you can turn to 40.

So the review guidance provides a set of four appendixes. These serve as references of an example for the reviewers. Pretty much Appendix A and Appendix B are examples of comments that were submitted for the LWR standard.

Then Appendix C is the JCNRM approved criteria on structure and organization of the PRA standard, and then Appendix D is the approved action verbs.

So that's all I have for the presentation. If there is no question I'll turn it to Hanh.

MR. PHAN: So for the conclusion statement, again, the staff appreciates your time and your advice on our plan to review and endorse the non-LWR PRA standard, knowing that there are many challenges in front of us.

As you've seen in our presentations, this is an integrated standard with thousands of supporting requirements and 20 percent of those are addressing

unit issues as multi-unit.

There are many gaps when comparing the design-specific PRA and plant-specific PRAs against the standard because the early stage of the designs and early stage of the operations are those mentioned in Marty's presentation.

And as was said to us by Anders and Michelle that even those we have a detailed guidance the consistency throughout the reviews documenting the staff positions, that is a challenge to us.

However, we decided to move forward. The reason for that because we like to build a foundation that the future applicants, they can use those at least to justify the PRA acceptability and we will update those when time allows.

Thank you for your -- if you have any questions?

MEMBER MARCH-LEUBA: Before you go, is your intention of the standard -- the use of the standard to be used as like an approved methodology? So as long as the applicant uses the standard you will do a summary review of the PRA and say, well, as long as I use the standard the PRA is good?

Or is the intention help to the applicant to generate a good quality PRA and then you will do an

in-depth review of the real PRA? Do you see what I mean? Once we have an approved methodology, when you submit the license amendment, you say, I used approved methodology. Okay. You don't have to do anything else. How do you intend to use it?

MR. PHAN: Please correct me if I am not answering your question, you know, to the point that you asked.

Currently, there are no guidance of requirements saying that the applicants -- to do a peer review and using this standard before submitting the application.

In the past, when we review the LWR standard we stated that even though those applicants performed peer reviews but we not that the peer review's findings as the staff position for any decision making.

We use those as a starting point to gain confidence in their PRA and from there we add additional questions if we felt were not addressed in the peer review's report to the process.

For future application in Marty's presentation we expect we may have to ask them to do a peer review because the times allowed to us to uplift -- you know, make confident statements on their

PRA if they use the PRA for anything else besides the information in Chapter 19.

For example, if they use the LMP process then we have to make at least -- you know, the confident statements that the PRA is reasonable for that particular application.

But, still, at this point we don't have any requirements or statements out there to ask a future application to do any peer reviews yet. So there is no checklist to say if you do this then the staff would not repeat any of those reviews yet.

MEMBER MARCH-LEUBA: Yeah. I just wanted to put on the record that I would like the standard not to be used as an excuse for the NRC staff not doing a full review of the final product.

Okay, because you guys are going to be under tremendous pressure to do the review cheaply and fast, and if the standard now suddenly substitutes an SRP, I mean, as long as you follow the standard we don't have to review your final product. I will be very concerned.

MR. PHAN: Thank you.

CHAIRMAN BLEY: Anything else from members of the committee before we go for public comments?

MEMBER KIRCHNER: Dennis, I don't know if

I can succinctly --

CHAIRMAN BLEY: We will have comments at the end so --

MEMBER KIRCHNER: Okay. I'll wait then.

CHAIRMAN BLEY: If it's questions -- now questions. Can we get the phone line opened up? And while we are doing that, is there anyone in the room -- is there anyone in the room who would like to make a comment? If so, please come to the microphone. Identify yourself and make a comment.

MS. ANDERSON: Victoria Anderson with NEI. We have surveyed some of our member reactor vendors that are working on non-light water reactors and there's a little bit of concern about the potential to endorse the 2013 trial used version of the standard versus incorporating the lessons learned from the pilots and trial uses that have been conducted.

So while there's support for potentially using this standard as part of the licensing modernization project, there's a lot of caution that they -- and a lot of trepidation they have about pursuing endorsement of the standard without updating it to reflect those lessons learned.

And I also wanted to convey, on behalf of the JCNRM, as Karl mentioned earlier, they are going

to be writing a letter to the NRC staff urging them to not endorse the 2013 trial use standard.

So we wanted to make sure that that was on the record today that the ASME/ANS Joint Committee on Nuclear Risk Management is not in favor of endorsement of the 2013 version of the standard.

CHAIRMAN BLEY: Thanks, Victoria. Anyone else in the room?

MR. PHAN: In addition to that, at that meeting the staff requested JCNRM's in the lab that includes the schedule -- the new schedule for the next revision of the standard.

CHAIRMAN BLEY: Bob?

MR. BUDNITZ: Dennis, this is Bob Budnitz. Can I talk to you from California?

CHAIRMAN BLEY: You absolutely can. Thank you for calling in or listening in. Go ahead.

MR. BUDNITZ: I've been listening since 5:30 in the morning. You really shouldn't start so early, you know.

[Laughter.]

CHAIRMAN BLEY: I don't disagree but go ahead. You're on.

MR. BUDNITZ: Rick Grantom and I are the two co-chairs of the JCNRM and I was just going to

supplement what Victoria Anderson from NEI just said.

Rick and I are on the schedule to write a letter that we will both sign that says exactly what Victoria just said and we are going to do that soon.

We submitted a motion at the JCNRM --this was a week ago so that's Thursday, just six days ago -- that authorized Rick and me to send that letter to the NRC saying that we don't think that endorsing the 2013 standard is appropriate.

My rationale is that when it was voted on in 2013, it was not voted on with the intent it should be released and endorsed this way and I have a suspicion that if in 2013 they had known that six years later that was going to happen people would have voted against releasing it for trial use.

The whole point of the trial use it was a trial use, and we all -- we all knew that it was done that way. So I just want to make that point that people at JCNRM, I mean, Rick Grantom is the other co-chair with me, we will be doing that.

CHAIRMAN BLEY: Thank you, Bob. Anyone else on the phone line, please?

Okay. We can close the phone line now. Usually, we are complete at this point but, Karl, if you want to make a last comment, go ahead.

MR. FLEMING: Yeah. I just want to point out that while the industry and the NRC are working out which standard to endorse, if the -- if the staff were to endorse the next edition, they would have to review the current standard because what they are going to get in the next edition is going to be built on that.

So any investment they make to start reviewing the 2013 right now won't be in vain even if they change which one they are going to use.

CHAIRMAN BLEY: I don't think we need a lot more clarification here but underscore that.

MR. GILBERTSON: I just wanted to add, I don't know if it's been said that, you know, we have talked about endorsing the trial use standard as if it's being done in isolation.

But part of the action plan and the approach is really to endorse that, which is a publicly available document, understanding what is already available and as informed by the latest draft version of whatever is available for the new version of the non-LWR PRA standard.

So I just wanted to make -- to point that out that we are not just blindly going forward with the trial use standard. It would be as informed by

whatever latest version we have of the next version.

CHAIRMAN BLEY: Thank you.

MEMBER REMPE: Even if you've not approved the latest version you want them to be informed and do it?

MR. GILBERTSON: That's the plan.

MEMBER REMPE: Okay.

CHAIRMAN BLEY: I think we are finished with our discussion with the presenters. At this time, I'd like to go around the table and hear from the members.

Jose, let me start with you.

MEMBER MARCH-LEUBA: I don't have any further comments.

CHAIRMAN BLEY: Okay. Thank you. Charlie? Joy?

MEMBER BROWN: Nothing else.

MEMBER REMPE: I wanted to thank everyone for their presentations. But I don't have any additional comments.

CHAIRMAN BLEY: Pete had no comments.

Walt?

MEMBER KIRCHNER: What I heard sounds good. I was heartened by Marty's slides 25 and 26 as to actual uses of the PRAs to support the initial

licensing.

So I, at this point, have no further comments on the standard itself. Thank you.

CHAIRMAN BLEY: Thank you, Walt.

Dave?

MEMBER PETTI: I just think it's good to see something that's started back in the late '70s, early '80s finally come to fruition and I think that the trial period was a great idea by Mary to really wring it out.

So it's good -- it's good to see the large range of people and organizations really testing it. So it's good.

CHAIRMAN BLEY: Thank you.

I have just a few. I think the staff needs to think carefully about if there are any gaps in the standard and what you're going to do about that, where you're going to fill them in on in your guidance document. Things like Karl mentioned -- the spent fuel pool and things outside of the reactor not being in there -- maybe they will be in by the time we get somewhere.

But if they are not, what are you going to do about those?

Karl talked a little bit about -- I'll

call it enhanced screening but the ability to be flexible and screen things that we wouldn't normally screen.

And, you know, maybe that's a necessary idea here. But if so, there needs to be pretty good controls and we will see what the standard comes up with for those controls.

It seems like they ought to be quantitative and you need to be very careful that we are not dropping things out based on screening analyses that aren't complete enough to really ensure that we are not missing something potentially important to risk.

I endorse the idea that was brought up by Marty, I think, of requiring independent peer review before submittal, especially for people using the LMP.

It just seems LMP is pushing PRA into a new realm and you can't do that without a really thorough going over the PRA, and beyond the independent review I think LMP points to the fact that staff needs to dig into these more than they've done on, say, design certs so far.

I already mentioned but I'll hit it again -- things like the mechanistic source term, your folks who are working on the computer code strategy two for

the vision and strategy three's new reactors, really need to be involved with you.

And I'll go back to what I started with and now we have heard a lot from the industry. If it's all possible I think you really need to endorse the revised standard.

I think the folks who have made public comments as well as what Karl has said has also pointed out a hazard, a danger, in endorsing the current standard that was issued without expectation of being endorsed by NRC and the chilling effect that might have in the future.

I mean, we have got all these trial applications that maybe we wouldn't have had otherwise and I think they are pretty essential.

So even if it delays you a little bit, I am getting the sense it probably won't. Endorsing the real standard, the one that's put out for use rather than trial use would make a lot more sense for you.

That said, I think we are all finished. I thank everyone for their presentations and the very good discussion, and we are adjourned.

[Whereupon, the above-entitled matter concluded at 12:02 p.m.]

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Review and Potential Endorsement of ASME/ANS RA-S-1.4 "PRA Standard for Advanced Non-LWR Nuclear Power Plants"

Briefing for the
Advisory Committee on Reactor Safeguards
Subcommittee on Future Plant Designs

Hanh Phan, NRO
Martin Stutzke, NRO
Anders Gilbertson, RES
Michelle Gonzalez, RES
Karl Fleming, JCNRM

October 2, 2019

Presentation Outline

1. Background and Action Plan for Potential Endorsement of the Non-LWR PRA Standard (Hanh Phan)
2. Staff's Perspective on PRA Acceptability for Non-LWRs (Marty Stutzke)
3. Non-LWR PRA Standard Development and Lessons Learned from the Pilots (Karl Fleming)
4. Development of Review Guidance (Anders Gilbertson, Michelle Gonzalez)

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Background and Action Plan for Potential Endorsement of the Non-LWR PRA Standard

Hanh Phan

Office of New Reactors
Division of Advanced Reactors

Regulations

Pertaining to DC applicants, COL applicants, and COL holders:

- 10 CFR 52.47(a)(27) - DC application must contain an FSAR that includes a description of the design-specific PRA and its results.
- 10 CFR 52.79(a)(46) - COL application must contain an FSAR that includes a description of the plant-specific PRA and its results.
- 10 CFR 50.71(h)(1) - No later than the scheduled date for initial loading of fuel, each holder of a COL shall develop a level 1 and a level 2 PRA. The PRA must cover those initiating events and modes for which NRC-endorsed consensus standards on PRA exist one year prior to the scheduled date for initial loading of fuel.
- 10 CFR 50.71(h)(2) - COL holder must maintain and upgrade the PRA required by 10 CFR 50.71(h)(1). The upgraded PRA must cover initiating events and modes of operation contained in NRC-endorsed consensus standards on PRA in effect one year prior to each required upgrade. The PRA must be upgraded every four years.
- 10 CFR 50.71(h)(3) - COL holder must, no later than the date on which the licensee submits an application for a renewed license, upgrade the PRA to cover all modes and all initiating events.

NEIMA

Congress recently passed the Nuclear Energy Innovation and Modernization Act (NEIMA), where under Title 1, Advanced Nuclear Reactor and User Fees, in Section 103(b)(4)(B), the NRC should evaluate options for licensing commercial advanced nuclear reactors including:

(iii) collaboration with standards-setting organizations to identify specific technical areas for which new or updated standards are needed and providing assistance if appropriate to ensure the new or updated standards are developed and finalized in a timely fashion;

(iv) the incorporation of consensus-based codes and standards developed under clause (iii) into the regulatory framework—

- *to provide predictability for the regulatory processes of the Commission; and*
- *to ensure timely completion of specific licensing actions.*

Recent Developments

- "Probabilistic Risk Assessment Standard for Advanced Non-LWR Nuclear Power Plants," ASME/ANS RA-S-1.4
  - Issued in 2013 by ASME/ANS for trial use
  - Addresses Level 1 through Level 3 PRA, all hazards, and all operating modes
  - Has been piloted and is scheduled to be finalized as an American National Standard Institute (ANSI) standard in 2021
- "Risk-Informed Performance-Based Guidance for Non-Light Water Reactor Licensing Basis," NEI 18-04
  - Revision 1 was issued in 2019 by NEI
  - Presents a technology-inclusive, risk-informed, and performance-based (TI-RIPB) process for selection of LBEs; safety classification of SSCs; identification of safety functions; and determination of DID
- "Guidance for a TI-RIPB Approach to Inform the Content of Applications for Licenses, Certifications, and Approvals for Non-Light-Water Reactors," DG-1353, Sept 2018, which endorses NEI 18-04

Action Plan for Potential Endorsement

Objective - Address the PRA acceptability needed to support non-LWR efforts, including applications for DC, COL, CP (some may be submitted in accordance with NEI 18-04), along with pre-operational and post-operational regulatory activities. The plan describes the specific tasks, approach, activities, schedule, and resources to implement the plan.

Outline of Action Plan -

Task 1: Supporting development of the non-LWR PRA standard

Task 2: Preparation for review of the non-LWR PRA standard

Task 3: Reviewing the non-LWR PRA standard

Task 4: Maintaining the non-LWR PRA standard

Task 5: Development of schedule

Task 6: Identification of resources

Task 7: Development of communication plan

Task 2: Preparation for Review of the Standard (6 Subtasks)

- **Subtask 2-1:** Determine the scope of regulatory risk-informed activities
  - Describe each type of application along with their associated activities
  - Identify the capability category, whether the SRs need to be Capability Category I or II
- **Subtask 2-2:** Comparison of the non-LWR PRA standard to the LWR PRA standard
  - Understand the differences between the non-LWR and LWR PRA standards
- **Subtask 2-3:** Identify the needed technical expertise to review the standard
  - Determine whether adequate expertise is available to perform the review and endorsement within the staff

Task 2: Preparation for Review (Con't)

- **Subtask 2-4:** Develop staff position for an acceptable non-LWR PRA
  - Establish the technical basis (attributes and characteristics needed) for reviewing and potentially endorsing the non-LWR PRA standard
  - Develop the staff position on an acceptable peer review process, team qualifications, and documentation
- **Subtask 2-5:** Identification and resolution of technical and policy issues
  - Review each technical element for each application type and identify possible technical or policy issues
  - Describe the significance of the issues
  - Identify whether there is ongoing research to address the issues and what research is needed
- **Subtask 2-6:** Guidance for review of non-LWR PRA standard for endorsement
  - Develop guidance on how to approach the review
  - Establish criteria for determining acceptance

Task 3: Reviewing the Standard (3 Subtasks)

- **Subtask 3-1:** Develop draft regulatory guide (DG)
  - Develop a preliminary guide which, when finalized, will provide the vehicle for staff endorsement. This new RG will be similar in structure to RG 1.200.
- **Subtask 3-2:** Review PRA standard
  - Develop a staff position of the non-LWR PRA standard. The staff's position on each requirement is to be categorized as:
    - No objection – no objection to the requirement
    - No objection with clarification - no objection to the requirement. However, certain requirements are unclear, therefore the staff has provided its understanding of these requirements
    - No objection subject to the following qualification - a technical concern with the requirement and has provided a qualification to resolve the concern
- **Subtask 3-3:** Finalize regulatory guide (RG)
  - Issue the DG for public review and comment
  - Evaluate public comments and revise the DG where appropriate
  - Issue final RG for use

Tasks 4 and 5

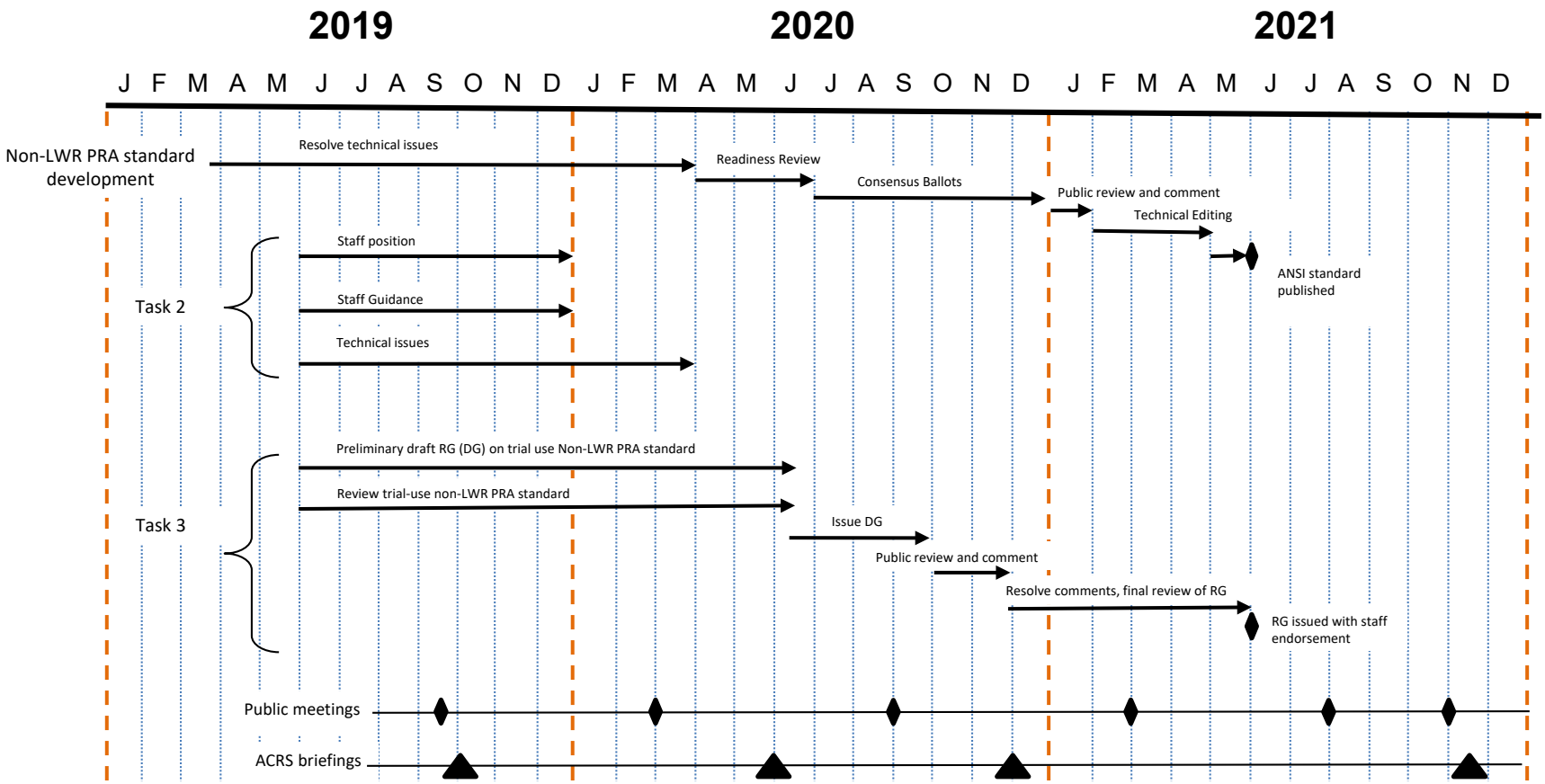
Task 4: Maintaining the Non-LWR PRA standard

This is an ongoing task to ensure that lessons learned from using the non-LWR PRA standard (and even the LWR PRA standards) are factored into both the non-LWR PRA standard and staff endorsement.

Task 5: Development of schedule

Develop a schedule for the tasks. This schedule will of necessity be conditional on the completion of the standard.

Tentative Schedule



Task 7 – Communication Plan

- Communication with internal stakeholders
  - The staff will brief the ACRS and Management as part of the normal process of developing a RG
  - The meetings/briefings occur during the draft guide development and before issuance of the final RG
- Communication with external stakeholders
  - The staff will hold public meetings to share its view and to solicit input
  - DG and final RG will be formally issued for public review and comment

Status and Path Forward

- Draft staff action plan (completed)
- Draft staff review guidance (completed)
- Initiated development of staff position
- ANSI standard will not be publicly available until 2021, the staff is proposing to review and endorse the trial use standard

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Staff's Perspective on PRA Acceptability for Non-LWRs

Marty Stutzke

Office of New Reactors
Division of Advanced Reactors

Topics

- Regulatory requirements
- SRP acceptance criteria for PRA acceptability
- DC/COL-ISG-028 guidance
- Challenges for developing PRAs to support initial licensing

Regulatory Requirements

- Licensing under 10 CFR Part 52 – applicant is required to provide a description of the PRA and its results:
  - Standard design certification (DC): 10 CFR 52.47(a)(27)
  - Combined license (COL): 10 CFR 52.79(a)(46)
  - Standard design approval (SDA): 10 CFR 52.137(a)(25)
  - Manufacturing license (ML): 10 CFR 52.157(f)(31)
- Proposed Parts 50/52 rulemaking will align PRA requirements for new reactor applications using the 10 CFR Part 50 licensing process (construction permit/operating license) with PRA requirements in 10 CFR Part 52:
  - SECY-15-0002 (January 8, 2015)
  - SRM to SECY-15-0002 (September 22, 2015)
  - SECY-19-0084 (August 27, 2019)

SRP Acceptance Criteria

- NUREG-0800, Rev. 3 (December 2015), Chapter 19.0:
  - Applies to PRAs for LWR DCs and COLs
  - Also addresses deterministic evaluation of design features for the prevention or mitigation of severe accidents
- SRP acceptance criteria are derived from various Commission policy statements and staff requirements memoranda (SRMs)

SRP Acceptance Criteria for PRA Acceptability (1 of 5)

Item 9 (pp. 19.0-12/13): Consistent with the guidance in Section 5 of RG 1.174, the staff expects that the applicant will have subjected its PRA to quality control. In accordance with the Statement of Consideration (72 FR 49365) for the revised 10 CFR Part 52, the PRA is not part of the design-basis information, therefore, the PRA is not subject to the quality assurance requirements of 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants." However, the applicant should describe the quality control program that was applied to the PRA. The reviewer should verify that this quality control program includes, as a minimum, the following elements:

A. Use of personnel qualified for the analysis
B. Use of procedures that ensure control of documentation, including revisions, and provide for independent review, verification, or checking of calculations and information used in the analyses
C. Documentation and maintenance of records, including archival documentation as well as submittal documentation
D. Use of procedures that ensure that appropriate attention and corrective actions are taken if assumptions, analyses, or information used previously are changed or determined to be in error

SRP Acceptance Criteria for PRA Acceptability (2 of 5)

Item 10 (p. 19.0-13): The staff will determine whether the technical adequacy of the PRA is sufficient to justify the specific results and risk insights that are used to support the DC or COL application. Toward this end, the applicant's PRA submittal should be consistent with prevailing PRA standards, guidance, and good practices as needed to support its uses and applications and as endorsed by the NRC (e.g., RG 1.200). As discussed in RGs 1.174 and 1.200, the quality of a PRA is measured in terms of its appropriateness with respect to scope, level of detail, and technical adequacy. Technical adequacy should be assessed via a peer review as described in RG 1.200. The applicant's adherence to the recommendations provided in RGs 1.174 and 1.200 pertaining to quality and technical adequacy will result in a more efficient and consistent NRC staff review process. With respect to PRA quality, the following items are noted:

A. There are no regulatory requirements in 10 CFR Part 52 that specifically pertain to PRA quality with respect to DC or COL applications.

B. RG 1.206 and this SRP section indicate the expected scope and level of detail of a PRA used to support a DC or COL application. Exceptions to this expected scope and level of detail may be acceptable if adequately justified by the applicant.

SRP Acceptance Criteria for PRA Acceptability (3 of 5)

Item 11 (p. 19.0-13): PRAs that meet the applicable supporting standards for Capability Category I and meet the high-level requirements defined in the ASME PRA Standard (ASME/ANS RA-S-2008 and addenda ASME/ANS RA-Sa–2009) should generally be acceptable for DC and COL applications. Alternatively, the applicant may identify, and justify the acceptability of, alternative measures for addressing PRA quality and technical adequacy. The staff should specifically review the acceptability of these alternative measures in the context of the specific uses of the PRA in the licensing process.

SRP Acceptance Criteria for PRA Acceptability (4 of 5)

Item 12 (p. 19.0-13/14): In making its determination of technical adequacy of the PRA, the staff will consider the information provided by applicants in FSAR Chapter 19 and responses to the staff's RAIs or obtained by the staff during onsite audits. In addressing the technical adequacy of the PRA, the applicant should discuss:

A. Prior NRC staff review of the PRA (e.g., during the DC process), findings (i.e., facts and observations) from that review, disposition of those findings, and the relevance of that review to the technical adequacy of the current plant-specific PRA.

B. The scope, level of detail, and technical adequacy needed to support the specific uses and risk-informed applications.

C. The method used for determination of technical adequacy for pertinent PRA scope areas for which the NRC has not endorsed PRA standards (i.e., identify the guidance and good practices documents relied upon to determine the technical adequacy of the PRA).

SRP Acceptance Criteria for PRA Acceptability (5 of 5)

Item 12 (continued):

D. The independent peer review process, including the qualifications of the team members and the findings identified as a result of the review.

E. The process for dispositioning independent peer review findings and maintaining or upgrading the PRA, as appropriate, to ensure that it reasonably reflects the as-designed, as-built, and as-operated plant, including the corrective action and feedback mechanisms involving the periodic evaluation of the PRA, consistent with its uses and risk-informed applications, on the basis of actual plant-specific equipment, train, and system performance and relevant industry operational experience.

DC/COL-ISG-028 Guidance

- DC/COL-ISG-028 (November 2016)
  - Applies to PRAs for advanced LWR DCs and COLs
  - Guidance was developed because the PRA Standard was developed for currently operating reactors. As a result, for PRAs developed for the DC and COL application stages:
    - Some supporting requirements in the PRA Standard are not applicable or cannot be achieved as written
    - Other supporting requirements need some clarification to understand how they can be achieved.
- The current version of RG 1.200, which endorses the PRA Standard, was also developed for currently operating light-water reactors and does not specifically address how to apply the PRA Standard to an ALWR design at the DC or COL application stage.

Challenges for Developing PRAs to Support Initial Licensing (1 of 2)

From DC/COL-ISG-028:

1. DC applications do not include site-specific information related to site features and characteristics.
2. The events/hazards screening criteria in the PRA Standard can be orders of magnitude above the total plant risk because the improved safety of ALWR designs potentially results in screening significant risk contributors (relative to total plant risk) from the analysis.
3. The specific layouts and routing of cabling and equipment and the capability of the equipment might not be fully known.
4. There is no plant-specific operating experience and data.

Challenges for Developing PRAs to Support Initial Licensing (2 of 2)

From DC/COL-ISG-028 (continued):

5. There is no plant-specific operating guidance (e.g., procedures, maintenance practices, testing frequencies, and equipment realignment frequencies).
6. There are no trainers or operations staff with plant-specific experience to support interviews, reviews, or assessments.
7. Walkdowns cannot be performed to confirm information and/or identify site-specific and plant-specific conditions.
8. Uncertainties associated with the PRA are greater because of the lack of plant-specific information and experience, as identified above, and these additional uncertainties might affect other risk-informed applications of the PRA.

Addressing the Challenges

Item	Challenge	Initial Licensing	Fuel Load	After 4 Operating Years
1	Lack of site-specific information	DC, SDA, ML – C or Q COL, CP/OL – n/a	n/a	n/a
2	Screening criteria	all - C or Q	C or Q	C or Q
3	Lack of detailed cabling and equipment layout	all - C or Q	n/a	n/a
4	Lack of plant-specific data	all - C or Q	C or Q	n/a
5	Lack of plant-specific operating guidance	all - C or Q	n/a	n/a
6	Lack of experienced operations staff	all - C or Q	C or Q	n/a
7	Inability to perform walkdowns	all - C or Q	n/a	n/a
8	Potential large uncertainties	all - C or Q	C or Q	C or Q

C or Q - staff will provide a clarification or qualification in its endorsement
n/a - challenge does not apply; staff expects requirement to be met as stated

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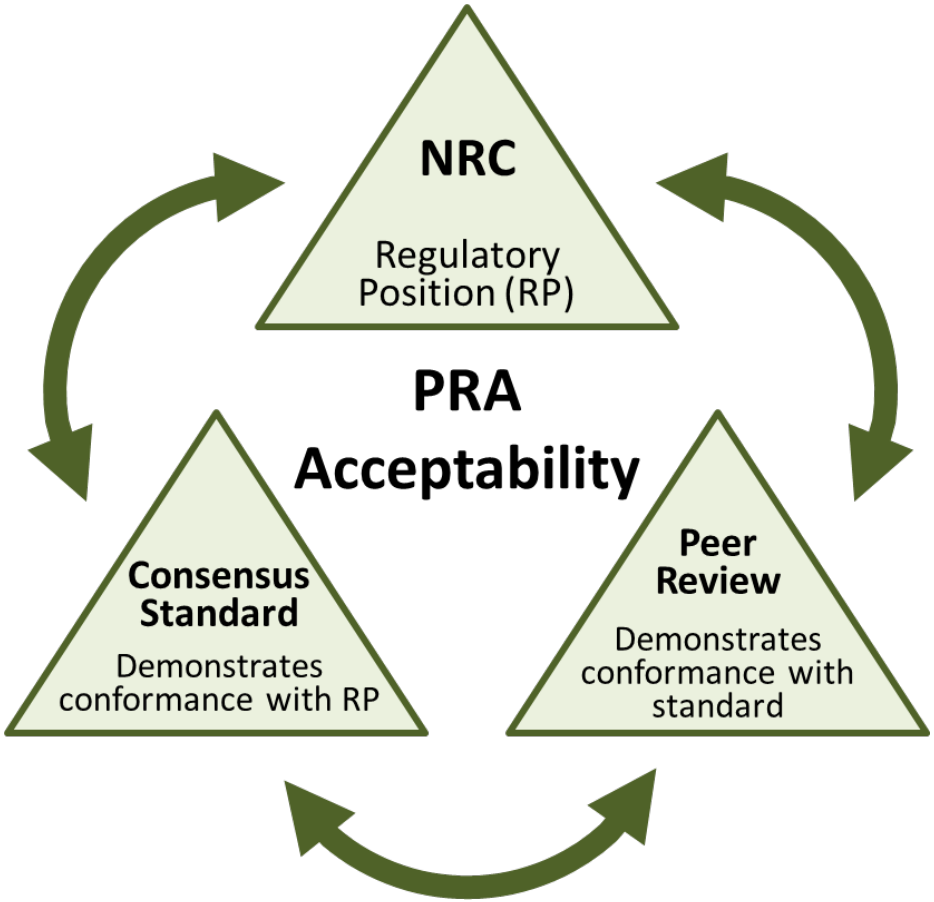
Development of Review Guidance

Michelle Gonzalez Anders Gilbertson

Office of Nuclear Regulatory Research
Division of Risk Analysis

PRA Acceptability



All three elements must work together

NRC Review Guidance

- Provides a structured, multi-tiered approach to the review of the non-LWR PRA standard and related peer review guidance

- Explains the purpose, organization, and structure of the non-LWR PRA standard and peer review guidance

NRC Review Guidance

- Maintains consistency with:
  - ASME guidelines for a valid code or standard
  - JCNRM consensus consistency criteria for a PRA standard being developed or maintained as related to:
    - Structure/organization
    - Use of terms
    - Use of capability categories
    - Coordination between parts/technical elements
    - Documentation requirements
  - Prior endorsements of peer review guidance

NRC Review Guidance

- Scope of review for the non-LWR PRA standard includes:
  - All hazards
  - All modes of operation
  - All levels of analysis (from initiator to consequence)
  - All stages of the licensing process

NRC Review Guidance

- Multi-tiered review approach of the non-LWR PRA standard uses different types of reviews to assess the standard at a high-level as well as for each requirement
  - PRA generalist
  - PRA technical expert

NRC Review Guidance

- PRA generalist reviews the entire standard for
  - Consistency between requirements and the objective and scope of the PRA standard
  - Well-defined terms, consistent with state of practice, that are used consistently
  - Configuration control requirements
  - Relationship and consistency between technical elements
  - Consistent use of screening criteria
  - Peer review requirements

NRC Review Guidance

- PRA technical experts review specific technical areas
  - Requirements are understandable, technically correct, complete, and consistent with state-of-practice
  - Consistency between objectives, HLRs, and SRs
  - Consistent use of defined terms
  - Appropriate referencing to other requirements
  - Technology neutral requirements

NRC Review Guidance

- Review of peer review requirements
  - PRA generalist reviews for adequacy of the peer review process and peer review team qualification requirements; also, for consistency with the related requirements in the ASME/ANS Level 1/LERF PRA standard
  - PRA technical expert reviews to ensure requirements are adequate for the specific technical area

NRC Review Guidance

- Review of industry peer review guidance
  - Staff ensure they have identified the needed attributes and characteristics for an acceptable peer review of a non-LWR PRA
  - Consistent with NRC reviews of existing PRA peer review guidance documents
  - Industry peer review guidance for non-LWR PRA planning to be developed

NRC Review Guidance

- Documentation of staff review
  - Acceptable requirements
  - Not acceptable requirements

- Each statement in the non-LWR PRA standard and the peer review guidance document is reviewed for acceptability

NRC Review Guidance

- No staff objection – Requirement is acceptable
  - Requirement is clear, any ambiguity does not affect acceptability of a PRA model
- No staff objection, subject to a clarification or qualification – Requirement is not acceptable
  - Clarification: Requirement is not clear or is sufficiently ambiguous such that it impacts PRA acceptability; typically only a minor change(s) proposed by staff
  - Qualification: Requirement is not technically sound such that it impacts PRA acceptability; a more substantial change(s) proposed by staff

NRC Review Guidance

- Appendices provide contextual information for review based on relevant issues from the LWR PRA standard
  - Appendix A: NRC-identified issues with last addendum to the Level 1/LERF PRA standard
  - Appendix B: NRC-identified issues on the next edition of the Level 1/LERF LWR PRA standard
  - Appendix C: JCNRM-approved criteria on the structure and organization of a PRA standard
  - Appendix D: JCNRM-approved action verbs

Acronyms

ACRS	Advisory Committee on Reactor Safeguards
ALWR	advanced light-water reactor
ANS	American Nuclear Society
ANSI	American National Standard Institute
ASME	American Society of Mechanical Engineers
COL	combined license
CP	construction permit
DC	design certification
DG	draft regulatory guide
DID	defense-in-depth
FSAR	final safety analysis report
HLR	high level requirement
JCNRM	Joint Committee on Nuclear Risk Management
LBE	licensing basis event
LERF	large early release frequency
LMP	Licensing Modernization Project
LWR	light-water reactor
ML	manufacturing license
NEI	Nuclear Energy Institute
NEIMA	Nuclear Energy Innovation and Modernization Act
Non-LWR	non-light-water reactor
NRC	U.S. Nuclear Regulatory Commission
PRA	probabilistic risk assessment
RAI	request for additional information
RG	regulatory guide
SDA	standard design approval
SR	supporting requirement
SRMs	staff requirements memoranda
SRP	Standard Review Plan
SSCs	structures, systems, and components
TI-RIPB	technology-inclusive, risk-informed, and performance-based

PRA Standard For Advanced non-LWR Nuclear Power Plants

By:

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Chair JCNRM Non-LWR Writing Group

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Presented to:

U.S. NRC Advisory Committee on Reactor Safeguards
October 2, 2019

Disclaimer

- The information and material provided in this presentation was prepared by the ASME Joint Committee on Nuclear Risk Management and its Working Group on Non-Light Water Reactors.
- It is for informational purposes only and are not intended to be construed as a formal commitment by ASME or ANS.

Discussion Topics

- Background
- ASME/ANS RA-S-1.4-2013 Trial Use Standard
  - Comparison with LWR PRA standards
  - Lessons learned from non-LWR PRA pilots
- ASME/ANS RA-S-1.4-2020 Proposed upgrades for ANSI status
  - Key changes
  - Actions and schedule to complete

Background

- In 2006 ASME BNCS directed the CNRM to initiate PRA standards for advanced LWRs and non-LWRs
- PRA applications envisioned for non-LWR standard included:
  - Incorporation of risk insights into design
  - Selection of licensing basis events
  - SSC safety classification
  - Evaluation of defense-in-depth adequacy
- Technology inclusive approach adopted to address all known advanced non-LWR concepts using integrated treatment of hazards
- Coordination of non-LWR and ALWR WGs for consistency in treatment of preoperational PRAs
- Draft standard issued for review and comment in 2008
- Standard issued by JCNRM for trial use in 2013 (ASME/ANS RA-S-1.4-2013)
- Trial Use Standard used in many pilot applications

Source Material

- Previously completed non-LWR PRAs
  - Primarily HTGR and SFR PRAs
- Requirements from LWR Standards (80%)
  - LWR Level 1/LERF PRA Standard
  - LWR Low Power and Shutdown Standard
  - LWR Level 2 PRA Standard
  - LWR Level 3 PRA standard
- New requirements for non-LWRs (20%)

Scope of Standard

- Multiple plant operating and shutdown states
- Event sequences developed to end states with mechanistic source terms and offsite radiological consequences
- Technology inclusive end states and risk metrics
  - Frequencies of event sequences, event sequence families, and release categories
  - Mechanistic source terms and radiological doses and health effects
  - Options with requirements for user defined end states (e.g sodium boiling)
- Event sequences involving two or more reactors or radionuclide sources
- Requirements for PRAs done at preoperational design stages
- Requirements to address uncertainties in establishing passive system reliability
- JCNRM requirement to maintain consistency with LWR PRA standards where appropriate

Technical Elements with Integrated Treatment of Hazards

PRA Elements	Scope of Hazard Groups		
	Internal Events	Other Internal Hazards	External Hazards
Plant Operating State Analysis (POS)	X	X	X
Initiating Event Analysis (IE)	X	X	X
Event Sequence Analysis (ES)	X	X	X
Success Criteria Development (SC)	X	X	X
Systems Analysis (SY)	X	X	X
Human Reliability Analysis (HR)	X	X	X
Data Analysis (DA)	X	X	X
Internal Flood PRA (FL)		X	
Internal Fire PRA (FI)		X	
Seismic PRA (S)			X
Other Hazards Screening Analysis (EXT)			X
High Winds PRA (W)			X
External Flooding PRA (XF)			X
Other Hazards PRA (X)			X
Event Sequence Quantification (ESQ)	X	X	X
Mechanistic Source Term Analysis (MS)	X	X	X
Radiological Consequence Analysis (RC)	X	X	X
Risk Integration (RI)	X	X	X

PRAs Using Standard

PRA	Reactor Type	PRA Organization	Time Frame
PRISM	SFR	GE-Hitachi, ANL	2017
HTR-PM	PB-HTGR	Tsingua Univ. ROC	2013-Present
TWR	SFR	Terrapower	2013-Present
PBMR	PB-HTGR	PBMR Ltd.	2006-2010
Xe-100	PB-HTGR	X-Energy	2014-Present
MCFR	MSR	Terrapower	2014-Present
FHR	MSR/PB	Kairos	2018-Present
MSRE	MSR	EPRI, Vanderbilt Univ.	2018-Present
eVinci	Micro-Reactor	Westinghouse	2019-Present
HTGR	Prismatic HTGR	JAEA, Japan	2017-Present
CFR-600	SFR	ANL	2018-Present
VTR	SFR	GE-Power, ANL	2019-Present

Lessons Learned from Pilots

- Consensus among pilots that standard was useful in establishing PRA technical adequacy
- Most significant and useful feedback obtained from PRISM, HTR-PM and TWR PRAs
- More clarification needed on intent of some requirements
- Most significant technical issues include:
  - Issues with applying LWR PRA approach to risk significance
  - Need more guidance on dealing with very small risk levels
  - Need to rethink roles of relative and absolute risk importance measures
- Sufficient experience in applying trial use standard to justify development of ANSI version of standard

Risk Significance Feedback

- Standard extended LWR approach to defining risk significance in terms of "frequency-centric" metrics (CDF and LERF) to release category frequencies and use of relative risk importance metrics
- PRISM PRA included 40 release categories; too many risk importance measures obscuring risk insights
- Risk significance criteria did not utilize the quantified consequences supported by non-LWR standard

LMP Insights for PRA Standard Consideration

- PRA standard used in LMP demonstration projects on Xe-100, GE-PRISM, MSRE, Kairos-FHR, and Westinghouse eVinci Micro-Reactor
- More full scale implementation of LMP with external hazards being carried out for VTR project
- LMP proposed use of absolute risk significance criteria for event sequences, SSCs, and basic events
- Absolute risk criteria used for defining risk significant LBEs and SSCs; role of relative risk metrics needs to be clarified
- Scope of radiological hazards needs to be expanded from reactors to include other risk significant sources (e.g. off-gas systems in some reactors)
- More clarification needed that some technical elements and requirements do not apply for PRAs introduced early in design
- PRA Peer reviews need to put more emphasis on reviewing differences in reactor specific safety characteridtics that impact PRA modeling

Revised Risk-Significance and Screening Approach

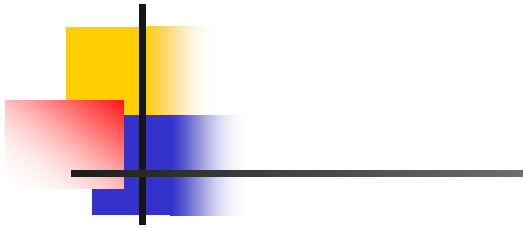
- Risk significance defined in terms of total integrated risk with both frequencies and consequences considered
  - Exceedance frequency for each relevant consequence measure (e.g. dose, health effects, QHO metrics)
  - Sum of product of mean event sequence frequencies and consequences
- Roles of absolute and relative risk significance criteria being clarified
  - Absolute criteria may be used for risk-informed decision making, e.g. setting design requirements
  - Relative criteria may be used for screening and identifying risk contributors and applying PRA requirements for realism in Capability Category II
- More flexibility to use of relative and absolute screening criteria to screen out parts of the PRA model demonstrated to be of low risk significance (events, hazards, SSCs, radionuclide sources)

2020 Version Status and Schedule

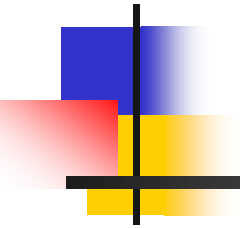
- Major Tasks to Complete
  - Achieve alignment with supporting LWR PRA Standards: LWR next edition, LPSD, Level 2, and Level 3 (draft completed)
  - Incorporate new risk significance and screening approaches (draft completed)
  - Resolve questions on applying PRA requirements to very rare events
  - Incorporate other feedback from pilots (draft completed)
  - Complete cross-reviews and consistency checks
  - Complete readiness review
- Next Edition ballot expected in early to mid-2020 largely dependent on completion of LWR next edition

Upcoming JCNRM Actions

- Based on the level of consistency already attained, the JCNRM decided to decouple schedule from LWR next edition schedule
- A letter will be sent to the NRC Standards Executive relative to NRC endorsement plans for the Non-LWR Standard and JCNRM actions to support NRC and industry LMP efforts



Questions?



Backup slides

ASME/ANS JCNRM Officers

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Dr. Pamela Nelson	UNAM
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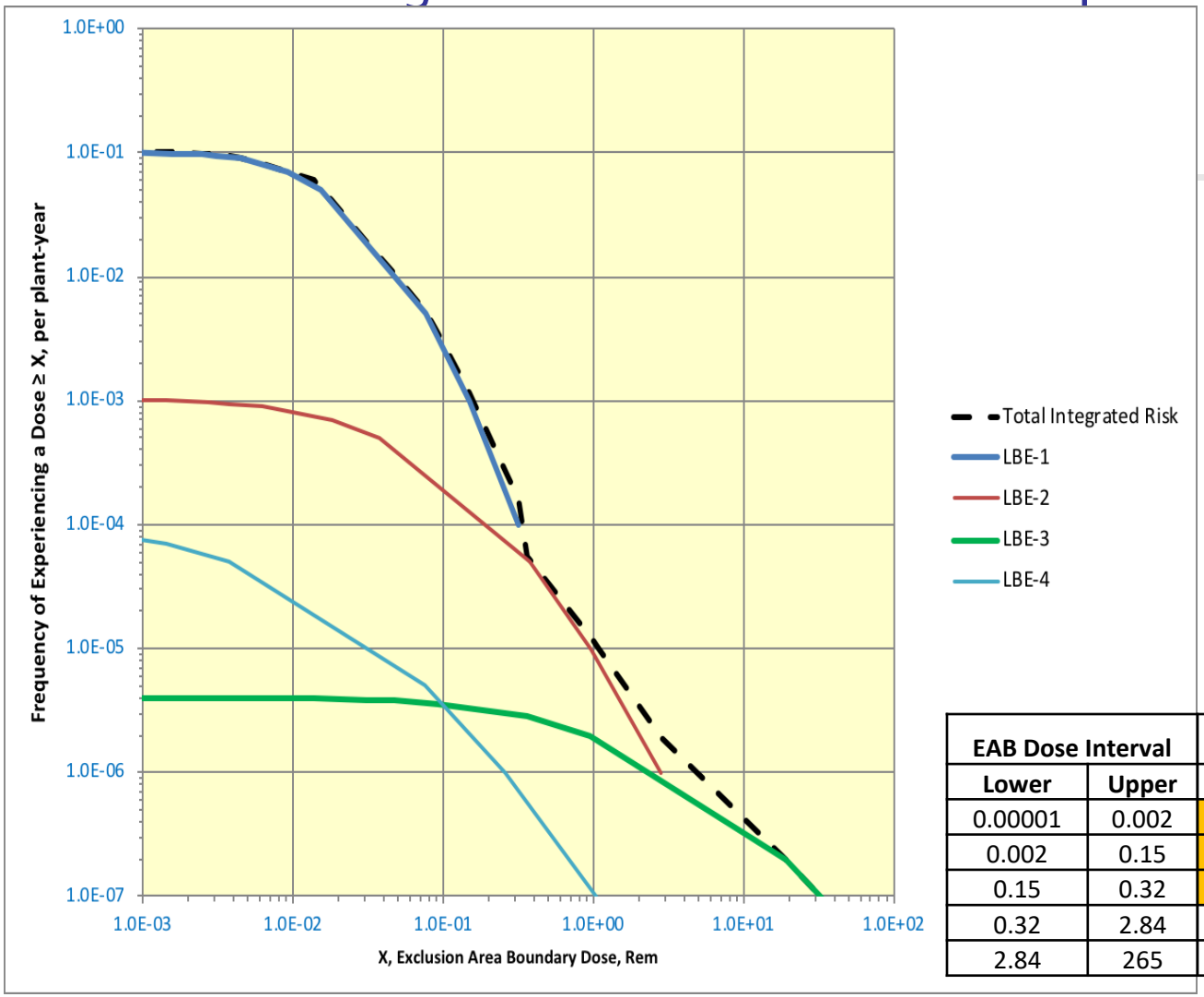
Ken Muramatsu	Tokyo City University, Japan
Jordan Hagaman	Kairos Power
Matt Denman	Kairos Power
Alex Hunning	ORNL
Andrew Clark	SNL
Zac Jankovsky	SNL

Comparison of PRA Standards

ASME/ANS-RA-S-1.4-2013	Corresponding LWR PRA Standard
Plant Operating State Analysis (POS)	Similar to POS in ANS Low Power and Shutdown PRA standard[44] to support PRA models covering operating and shutdown modes
Initiating Event Analysis (IE)	Similar to IE in ASME/ANS-RA-Sb-2013[42] except that LWR IE categories are replaced by reactor technology neutral categories and both single unit and multi-unit initiators are included
Event Sequence Analysis (ES)	Similar to AS in ASME/ANS-RA-Sb-2013 except that event sequences are developed to user defined intermediate end states and release categories
Success Criteria Development (SC)	Similar to SC in ASME/ANS-RA-Sb-2013 except that safe stable end states are defined to prevent user defined end states rather than to prevent core damage and large early release
Systems Analysis (SY)	Similar to SY in ASME/ANS-RA-Sb-2013
Human Reliability Analysis (HR)	Similar to HR in ASME/ANS-RA-Sb-2013
Data Analysis (DA)	Similar to DA in ASME/ANS-RA-Sb-2013
Internal Flood PRA (FL)	Similar to FL in ASME/ANS-RA-Sb-2013
Internal Fire PRA (FI)	Similar to FI in ASME/ANS-RA-Sb-2013
Seismic PRA (S)	Similar to S in ASME/ANS-RA-Sb-2013
Other Hazards Screening Analysis (EXT)	Similar to EXT in ASME/ANS-RA-Sb-2013
High Winds PRA (W)	Similar to W in ASME/ANS-RA-Sb-2013
External Flooding PRA (XF)	Similar to XF in ASME/ANS-RA-Sb-2013
Other Hazards PRA (X)	Similar to X in ASME/ANS-RA-Sb-2013
Event Sequence Quantification (ESQ)	Similar to QU in ASME/ANS-RA-Sb-2013 except that the event sequences are mapped to user defined end states and release categories and cover anticipated events, and events within and beyond the design basis, and accidents involving single reactor units and multiple reactor units
Mechanistic Source Term Analysis (MS)	Similar to source term requirements in ANS Level 2 PRA standard[45] except that source terms cover both single unit and multiple reactor units
Radiological Consequence Analysis (RC)	Similar to the requirements in the ANS Level 3 PRA standard[75] except that there is an option to limit the scope to the performance of site boundary dose calculations rather than a full Level 3

Total Integrated Risk Exceedance Frequency Metric



EAB Dose Interval		ES Family Risk Significant?			
Lower	Upper	LBE-1	LBE-2	LBE-3	LBE-4
0.00001	0.002	Yes	No	No	No
0.002	0.15	Yes	Yes	No	No
0.15	0.32	Yes	Yes	Yes	No
0.32	2.84	No	Yes	Yes	No
2.84	265	No	No	Yes	No