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UNITED STATES OF AMERICA

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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OPEN SESSION

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WEDNESDAY

FEBRUARY 7, 2018

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ROCKVILLE, MARYLAND

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The Subcommittee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B1, 11545 Rockville Pike, at 8:59 a.m., Dennis Bley, Chairman, presiding.

COMMITTEE MEMBERS:

DENNIS BLEY, Chairman

RONALD G. BALLINGER, Member

CHARLES H. BROWN, JR., Member

MICHAEL CORRADINI, Member

VESNA B. DIMITRIJEVIC, Member

WALTER L. KIRCHNER, Member

JOSE A. MARCH-LEUBA, Member

DANA A. POWERS, Member

HAROLD B. RAY, Member

PETER C. RICCARDELLA, Member

GORDON R. SKILLMAN, Member

JOHN W. STETKAR, Member

MATTHEW W. SUNSERI, Member

ACRS CONSULTANT:

STEPHEN SCHULTZ

DESIGNATED FEDERAL OFFICIAL:

MARK BANKS

GIRIJA SHUKLA

ALSO PRESENT:

AMY CUBBAGE, NRO

BOB FITZPATRICK, NRR

BRIAN GREEN, NRO

JIM KINSEY, Idaho National Laboratory

IMTIAZ MADNI, NRO

JAN MAZZA, NRO

SHEILA RAY, NRR

JEFF SCHMIDT, NRO

JOHN SEGALA, NRO

TANJU SOFU, Argonne National Laboratory

ANDREA D. VEIL, Executive Director, ACRS

*Present via telephone

P R O C E E D I N G S

8:59 a.m.

CHAIRMAN BLEY: The meeting will come to order. Good morning. This is a meeting of the Advisory Committee on Reactor Safeguards Subcommittee on Future Plant Designs. I'm Dennis Bley, Chairman of the Subcommittee.

ACRS members in attendance are or shortly will be Joy Rempe, Charlie Brown, Walt Kirchner, Jose March-Leuba, Mike Corradini, Dana Powers, Harold Ray, Matt Sunseri, Ron Ballinger, Pete Riccardella, John Stetkar, and Vesna Dimitrijevic.

Dr. Stephen Schultz, ACRS consultant, is also in attendance. Mark Banks, filling in for Girija Shukla, of the ACRS staff is the Designated Federal Official for this meeting.

The purpose of today's meeting is to review the final Regulatory Guide 1.232 guidance for developing principal design criteria for non-light water reactors.

The subcommittee will gather information, analyze relevant issues, facts, and formulate positions and actions as appropriate for consideration by the full committee. The full committee is scheduled to address this matter at the

March 2018 full committee meeting.

The ACRS was established by statute and is governed by the Federal Advisory Committee Act, FACA. That means that the committee can only speak through our published letter reports.

We hold meetings to gather information to support our deliberations. Interested parties who wish to provide comments can contact our offices requesting time after the Federal Register notice of the meeting is published.

That said, we set aside time for extemporaneous comments from members of the public attending or listening to our meetings. Written comments are also welcome.

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

Detailed proceedings for conduct of ACRS meetings was previously published in the Federal Register on October 4, 2017. The meeting is open to public attendance. And we have received no requests for time to make oral statements.

Today's meeting is being held with a telephone bridge line allowing participation to the

public over the phone. A separate teleconference line has also been established to allow participation of staff consultants from DOE laboratories.

A transcript of today's meeting is being kept. Therefore, we request that the meeting participants either on the bridge line or teleconference line identify themselves each and every time they speak and to speak with sufficient clarity and volume so they can be readily heard.

We request those participants on the public bridge line to keep their phones on mute until they are called on to speak during the public comment period at the end of the subcommittee meeting.

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

At this time, I ask that attendees in the room please silence all your cell phones and other noisemakers.

And I remind speakers at the front table to turn on the microphone touching it at the bottom where it says push, indicated by the illuminated green light when speaking, and likewise turn it off when you're not speaking. That keeps the bridge line quieter so everybody can hear.

We'll now proceed on with the meeting. And I'll call upon John Segala, Chief of the Advanced Reactor and Policy Branch, Office of the NRO, to make introductory remarks.

PARTICIPANT: Dennis?

CHAIRMAN BLEY: Just before we go ahead, first Dr. Corradini.

MEMBER CORRADINI: Just so the members know, I'm a member of the DOE NEAC subcommittee on advanced reactors, or on reactor technology. So I've seen some of the reference material before.

MEMBER REMPE: So I also have a similar comment, because of member, in order to comply with Section 10.1 of our bylaws, I have the --

CHAIRMAN BLEY: Good for you.

MEMBER REMPE: -- knowledge, and I am a member also of this Department of Energy Nuclear Energy Advisory Committee, as well as the former Secretary of Energy Moniz's SEAB task force. And we had to review and provide comments on some of the material that we were provided in preparation of this meeting.

CHAIRMAN BLEY: Thank you, Joy. Harold, are you still a member of that?

MEMBER RAY: No.

CHAIRMAN BLEY: Okay. At this time, John, please go ahead.

MR. SEGALA: Well, thank you. So, before we get into too much detail on the non-light water reactor design criteria, I wanted to very quickly provide you an overview of the advanced reactor program, our readiness activities, and some of our past and planned ACRS meetings just so that you can see sort of how this fits in the overall approach that we're taking. Next slide, please.

So last March the staff presented the non-light water reactor vision and strategy and near-term implementation action plans to the ACRS future plants subcommittee and the full committee meeting.

The near-term implementation action plan has six strategies. And you can see them in the top blue boxes across the top there. And we've been working on readiness activities under each strategy.

However, we have been focusing our efforts on Strategies 3 and 5 based on recommendations in the ACRS letter from last March.

Several items, readiness activities we've completed are shown with the checkmarks in the green boxes. The boxes highlighted in yellow at the bottom under Strategies 3 and 5 are areas that we've

been focusing a lot of our attention on in the near-term. And those are also areas that we plan future interactions with the ACRS.

The non-light water reactor design criteria box under Strategy 3 represents information that the non-light water reactor designers need early on to proceed with the development of their designs. This effort has been underway since 2013 and represents a more traditional, deterministic approach with some performance-based aspects.

Stakeholders have indicated to us that this Reg Guide is of high priority to them, and they would like us to move forward with issuing the final Regulatory Guide.

More recently we have been working on the review of the industry-led licensing modernization program, which is the bottom box under Strategy 3, which is a risk-informed, performance-based approach for determining the licensing basis events.

The LMP includes four industry white papers. There's the licensing basis event selection, defense-in-depth, PRA, and SSC safety classification white papers, which build off of the NGNP white papers that were submitted back in the 2010 timeframe.

Industry plans to fold all those white

papers into a consolidated NEI document and submit that to the NRC, requesting for our endorsement in a Regulatory Guide.

If the staff gets to the point where we can come to a decision to endorse the LMP in a Reg Guide, both the non-light water reactor design criteria Reg Guide and separately the LMP Reg Guide would be two acceptable approaches for developing a licensing basis for a non-light water reactor.

The outcome of the LMP process may serve to help risk inform some of the non-light water reactor design criteria. And the Reg Guide could be modified in the future if needed.

But we feel that the non-light water reactor design criteria Reg Guide as it is is a conservative and acceptable approach moving forward.

CHAIRMAN BLEY: John?

MR. SEGALA: Yes.

CHAIRMAN BLEY: If I remember correctly, you expect to brief us on this in, sometime in the June timeframe, right?

MR. SEGALA: Yes, so the next slide, next couple slides I'll get into that. I'll give you the specific dates and --

MEMBER CORRADINI: So can I ask questions

under the boxes under 3? So the first question is the prototype guidance, that has been rolled into a roadmap as an appendix.

MR. SEGALA: Yes.

MEMBER CORRADINI: Has that been -- I mean, in some sense I do that as an explanatory document for a one sentence in 10 CFR 50.

MR. SEGALA: Yes.

MEMBER CORRADINI: Has that undergone approval such that it is now the guidance that one follows, or it's still under discussion?

MR. SEGALA: So that regulatory roadmap has been finalized. We issued multiple drafts of that. We had multiple stakeholder meetings where we discussed the roadmap as well as the prototype guidance. And then we issued that final. It's on our public website.

The prototype guidance, a lot of that is based off of a SECY paper that was written years ago. And we've actually included in part of the prototype guidance the flowchart and the information from the SECY paper.

MEMBER CORRADINI: Okay. So my question kind of goes like this. I've read, I don't know which version I've read of the prototype guidance.

It seems reasonable as a generalized guide. But does it give enough guidance that if somebody wanted to pursue that path they understand what they have to do, because it struck me as still a bit vague?

MR. SEGALA: Well, I guess that remains to be seen.

MEMBER CORRADINI: Should I ask the industry that?

MR. SEGALA: Yes, it might be a good question. I mean, as we went through the process of submitting it as a draft and soliciting stakeholder feedback, we didn't receive a lot of comments that -- and it didn't really change significantly.

But, you know, the requirements of 50.43(e) lays out that you need a combination of testing, analysis, and operating experience in order to demonstrate the capabilities of your safety systems.

And if, you know, and it goes through a whole process by which you can, you know, do different kinds of testing and leverage different things. And it kind of leaves the prototype as kind of the last resort but, that you could go down that path. We just haven't actually done that.

MEMBER CORRADINI: Okay. All right.

I'll leave it there, because I guess I've got to make sure I see the latest version to make sure. But at least the version --

MR. SEGALA: -- get that.

MEMBER CORRADINI: -- the last version I saw is, I was looking for attributes that have to be satisfied in some generalized fashion so that if somebody wanted to pursue that path they actually understood what was expected of them.

But let me just move on. So --

MR. SEGALA: We can --

MEMBER REMPE: Before you move on --

MR. SEGALA: We can provide you all a copy of that.

MEMBER CORRADINI: Okay.

MR. SEGALA: I mean, we --

MEMBER REMPE: Where is that, because the version that we got in preparation for this meeting says preliminary draft?

And yet there's been -- have we discussed that roadmap at all, because I like a lot of things I see in there like the implementation action plan? And I have a lot of questions about the roadmap. And I don't recall us discussing --

CHAIRMAN BLEY: We did a long time ago,

a couple years ago.

MEMBER REMPE: The regulatory roadmap, but I don't think we did this one, did we?

MR. SEGALA: The roadmap isn't really creating a whole lot of new information. It's basically laying out all the different flexibilities we have in the current regulations, whether it's Part 50 under the construction permit operating license or whether you're under Part 52 and you're looking at, you know, an ESP design cert, all the different options and standard design approval.

And so we kind of go through all the different flexible approaches that we have and the fact that we're willing to engage very early with pre-applicants and talk. We stress a lot the need to establish a regulatory engagement plan or licensing project plan.

MEMBER REMPE: How is that going over with the potential applicants --

MR. SEGALA: We --

MEMBER REMPE: -- or do you even have any that are getting ready to submit --

MR. SEGALA: We do have licensing project plans that have been submitted to us. And we're currently working on those in terms of we're actually

implementing what's in there. So we think it's working well.

We encourage early discussions with us, provide us drafts. We can provide feedback. The whole idea of the licensing project plan or regulatory engagement plan, which is now what we're calling it, is to have agreement early on so that there's clear expectations that during the pre-application phase we understand what the expectations and the outcomes are so that we ensure that you don't just have pre-application meetings for the sake of meetings and have --

MEMBER REMPE: Yes, I think there's great --

MR. SEGALA: -- unfocused --

MEMBER REMPE: -- ideas.

MR. SEGALA: Yes.

MEMBER REMPE: I just am curious, because I haven't, I guess I missed it if we discussed that before. And I also was interested in some of the discussion about 104, the prototype, and a lot of that in this roadmap.

MR. SEGALA: Yes.

MEMBER REMPE: And so I would like to spend some time, but I don't think we have time today

to talk about that more.

CHAIRMAN BLEY: Yes, that's not up for today --

MR. SEGALA: Well, we can certainly provide you --

CHAIRMAN BLEY: -- but we'd be interested in --

MR. SEGALA: We can provide you the updated final version. And then, you know, we can, if you want to have a separate discussion on that, we could do that.

MEMBER REMPE: Yes, because especially with the 103 versus the 104 and what would happen if you went above 10 megawatts, for example, and things like that.

MR. SEGALA: Okay.

MEMBER REMPE: I'm curious on what you're thinking is.

MR. SEGALA: Okay.

MEMBER CORRADINI: Okay, okay. I'm sorry.

MR. SEGALA: That's fine.

MEMBER CORRADINI: Can I now go to the yellow boxes?

MR. SEGALA: Okay.

MEMBER CORRADINI: So is it that if I'm Joe's -- I'll use Member Stetkar's analogy. It's such a good analogy. So, if I got Joe's reactor, do I have to satisfy both the yellow box that says non-light water reactor design criteria and the white papers? Is it an either/or, or is it an and? I'm still struggling to figure out, if I apply, what do I have to follow.

MR. SEGALA: Well, I mean, technically, the requirements are that you have to establish principal design criteria for your reactor design.

So you could come in and completely ignore the Reg Guide on the non-light water reactor design criteria and come up with your own principal design criteria. But you have to justify why those are the appropriate design criteria for your particular design. So the Reg Guide is really optional for them to choose. MEMBER CORRADINI: But --

MR. SEGALA: We're trying to give them an example of what, one example of what the staff would find acceptable.

But in the end, they're going to have to go through that Reg Guide if they want to adopt the design criteria. And they're going to have to

justify that those are appropriate for their facility.

MEMBER CORRADINI: Okay.

MR. SEGALA: Now, they could use the non-light water reactor design criteria Reg Guide in conjunction with the LMP. And so you could very early on in your preliminary design, you could apply the non-light water reactor design criteria to your design to help you design it.

And then the licensing modernization process is actually an iterative process that you go through multiple times along the design development. And then you could use that to fine tune your principal design criteria.

MEMBER CORRADINI: So, okay. So I got the first part. The second part I'm still fuzzy. Are we going to talk about the second yellow box today or just the first yellow box?

MR. SEGALA: Just the first.

MEMBER CORRADINI: So --

MR. SEGALA: And then we --

MEMBER CORRADINI: So I still don't understand the second yellow box. What you said, I heard what you said. I don't understand how I do it if I were a licensee using, because I thought the

four white papers from the NGNP were useful as to what to do and what to avoid the next time we try this. And I'm just trying to see how the two marry together.

MR. SEGALA: So the LMP is basically an extension of what was done for NGNP. But I think, you know, to do that, to do a discussion on LMP in a very short period of time --

MEMBER CORRADINI: No, that's fine.

MR. SEGALA: -- is going to be --

MEMBER CORRADINI: But eventually I think --

MR. SEGALA: -- difficult.

CHAIRMAN BLEY: We do have a subcommittee meeting.

MEMBER CORRADINI: Okay. I'm sorry.

MR. SEGALA: We'll have a series of meetings, which I'll get to --

MEMBER CORRADINI: Okay. Thank you.

MR. SEGALA: -- or we can go into that in detail.

MEMBER CORRADINI: Thank you very much.

MR. SEGALA: So really quick on, the staff is also, if you go under Strategy 5 for emergency planning, we're in the process of

developing a proposed rule for a consequence-oriented approach for determining the size of the emergency planning zone for small modular reactors and other new technologies, which include non-light water reactors.

Back in April, we shared with the ACRS our draft regulatory basis on that rule. And ACRS elected to wait to have a meeting until after the proposed rule is developed.

For the functional containment performance criteria --

CHAIRMAN BLEY: Sorry. What's on ONT?

MR. SEGALA: Other new technologies.

CHAIRMAN BLEY: Oh.

MR. SEGALA: So --

CHAIRMAN BLEY: So miscellaneous.

MR. SEGALA: So originally it was non-light water reactors and medical isotope. That was the scope of other new technologies.

For functional containment, the staff is developing a commission paper to address the previous commission direction to define performance criteria for design features that limit the release of radioactive materials.

Since such of the previous discussions on

this topic have been focused on high temperature gas-cooled reactors, another goal of the SECY paper is to get commission approval to a more technology inclusive approach.

MEMBER CORRADINI: So, sorry, and again on all these questions that you can defer till later.

So, under the, where in the green and the yellow is a discussion about a general procedure or policy on a facility versus modules in the facility, because the EP would be affected by that? The source term would be affected by that. Where is that?

MR. SEGALA: Well, we have a series of policy issues that we have laid out for SMRs and non-light water reactors. And that policy issue I believe was already addressed.

MEMBER CORRADINI: Okay. So then, if it's been addressed, if it comes up in a specific, I'll ask, because I'm still vague. I'm still unclear.

MR. SEGALA: So what's your specific --

MEMBER CORRADINI: Well, I don't want to pick on a design. So let's say if I have Joe's reactor and Joe has two of them onsite on a facility or 6 or 12, or if I'm into the microreactor fab world that I'm in, 100, do I take every one of the 100 as

the facility to analyze for non-light water reactor design criteria? Or do I take three?

What is the process by which one decides what has to be included between the facility and the modules?

MR. SEGALA: Yes, and I think the approach is to look at one module at a time. But then we also have to look at is there any conditions under which there are shared systems that you could have a situation where multiple modules could fail at the same time.

CHAIRMAN BLEY: Or shared initiating events or shared many other things, operator involvement.

MEMBER CORRADINI: So is it, so what I interpret that to mean is it's kind of we're coming here on a case-by-case basis. There might be a policy out there, but the policy will be addressed on a case-by-case basis.

MS. CUBBAGE: So we're going to be having a separate meeting --

CHAIRMAN BLEY: Amy?

MS. CUBBAGE: -- on the --

CHAIRMAN BLEY: Amy?

MS. CUBBAGE: Amy Cubbage, NRC staff,

thank you.

We're going to be having a separate meeting on the whole licensing modernization project. But that effort is definitely taking into consideration --

MEMBER CORRADINI: Okay.

MS. CUBBAGE: -- the multi-module issues and whether you consider a facility, you know, how the PRA is done for a multi-unit --

MEMBER CORRADINI: Okay.

MS. CUBBAGE: -- module facility. Okay?

CHAIRMAN BLEY: Thank you.

MEMBER CORRADINI: Thanks.

CHAIRMAN BLEY: That's coming up soon.

MEMBER REMPE: So one last random question about the modernization project, in one of your implementation action plans you have a statement in there about doing licensing basis events and documenting them for highly prioritized technologies. And I was curious on how that's working out. How do you decide what's highly prioritized?

MR. SEGALA: Yes, I'm not sure.

MEMBER REMPE: Is it going to be what comes in first?

MR. SEGALA: So, say the question.

MEMBER REMPE: Well, it's in one of your IAPs, the implementation action plan you had in Section 3.2.

MR. SEGALA: Okay.

MEMBER REMPE: And it says you're going to document the licensing basis events for highly prioritized technologies.

MS. CUBBAGE: So I'd have to look at that language in context. But what I can tell you is the licensing modernization project is completely technology inclusive. And there's no activity currently to work that on a technology or design specific basis.

I think we're certainly trying to make sure that the process would be effective for any of the non-LWRs that we're aware of and that industry may be looking to try to tabletop or possibly pilot some of these activities with designs other than HTGRs where it's been mostly tested in the past.

MEMBER REMPE: Yes, I know that there's been an effort to try and group like sodium-cooled reactors --

MS. CUBBAGE: Yes.

MEMBER REMPE: -- and gas reactors, because there's a difference between pebbles --

MS. CUBBAGE: Right.

MEMBER REMPE: -- and prismatics. But on the other hand, when you try and do licensing basis events, it seems like you're going to have to do a concept specific. So I'm just kind of wondering how you deal with that.

MS. CUBBAGE: Well, we're focusing on the process now --

MEMBER REMPE: Okay.

MS. CUBBAGE: -- which is a technology inclusive process. Until we actually have an applicant for a specific design that needs to run through the process, we'd be focusing on technology inclusive today.

MEMBER REMPE: Thanks.

MEMBER CORRADINI: So, Amy, don't go anywhere. Sorry.

MS. CUBBAGE: That's okay.

MEMBER CORRADINI: So, I mean, to do this in some fashion, are you picking a couple of pilots? So, you know, what I'm trying to get at is --

MS. CUBBAGE: Yes.

MEMBER CORRADINI: -- I understand that you want to make it inclusive.

MS. CUBBAGE: Right.

MEMBER CORRADINI: But in some sense, it all gets down to the, what I think where Joy's going, it eventually gets down to specifics.

MS. CUBBAGE: Right.

MEMBER CORRADINI: So have you taken a couple of pilots to see?

MS. CUBBAGE: So where the rubber meets the road is ultimately applying this to a technology. And at this point, we can't drive that because, you know, we need an applicant to really --

MEMBER CORRADINI: Okay.

MS. CUBBAGE: -- fully drive the process.

But I think industry, Amir Afzali is here from -- he may be able to speak to this. But they are looking at opportunities to try to pilot with some of the designs that are more maturely developed, for example, the prism reactor where we had already done a preliminary design review back in the '90s. And certainly it's already been somewhat tested out on NGNP and other projects of that nature.

MEMBER REMPE: And you can do that. But then if nobody wants to build it, is that the one to prioritize? I mean, if you don't have, you know, if there's no one saying, hey, I'm getting ready to do this --

MS. CUBBAGE: Well, I mean, it's the chicken and egg.

MEMBER REMPE: Yes.

MS. CUBBAGE: You need to test it on what you know, or you have to wait until somebody comes forward with an application and applies it.

MEMBER CORRADINI: So, sorry.

MEMBER REMPE: Okay.

MEMBER CORRADINI: So I'm aware that DOE has development plans in four generic areas.

MS. CUBBAGE: Yes.

MEMBER CORRADINI: And then they have some sort of, we'll call it leading candidate design in the four generic areas. Is it really to the industry and DOE to kind of give you some examples to work on? That's what --

MS. CUBBAGE: That would be great. But, you know --

MEMBER CORRADINI: Okay.

MS. CUBBAGE: We discussed that at our last public meeting that it will be helpful to have some designs to pilot and work through these issues with. But it's yet to be determined --

MEMBER CORRADINI: Okay.

MS. CUBBAGE: -- if that's going to come

forward.

MEMBER CORRADINI: Thank you.

MR. SCHULTZ: John, before you leave this slide, since Strategy 4 feeds into Strategies 3 and 5, what is the staff's involvement right now in Strategy 4 in going forward?

MR. SEGALA: So we have people that are involved in the ASME Section 3, Division 5 activities. We're currently waiting for the NEI technology working groups through ASME to instruct us on whether we should move forward and endorse the 2017 edition of ASME Section 3, Division. 5. If we get that, we will move forward pretty heavily over the next two years or so and go down an endorsement process.

In ANS, well, I think also in ASME is the non-light water reactor PRA standard. And we have some people on that committee. And then on the ANS standards, Jan and some other people are members of the various subcommittees on non-light water reactors.

MR. SCHULTZ: Thank you.

MR. SEGALA: Okay. So this slide will be really quick. These are the dates for when we previously met with you all on the near-term

implementation action plans and the draft guide on the design criteria. So next slide.

So the top part is today's meeting on the Reg Guide 1.232. And then we plan to come back in March for the full committee meeting. And we're hopeful that we can get a clean letter so that we can move forward and issue the final Reg Guide.

The bottom three bullets are the other yellow boxes that I highlighted in the previous slide. We're planning to come talk to you on functional containment in a couple weeks and then come back in April for the full committee meeting.

For licensing modernization project, we listed two subcommittee meetings there because we wanted to have opportunities to get your input early in the process. So we haven't, we wanted to map out the opportunity to have your involvement twice during the development of the draft guide.

And then the December full committee meeting is just a planning wedge to come back with the final guide.

EP rule, the plan is to provide the draft proposed rule to you a month before the August 22nd meeting and then follow that up in October with the full committee meeting.

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

MS. MAZZA: Thank you, John. So I'm going to talk a little bit of some background and summary of the Reg Guide up to now before we get into the specific ACRS letter comments.

So this slide shows the recent progress on the Reg Guide. Back last February we issued Draft Guide-1330 for the 60-day public comment period. And then we had a public meeting in August of 2017 for additional staff interaction with the public on specific issues in order to finalize the Draft Reg Guide 1.232.

We continued the discussions in November on two specific areas, ARDC 17 and 26, which are electric power systems and reactivity control systems.

And then in January of this year, we issued the Draft Final Reg Guide 1.232 and then Draft Public Comment Resolution Table ahead of this meeting today. And we are hoping to issue the final Reg Guide in March of this year.

So now I'm going to go through some slides you've already seen before, but just go through the background of the Reg Guide and what the purpose is.

So in 2013 the NRC and DOE agreed to pursue an initiative to provide guidance to non-light water reactor designers for developing principal design criteria. The idea was to establish design criteria for non-light water reactors similar to the light water reactor focused general design criteria in 10 CFR 50 Appendix A.

Non-light water reactor designers could then use these design criteria to develop the principal design criteria for their facilities.

The regulations in 10 CFR 50 Appendix A state that general design criteria establish minimum requirements for the principal design criteria for water-cooled nuclear power plants and are generally applicable to non-light water reactors.

And then the contents of application, technical information sections of 10 CFR 50 and 52 state that applications must include principal design criteria for their facility based on the general design criteria.

So, as mentioned on the last slide, the principal design criteria are derived from the general design criteria in 10 CFR 50 Appendix A, which establishes the applicability of the general design criteria to both light water reactors and non-light

water reactor designs.

And so, on this slide, we have an excerpt from 10 CFR 50 Appendix A. And the first part in black speaks to the light water reactors. And then the red on the bottom speaks to the non-light water reactors.

It says the general design criteria are also considered to be generally applicable to other types of nuclear power units and are intended to provide guidance in establishing principal design criteria for such other units.

So the language in 10 CFR 50 Appendix A indicates that the general design criteria are guidance for non-light water reactors. And as such, non-light water reactor applicants would not need to request an exemption from the general design criteria when proposing their principal design criteria for their specific design.

So this Reg Guide provides the additional guidance for reactor designers and applicants of non-light water reactor designs for developing a principal design criteria.

So, as discussed in the Reg Guide, applicants are, it is the responsibility of applicants to develop the principal design criteria

for its facility based on the design using the general design criteria, non-light water reactor design criteria, or other design or technology specific criteria as needed.

So, for instance, a fluoride high temperature reactor uses, say, the TRISO fuel similar to modular high temperature gas reactors. So, when they develop their principal design criteria, they may use some of the advanced reactor design criteria for some things and then maybe a modular high temperature gas reactor design criteria for others. So it provides flexibility.

Applicants also must consider the public safety --

CHAIRMAN BLEY: Can I interrupt you, Jan --

MS. MAZZA: Um-hmm.

CHAIRMAN BLEY: -- because what you just said makes sense? But when I read the Reg Guide, and I guess what you say in there was a matter of intent. I was thinking you have, you now have two sets of sort of design specific, at least concept specific design criteria that people with those kinds of reactors we'd expect them to follow.

But we also have the more general ARDCs.

And I was thinking, well, what do they apply to? You know, are they just the straw man that you then adapt, which is kind of what you just said?

But the words in here I thought said that you and DOE, who helped in this development, thought that for four designs, the lead fast reactors, gas-cooled reactors, fluoride high temperature reactors, and molten salt reactors, the ARDC would apply as is. But you're just saying maybe not.

MS. MAZZA: Well, yes --

CHAIRMAN BLEY: And that seems reasonable --

MS. MAZZA: But --

CHAIRMAN BLEY: -- maybe not.

MS. MAZZA: It's a guidance document. It provides flexibility. It just gives applicants an idea of how the staff thinks that the general design criteria could be adapted to the non-light water reactor design criteria.

CHAIRMAN BLEY: Okay. Thanks.

MS. MAZZA: So also, applicants are responsible for considering the public safety matters and fundamental concepts, such as defense-in-depth, in the design of their specific facility and for identifying and satisfying necessary safety

requirements, also to provide the principal design criteria for the design and supporting information that justifies how the design meets the principal design criteria submitted, and how the principal design criteria demonstrate adequate assurance of safety.

And then in instances where a general design criteria or a non-light water reactor design criteria is not proposed, the designer or applicant must provide a basis and justify the omission from a safety perspective.

MEMBER SKILLMAN: Jan, let me ask you to go back a slide, please. Back one more. The boldened would not need to request an exemption. Would you describe to us what discussion occurred among the staff to, if you will justify that idea?

MS. MAZZA: Well, we basically discussed it with our general counsel. And they were in agreement that that, since the design criteria, the general design criteria are requirements for light water reactors and are generally applicable and guidance for non-light water reactors, therefore, they would not need to follow the general design criteria in Appendix A. Non-light water reactors would not need to follow that word for word just like,

as the light water reactors are required to today.

MEMBER CORRADINI: I'm with him. I'm confused.

MEMBER SKILLMAN: Well, let me explain why I asked the question. I can understand the desire to not have an exemption. That takes a huge amount of administrative burden off the table.

On the other hand, the effort to create what would either be the basis or justification for an exemption would exemplify the degree to which the NSSS designer and the staff considered the consequence of what it is that might have been in the exemption.

It just seems to me that there are a number of very basic concepts that we hold to in our industry that have kept us safe for a long time. And I can understand a novel design wanting an exemption because their specific design doesn't fully meet at least what I would think is the intent of the general design criteria.

But the effort to justify what might conceivably be an exemption explores perhaps unintended consequence. And to me that's the value.

It is much like having to do a root cause before the event has occurred. Smart and intelligent

men and women look at the whatever it is that's different and give real consideration to why that is acceptable.

And so I'm just curious. Was this just an added phrase where counsel said, yes, write that and that way they don't have to do a lot of work? Or was there consideration to the greater effort that would truly provide the NSSS designer and the Agency basis to say, even though that's different, that's okay?

MS. MAZZA: So, once again, non-light water reactor applicants would have to submit their principal design criteria. And that would be subject to staff review. And, you know, all of those aspects would be part of that review, you know, even though it wouldn't be a specific exemption.

And I think Amy has something --

MS. CUBBAGE: Yes, this is Amy Cubbage. This really has nothing to do about the burden of an exemption or not. It's basically saying that a non-LWR applicant cannot use these blindly. They have to develop a whole set of PDCs. And, you know, the issue of an exemption or not is because these don't apply.

MR. SEGALA: And regardless of whether

they submit an exemption request or not, they still have to provide justification for why these are appropriate.

MS. CUBBAGE: Right. So all the technical work needs to be done to justify why their principal design criteria are sufficient and appropriate for their design.

MR. SEGALA: And I think also we have to live within the regulations. We can't require something of an applicant that the regulations don't support.

So, you know, but we need to make sure that the design is safe and that they have the right principal design criteria and that they adequately justify that.

And there will be lots of discussions and documentation of why that particular PDC is appropriate for that design and whether they missed anything, you know, because they can't just blindly apply the ARDCs or the SFRDCs to their design and say I'm an SFR, therefore I'm only giving you the SFRDCs.

They need to look broader than that and say are there any unique aspects of my SFR that needs additional principal design criteria that wasn't envisioned when we developed the Regulatory Guide.

MEMBER KIRCHNER: So may I jump in, Dick?

MEMBER SKILLMAN: I want to thank John and Jan and Amy.

MS. MAZZA: Okay.

MEMBER SKILLMAN: I'm satisfied very well.

MS. CUBBAGE: Great. Thank you.

MEMBER KIRCHNER: So this is the danger of coming back to the committee. You gave us quite a few months to churn on this material.

So, John, to follow up what you just said, the more I think about it, the more I would expect that you would develop advanced reactor design criteria. And you've, many times now the staff has come in front of us to say we're trying to be technology neutral. We're going more to performance-based and such. And fine, I agree with that.

What I sense -- and I know you collaborated with the DOE on this, and a tremendous amount of work has been put into this. But basically what I sense is for the HTGR and the sodium fast reactors you kind of, I wouldn't say you've fallen into a trap per se. But you've almost developed the PDCs for specific designs or at least broad outlines for the PDCs. That's what the GDCs do.

But it presumes -- there's too much in my opinion presumption of design choices and results in both of those specific, reactor specific types, Jan.

And I wonder if you're not better served to fall back on your basic principles for general design criteria and just stick with the advanced, and we can talk about the details of those, as the template. And then have the Department or the applicant jointly come in and propose what they want, because I see in many places you're presuming the design. What if the high temperature gas-cooled reactor turns out to be a fast reactor and it doesn't have particle fuel, right?

So then -- and what it's forced you into in your containment, functional containment paper is the multiple, is to come up with multiple definitions of containment for each reactor. And it seems to be philosophically what you want is to define what the function of the containment is in a very, in a functional sense.

So I'm with you where you're going, but not get -- at least the NRC, the applicant and the DOE is a different matter -- get trapped into endorsing, if you will, expected outcomes when you don't have the design yet, you don't have the

qualified fuel, you don't have sufficient detail to say that this adaptation of our basic principles is warranted.

Do you see where I'm going? It's a philosophical point. And I know you've put a lot of work in. It's rather late, a year later, to bring something like this up. But --

MS. MAZZA: Well --

MEMBER KIRCHNER: -- I was struck that the advanced criteria as a whole were pretty good. So I'm not throwing, I'm not trying to throw a wet blanket on everything. Why wouldn't you stand by that, and then let the applicant come in and modify?

MS. MAZZA: Well, again, this is a guidance document. And so I think it's helpful to the modular high temperature gas reactor community and the sodium fast reactor community to see where we would, what we would agree with and not agree with in the design criteria.

And again, it's, each applicant's going to have to come in and propose their own principal design criteria.

This is just, this is where staff is. This is what staff was thinking when they looked at, you know, the SFR designs that are out there. And,

you know, here's how we think, you know, our general design criteria could be adapted to that.

And so I think that's helpful to designers out there. And, you know, we've gotten good feedback from that, too. So --

CHAIRMAN BLEY: Jan, following up on Walt's point, maybe, you know, deciding to keep them, which I expect you're going to do --

MEMBER KIRCHNER: Yes, I'm not saying throw them out by the way.

CHAIRMAN BLEY: -- some definition of what's involved in the design that led you to that that's attached to the paper might be very helpful, not just for now but for when something that doesn't quite fit that comes in and it helps you explain why you don't think their, they've come up with the right principal design criteria.

MR. SEGALA: And I'd like to add, I mean, I can't think of a specific example. Maybe Jan can.

But I think, and what we got from DOE and then what we ended up with, there are a lot of circumstances where we proposed things more general because we were trying to think outside the box and say, well, there could be a design that has active cooling so we need to have this extra GDC or PDC in

there that maybe DOE didn't have in their original submittal.

So I think a lot of the disagreements and maybe some of the public comments and how we resolve them, we kept some PDCs in the Reg Guide that maybe industry felt that shouldn't be in there because we're trying to, well, what if a design comes in with that. We still need to have these design criteria there. So --

MR. SCHMIDT: Yes, this --

CHAIRMAN BLEY: I didn't say it before. But your rationale on each one of these gives a lot of helpful information.

MR. SCHMIDT: Yes, this is Jeff Schmidt from the staff.

So I can think of one example, while you were speaking, of where we diverge from the DOE. DOE wanted to basically say residual heat removal and ECCS were the same function and could be rolled into one ARDC, ARDC 34.

And the staff was hesitant because we were concerned that some design could come in and still require injection. And we thought the way the current DOE was structured would preclude that.

So there were deviations. But I think

it is a fair statement to say that the modular high temperature section, the sodium have some concept of a design inherent in them that we were more familiar with so we felt probably more comfortable in breaking those out. And I think that's a fair statement.

MR. SCHULTZ: I think that makes sense. But here you have a general comment that suggests that, it gives a suggestion that in staff's review of an application, if the applicant is following something that is a proposed PDC derived from the GDCs, then exemption isn't going to happen. And I think that's too general a statement.

The specific application is going to determine what the staff needs to do and whether an exception is going to come into the picture. I think a general statement like this is, in fact, misleading, because what you're derived from can be very, interpreted as very broad for an applicant that deals. They've derived their overall PDC approach from the GDC. And so they're free and clear with regard to moving forward --

MR. SEGALA: I think --

MR. SCHULTZ: -- staff moving forward to an exemption.

MR. SEGALA: I think the exemption is

just tied to whether they use light water for the coolant or they don't. And if they don't, they don't, the GDCs themselves don't, they don't have to meet those. And therefore, they don't need to have, to submit an exemption for something that they don't have to comply with.

MR. SCHULTZ: So that's another way to read the words --

MR. SEGALA: I mean, that's --

MR. SCHULTZ: -- in applying the staff --

MR. SEGALA: -- that's the legal kind of interpretation is, you know, just looking at the words.

But they're still going to need to go through an analysis and justify that they have the appropriate design criteria for that design and have a basis for that. And then we're going to, the staff's going to challenge them on each one of those and make sure that we agree and that there's not something missing that should be there.

MR. SCHULTZ: Thank you.

MS. MAZZA: So we received an ACRS letter in March of 2017. And the items you see on the slide here are basically what the comments were. We're

going to go through these today.

So it was technology-specific licensing basis events, facilitating PRA in the design criteria, reactor fuel design limits, specifically MHTGR-DC 10, containment, which covered all three design criteria, electric power systems, which is ARDC 17, and then reactivity control systems, which is ARDC 26.

So, before we begin the discussion on the ACRS comments, we were requested to provide a summary of the topics presented in 2017 for the Future Plant Design Subcommittee meeting. All four of the topics on this slide were the subject of comments in the March 21st letter. And we're going to be discussing these further today.

In the interest of time, if you wouldn't mind me just flipping through this --

CHAIRMAN BLEY: Yes, that's fine.

MS. MAZZA: -- since we're going to be going through those.

So the next thing I want to talk about is the interface between the Vision and Strategy Activities 3 and 5. As John showed you before, the staff is focused on resources, focusing our resources on Strategies 3 and 5 and specifically in the areas

highlighted in yellow on the slide.

And as we gain more insight into these topics, it's become apparent that they are closely related. The LMP includes a series of white papers that we talked before about. And then under Strategy 5, we have the EP for SMRs and other new technologies and then the functional containment performance criteria. And as John mentioned, we have near-term interactions on all those.

So this brings me to the first ACRS comment. This comment was included in the Vision and Strategy portion of the ACRS letter. However, it was mentioned several times during our discussions. So we decided to include it as part of this presentation.

So the comment was, Strategy 3, Contributing Activity 3.2, which develops approaches to licensing bases and will determine licensing bases for non-light water reactor technologies, is particularly important to implement early on. Identification of technology-specific licensing basis events need to be developed to ensure that the associated design criteria are complete.

So the staff agrees with this comment and understands the importance of defining the technology-specific licensing basis events. As

mentioned on the previous slide, we're participating in the industry led LMP. And the licensing basis event methodology was outlined in the LBE white paper.

And this was the first paper submitted to the NRC for review. And we will be discussing this with the ACRS in June and October of this year.

So another ACRS comment was, it would be useful to ensure that the language of the ARDCs facilitate or at least does not preclude the use of probabilistic risk assessment, especially in the areas where graded compliance is suggested.

So the staff doesn't believe that the ARDCs as written would preclude the use of the PRA. The PRA and other licensing modernization project products will establish the design basis events. And then the design basis events will be used to determine the set of safety-related SSCs required for design basis accidents, as well as the graded approach to determine the special treatment of SSCs for other event categories.

So the ARDC and the LMP products can then inform what the design specific principal design criteria should be. And this is an iterative process that ensures safety and supports the need for

integrated plant safety analysis.

So the next slide shows the ACRS comment regarding the use of specified acceptable system radionuclide release design limits in place of a specified acceptable fuel limits for modular high temperature gas reactors and perhaps other technologies such as molten salt reactors.

So the comment reads, MHTGR Design Criteria 10, as presently written, is cryptic. The phrase, specified acceptable system radionuclide release design limits, SARRDL, needs to be clearly defined.

Replacing the GDC specific, specified acceptable fuel design limit, SAFDL, concept with the proposed SARRDL concept in the ARDCs is acceptable. However, during design, reactor designers will need to develop their own design specific limits in order to characterize and evaluate their own design.

The new SARRDL concept requires additional analysis that the staff will have to review and approve. Later during operation, licensees will monitor both circulating activity and plate-out activity to ensure acceptable fuel performance, that is as evidence that the SARRDLs are being met.

So, again, the staff agrees with this comment. And so we note that the definition of SARRDL depends on several factors, including mechanistic source term, licensing basis events, and then the functional containment performance criteria.

Reactor designers will need to consider all of these collectively in order to define the design specific SARRDL that will meet the requirements. And the functional containment performance criteria SECY paper will discuss topics integral to the functional containment like the SARRDLs.

And again staff is scheduled to discuss this with ACRS on the 22nd of this month.

MEMBER KIRCHNER: So may I interrupt?

MS. MAZZA: Sure.

MEMBER KIRCHNER: Do you really need this SARRDL? Are you introducing problems?

I've worked with this technology. I understand its robustness and benefits. I'm trying to sort out why you wouldn't just stick with the, terrible acronym, SAFDL instead of SARRDL and then proceed to analyze your reactor coolant system and your functional containment to ensure that, if you were using performance-based EPZ and performance-

based containment that the off-site doses are acceptable and such. I'm just struggling what does this SARRDL concept buy you.

MR. SCHMIDT: This is Jeff Schmidt from the staff. What we were -- so, in my sense, the TRISO-based fuel can degrade under most expected conditions rather gracefully.

MEMBER KIRCHNER: Right.

MR. SCHMIDT: Right. And so what we were trying to move away from, the SAFDL has kind of a concept of, if you hit certain criteria, that you would basically fail to fuel in a complete fashion. In other words, you'd lose the integrity of the clad.

MEMBER KIRCHNER: You'll do the same with TRISO fuel if you get it hot enough.

MR. SCHMIDT: You're correct. You're right. You would. But I think the issue is the margin to those points are farther away in general than, say, for the light water reactor.

MEMBER KIRCHNER: You don't know that. You haven't had the design submitted yet. This is to my philosophical problem.

MR. SCHMIDT: Right. This assumes something.

MEMBER KIRCHNER: You're adapting in

advance to something you expect.

MR. SCHMIDT: Yes.

MEMBER KIRCHNER: But you don't have it yet.

MR. SCHMIDT: That's correct.

MEMBER KIRCHNER: So I would be more comfortable sticking with your existing definition for fuel design limits and then let the applicant and the Department make their case. And I think they can make a case.

So I'm not, again, being an obstructionist. But I do think you're introducing a complexity and you're building in advanced design expectations and performance expectations that need to be demonstrated.

MR. SCHMIDT: I think --

MEMBER KIRCHNER: All fuel leaks.

MR. SCHMIDT: I think that's true, yes.

MEMBER KIRCHNER: Right?

MR. SCHMIDT: I agree. But --

MEMBER KIRCHNER: So you have leaky fuel. You have circulating activity in PWRs.

MR. SCHMIDT: Sure.

MEMBER KIRCHNER: Or BWRs.

MR. SCHMIDT: Sure. I think this is --

MEMBER KIRCHNER: It should be lower.

MR. SCHMIDT: -- trying to move more --

MEMBER KIRCHNER: What you're doing backhandedly is saying there's a QA requirement on this fuel that limits the amount of circulating inventory.

MR. SCHMIDT: Right.

MEMBER KIRCHNER: But that's a design detail. I mean, there should be quality fuel in any reactor, I mean, we'd hope.

But I wonder how much you're gaining with doing this, because, just as Jan said earlier, you know, hanging out there is functional containment. And that's going to interact with this.

So, if you're going to a performance-based containment during the accident sequences, this is where PRA will help, and you go through all this, you're going to back through the system just like you do with conventional reactors now. You're going to go from fuel to reactor coolant boundary to functional containment. So I don't see exactly what this is buying you at this point.

MR. SCHMIDT: You know, the --

MEMBER KIRCHNER: It's just a philosophical observation.

MR. SCHMIDT: So, if you turn the coin on the other side --

MEMBER KIRCHNER: Right.

MR. SCHMIDT: -- you can kind of argue that SAFDL is artificial, right?

MEMBER KIRCHNER: Of course, yes.

MR. SCHMIDT: I mean, so it's --

MEMBER KIRCHNER: There's no one point.

MR. SCHMIDT: Right, it's an overly conservative construct we've created to protect effectively dose, right?

MEMBER KIRCHNER: Right.

MR. SCHMIDT: So we're trying to move it to the more performance-based dose aspect. And you're right. It's a function of the other barriers and the transport of those that will -- it kind of goes along with the frequency consequence curve concept --

MEMBER KIRCHNER: Right.

MR. SCHMIDT: -- where the criteria in that construct is the dose to the public, right, or the dose at the boundary.

The other thing I would say -- I mean, I think you can argue, like you're saying, that maybe SAFDL isn't appropriate for modular high temperature

gas reactors.

MEMBER KIRCHNER: Yes.

MR. SCHMIDT: But there are other designs where I'm going to have no SAFDL, right, a liquid fuel design --

MEMBER KIRCHNER: Let's put liquid fuel --

MR. SCHMIDT: Right, I understand.

MEMBER KIRCHNER: -- in a different category because --

MR. SCHMIDT: But, I mean, the concept.

MEMBER KIRCHNER: -- a liquid fuel reactor's normal operating state is the worst nightmare for any other reactor design. You've got the fission product inventory circulating. So let's leave the liquid fuel things out -- they have been dropped over the years for good reason -- and come back to this.

That was a statement. I guess --

(Laughter.)

MEMBER CORRADINI: Just then as a personal opinion.

MEMBER KIRCHNER: A personal opinion. But I would direct you to Glasstone & Sesonske, which documents just about every liquid fuel reactor and

the problems they had with it.

But coming back to this, and let me stay on point, that I think the SAFDL would work, because I've worked with this technology and I've designed and built the reactor.

So you're going to, the designer is going to set a limit, a temperature limit, just like your 2200 for LWRs fuel because they are going to want comfortable margin before that point where the TRISO particles shows substantial degradation.

So, when you design this reactor, the designer is going to come in and say my peak temperature under all the accident sequences, it's passably safe, all that.

He's going to design it or she such that the peak temperature, with an uncertainty and numerous calculations, gives him or her confidence that they're not challenging the breakpoint on the TRISO particle fuel performance such that you have significant deterioration and release into the primary coolant system.

So it's really in a -- again, I'm being philosophical. But in a design sense, it's really no different than an LWR. Now, the fuel may be much more robust. And we're not going to argue that

today. But from a designer's approach, that's what you really will do.

And you'll look at that MHTGR in a passive cool-down mode. And you know what, that temperature you pick so that you have margin determines the diameter of the vessel and the size of the core.

MR. SCHMIDT: Right.

MEMBER KIRCHNER: So I kind of get where the applicant and the Department may be coming from. But from you, as a regulator, I think the SAFDL concept works.

MEMBER REMPE: Well, are you assuming prismatic fuel in your comments?

MEMBER KIRCHNER: No.

MEMBER REMPE: You're considering both pebble --

MEMBER KIRCHNER: It could be pebbles. It could be prismatic. It could be --

MEMBER REMPE: And then didn't we spend also last time a lot of time talking about it's time at temperature. It's not just a temperature --

MEMBER KIRCHNER: Time at temperature is another --

MEMBER REMPE: Yes.

MEMBER KIRCHNER: -- issue. So you need to go through that analysis.

But again, at least for the concepts, because you're writing things -- see, this is what I was philosophically objecting to earlier. You're assuming something about the design, and then you're writing the GDCs to fit the design.

Yes, a gas-cooled reactor is different than an LWR. But this is an example where I don't think you need to go there.

MR. SCHMIDT: One aspect I think we do pick up, though, is the concept of, what I was thinking was under an AOO you might have additional leakage or bypass from a TRISO fuel particle where we would not necessarily allow that in an LWR fuel, right.

So, you know, LWR SAFDL concept is kind of a binary concept. You either fail or don't fail, right. And this, one of the things was, as you heat up and you have additional, say, leakage from the TRISO fuel, this would allow that concept to occur and kind of it goes with the frequency consequence curve where it's kind of a continuum instead of a binary change --

MEMBER KIRCHNER: But as Jan said,

there's time at temperature as well is a factor in a lot of these scenarios that you'll analyze.

But I still submit even for an AOO you will, as a designer, you'll do the same thing. You'll pick a temperature limit that you think you can withstand for the length of the transient. That's what you'll design to.

MR. SCHMIDT: But we're kind of allowing some potential additional radionuclide and dose with this concept where the SAFDL would not, right. So it's more of a continuum again.

So, if you look at the frequency consequence curve, you know, you would say, okay, well, I have this fuel. It's doing most of the containment, confinement, whatever word you want to --

MEMBER KIRCHNER: Right.

MR. SCHMIDT: -- you know, use.

MEMBER KIRCHNER: It's the primary barrier.

MR. SCHMIDT: Yes, it's the primary barrier. Thank you.

MEMBER KIRCHNER: Sounds like LWR fuel, doesn't it?

MR. SCHMIDT: Yes, it does.

MEMBER KIRCHNER: Yes.

MR. SCHMIDT: It does to a certain degree. But I think in LWR space, though, the other barriers probably are equally important, especially for, in accident scenarios, right --

MEMBER KIRCHNER: I already submitted that this is probably a more robust --

MR. SCHMIDT: Right.

MEMBER KIRCHNER: -- fuel form. That's to be demonstrated, but it probably is.

So I just feel, as somebody who's going to approach the design, yes, okay, but it's a complication that then takes you into several steps. You're mixing a bunch of things together.

MEMBER CORRADINI: So can I ask Walt's question a different way, because I'm listening to you guys go back and forth and I'm not sure where I, where it stands?

Is there something unique about the particular design you thought about as you developed this that makes this necessary? Or is this just your evolving -- the way you argued back with Walt or discussed with Walt was, well, this is a natural evolution. And it could be applied to light water reactor fuel. That's what I thought you said.

MR. SCHMIDT: Right, you could.

MEMBER CORRADINI: Or is it more that there's something particular about a particular MHTGR design that requires this? That's what is the only thing, it kind of goes back to your starting point, which is they were thinking of something --

MEMBER KIRCHNER: Yes.

MEMBER CORRADINI: -- when they wrote this down.

MEMBER KIRCHNER: Well, you're always going to have leakage with the TRISO fuel. You'll have defects. The challenge is obviously to have a very high quality fuel with very low leakage.

And so it is, as Jeff was saying, there is something of a gradation that is a little bit different than an LWR fuel performance where you maybe get -- but even LWR fuel, although the quality has improved drastically, you do get leakage. And you do get circulating inventory.

So I just struggled with this when I went back again. Like I said, you gave us too much time and material.

So I just, now maybe the proponents have much more, I'm not asking to hear it, sophisticated set of arguments for this versus using, sticking with

the acceptable fuel design limits.

CHAIRMAN BLEY: I think we've worked this through.

MEMBER KIRCHNER: I made my point.

CHAIRMAN BLEY: And we need to march ahead if we're going to get done. We'll probably stay an extra half hour till about 12:30 to finish up, but don't count on that.

MS. MAZZA: Okay.

CHAIRMAN BLEY: Keep trying to catch up. There's a long way to go.

MS. MAZZA: All right. So we're going to skip containment for now because our presenter is not here yet. So we're going to go into number or to reactivity control systems since Jeff's sitting here. And then we'll do electric power systems. So this is Jeff's.

MR. SCHMIDT: Okay. This is Jeff Schmidt from the staff.

I'm going to talk about ARDC 26. So ARDC 26 eliminated the GDC requirement for controlling the rate of reactivity changes resulted from planned, normal power changes. For harder spectrum reactors, particularly liquid fuel systems, the control of the rate of reactivity insertion can be very important

and should be retained.

So that was the ACRS comment on the first re-write of ARDC 26.

MEMBER CORRADINI: So can I ask? Well, can I go to GDC 26? And I'm still in a learning mode. Is this normal operation for GDC 26?

MR. SCHMIDT: Okay. So this is, there's very --

MEMBER CORRADINI: This affects other things. So --

MR. SCHMIDT: Well, there's very clever wording in GDC 26.

MEMBER CORRADINI: Clearly.

MR. SCHMIDT: So it's not, you know, normally we would call it normal operation. But the writers of GDC 26, in my opinion, were very careful. They said, they didn't use the word normal operation. They used planned, normal power changes, which, in my opinion, means normal plant operations day to day.

So that's a very important distinction in my mind, because a lot of times people will argue normal operations includes AOOs. So it's the upset condition and what you do day to day.

So I think that the original writers of GDC 26 didn't want to use normal operations because

it could imply AOOs, the upset condition. So they used planned, normal power changes.

MEMBER CORRADINI: Okay. So, to put it crudely, AOOs are out per your understanding of history.

MR. SCHMIDT: For 26 I think that it doesn't address the upset condition.

MEMBER CORRADINI: Fine. Okay. I just want to get clear what you thought.

MR. SCHMIDT: Yes, it does not address the upset condition. It doesn't, it addresses the day-to-day, normal operation of the plant.

MEMBER CORRADINI: Thank you.

MR. SCHMIDT: As previously discussed, ARDC 26 kind of takes 26 and 27 and combines them into one ARDC to deal with reactivity control under AOO and postulated accidents.

In part, ARDC 26 was rewritten as the term reliably controlling reactivity changes in both GDC 26 and 27 was ambiguous. Revised ARDC 26 provides explicit performance criteria on the rate and amount of negative reactivity insertion. ARDC 26 was significantly revised based on the ACRS and public comments of the draft guide.

MEMBER BROWN: Can I ask a question?

MR. SCHMIDT: Sure.

MEMBER BROWN: Where is any reference to subcritical shutdown? Has that disappeared from ARDC 26?

MR. SCHMIDT: It actually does appear on the next slide. So we'll go through this --

MEMBER BROWN: I mean, but it's not in the new, it's not in the ARDC. If you say it's on the next slide, I don't know what that means.

MR. SCHMIDT: Oh, yes, the next slide I think is the -- I write down the specific ARDC, and we go through individual words to show that.

MEMBER BROWN: Go ahead.

MR. SCHMIDT: Okay. So this was the draft ARDC that went out, draft final, I'm sorry, draft final.

So the first item, so it's broken up by Items 1 and 2 are AOOs. Item 3 is postulated accidents. And Item 4 kind of picks up the reactivity requirements for getting what used to be called cold shutdown in 26. But we've changed kind of the meaning of cold.

So Item 1 is a means of inserting negative reactivity at a sufficient rate and amount to assure that the appropriate, what the appropriate

margin for malfunctions, that the design limits of the fission product barriers are not exceeded and safe shutdown is achieved and maintained during normal operations, including AOOs.

MEMBER KIRCHNER: So are you going to define safe shutdown?

MR. SCHMIDT: It=s safe shutdown consistent with SECY-94-084.

CHAIRMAN BLEY: And they refer to that, right? I think I remember B-

MEMBER KIRCHNER: Yes, I saw that.

MR. SCHMIDT: Shutdown means subcriticality.

MEMBER BROWN: Why do we have to have some other document that makes that definition as opposed to having that in the ARDC?

I just don=t understand why that=s totally divorced from whatever the proposed design criteria are. So it=s in the SECY paper. Is somebody going to go back and B- that=s the SECY-94?

MR. SCHMIDT: Well, but, I mean, shutdown means subcritical. So B-

MEMBER BROWN: That=s not what we=ve been listening to.

MR. SCHMIDT: Well, I guess --

MEMBER BROWN: Shutdown and the comments on B-

(Simultaneous speaking.)

MEMBER KIRCHNER: So, Jeff or Dan, would you have definitions? I don=t think there are definitions in the current draft. Is there?

Now, the old GDCs that are in Appendix A do have three definitions, because the original B- for example, they define single failure. Are you going to use that same definition?

MR. SCHMIDT: Of single failure, for B-

MEMBER KIRCHNER: Yes.

MR. SCHMIDT: I have assumed in this, yes, that we=re using the single failure B-

MEMBER KIRCHNER: Just a suggestion that the preamble or whatever might benefit from definitions of a few key words, and that=s one. We were provided, or maybe, Dennis, you provided us the original GDCs from B-

CHAIRMAN BLEY: Well, almost original proposed.

MEMBER KIRCHNER: And what they did when they went to B-

CHAIRMAN BLEY: I can=t say for sure.

MEMBER KIRCHNER: -- the GDCs as we know

them now from Appendix A, they took that single failure out as a criterion and made it a definition. I believe it=s a definition in the current GDC.

MR. SCHMIDT: It is, yes.

MEMBER KIRCHNER: I think it would, like Charlie, benefit to have a definition that is unambiguous.

Safe shutdown, I can understand the temperature issue is a little different than perhaps a light water reactor. But certainly there should be no misunderstanding. A shutdown is shut down. And it means it=s subcritical. These systems then are capable of keeping it subcritical.

MEMBER POWERS: My understanding, and I think this is right, is that shutdown does mean subcritical. The crucial difference here is safe shutdown, which means there are additional requirements, and that is that the fuel is cooled and coolable for a long period of time.

There=s no ambiguity about shutdown as I see it. The crucial term here is safe shutdown. Am I wrong about something here?

CHAIRMAN BLEY: I agree with Dana. I mean, safe shutdown means safe and shut down both.

MEMBER KIRCHNER: Shutdown, yes, right,

right. Fair enough.

MEMBER BROWN: I guess I=m a little confused. When you talk about coolable, is that, does that get you now into the realm where you can be critical but coolable? Does that mean B-

(Simultaneous speaking.)

MEMBER BROWN: You're shut down. And you=re critical. And you=re coolable. And it=s okay.

(Simultaneous speaking.)

CHAIRMAN BLEY: You can=t be shut down and critical.

MEMBER BROWN: You=re both cooled and coolable.

CHAIRMAN BLEY: There=s something different going on in the other meeting we had than this.

MEMBER BROWN: Well, there=s something different going on in my brain I think.

(Laughter.)

MEMBER BROWN: I mean, subcritical to me means subcritical. It doesn=t mean some other ambiguous definition of what subcritical means. It means --

CHAIRMAN BLEY: It means shut down.

MEMBER BROWN: Okay. Effective is less than one.

CHAIRMAN BLEY: Both cases, yes.

MEMBER BROWN: Well, but shutdown based on some earlier discussions didn=t come across to me. It seems we=ve got stuff B-

(Simultaneous speaking.)

MEMBER BROWN: We=re wrapping definitions around definitions to try to get to the bottom line.

MEMBER POWERS: Well, there=s people seeking a change in the world as we understand it and shouldn=t be confused here. I mean, they=re saying they want not just shutdown, they want safe shutdown. And that has been the understanding for a very, very long time.

MEMBER BROWN: Where is that defined then? Where is the term safe shutdown defined? I=m not aware B-

MEMBER POWERS: Safe shutdown is defined in the GDCs.

MEMBER BROWN: Where?

MEMBER POWERS: General design criteria.

MEMBER BROWN: I never saw it. When I=ve scanned through and I B-

MEMBER POWERS: I think you can find it.

MEMBER KIRCHNER: I think it=s implied B-

(Simultaneous speaking.)

MEMBER BROWN: I=ve looked for shutdowns, safe and subcritical. And I didn=t find safe shutdown defined. And if I=m wrong, that=s fine.

CHAIRMAN BLEY: I think there we just fall back on nuclear engineering, which has defined those terms.

MEMBER BROWN: That B-

CHAIRMAN BLEY: They mean the same thing here as they do anywhere else.

MR. SCHMIDT: That=s correct.

CHAIRMAN BLEY: Let=s not bring in the discussion from the other meeting B-

MEMBER BROWN: I=m just trying to focus on these words, which are not in my own mind need to have a definition. If we=re going to work on these new design criteria, we ought to make sure that type of a term is clearly understood as to what it means relative to criticality, coolability of the fuel, et cetera, somewhere so that people that are using these now to adapt to their non-light water reactors

understand what that means.

CHAIRMAN BLEY: Point made.

MEMBER BROWN: Okay.

MR. SCHMIDT: Just to offer, we could define safe shutdown consistent with that SECY paper and put it in if that helps.

MEMBER KIRCHNER: I think that would be valuable.

MEMBER SKILLMAN: Amen. I think that would be a very good B-

MEMBER BROWN: This is SECY-94-0 B-

MEMBER SKILLMAN: 84.

MR. SCHMIDT: 084, yes.

MEMBER SKILLMAN: Yes, I think that would really --

MEMBER BROWN: Let me go find that and see --

MEMBER SKILLMAN: -- really address what we are B-

MR. SCHMIDT: Yes, I mean, the staff=s intent was adequate cooling and subcritical.

MEMBER SKILLMAN: Yes, yes.

MR. SCHMIDT: In my mind, there=s no ambiguity. But I have no problem B-

MEMBER BROWN: Well, if that=s in the

SECY-94, it just, I guess my opinion would be B-

MR. SCHMIDT: Move it to here.

MEMBER BROWN: -- that we ought to have that, if we=re going to use those terminologies somewhere in this thing, we ought to have definitions of certain terminology that are used. And if the SECY paper says that, it would be good to incorporate that into these design criteria.

MEMBER SKILLMAN: Yes.

MR. SCHMIDT: I=m leaving it to these two. That was the mass intent of my B-

MEMBER SKILLMAN: Let me ask one question. In the course of years, the word hold-down has disappeared. But early on, those of us who were deeply involved understood there was shutdown and hold-down. And hold-down was the clamp that made sure a shutdown stayed shut down.

MR. SCHMIDT: Right.

MEMBER SKILLMAN: Is there any way you might weave hold-down into this? I believe it holds up 94-84 in a way that really eliminates any ambiguity as to what we=re talking about.

MR. SCHMIDT: I tried to address that explicitly by the word maintained. And you=ll see the difference, as we move from AOO to postulated

accident, that achieved and maintained softens for Item 3. And we=ll get into that when we get to Item number 3. I=m sure you=ll have a lot of questions.

MEMBER SKILLMAN: Okay. Thank you, Jeff.

MR. SCHMIDT: Yes.

MEMBER KIRCHNER: Jeff, on number 2 B-

MR. SCHMIDT: Yes, okay.

MEMBER KIRCHNER: -- I=m just reading the words again afresh and thinking, could you put independent and diverse up in the prologue, a minimum of two independent and diverse reactivity control systems, or means shall provide B-

MR. SCHMIDT: Yes, that=s how the way the current GDC is written. I=d have to think about that some more in case there=s unintended consequences associated with that.

MEMBER KIRCHNER: Yes.

MR. SCHMIDT: But it is consistent with the current GDC 26.

MEMBER KIRCHNER: Yes, and because 2, as I read it now afresh from the new guide, it says independent and diverse from others. What others?

MR. SCHMIDT: The others in 1 and 3. So that=s the B- it=s diverse from the other criteria in

this list. That=s what it meant by others.

MEMBER KIRCHNER: But usually one of the two in the preamble is going to do number 3 and probably --

MR. SCHMIDT: Then you have --

MEMBER KIRCHNER: -- number 1.

MR. SCHMIDT: You can have one system do multiple functions.

MEMBER KIRCHNER: Of course.

MR. SCHMIDT: Let=s say a boiler does a 1 and 3 with control rods alone. You're saying, I=m saying you have to have another one, which is kind of consistent with the way GDC 26 is right now, of controlling reactivity.

So, if you take a look at B-

MEMBER KIRCHNER: It=s almost, as I read it, it almost like implied a third system.

MR. SCHMIDT: No, no, the intent B-

MEMBER KIRCHNER: Okay.

MR. SCHMIDT: The intent is not to imply a third system.

MEMBER KIRCHNER: Okay. All right.

MR. SCHMIDT: If you can do everything with two B-

MEMBER KIRCHNER: If that=s the way you

read it, fine.

MR. SCHMIDT: -- then do everything with two. If you need four, you need four.

MEMBER KIRCHNER: All right.

MEMBER BROWN: Just to make sure I understand, when we, number 3, when we say, once we define safe shutdown so we know what that means, then when we say with appropriate margin for malfunctions, that=s intended to include something similar to one rod stuck or whatever, and whatever the new non-light water reactor looks like.

MR. SCHMIDT: That is correct.

MEMBER BROWN: And we don=t define explicitly what those are. It=s just more general terms. Okay.

MR. SCHMIDT: That is correct.

MEMBER BROWN: And don=t take my comments as being I disagree with trend. I think the new GDC 26 amalgamating 26 and 27, the previous approach kind of led to some ambiguity. And this, to me, had some clearer stuff with the exception of some of the nuances. So I understand what you=re saying now in 3. So thank you.

MEMBER SKILLMAN: Jeff, let me ask one more.

MR. SCHMIDT: Okay.

MEMBER SKILLMAN: The potential misinterpretation of others on the underlined in the first sentence of number 2, would you consider a means which is independent and diverse from 1 above and 3 below instead of others?

MR. SCHMIDT: Right, right.

MEMBER SKILLMAN: Thank you.

MR. SCHMIDT: Okay. I think that=s a good comment.

MEMBER SKILLMAN: Thank you.

MR. SCHMIDT: So Item 2 is actually in direct response to the ACRS= comment, which was on the previous slide. It=s where B- in an earlier version, I remove the planned, normal power change control. And it=s now reinserted back as Item number 2, just so everybody has a clear sense of B- that=s a direct response to the ACRS comment.

CHAIRMAN BLEY: I got that reading --

MR. SCHMIDT: Okay. All right. Item number 3 deals with the postulated accident. And right now, as this is written, it=s talking about safe shutdown following a postulated accident.

I=m going to defer 3 for a second, because when I was putting these slides together, I

realized I made kind of a mistake in 3 that I want to propose a new Item number 3.

And the issue with Item number 3 that I realized, and I never got any comments on, was I only discuss what=s following the postulated accident, the acceptance criteria, not the acceptance criteria during.

And it was a miss on my part. And I didn=t realize it until I put the slides together. So I=m going to propose a new Item number 3.

CHAIRMAN BLEY: I look forward to seeing that. But I=ll say, when I read it, to me following the accident meant from the incident occurs from thereafter B-

MR. SCHMIDT: No.

CHAIRMAN BLEY: -- which is during.

MR. SCHMIDT: No, it does B-

CHAIRMAN BLEY: So that isn=t what you meant.

MR. SCHMIDT: It is not what I B-

CHAIRMAN BLEY: That=s what I interpreted.

MR. SCHMIDT: Right. It is not. So I=m going to, after we go through 4, I=m going to go to a back-up slide with a new version of number 3.

CHAIRMAN BLEY: That sounds fine.

MR. SCHMIDT: So number 4 is really to try to address GDC 26, the last item of cold shutdown requirement. And here I got a lot of comments on the cold portion of shutdown.

A means for holding the reactor shutdown under conditions which allow for interventions such as fuel loading, inspection, and repair shall be provided.

MEMBER STETKAR: Jeff, I was just thinking. Your proposed change to number 3, currently operating pressurized water reactors would not satisfy your proposed change to number 3.

MR. SCHMIDT: As written here.

MEMBER STETKAR: No, during. Large steam line break, they go read critically --

MR. SCHMIDT: But the concept B-

MEMBER STETKAR: -- during the accident.

MR. SCHMIDT: That=s right. See B-

MEMBER STETKAR: They later go subcritical, later.

MR. SCHMIDT: And that=s the exact thing that we=re trying to parse out is following is the long-term equilibrium state. What=s missing is the short-term. So I agree with you.

CHAIRMAN BLEY: So we ought to wait for your slide, your back-up slide before we discuss.

MR. SCHMIDT: But I think that=s an important point, is that, you know, this Item 3 as written is the long-term kind of equilibrium state.

CHAIRMAN BLEY: Right, right.

MR. SCHMIDT: And I realized I never said B- so, if you look at Item number 1, it basically says, like it says basically protect the fission product barriers during the whole event.

That is missing from Item 3 for postulated accidents, so what=s your success criteria for the during phase, not the short-term phase where you=re actively mitigating I would say.

Is that clear what B-

(Simultaneous speaking.)

CHAIRMAN BLEY: Can we go to your slide before we continue the discussion?

MR. SCHMIDT: Yes.

CHAIRMAN BLEY: I think it will help.

MR. SCHMIDT: Okay. Let=s go to the back-up.

CHAIRMAN BLEY: Well, I hope it will help.

MR. SCHMIDT: Okay. So this is my new

proposed 3.

A means of inserting negative reactivity at a sufficient rate and amount to assure with appropriate margin for malfunctions that the capability to cool the core is maintained and a means of shutting down the reactor and maintaining at a minimum safe shutdown condition following a postulated accident.

So here=s your criteria for what I would call the short-term. And it=s consistent with the current GDC 27. It=s adequate cooling. And then in the long-term, you should be shutdown.

CHAIRMAN BLEY: The thing that bothers me here is just my reading. I mean, you had a problem before with the original in that long-term is not defined. We have a, I have a problem here in that following --

MR. SCHMIDT: What's the definition of --

CHAIRMAN BLEY: -- at what point following.

MR. SCHMIDT: Following, yes.

CHAIRMAN BLEY: You know, maybe after the transient of the accident or something like that.

MR. SCHMIDT: So I try to address that

in the rationale, because I agree.

CHAIRMAN BLEY: Yes, but will the rationale be there in the long run? Is it going to live with this document?

MR. SCHMIDT: Yes.

MEMBER BROWN: Yes, but will people look at it when they=re doing a design? I mean, the notes of how they got there, it=s difficult. In my own mind, they=re going to look at these and say that=s B-

MR. SCHMIDT: I=m hoping they go to the rationale.

CHAIRMAN BLEY: In the long-term would work better for me here than following.

MEMBER BROWN: Exactly.

MR. SCHMIDT: I would be perfectly fine with that. I think you then have the question of what is the long-term. But I=m not sure B-

MEMBER KIRCHNER: Can you, Jeff, without having too many words, couldn=t it be during and following the postulated?

MEMBER CORRADINI: No, because current light water reactors don=t sense that.

MEMBER KIRCHNER: But we=re not writing this for current. We=re writing it for advanced

reactors.

MR. SCHMIDT: But it's -- that=s true. But it=s within, the context is what are we currently kind of licensed to a situation for PWRs during main steam line break that has short-term reciprocality. The idea was not to impose additional requirements necessarily on non-light water reactors.

So I understand what you=re saying. But I think that=s B- I tried to keep the current construct but add clarity that in the long-term you should have like shutdown rods or some means of going subcritical at the end of the day.

MEMBER REMPE: But in the long-term really kind of B-

MEMBER KIRCHNER: But do you now move the position of achieving safe shutdown from your first draft, right?

MR. SCHMIDT: Yes, you=re right. So the original one had shutdown was the specific performance requirement. And I got numerous comments on that was effectively requiring additional regulations that=s not supported in the current GDC.

MEMBER BROWN: Why wouldn=t some words like subsequent to the initial transient and mitigating actions following a postulated accident?

I mean, that=s what you=re really talking about. The accident occurs. The transient get there. The mitigating actions are taken. And then you have to deal with the following, the stuff that follows on after that.

MR. SCHMIDT: I think, I mean, in my opinion B-

MEMBER BROWN: It=s a struggle B-

MR. SCHMIDT: -- this is what this says, and it=s kind of consistent with the current GDC 27 language. So I=m not trying to reinvent the language as much.

What I really was trying to answer in this -- it=s very consistent with the current language of GDC 27 other than I=m having the safe shutdown following the postulated accident B-

MEMBER KIRCHNER: But these again are for advanced reactors and their guidance. And they don=t apply to LWRs.

MR. SCHMIDT: Right.

MEMBER KIRCHNER: And for an advanced reactor, we expect better performance, right? Isn=t that -- there's some commission statement along those lines.

MR. SCHMIDT: I=m not sure that B-

MEMBER CORRADINI: I guess I=ve been quiet. So now I won=t be.

It strikes me that, as long as the core remains cool and there is no challenge to the fuel, that this is consistent with what we=ve got now. I=m not sure I need to be more safe than what we have now for current reactors. That=s what I thought Jeff was saying.

MR. SCHMIDT: That is what I=m saying by the capability to cool the core is maintained, which is language consistent with GDC 27 today. But that=s a philosophical B-

MEMBER CORRADINI: I understand.

MR. SCHMIDT: -- point of whether you want it to be shutdown is a safer configuration than what is currently in our GDCs and what has effectively been portered over to ARDC 26. What is spelled out is the shutdown requirement in the long-term.

CHAIRMAN BLEY: Just for Walt=s point, the thing you were looking for from the commission is on page 6 of the Reg Guide.

MEMBER KIRCHNER: It is?

CHAIRMAN BLEY: Yes, the core is in there.

MEMBER REMPE: So, in all this back and

forth, I thought I heard you say, oh, you ought to change that word to in the long-term. And I thought someone up there took a note saying, oh, yes, we could do that.

But I think if you bring in that new phrase without explaining it, you=re going to have a lot of questions. And so I=d like to add the caveat to making a word change.

CHAIRMAN BLEY: I think what they=ve done, as long as this stays in the long-term, having the rationale there works.

MR. SCHMIDT: The rationale tried to explain what following meant. And I don=t want to put everything in the ARDC.

CHAIRMAN BLEY: I think you did a great job in the rationales across the board. They=ve really helped me in reading through this.

MR. SCHMIDT: So I would propose, since I think the draft guide missed kind of the boat, I would propose that this be the third item. So our proposal is that this would go into the final Reg Guide.

MEMBER BROWN: I guess along with some definition of safe shutdown.

MR. SCHMIDT: I am not opposed to that.

But I=m going to leave it to these guys because they=re the controllers of the Reg Guide.

(Off mic comments.)

MR. SCHMIDT: Was there any question on 4, though, on the cold shutdown before we leave that?

MEMBER SKILLMAN: Jeff, one of the, a question about your choice of the word interventions. That=s a new term. And I don=t think there=s anything fundamentally inappropriate with it.

But it would seem to me that the jargon that we use in the industry might be, either you=re adding a word to our lexicon, or you would use a word which allowed for normal activities such as fuel loading and refueling, inspection and repair, unless you had a reason for interventions to make it substantially different from jargon that we=ve used historically. Nothing wrong with it. It just kind of jumps out as a brand new word.

MR. SCHMIDT: You know, the thought process was there=s an old Reg Guide, which I=m not remembering the number, that said, you know, one of the functions of getting to cold shutdown was to be able to, following a transient, following either an AOO or postulated accident, was to get down to cold to be able to inspect and repair. So I used the word

intervention kind of in that vein of the intent of that original Reg Guide.

CHAIRMAN BLEY: You have a reference to that somewhere in this document. I remember reading it.

MR. SCHMIDT: Yes, I do, I do. But that=s B- I=m not necessarily wed to interventions. But I B-

CHAIRMAN BLEY: Can I make a caution for you guys? We aren=t editing this for you on the fly. We=ve suggested, at least for me, things that come off the tops of our heads. Be careful as you consider those things that are comments in the throes of a meeting here.

MR. SCHMIDT: Right. But I guess my real statement was I don=t B- interventions was just to B-

MEMBER SKILLMAN: Or maybe it=s a good thing, because you=re the author. And I wasn=t trying to change your mind. It just seems we=ve got a lexicon that we=ve used for years. This was different. Maybe it=s appropriate to embed a new term.

MR. SCHMIDT: Okay.

MEMBER SKILLMAN: Up to you.

MR. SCHMIDT: Okay. Thank you.

(Off mic comments.)

MR. SCHMIDT: Yes, I think we've gone -- so I guess this is a lot we=ve talked about.

Basically, Item 1 is we talked about the specific words that were added. The original guide talked more, the original ARDC 26 in an earlier draft talked more about shutdown. And there was a lot of confusion. Is it only shutdown related? And the answer is no. It=s consistent with the current GDC 26 is you got to get a sufficient rate and amount to protect the SAFDLs or the primary coolant boundary.

And those are the fission product barriers we=re talking about is fuel and coolant barrier. And again safe shutdown was added. I think those are specific performance criteria.

CHAIRMAN BLEY: Well, I was looking over John=s shoulder here. He=s been rummaging through the regulations. And if you do define safe shutdown, you=ve got the one document you=ve cited, but also Part 50 has a definition, too.

MR. SCHMIDT: Yes, 50.2, you mean --

CHAIRMAN BLEY: Yes, be sure to look to at that.

MR. SCHMIDT: -- the SSEs --

CHAIRMAN BLEY: Yes.

MR. SCHMIDT: -- related? Yes, right, right.

And then Item 2, we've talked about a means, which is independent and diverse from the other ones in this list, shall be capable of controlling the rate of reactivity changes from planned, normal power changes.

Again, this was added for ACRS comments. And the purpose is to provide additional protection of fission product barriers and limit and challenges to the protective action. So we're trying to limit any protective actions that may be required by just doing a good job controlling reactivity changes.

Again, this is kind of what we have talked about. The word following was included to establish that safe shutdown should be achieved in the long-term equilibrium state, allows re-criticality in the short-term consistent with some licensed PWR postulated accident if sufficient heat removal capability exists to survive that.

MEMBER SKILLMAN: And, Jeff, are these the new words or the old? You're going to adapt these slightly for the new text?

MR. SCHMIDT: So the words for 3 changed. The intent of the bullets below does not change.

MEMBER SKILLMAN: Okay.

MR. SCHMIDT: It was never our intent to change those.

MEMBER SKILLMAN: Thank you.

MR. SCHMIDT: I just realized I had missed.

MEMBER SKILLMAN: When you wrote the bullets.

MR. SCHMIDT: When I wrote the bullets, I realized I didn't really address the during criteria.

MEMBER POWERS: When you use the word equilibrium state, what you, I think what you mean here is the quasi-equilibrium or long-term state --

MR. SCHMIDT: Right, right. That's right. So, you know, it's somewhat in the construct of expecting that future designs will be generally passive. And that's why I use the word equilibrium, right.

So, say if it cools down and it has a potential of becoming re-critical, there should be some system that might be active to stop that, right? So the equilibrium state was to try to denote maybe the passive nature of future plants.

MEMBER POWERS: Of course, the problem

you have is all the source trend people, equilibrium means something very different to us. And your equilibrium is not the same as our equilibrium. And we're still releasing fission products out of this thing.

MR. SCHMIDT: Right.

CHAIRMAN BLEY: Perhaps steady state, but we don't --

MEMBER POWERS: Well, the steady state or quasi-equilibrium cooled state is something to be considered. I don't question. I put this up to understand. And maybe in the, as you elaborated these paragraphs before, it becomes very clear that you're talking about a thermal equilibrium --

MR. SCHMIDT: Yes.

MEMBER POWERS: -- here. And you don't need to change things here, because there's a lot of words here that come from the skill of the art. And fair enough. That's perfectly acceptable, otherwise the criteria becomes so long and the definitions so abstruse that nobody can read it.

MR. SCHMIDT: Right.

MEMBER POWERS: But just remember that those of us that have to worry about 10 CFR Part 100 here are going to be still worried for 30 days.

MR. SCHMIDT: -- noted.

MEMBER SUNSERI: Well, I would suggest that maybe you don't even need to qualify the term long-term. Just leave it at long-term, because the rest of the ADRC defines the state.

(Simultaneous speaking.)

MR. SCHMIDT: Yes.

MEMBER POWERS: Well, there are a lot of people that worry about 10 CFR Part 100.

CHAIRMAN BLEY: Yes, that's true.

MEMBER POWERS: And they have to worry for 30 days.

MR. SCHMIDT: You know, the long-term equilibrium states in the rationale and there is -- you know, we try to find the right wording to address this condition. And I think this is the best we could come up with.

MEMBER POWERS: Fair enough. I mean, don't --

MR. SCHMIDT: Okay.

MEMBER POWERS: Just understand that, for instance, now I am still agonizing over how to describe fission product release from the Fukushima fuel.

MR. SCHMIDT: Right, right, right.

MEMBER POWERS: Okay.

MR. SCHMIDT: What's the equilibrium state?

MEMBER POWERS: Because it is occurring and it is causing headaches for those people that are trying to recover the reactors.

MR. SCHMIDT: I mean, in some sense, you know, these are reactivity --

MEMBER POWERS: Yes, it is.

MR. SCHMIDT: -- GDCs. And you have to put it in this first perspective. What's your equilibrium reactivity state? And obviously, multiple things affect reactivity.

MEMBER POWERS: I understand and hope it can contain just one --

MR. SCHMIDT: Go ahead, Jan.

CHAIRMAN BLEY: If we're ready to move on, we're going to take a short break. Do you have more?

MR. SCHMIDT: No, we're -- other than, if you don't have any questions on 4, I am done.

CHAIRMAN BLEY: Going, going. We will recess for 15 minutes until 10:55. We will also go until 12:30. Some of our members will have to leave for another session --

MEMBER POWERS: I will quickly point out that 212 boiling point of water is true only at sea level. Reactors built for IM would have to have much colder --

(Laughter.)

(Whereupon, the above-entitled matter went off the record at 10:40 a.m. and resumed at 10:56 a.m.)

CHAIRMAN BLEY: Okay, we are back in session. Jan, I'll turn it back over to you.

MS. MAZZA: Thank you. So next we're going to have a presentation on electric power systems, which is ARDC 17 and Bob Fitzpatrick is going to do a presentation on that. Bob?

MR. FITZPATRICK: Good morning; I'm Bob Fitzpatrick with the Electrical Engineering Branch in NRR. Next slide.

The ACRS comment that came out in the March of '17 letter was the staff should improve the clarity of ARDC 17 with respect to the term "vital functions." Even if electric power is not needed for operational equipment, reliable power is still needed for monitoring plant status, habitability, lighting and communications. And this was not the only good comment to come out of the ACRS, it didn't make the

letter, but also you said at the time in the meetings that we should expound upon what we meant by just systems as we get into this, and so we did that as well. And also note that basically your comments were pretty close to industry, so everyone was thinking we need more specificity and clarification but not necessarily more regulation, so.

If we can have the next slide.

What I've done here is the next slides are exactly what's in our draft, final version of the reg guide, and I've highlighted some of the words to point out what we've changed or what we've emphasized along the way. So this is Paragraph 1 of our ARDC 17, which by the way is exactly the same electrically as SFR 17 and MHTGR 17; we make no distinction electrically between any of the designs. So when we said "electric power systems," that was one of your first comments that we should beef that up a bit. And the one required actually came from industry, the public. We may or may not need electric power systems because these are advanced designs that are considered probably to be passive to at least some extent. So we put that in there to not just appease but to agree with and, just whatever. Anyway, we put it in there so it makes that distinction,

functioning of systems, structures and components and the safety function for each power system. A little more emphasis on more than one shall be to provide and then the two items that are provided there.

So we can move onto No. 2, Paragraph 2.

Now it goes the electric power systems shall be comprised of an on-site power system and an additional power system. The on-site power system shall have sufficient independence, redundancy and testability to perform its safety functions assuming a single failure. And an additional power system shall have sufficient independence and testability to perform its safety function. And we expound on this in the rationale.

And then we added a third paragraph which was not there before, and this was back to the importance of safety. If electric power is not needed for anticipated operational occurrences, accidents, the design shall demonstrate that powerful and important safety functions is provided. And we also expound on that in the rationale.

CHAIRMAN BLEY: This is kind of minor, but I noticed the words on your previous slide aren't identical to the words in the draft I'm reading. For example, "shall be comprised of, shall include."

MR. FITZPATRICK: Oh.

CHAIRMAN BLEY: Which is, that's not a big deal, but which is right? Did you make changes since you sent us the draft?

MR. FITZPATRICK: I may have grabbed the wrong version to put in here.

CHAIRMAN BLEY: Except for that, it looks pretty -- go ahead, but check on what you --

MR. FITZPATRICK: Yes, so we'll certainly check on it. I just don't know the answer to that. But we certainly didn't try to change the meaning in the process.

So going onto the rationale to support these three paragraphs is the next slide.

All right, so I'll go through it, but we really added for new things is at the bottom. The electric power systems are required to provide reliable power for SSC's during anticipated operational occurrences or postulated accident conditions when those SSC safety functions require electric power. So again, a distinction that may not, but if they do, this is what it is. The safety functions are established by the safety analyses -- yes, that's it, which includes mitigating the design base as accidents.

Where electric power is needed for anticipated operational occurrences or postulated accidents, the electric power systems shall be sufficient in capacity and capability to ensure that safety functions as well as important safety functions are maintained. The electric power systems provide redundancy and defense-in-depth since there would be a minimum of two power systems.

MEMBER STETKAR: Bob, why do you need to distinguish between safety functions and important to safety functions?

MR. FITZPATRICK: Well, in this case the safety functions of a perspective we put in here is that that would be something where you needed like motor power; a motor, a pump, something along the way. An importance to safety is those support system type functions that we talked about previously at previous meetings.

MEMBER STETKAR: I guess I don't really follow the distinction; either something is important to safety or it's not important to safety. And if it's important to safety, it ought to have power; and if it's not important to safety, you can talk about it. I don't distinguish between a mode of power or a power for an instrument that might be useful to an

operator. If it's important to safety, it's important to safety. I just don't get it.

MEMBER SKILLMAN: Yes, I'd like to agree with John; it seems like you could have a SSC that truly is a device that has to change physical status because it's powered and it is a safety component, but the exit lighting under fire conditions is also the safety function. And unless these words are clear to ensure that instrumentation, lighting and some of what we might consider minor functions are highly important. They can get left out, so I think there is basis for ensuring that this applies not only to powers SSC's but also to subordinate safety functions that are there for the unit.

MR. FITZPATRICK: Right. Well, we've added a paragraph and a rationale for that that's I think like two paragraphs down from this.

If we can have the next slide.

This slide, compared to GDC 17 more emphasis is placed here on requirement or reliability of the overall power supply scheme rather than fully prescribing how such reliability can be obtained. For example, reference to the off-site electric power systems was deleted to provide for those reactor designs that do not depend on off-site power or the

functioning SSC's important to safety or do not connect to a power grid, so we didn't make any changes. This is getting back down to into what we, on the next slide, No. 3, what we've been talking about here.

The on-site power system is envisioned as a fully class-winning power system. Any additional power system is left to the discretion of the designer as long as it leads to the performance criteria in Paragraph 1 and the design criteria of Paragraph 2. For example, an additional independent power source could be from the electrical grid, a diesel generator, a combustion gas turbine or some other alternative, again, at the discretion of the designer. So we tried to put that specificity in here as what it might be, but leaving it to the designer to come up exactly what it is going to be.

The next paragraph.

And the important to safety functions include post-accident monitoring, control room habitability, emergency lighting, radiation monitoring, communications, and/or any others that may be deemed appropriate for the given design. The electric power system for important to safety functions could be non-class 1E and would not be

required to have redundant power sources.

MEMBER STETKAR: Bob, have you looked at the rest of the NRC and what they mean by "important to safety?" This strikes me as being not consistent with the NRC's use of the term "important to safety" throughout its regulatory guidance, and in the context in particular of risk-informed regulation of how an applicant can use perhaps their own criteria to determine what is or is not important to safety, and that's a term. You've redefined that term specifically in this rationale differently from its use throughout the rest of the agency, so I'm curious why you did that?

MR. FITZPATRICK: We just try to make a distinction between, like I said, equipment that needs motive power.

MEMBER STETKAR: Equipment that needs motive power is equipment that needs motive power. That doesn't have anything to do with being important to safety or not important to safety.

MR. FITZPATRICK: Well --

MEMBER STETKAR: Important to safety is -- I'm not going to say it again because we're pressed for time here -- take a look at it, please, from my perspective, because --

MR. FITZPATRICK: We will take a look at that.

MEMBER STETKAR: -- it is a term that is used quite extensively throughout the agency. And indeed, we've had with the ACRS some discussions about what particular criteria might a particular applicant use to determine which particular equipment or functions is over the line, if you will, as being important to safety or under the line as being deemed not important to safety.

MS. RAY: This is Sheila Ray from the staff in NRR, Electrical Engineering New Reactor and License Renewal Branch. We tried to keep it a bit open when we included "important to safety functions" in the rationale. We said these are things that may include, but we did not have the intention of defining it. We said these are some examples but the design may have to consider other items that are important to safety.

CHAIRMAN BLEY: I think -- you were trying to respond, I think, to comments from various people in the past that said we need to have some way to monitor the plant after an accident, and that's what all of these are looking at. Elsewhere in the regulations, "important to safety," at least in the

places I'm aware of it, means the risk assessment showed that in fact they were contributors to risk. And I think John's right, this was confusing what everybody else means by "important to safety." And some other words here you're really going after monitoring, so something that will get you out of the woods. But that's what you're after and it'll avoid some confusion.

MEMBER STETKAR: This is a case, if you just -- again, it's a subcommittee meeting, you're hearing individual feedback, but if you can edit the rationale to just make sure that applicants, designers and reviewers recognize that they need to be cognizant of the ability of the operators to monitor plant performance. Without getting into this, is it motive, is it -- despite the fact that you might not need AC or DC power in terms of a motive capability, but just bring out this notion of retention of capability for operators to monitor plant status.

MR. GREEN: Yes, Brian Green, NRC staff. We've took this comment back after I believe it was a November meeting, a similar concern was brought up about monitoring and there were some changes made in ARDC 19 to help alleviate some of that. I don't

think it's planned in the discussion today, but a quick recap is that much of the words from GDC 19 about the operators having a control room where they can safety control the plant was maintained but the rationale was expanded to describe that the operators must be able to monitor in order to safely control the plant. So there was some additional rationale added to help clarify that concern.

CHAIRMAN BLEY: Okay, our comments here weren't about the concept. We agree with the concept; I think most of us agree with the concept, at least I do. But particular language.

MEMBER STETKAR: Jan?

CHAIRMAN BLEY: We can't hear you. You couldn't hear me either.

MS. MAZZA: I'm sorry. That concludes electric power systems, so now we're going to move onto containment and Imtiaz Madni is going to present on that.

MR. MADNI: Good morning; this is Imtiaz Madni from NRO and I'll be talking about the containment design criteria. So next slide.

This slide shows ACRS comments on the containment design criteria from the letter dated March 21st, 2017. ARDC 16, the functional

containment performance requirement is vague and needs to be defined. For example, the phrases "essentially leak-tight" or "low leakage" are not adequately defined. An examination for the possibility of reactor pressure boundary failure to induce the containment failure should be included explicitly. So here we have three comments in there; the first one is "essentially leak-tight" and that refers to the language in the ARDC 16. The next one is "low leakage" and that refers to the language in SFR-DC16. And then for the third one, except for MHTGR's, all other currently proposed advanced reactor designs are low pressure, so it's interpreted that the final sentence in the comment is in reference to MHTGR-DC16; however, we do address primary coolant boundary failure for SFR-DC16 as well in respect to this comment.

MEMBER KIRCHNER: You weren't here earlier, Imtiaz, when I made some comments about generic application of your requirements. You once again, I think, fall into a trap of assuming performance of one of these advanced designs and the whole family of accident sequences, but I can imagine not only HTGR operates at high pressure, so you have the possibility of a pipe break there. But with a

sodium-cooled reactor, should you have a sodium water reaction you're going to generate lots of energy, lots of pressure. Now, conventional containments for LWR's have, what should I describe it, resilience against some of the consequences that they will see in their accident scenarios. So why jump to an exception for the HTGR?

MR. MADNI: Well, the helium pressure boundary is very high pressure, not to the extent of LWR's, but it's high pressure. But if you look at the sodium-cooled reactor, for example, it's operating. And so it's only when something happens, let's say there's a boundary failure, so it's not a pressure boundary failure as the terminology, that the terminology will be it's a coolant boundary failure because pressure boundary implies that uses high pressure. But nonetheless, as I mentioned, that we do address the failure of this sodium-cooled reactor pressure boundary as well.

MEMBER KIRCHNER: I understand it's low pressure but the consequences of a failure in such a design, and should you encounter a steam generator rupture or something like that and you mix the coolant with the water, can result in a significant pressure pulse.

MR. MADNI: I will say really --

MEMBER KIRCHNER: Just like a hydrogen burn would give you a pressure pulse and LWR.

MR. MADNI: I was referring to the specific comment that was made by ACRS. An examination for the possibility of reactor pressure boundary failure, reactor pressure boundary failure, not intermediate, reactor pressure boundary. So the reactor boundary is actually atmospheric pressure, not high pressure. If you want to talk about intermediate system, that could be something else. And we will cover that also. But I'm just responding to the ACRS comment.

MEMBER KIRCHNER: Okay.

MR. SOFU: Tanju Sofu from Argonne National Lab. The steam generators are usually, almost always outside the containment, so steam generators, tube rupture would not result in any --

MEMBER KIRCHNER: We don't know that yet. Again, that's an a priori adaptation of the GDC's to the anticipated design and its performance.

PARTICIPANT: And it's unstated.

MEMBER KIRCHNER: And it's unstated, yes. Now if you stated that the water systems had to be outside containment, it would be a different

matter.

MR. MADNI: So we go to the next slide. This slide addresses the RDC content and the NRC rationale for adaptations to the GDC. And for the ARDC 16 content NRC plans to use the current GDC 16. You may recall that this is the first proposal which was for the functional containment for the RDC. By coming to the NRC rationale the first bullet says "For non-LWR technologies other than SFR's and HTGR's, designers may use the current GDC to develop applicable PDC's or potential design criteria." However, non-LWR designs could share common features with SFR's and HTGR's; hence designers may propose using SFR-DC or HTGR-DC as appropriate. And the use of MHTGR-DC16 will be subject to a policy decision by the commission, and this policy decision will be addressed in the Functional Containment Performance Criteria SECY paper that Jan mentioned earlier, and the reg guide may be modified in the future to incorporate the commission's position on this.

MEMBER KIRCHNER: May I interject here? Jan went through this; what's the time frame for that policy decision by the commissioners?

MS. MAZZA: So the draft paper has been written and gotten feedback from the public in some

of our stakeholder meetings. Bill Reckley will be here on the 22nd of February to talk to you all about it. And then the Commission had asked how quickly we needed a decision on that yesterday, so I'm not sure exactly what the time frame as far as what their decision will be.

MR. SEGALA: Yes, and I think we're shooting for this spring to issue the SECY paper.

MEMBER KIRCHNER: Okay, so we have -- it's still about GDC, so I'll go to the paper that we have on functional containment performance, and it does summarize your three different version of GDC 16 and starts with the advanced reactor containment criteria being the same. The SFR being somewhat different, but then the SFR has a second paragraph, which I actually like if you're going to go to functional performance; the containment leakage shall be restricted to be less than that needed to meet the acceptable on-site and off-site dose consequent limits as specified in 10CFR50.34 for postulated accidents. That gets at the weakness in what is an essentially leak-tight barrier; well, it's got to be tight enough to prevent that occurring. So it seemed to me -- and then you would do mechanistic source terms, you would look at your barriers whether it's

HGTR or a sodium reactor or some other undefined advanced reactor. But I'm struggling with your having three different takes on what is containment.

MR. MADNI: Which slide are you referring to?

MEMBER KIRCHNER: I'm not referring to your slides, actually; I'm just reading the GDC's, they were summarized in your functional containment document.

MR. MADNI: Oh, okay.

MS. MAZZA: So as far as the advanced reactor design criteria, we kept that the same as the general design criteria because the issue of functional containment seemed to be a modular high-temperature gas reactor issue in the policy papers, like 93-092 and 030 and 047.

MEMBER KIRCHNER: I don't think so.

MS. MAZZA: But --

MEMBER KIRCHNER: You're heading down the path of doing performance-based containment.

MS. MAZZA: Correct. But we didn't want to get --

MEMBER KIRCHNER: Risk-informed, et cetera. So if you're going in that direction, why don't you try and create a design criteria for

advanced reactors that envelopes and embraces where you're going?

MS. MAZZA: Correct.

MEMBER KIRCHNER: Otherwise.

MS. MAZZA: Yes, and we agree with that. And that's something that we may change in the reg guide once we get this policy decision because staff, we feel that we have --

MEMBER KIRCHNER: But why do you want the policy decision for just HTGR's?

MS. MAZZA: We want it for everything; it's going to be a technology inclusive policy decision. We didn't want to get ahead of the policy decision by putting that in here.

MEMBER KIRCHNER: You should then construct what would be a satisfactory for you, the regulators, not for the industry, for you, what is your idea of the approach that you're going to use for functional containment performance.

MS. MAZZA: That's what the SECY paper will do unless we get an answer from --

MEMBER CORRADINI: I'm just -- you guys seem to me either in violent agreement or missing each other. So what I thought Walt is getting at is that if you go through all this effort to develop

something that is, I'll call a new direction, it ought to be applicable to all. And your answer back is that it is. But as you state the criteria, the ARDC is the old GDC 16 and --

MEMBER KIRCHNER: The SFR is something else.

MEMBER CORRADINI: And the SFR is something else and the reactor --

MEMBER KIRCHNER: HGTR is something else. And you're using different terminology, so now I'm confused where you're going with this. Again, you want to be -- it's the first order, it's not always possible -- technology neutral. I think you've got an envelope a way of going, I'm just trying to help you along.

MEMBER CORRADINI: As a personal opinion.

MEMBER KIRCHNER: But I don't think you're helping -- as a personal opinion, as one member, but I don't think it behooves the agency to have three different definitions for containment, principle design criteria.

MEMBER BROWN: A side observation from looking at it; if you look at the ARDC which is the same as the existing one and you look at the MHTGR

which is kind of the same, you've got the second paragraph in here for the SF, the sodium fuel, which really provides kind of a definition of what leakage means, almost like I'd put that paragraph in each one of the containment criteria of 16. The other words just say you should control it in all three of them to meet "important to safety" or "not violated" or "not exceeded," where as that's kind of mushy, where as that second paragraph really provides the boundary conditions on what leakage is allowed. It's to meet radiation dose limits for both on-site and off-site.

MEMBER KIRCHNER: Right.

MEMBER BROWN: So I mean, if we're going to go change these or make it better, more informative, then you ought to put that in all of them.

MR. MADNI: But when you have these design criteria for MHTGR, we know it's functional containment. But we also know that there's still a policy position that's going to hold up any regulatory effort in that direction. And for ARDC which is technology inclusive you do not know what the new design is going to be, so if you --

MEMBER KIRCHNER: You don't know what the HTGR design is going to be?

MEMBER BROWN: But letting radiation dose exceed, why is that -- those words are as about technology neutral as you can get. It just says we shouldn't expose people either on-site or off-site.

MR. MADNI: But if the ARDC happens to be like SFR, then your definition will be according to the SFR-DC16. And if it were like MHTGR it would be that. But what if it comes up with something else where functional --

MEMBER BROWN: That's my point; don't these words mean the same anyway? Whether it's something else, you just still don't want to expose people either on-site or off-site? That is such --

MEMBER KIRCHNER: Basic.

MEMBER BROWN: -- basic definition, a principle of all designs that we could possibly ever get I would think. I'm not trying to be argumentative; I'm just trying -- well, maybe I am.

MR. MADNI: When we started on the process of developing the design criteria for advanced reactors, we started with the GDC and we developed these technology specific criteria and we also left one for design and technology inclusive criteria. So what I'm saying is that lets the designer, whoever he is, come up and develop his own

PDC's based on the GDC that just says we develop technology specific criteria for our reg guide. They can come up and develop their own PDC's from the GDC.

MEMBER KIRCHNER: You are actually, though -- you weren't here earlier -- my point, I'll repeat, is that you've fallen into the trap of actually almost writing the PDC's for the applicant. And it seems to be especially on the issue of containment, or confinement, whichever you're going to call it -- for example, let me read to you what you have for the MHTGR. A reactor functional containment consisting of multiple barriers, internal or external to the reactor and its cooling system -- well, I mean, that sounds like a LWR. I know where they're going, you know where they're going; they're going to keep the fuel or primary barrier and they're going to put the emphasis there because that's foundational to that design approach. But if you go back to your ARDC, I think from a policy standpoint, that and the second paragraph of SFR16 are probably something in that order would then pave the way for doing the functional containment that's based on performance and dose assessment, mechanistic source terms, et cetera, and propagating that and seeing if the health and safety of the public is protected.

But I don't think these -- now I'm being too repetitive -- these don't help, I don't think. They just interject multiple definitions of what containment is.

MR. MADNI: Well, if you look at SECY 9309, 092 or 093, then there you see the commission's view of the containment. And they felt that pressure retention is what we need. And so they approved, actually, this kind of approach for the definition of the containment for SFR.

MEMBER KIRCHNER: Well, if you say as you have in the ARDC and we can argue what "essentially leak-tight" is, but the idea of having a leak-tight barrier is a pressure holding barrier, whether it's confinement or containment as we know it with LWR's.

MR. MADNI: Well --

MEMBER KIRCHNER: I'm trying to push you down the road because you're going to have to, at some point, come back when you address that item under Strategy 5, and it's a double whammy because you want to go down the road -- you're going to shrink the EPZ's -- you can do it two ways, right; you can say precedent for the HTGR, Fort Saint Vrain had a 5-mile barrier. Or we're going to do a mechanistic source term, and that's going to be the basis for determining

EPC. And then that mechanistic source term is going to be dependent on a functional containment performance, right. So why not lay the groundwork to go there, because that's where I think we want to go?

MS. CUBBAGE: So this is Amy Cubbage from the staff. I don't think we have any disagreement with your concept that we need to move towards a more performance-based approach across the board for functional containment. We just don't want to get ahead of the commission. We have explicitly weighed in, in the past on gas reactor functional containment, they have not in other areas. So we just want to get that cleared up before we could go forward.

CHAIRMAN BLEY: But it almost seems that if you're going to keep Appendices B and C, which I'm sure you're going to, that at least in this area it would be prudent or wise to something very simple here while you await the commission's decision -- I assume you're already laying out how you think this would go given if the Commission goes in the direction of functional containment. But just use the GDC's and apply them for your design and live with that, instead of putting this placeholder in here that you

think you're going to wipe out and adds confusion at this time.

MR. MADNI: Which one of the placeholders?

MS. CUBBAGE: I think the --

MR. MADNI: Okay, so we can rethink that.

MS. CUBBAGE: No, wait a second. We appreciate your view on that and we understand; however, industry, Department of Energy, everybody wants us to proceed with this to provide a starting point for them to work towards. If they want to propose something that's more performance-based or in a different direction when they develop their site-specific replace, specific PDC's, they can do that, but they are looking for us to put this out in its current form.

MS. MAZZA: Also, I would like to point out that our general counsel did not, they did not specifically want us to change that ARDC until this policy decision was made. So did not want to get ahead of the policy.

CHAIRMAN BLEY: I was not suggesting that; I was suggesting you live with that instead of the others. But Walt's convincing me more and more that if you keep this approach, you somehow have

to, at least in crucial places like this, define what the design is. You've built this, too.

Go ahead.

MR. MADNI: Okay, so coming back to the -- let's see, this was ARDC --

PARTICIPANT: First part of the comment.

MR. MADNI: Okay. All right, so the ACRS letter noted that the phrase "essentially leak-tight" is not adequately defined. This phrase is used in the current GDC16 from MCFR Part 50 Appendix A and 10CFR Part 50 Appendix J, defines the testing requirements for the "essentially leak-tight" barrier. So the phrase has been taken directly from the Court of Federal Regulations. So that's an answer to the concern that the "essentially leak-tight" is not adequately defined.

Now we move to --

CHAIRMAN BLEY: I think -- I'm sorry, we just had a little discussion -- you suggested that the language is used in legal documents. A lot of undefined language is used in legal documents off and on purpose. Here we were saying from a technical point of view that phrase is not defined. And were you saying it is defined somewhere or were you just saying it's used in legal document?

MR. MADNI: It's defined somewhere. It's like at least .1 percent every 24 hours or something like that.

CHAIRMAN BLEY: Where is that defined?

MR. MADNI: I have to look that up.

CHAIRMAN BLEY: Okay. You ought to refer to it, anyway.

MEMBER KIRCHNER: That kind of falls under this area if you're going to provide some definitions, that'd probably work.

MR. MADNI: If you look at Appendix J it defines for multiple tests to verify the "essential leak-tightness" of the containment. So Appendix J is many pages.

MEMBER KIRCHNER: I don't think that's referred to in your rationale, is it?

MR. MADNI: Let's see --

MEMBER KIRCHNER: No, I don't -- take a look. Don't reply to that on the fly here. I don't think it's in the rationale, at least not in --

MR. MADNI: It should be, but we'll check it.

MEMBER KIRCHNER: Okay, thank you.

MR. MADNI: Okay, so if there are no questions on this slide, we'll go to the next one.

This slide shows the NRC language for SFR-DC16. A reactor containment consisting of a low leakage pressure retaining structure surrounding the reactor and its primary cooling system shall be provided to control the release of radioactivity to the environment and to ensure that the reactor containment design condition is important to safety and not exceeded for as long as postulated accidents and conditions require. So here the term "high strength" has been removed to allow flexibility in the criteria for new, innovative designs that may not require a high-strength containment. So that's the reason why high-strength was removed from the definition and the criteria.

MEMBER SKILLMAN: Will the staff be comfortable if an applicant comes in with a tin shed? Yes or no?

MR. MADNI: Well, it has to fulfill the requirements.

MEMBER SKILLMAN: So a tin shed is okay as long as it fulfills the requirements?

MR. MADNI: But it should be pressure retaining.

MEMBER SKILLMAN: Oh, really?

MR. MADNI: We just removed the high-

strength part to allow for innovative designs, but we've maintained the pressure retaining quality. If the tin shed can retain pressure -- but of course the tin shed will have to fulfill some other requirements as well. So I can't say about the tin shed. But I can tell you this, it has to be pressure retained.

MEMBER SKILLMAN: You know, T-I-N, S-H-E-D. Okay, I got it.

MEMBER KIRCHNER: So may I jump in here?

How did the high strength get in there to begin with?

MR. MADNI: It has been used commonly for SFR type containments.

MEMBER KIRCHNER: Well, that's the applicant's words, but your GDC doesn't contain anything about high strength for the advanced reactors.

MR. MADNI: For the advanced reactors?

MEMBER KIRCHNER: Your advanced reactor containment design criterion is the same as the GDC.

MR. MADNI: Yes, the advanced reactor is technology inclusive. We are talking about technology specific slide here. This is not technology inclusive, it's technology specific for SFR.

MEMBER KIRCHNER: So what I'm confused is how did high strength get in there to begin with, and then why was it struck?

MR. MADNI: Well, the reason high-strength got in is because in sodium fast reactors you have very strong temperature gradients across the vessel. For example, compared with 30 degree rise in temperature for the reactor core in LWR's, you have 150 degrees because sodium has such high conductivity and also very high temperatures because it has a very high boiling point. So you're talking about large temperature gradients; if you don't have a high-strength containment, you may have some problems.

MEMBER KIRCHNER: But you're proposing to delete it?

MR. MADNI: Whether we delete it just to allow for new design, that does not mean we cannot -- we will evaluate of course the applicant -- if there's some problems with strength, then we will bring that. By removing it, it doesn't mean we cannot use it in evaluating an applicant.

MEMBER RICCARDELLA: As a metallurgy structural engineer, the words high-strength is very ambiguous.

MEMBER KIRCHNER: I know; I agree. I don't think it should be there.

MEMBER MARCH-LEUBA: Well, I don't know. Have you considered the effect of missiles, like hurricane/tornado, because the containment typically contains all those.

MR. MADNI: Okay, these containments are generally underground.

MEMBER MARCH-LEUBA: Again, you're assuming missiles --

(Simultaneous speaking.)

MR. SEGALA: Those are other requirements, so if they need a structure to protect the safe-related equipment from missiles or flooding or whatever, they're going to have to have a structure that can meet those requirements.

MEMBER CORRADINI: Can you remind us where that is for those of us that are struggling to find your other requirements?

MS. MAZZA: No. 2, GDC-2.

MEMBER CORRADINI: We were in the teens. Thank you.

MR. MADNI: Okay, so the term "low leakage" as is mentioned in the SFR-DC content has been used in the SFR-DC content. It is addressed

here in the second bullet and on the next slide as well. So the phrase in the bullet that is tying in the low leakage with performance-based criterion related to leakage. So it says in the first bullet, "The reactor containment design conditions important to safety are not exceeded." This one refers to the performance-based criterion is restricting the release due to leakage.

Indicated in the second bullet which is "The containment leakage shall be restricted to be less than that needed to meet the acceptable on-site and off-site dose consequence limits as specified in CFR 50.34 for postulated accidents. So that's where the low leakage is defined in terms of a performance-based criteria related to leakage.

MEMBER KIRCHNER: Now again, I would go back and challenge you; I think your advanced reactor criterion for No. 16 is better than this one. You are once again presuming it's a pool-type system and everything will be contained. We just talked about it may be cited underground, but what if I want to go the LOOP? And we have loop systems, FFTF, so why are you saying it's surrounding the reactor and its primary coolant system?

MR. KINSEY: This is Jim Kinsey from the

Idaho National Lab. Just maybe a little bit of background on this topic because I know it's come up a couple of times through the discussion this morning, but back in 2013 when we developed the proposals in conjunction with industry and with input from DOE, we put out a call for design information and got it out 15 or so responses from industry in various level of detail. We used that information to form the content of the proposal that the NRC staff then reviewed. And to your point of this being trapped in or being clear on what those proposals were based on; because we had additional information available to us on those responses, we actually wrote some summary information in the proposal report that went to NRC that described the key aspects of both the SFR and the modular HTGR, so the criteria were built around that.

MEMBER KIRCHNER: Okay.

MR. KINSEY: So those -- that may have gotten lost in the chain of communication along the way here, but there are some summary bases for why the proposals were made as they were and why NRC has retained a lot of that structure along the way that's not reflected in the reg guide. So just to give you that background.

MEMBER KIRCHNER: Well, I'm still going to be a thorn into your blanket today. I did an independent review when I was at Los Alamos at the prison reactor; this was back in the 90's when you had the staff doing its -- what do you call it -- Preliminary Safety Evaluation Report. So we did an independent technical review of both. The HTGR modulates TGR and the prison concept. So when you write something like this, you're presuming that primarily the design you'd be reviewing, but when you do this --

MR. MADNI: What presumption is there?

MEMBER KIRCHNER: That it's probably a prison-like design.

MR. MADNI: No, not necessarily.

MEMBER KIRCHNER: Okay, not necessarily. When you -- some of those designs, and I don't think this is proprietary, have ECCS systems that are air-cooled.

MR. MADNI: We don't have ECCS system in SFR.

MEMBER KIRCHNER: The equivalent; you have the K heat removals.

MR. MADNI: There's no injection either.

MEMBER CORRADINI: I think he's talking

about a R-vac system, back in prison it was called a R-vac which is essentially the RCCS for the gas-cooled reactor.

MR. MADNI: Yes.

MEMBER KIRCHNER: Right, exactly. And that comes outside of containment.

CHAIRMAN BLEY: Well, I --

MEMBER KIRCHNER: Now we're getting into specific design and also it's kind of quasi -- not even qualitative review -- of a design approach. But I don't think you want to write this like this; I think you should fall back on the GDC.

CHAIRMAN BLEY: I'm going to interrupt this discussion here.

MEMBER KIRCHNER: That's my opinion.

CHAIRMAN BLEY: I think several people have made points on this and I think we got to go on because we don't have a whole lot of time.

MEMBER KIRCHNER: Okay.

MR. MADNI: Okay, so next slide.

This slide addresses the rationale for the use of the term "low leakage" and it defines the Commission approved the staff's recommendation to restrict the leakage of the containment to be less than that needed to meet the acceptable on-site and

off-site dose consequence limits in SECY 93-092. Therefore, the Commission agreed that the containment leakage for advanced reactors similar to a prison should not be required to meet the "essentially leak-tight" statement in GDC-16, and that's from the NUREG 3068 which is the PSCR from the NRC. So this has the commission's blessings and I don't think we are quite trapped here yet.

Okay, so this basically addresses the HTGR's comment related to the definition of low leakage. And also if you look at the first, if you look at Enclosure 1 Section A of SECY 93-092, it talks about satisfying 10 CFR Part 100 dose limits and Part 100 the first 10 CFR 50.34 which is the same as the previous slide.

Now, the other thing I wanted to mention was that public comments were generally supportive of this language, and hence there's a need to specify performance-based criterion and the expectation will be that the applicant will analyze what he assumes is taking place in the containment and provide a design with a low-leakage rate that meets Bullet 2 of SFR-DC16 which is the previous slide, which the staff will review for adequacy in meeting SFR-DC16. And currently SFR containment designs being considered

are varied; hence providing a prescriptive requirement such as that contained in Appendix J of 10CFR 50 would prove difficult. So that's the reasons for the performance-based, because you have radioactive for designs; we're not fixing ourselves to prison wall use, we are taking care of radioactive designs.

MEMBER KIRCHNER: Will you repeat what you said? You don't want to use an Appendix J like approach because it's not inclusive?

MR. MADNI: Yes, because that's prescriptive.

MEMBER KIRCHNER: No, I'm not referring to the details of it, but you don't want to use an Appendix J approach just because it's varied, which you seem to infer that you could not inspect it.

MR. MADNI: Well, here it is just that you want the applicant to move that from what is the objective of the low-leakage containment, which is to meet 10CFR Part 50.34 requirements and work backwards to see what should be the conditions in the containment. We cannot prescribe for them; we just give them performance-based criteria which they should satisfy.

CHAIRMAN BLEY: We've got about five or

six more slides in this area and I think we just got to go through them. We may bring up some areas again at the full committee meeting and you may see something like this later.

MR. MADNI: Okay, so the next slide, we move now to MHTGR-DC16. This slide shows the NRC language for MHTGR-DC16 content, "A Reactor functional containment consists of multiple barriers external to the reactor and its cooling system shall be provided to control the release of radioactivity to the environment and to ensure that the functional containment design condition reported as safety not exceeded as long as postulated accident condition required. So you might notice that this is something that is really for a variety of advanced reactor designs that you have this kind of performance-based criteria.

So the NRC language for MHTGR-DC16 as shown here and published in the reg guide is the same as the DOE proposal, many comments were received supporting this language. And here "functional containment design condition and important to safety" refers to the performance-based criterion restricting release of products to the environment. And that you can see in the next slide.

This slide shows the NRC rationale for adaptations to GDC. And the first bullet, the term "functional containment" is applicable to non-LWR's without a pressure retaining containment structure.

The second bullet; the functional containment can be defined as a barrier or set of values taken together that effectively limit the physical transport and the environment across a full range of AAO's, non-operating condition AAO's and accident conditions.

And the third bullet is the MHTGR functional containment safety design objectives, is to meet 10CFR 50.34 dose requirements at the plant, exclusionary boundary and off-site with margins.

So the objective is typically achieved without taking credit for the radio nuclei characteristics offered by the radioactive building which is the fifth barrier. So we just use the four barriers, three are in the fuel and then the high-pressure.

Next we continue with NRC rationale for adaptation to GDC. The NRC staff has brought the issue of functional containment to the Commission and the Commission has found it generally acceptable as indicated in -- sorry, I'm SECY 93-092 and SECY 03-

0047 -- in the SRM to SECY 03-0047 the Commission instructed the staff to develop performance requirements and criteria working closely with industry experts; for example, designers, et cetera, and other stakeholders regarding options in this area taking into account such features as core, fuel and cooling system design, and directed the staff to submit options and recommendations to the Commission for policy decision.

So the SECY paper that was to discuss functional containment and performance requirements mentioned by Jan earlier will be technology inclusive and will address topics and functions containment such as the use of SARRDL, and that's where it stands at present. The status is that we are still working on it and the reg guide may be modified to incorporate the Commission's position following the SECY paper. So once that is done, then the Commission rules on it, we can modify our reg guide accordingly.

The next few slides will address the last sentence of the ACRS comment on containment, which is an examination for the possibility of reactor pressure boundary failure to inducing containment failures should be included explicitly. So we start first with a new design criteria for MHTGR; since the

reactor building is not relied upon as part of the functional containment to meet the off-site dose requirements, the reactor building design base is not included in MHTGR-DC16 which is containment design. Instead, the requirements regarding its performance are addressed by a new MHTGR criterion 71 which deals with reactor building design basis and 72 provision for periodic reactor building inspection.

So this slide shows MHTGR-DC71 which is reactor building design basis. So the first bullet is the design of the reactor building shall be such that during postulated accidents it structurally protects the geometry for passive removal of residual heat from reactor core for the ultimate heat sink and provides a pathway for release of reactor helium from the building in the event of depressurization accidents.

And the second bullet; the reactor building functions are to protect and maintain passive cooling geometry -- this is part of the rationale -- and to provide a pathway for release of helium from building in case of line break in reactor helium pressure boundary. These new criterion show that these safety functions are provided. So here the ACRS comment which I will repeat, in examination

of the possibility of reactor pressure boundary failure to induce containment failure should be included explicitly. So for a brief explanation, brief explanation follows that radio nuclei retention is within the fuel during normal operation with relatively low inventory to the helium pressure boundary. In the helium pressure boundary break scenario, the reactor building is vented early when the helium circulating activity is low. The reactor building vent is closed laboring the transient when the particle fuel reaches maximum temperatures. Early venting ensures that the reactor building will not be damaged from helium pressure boundary rupture. So this is kind of an explanation in response to the ACRS comment.

MEMBER KIRCHNER: If this is the way you proceed, I'm just sitting here thinking, well I have a LWR, the fuel's pretty good, circulating inventory is low. So during a B-

(Simultaneous speaking.)

MR. MADNI: Well, here --

MEMBER POWERS: There are a lot of proposals to do that.

MEMBER KIRCHNER: I know.

MR. MADNI: Well, here the LWR you have

the fuel and the clad, and then you have the reactor vessel. And the containment is considered the ultimate barrier, everything goes into the containment. But here they're talking about a period of time when the radioactivity is confined within the fuel, the first three barriers within the fuel. And so --

MEMBER KIRCHNER: I know all this; I know they have to vent it because to build a pressure resilient building for the helium blow-down would be prohibitively expensive. I'm just remarking that your logic would suggest then LWR's would vent too, because you don't get to the fuel high clad temperature until well after the blow-down event. In fact, the blow-down cools the fuel.

MR. MADNI: You probably could do that. And that's probably one of the things that is under consideration; maybe there's division in there, you need filter venting or non-filter venting. There's a (Simultaneous speaking.)

MEMBER KIRCHNER: Is that the thinking, or you'll wait and see how the fuel qualification program goes and with operating experience backed it to do a filter vent?

MR. MADNI: I think you're not getting

into it because we are focused here on advanced reactors. I'm getting to the -- discussing lightwater reactors.

MEMBER KIRCHNER: I don't want to discuss LWR's; I want to discuss the gas-cooled reactor. Are you providing an advance for a filtered vent or just an uncontrolled vent?

MR. MADNI: Okay, that's a good question. Because imagine the high-pressure helium pressure boundary; if that fails, then you have a tremendous off coming out and if you try to filter it, the filters will blow out.

MEMBER KIRCHNER: I know that.

MR. MADNI: So therefore, this is a lever that opens and allows this puff to go out, and then closes.

MEMBER KIRCHNER: So what if you let the puff go through a pool of water?

MR. MADNI: But this doesn't have any radioactivity, let it go out.

MEMBER KIRCHNER: You don't know until you've got operating expenses in the reactor.

MR. MADNI: That's closely monitored. The helium LOOP is constantly monitored for plateout and for activity.

MEMBER KIRCHNER: So, what I think it begs though is an associated requirement about the quality of the fuel and the circulating inventory.

MR. MADNI: Yes, fuel qualification program has to be there.

MEMBER KIRCHNER: Okay, I've made my point. Thank you.

MR. MADNI: Okay, the next one is MHTGR 72; this slide addresses -- it reinforces the function of the reactor building. The reactor, the BC content is reactor building shall be designed to permit, Number 1, appropriate periodic inspection of all important structural areas in the depressurization pathway. And Number 2, an appropriate surveillance program.

And then the second bullet; this newly established criterion on periodic inspection and surveillance provides assurance that the reactor building will perform its safety functions of protecting and maintaining the configuration needed for passive cooling and providing a pathway for helium depressurization vents.

And that is the end of my presentation, so if you have any questions.

MS. MAZZA: So if you go to Slide No. 48,

going to Slide No. 48. So that concludes our presentations on the ACRS comments. For the public comments we received 127 comments from ten different stakeholders and of the 127 comments we agree with 64 of them and made appropriate changes to the reg guide. The most significant comments were discussed today and during the August and November meetings. Also, I note that Derek Widmayer had provided a summary of the significant comments to the ACRS, so you have that ahead of this meeting. But we --

CHAIRMAN BLEY: Was that all -- that was all the comments, is that right?

MS. MAZZA: Yes, so we'd be happy to talk about anything that we didn't discuss at this time.

CHAIRMAN BLEY: If I didn't miss something skimming through there, all of the public comments were either from some member of industry or from the DOE vote, is that right?

MS. MAZZA: There was also some other individuals that did comment.

CHAIRMAN BLEY: Were they in the document?

MS. MAZZA: Yes, they were in there.

CHAIRMAN BLEY: I somehow missed them as I read through it.

MS. MAZZA: If you look at the very first page of the, all the different comments.

CHAIRMAN BLEY: Oh, the different ones. Okay, thanks.

MS. MAZZA: So if there's any other specific comments that you all would like to discuss, we'd be glad to do that now.

MR. KINSEY: And a point of clarification -- this is Jim Kinsey -- the DOE comments included input from Oak Ridge and Idaho National Lab was for that team.

CHAIRMAN BLEY: Thanks.

MEMBER REMPE: So when I was looking through them, several individuals really were asking/begging for security-related information and the response from the staff was not helpful, and I'm wondering if that's going to continue?

MS. MAZZA: Well, for this reg guide that's a separate effort, so we're not going to address that in this reg guide but we are working on security issues.

MEMBER REMPE: Okay, and I guess I didn't see how quickly that would happen in the responses? It's underway and --?

MS. MAZZA: It's underway, and there's a

SECY paper that's on its way. Anyone else?

So next steps, we believe we addressed all the public comments --

MEMBER BROWN: Oh, I'm sorry --

MS. MAZZA: Oh.

MEMBER BROWN: Yes, I was looking for my comments. Trying to find which one it was now; I thought I just found it.

MEMBER REMPE: Well, while you're waiting, yes the response says it's on hold is what I saw in the response on security. So again, I think it's good to make sure those folks know.

MS. MAZZA: Okay, thank you.

MR. SEGALA: Well, there's two things as part of the development of the advanced reactor design criteria; we also developed security design considerations. Those were originally one effort and then they were split apart. We issued what we call draft security design considerations for public comment. We got a few comments, but we've put that on hold because we're working on this security, SECY paper on physical security. So we're going to go forward with the SECY paper, and then after that we get direction from the Commission; we're going to go back and look at whether we need to do anything with

the security design consideration document that we have. So that's kind of a piece that's on hold while we're -- it's all security but they were kind of two effort.

MEMBER REMPE: Thank you.

MEMBER BROWN: Thank you, I found it. This was back on ARDC 26 and there was a NEI comment which you all responded to, that they wanted to use anticipated operational occurrences and postulated accidents instead of design basis events in terms of that second criteria in 26. And you all agreed with that. And I guess I lost the bubble on why design basis events had disappeared from the criteria that we look at as opposed to just AOO's?

MS. MAZZA: So I don't think Jeff's still here but I believe it was a consistency issue that we didn't use design basis events elsewhere in the design criteria.

MEMBER BROWN: In the current design criteria?

MS. MAZZA: So in the reg guide and --

MEMBER BROWN: I got the flavor that in the original design, the GDC's, as they are presently stated, and I was trying to find that they actually refer to design basis events. I thought that was in

there, but I might have missed that.

MS. MAZZA: I don't think so. No, I don't --

CHAIRMAN BLEY: Do they have accidents?

MS. MAZZA: Throughout the design criteria it's normal ops, AOO's and postulated accidents, and that's -- really the comment was a consistency issue.

MEMBER BROWN: But it was relative to the second means of I guess shutting down, which implied, it said "The industry suggested reactors with inherent or passive shutdown capability fundamental to the physics of the system can justify that a second means would be superfluous." I guess I'm just trying to mush around why a second means of reactivity control would be superfluous? And you all imply -- you did not agree with that, but you did then agree with a second concern relative to using AOO's and postulated accidents instead of design basis, so --

CHAIRMAN BLEY: Maybe you could check with Jeff and address this at our full committee meeting.

MEMBER BROWN: Jeff is not here and I'm just making that comment during the last part of the meeting. I apologize for that.

MS. MAZZA: Okay. Any other questions on the public comments?

So our next steps, we believe we've addressed public comments satisfactory and we're looking forward to ACRS feedback. We think.

(Laughter.)

CHAIRMAN BLEY: I had a question. We're going to have a full committee meeting in about a month, almost exactly a month. If you -- are you going to get us any sort of revision, at least a week or a little bit before that full committee meeting on things you're actually making changes in?

MS. MAZZA: Okay.

CHAIRMAN BLEY: That would be helpful. And if it were received in a way we could see what was changed --

MS. MAZZA: Right. So right now you have a redline strikeout from the last meeting until now, so if I wipe that all out and --

CHAIRMAN BLEY: It's the new redline strikeout.

MS. MAZZA: Would that be acceptable?

CHAIRMAN BLEY: Yes, I think -- I don't know how many changes you're going to make, but I think two weeks would be nice, a week would be enough

for us to look through and see what the changes were, and then discuss them when you're there. Since almost the full committee was here at this meeting, I think you ought to focus at the next meeting on just a brief overview because it is a public meeting, full committee meeting, and then on the things that are new that we can consider before we go into our letter-writing session.

MS. MAZZA: Okay.

CHAIRMAN BLEY: I don't know how much time they're going to give us, probably two hours, so consider it two hours unless you hear from Derrick.

MS. MAZZA: Okay.

CHAIRMAN BLEY: Or if you think you don't need that much through Derrick. Any last comments on what we've just seen?

At this time I guess I'll get public comments and then go around the room.

We want to open the line for public comments, and while we wait for that; in the meeting room here if anyone wants to make a comment, please come to the microphone, identify yourself and make a comment.

Is there anyone on the phone line who would like to make a comment? If so, please identify

yourself and make your comment.

It's suspiciously quiet. Theron, do we have an open line?

It's really quiet. We're going to wait a minute for this one.

Hello? I think your line's open now. If there's anyone on the line who would like to make a comment, please identify yourself and make your comment.

I guess there's no one there. We can close the line again.

At this time I'd like to go around the room, but before I do that, if any members have a particular point you'd like to see addressed at the full committee meeting, you might raise them here. Your overall views are good. And if you have any particular comments you would like to have considered for inclusion in our letter, please email them to me or drop off a note.

Joy, can I start with you?

Oh, I see Vesna but I started with Joy because that's the way I wrote down all the names. And Vesna will get the distinct honor of being last.

MEMBER REMPE: Sorry. Sure. Okay, so first off I wanted to just emphasize because we didn't

during the meeting, that I did look through all of those comments and your responses back and I thought there were a lot of good comments and many times -- well, several times -- the commenters said, "Hey, appreciate this. You did a good job." And then also in response back to the comment about the design information, sometimes you pointed out, "Hey, you guys are assuming something about a design that there's other aspects of the other designs that might occur, so we need to be more general." And so I do think you are cognizant of some of the concerns that Walt raised.

On the other hand, though, I think that it would be good in the introductory remark where you talk about that you use the DOE document, that you do emphasize, as Walt continued to emphasize during the meeting, that you relied on this design information that Jim Kinsey said, because I think that would alleviate a lot of discussion we had today and say you realize that some of these other gas-filled reactors may not, or sodium reactors may not accommodate what was discussed in this DOE document. But so you'll need to justify this, but it just helps craft things 20 years from now we go back and do another one of these advanced reactor initiatives.

Things I'd really like to see addressed in the draft document, that we mentioned today, was the need to have a definition of terms and design information. But also then, I'd like to push back a little bit more on what Walt said about the need for SAFDL versus SARR -- whatever it is, the acronym is -- but I think with the pebble bed reactor that it might be easier to go with this other limit because of the fact that if it's a time temperature criterion, it might be more difficult for some designers to have to monitor what the pebble's doing. So I guess I'm on the other side of the fence on that one and I just thought I'd mention it.

Next.

CHAIRMAN BLEY: Go ahead, Charlie.

MEMBER BROWN: Okay, just two items and I don't know where they'll end up fitting in, whether they're -- I'd just like to firmly resolve the issue on ARDC 26 relative to the definition of safe shutdown which we discussed extensively and whether any change will be made. I would like to see that discussed again in the full committee if there was nothing going to be done, or what you're going to do if you are going to do something.

And the second one was the sodium fuel

reactor containment thing; on containment for all the, whether technology neutral or technology specific, it seems to me that containment principles are that you don't irradiate the public or the site people. And that second paragraph in the SFR-DC was a nice definition of let's take care, what's the bottom line high-level principle that's needed for containments, for any reactor that's designed. So I guess have it addressed in the full committee meeting and if you're not going to do anything with that, then hopefully get the committee to agree to say something in their letter.

MEMBER KIRCHNER: Thanks. Well --

CHAIRMAN BLEY: Well, I said enough.

(Laughter.)

So I thank the staff for all their effort, and I know there's a lot of effort in the back benches here. So I thank you all for your effort. And I didn't mean to just trash everything, but I actually did mean to say I think you've done a good job on the event, the actual design criteria. So thank you.

MEMBER MARCH-LUEBA: I want to agree with what Walt said during monthly meeting; during the meeting I kept turning my green light on to say

something and he would cover whatever I was going to say. So I would agree with the last one. Next, Pete.

CHAIRMAN BLEY: Oh, Pete's gone. That's right. John?

MEMBER STETKAR: Me too with Walt.

CHAIRMAN BLEY: Mike's gone. Dana?

MEMBER POWERS: No comment. Thank you, though, for the comment.

CHAIRMAN BLEY: Harold?

MEMBER RAY: Yes, I guess I'm meaning by what I'm going to say to underscore at least part of what Walt said, but I want to say it myself; I think we all should expect regulatory requirements to be as generic as possible. And where the requirements are based on a particular set of assumptions or understanding/concerning a design, they need to be explicit and specific, not simply implicit and based on our current understanding of what that technology will look like in the future.

CHAIRMAN BLEY: Thank you, Harold. Matt's gone. Ron?

MEMBER BALLINGER: I guess I'm on board with "Mr. I've Said Enough," but I'd like to --

CHAIRMAN BLEY: Not quite.

(Laughter.)

MEMBER BALLINGER: -- knock down, go down the original sources and the definitions and where they are and how they're defined are very obscure. I mean, believe it or not "essentially leak type" is not used in 10CFR 50 except to say "essentially leak type." Appendix J does not define -- it defines the leakage criteria, the limit, but it doesn't equate it to "essentially leak type." And as far as GDC-26 or whatever that one is, I've looked at every document that I could find except for the URD which is like 900 pages long, which I haven't read. But nowhere does it say -- does the word "sub-critical" appear in any of the documents, it's all thermally-based.

So I just, I'm not an expert in this area but it would seem to me that some clear definition, somebody said that, is appropriate for this. You've got an opportunity to do it, but goodness gracious if you need two PhD's and a law degree to go find out where to connect all the dots, it probably shouldn't be that way.

CHAIRMAN BLEY: Vesna?

MEMBER DIMITRIJEVIC: I thought maybe you would finish.

CHAIRMAN BLEY: No, we're not done, but

turn on your mic.

(Laughter.)

MEMBER DIMITRIJEVIC: Oh, okay. I mean, this is the beginning for me. I'm learning all of this. I mean, especially like the safety functions and the important for safety function obviously. It's very good to clean that. Also, I find that confusing for sanction if you define that as being shut down, it doesn't say we want to minimum reach this condition, and what is the maximum? I mean, that is all which we need, right, so why is it minimum condition?

So I mean, this time clean terminology would be helpful. Otherwise, that's all, I'm just learning.

CHAIRMAN BLEY: Okay, thanks Vesna. And our consultant, Steve. And you'll send me some content.

MR. SHULTZ: I sure will. Thank you.

Just for here, I would like to agree with Walt and with Harold. We started the discussion indicating that with regard to the GDC's as they were originally built, that they may apply to advanced reactors and that certainly what they say and what could be surmised. The process that was done there

with original GDC's was similar to what has been done here; that is the general design criteria have been proposed and then the industry has commented on how they would like them to be because they're specific designs that they want to move forward with. And I think this has been a good approach to take a couple of designs and demonstrate how the criteria would be derived for the particular features.

What concerns me is when we make statements about applicability of the design criteria for the examples that are provided in a general sense where we say if designs share common features with the designs that have been proposed and the Commission has provided discussion on exemption. Then those designers may apply what's been determined and decided. I think as Harold said, the designs are expected to be different as we move forward. And I think to suppose that decisions that were making with regard to regulatory requirements and their applicability have to be design specific, and that's not just the staff's responsibility, but it's the designer's responsibility to take the initiative to identify specifically what needs to be done to demonstrate that the design meets all the expected regulation, and for the staff then to review that in

course.

So that's what I would want to ensure happen. And I've become concerned when it seems to be suggested that the process is easy for a new design or a new designer or even something that's very similar. It really has to go through the rigors of evaluation, and that starts with the proposal of the applicant.

CHAIRMAN BLEY: Thank you. I would certainly like to thank the staff for very good discussions. I, too, think you've done a really good job bringing this to this point. I'm going to add to the chorus of agreeing with Walt; one way or another, and the way Joy suggested is probably the easiest way, just referring to the documents that you use to -- I call them concepts rather than specific designs because you don't -- you're not looking at specific designs, you're looking at conceptual designs. But referring to those so people know what those Appendix B and C design criteria were aimed at addressing, would be helpful now and invaluable in the future when people want to use them for things that aren't the same as you looked at, would be important.

We look forward to seeing you at the full

committee meeting and to getting whatever revisions you put together before then. If we can, as I said, if we can get them at least a week ahead in a mark-up, I think we can deal with that. And that will be helpful. And as soon as you can get the slides to us, that'll help too.

I think we've covered everything. Thanks so much to everyone who was here, and we are adjourned.

(Whereupon, the above-entitled matter went off the record at 12:21 p.m.)

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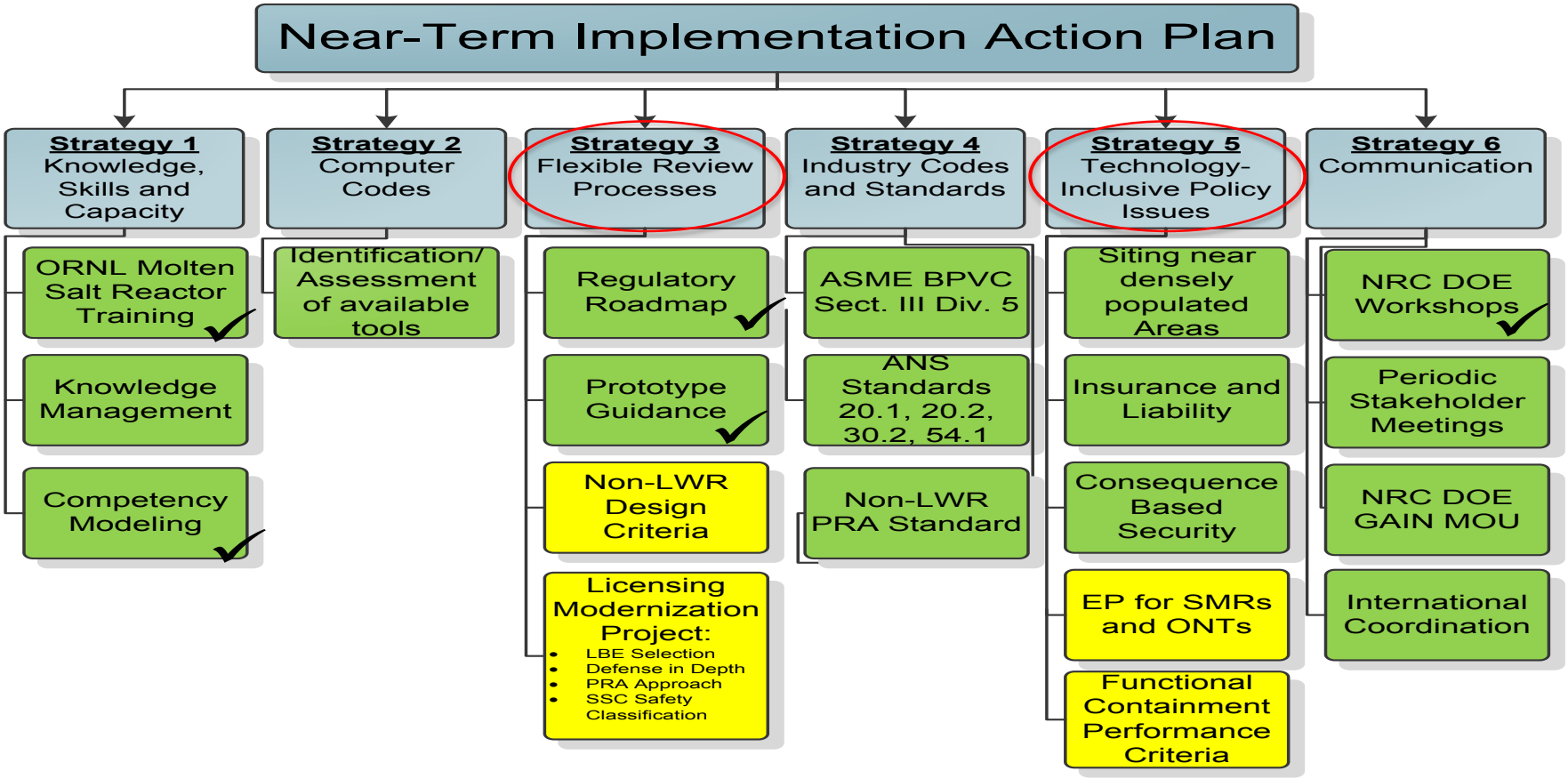
U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Non-Light Water Reactor Design Criteria
Introduction and Overview of ACRS Interactions

John Segala, Chief, Advanced Reactor and Policy Branch

February 7, 2018

Vision and Strategy for Advanced Reactors



2017 ACRS Interactions for Non-LWRs

- **Vision and Strategy Staff Report: Near-Term Implementation Action Plans**
  - 3/8/17 - Future Plant Designs Subcommittee
  - 3/9/17- Full Committee
  - 3/22/17 – ACRS Letter
- **Non-LWR Design Criteria – Draft Regulatory Guide 1330**
  - 2/22/17 - Future Plant Designs Subcommittee
  - 3/9/17- Full Committee
  - 3/22/17 - ACRS Letter

2018 ACRS Interactions for Non-LWRs

- **Non-LWR Design Criteria - Regulatory Guide 1.232**
  - 2/7/18 - Future Plant Designs Subcommittee
  - March 2018 - Full Committee
- **Functional Containment Performance SECY Paper**
  - 2/22/18 - Future Plant Designs Subcommittee
  - April 2018 - Full Committee
- **Licensing Modernization Project**
  - 6/19/2018 Future Plant Designs Subcommittee
  - 10/30/2018 Future Plant Designs Subcommittee
  - December 2018 – Full Committee
- **EP Rule**
  - 8/22/18 - Future Plant Designs Subcommittee
  - October 2018 - Full Committee

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Background and Summary of Non-LWR Design Criteria Discussed with ACRS in 2017

Jan Mazza, Project Manager
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February 7, 2018

Recent Progress on the Non-LWR Design Criteria RG

- **2-3-2017** DG -1330 Issued for 60 day public comment period
- **8-24-2017** Public meeting for staff interaction on public comments
- **11-1-2017** Additional Public Interaction on ARDC 17 and 26
- **1-15-2018** Draft Final RG 1.232 and Draft Public Comment Resolution Table issued for 2018 ACRS meetings
- **3-2018** Projected final RG issuance

Non-LWR Initiative Background

- In June 2013, DOE and NRC agreed to pursue a joint initiative to formulate guidance for developing principal design criteria (PDC) for non-light water reactor designers.
  - NRC Regulations 10 CFR Part 50 Appendix A establish General Design Criteria (GDC) specific to LWRs and "generally applicable" to non-LWRs.
  - Applicants must establish PDC based on the GDC (10 CFR Part 50.34(a)(3),10 CFR Part 52.47(a)(3), etc.).

Non-LWR Initiative Background cont.

- The general GDC in 10 CFR Part 50 Appendix A, establish the applicability of the GDC to both LWR and non-LWR designs:

  These General Design Criteria establish minimum requirements for the principal design criteria for water-cooled nuclear power plants similar in design and location to plants for which construction permits have been issued by the Commission. **The General Design Criteria are also considered to be generally applicable to other types of nuclear power units and are intended to provide guidance in establishing the principal design criteria for such other units.**

Non-LWR Initiative Background cont.

- 10 CFR Part 50, Appendix A indicates that the GDC are guidance for non-LWRs. As such, non-LWR applicants **would not need to request an exemption** from the GDC when proposing PDC, which are derived from the GDC.
- The RG provides additional guidance for reactor designers and applicants of non-LWR designs for developing PDC.

Non-LWR Initiative Background cont.

- It is the responsibility of the applicant to:
  - develop the PDC for its facility based on the design, using the GDC, non-LWR design criteria, or other design or technology specific criteria as needed.
  - consider public safety matters and fundamental concepts, such as defense in depth, in the design of their specific facility and for identifying and satisfying necessary safety requirements
  - provide the PDC for the design and supporting information that justifies how the design meets the PDC submitted, and how the PDC demonstrate adequate assurance of safety.
  - In instances where a GDC or non-LWR design criterion is not proposed, the designer/applicant must provide a basis and justify the omission from a safety perspective.

March 21, 2017 ACRS Letter

- Technology-Specific Licensing Basis Events
- Facilitate PRA in the design criteria
- Reactor Fuel Design Limits MHTGR-DC 10
- Containment ARDC, SFR-DC, & MHTGR-DC 16
- Electric Power Systems ARDC 17
- Reactivity Control Systems ARDC 26

Summary of Non-LWR Design Criteria Discussed during 2017 ACRS Meetings

Design Criteria No.	Title	Applicability	Extent of Modifications Since Last ACRS Meeting
10	Reactor Design	MHTGR-DC	No changes
16	Containment Design	ARDC, SFR-DC, MHTGR-DC	Minimal changes to SFR-DC 16. No changes to ARDC, or MHTGR-DC
17	Electric Power Systems	ARDC (SFR-DC & MHTGR-DC are same as ARDC)	Major changes to design criteria and rationale due to ACRS and public comments.
26	Reactivity Control	ARDC, SFR-DC, MHTGR-DC	Major Changes to both design criteria and rationale due to ACRS and public comments.

Summary of Non-LWR Design Criteria Discussed during 2017 ACRS Meetings cont.

Design Criteria No.	Title	Applicability	Extent of Modifications Since Last ACRS Meeting
34 & 35	Residual Heat Removal and Emergency Core Cooling System	ARDC 34, SFR-DC 34, MHTGR-DC 34, and ARDC 35	No changes to 34. Minor change to ARDC 35 due to public comments.
70-79	SFR specific criteria	SFR-DC 70-79	Minor changes and clarifications to address public comments.
70-72	MHTGR specific criteria	MHTGR-DC 70-72	No changes.

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Interface Between Vision and Strategy Activities 3 and 5

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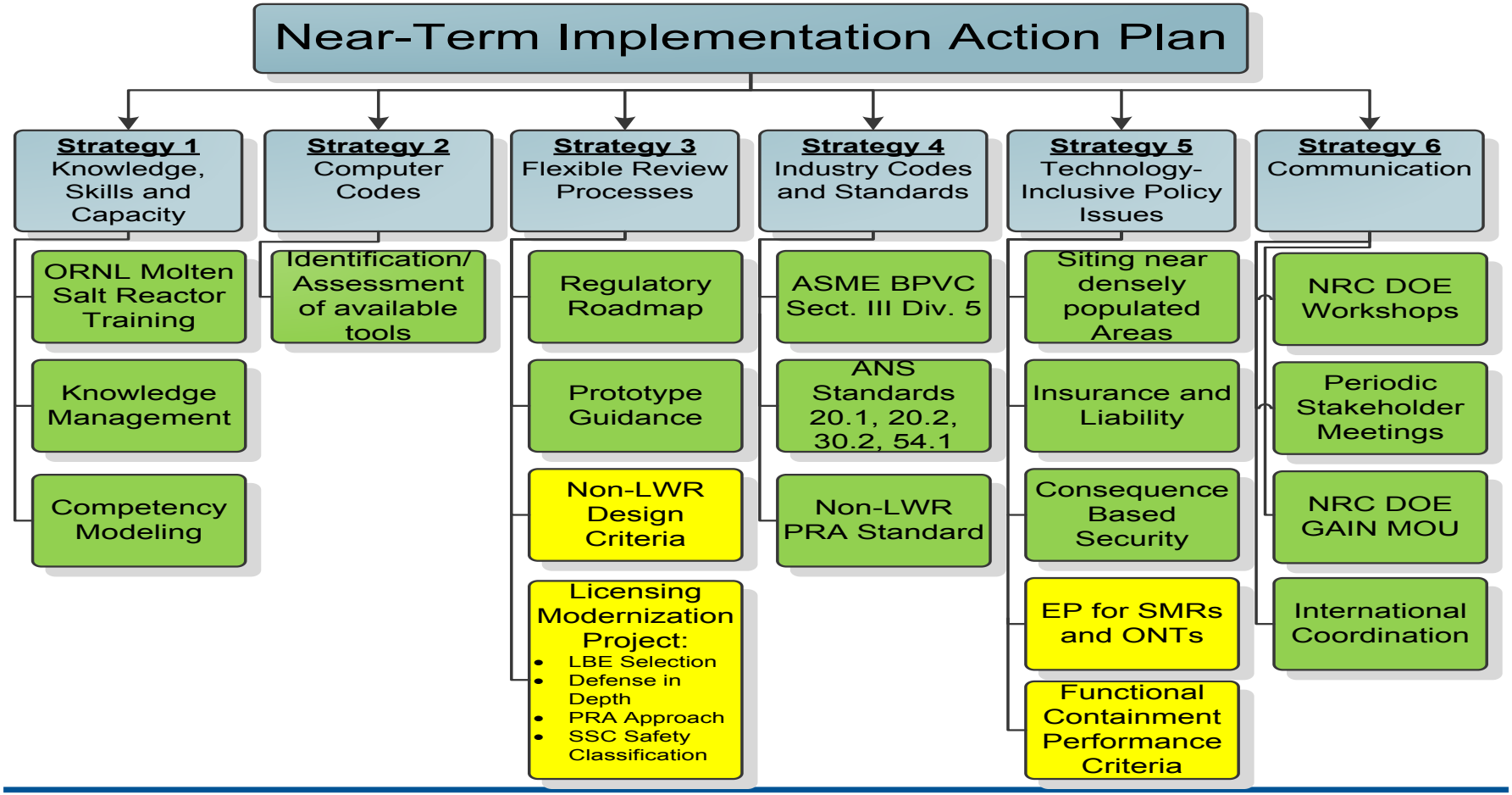
February 7, 2018

Vision and Strategy for Advanced Reactors



ACRS COMMENT - Technology Specific Licensing Basis Events

"Strategy 3, Contributing Activity 3.2, which develops approaches to licensing bases and will determine licensing bases for non-LWR technologies, is particularly important to implement early on. Identification of technology-specific licensing basis events need to be developed to ensure that the associated design criteria are complete."

ACRS COMMENT – Facilitate PRA

"… it would be useful to ensure that the language of the ARDCs facilitate, or at least does not preclude, the use of probabilistic risk assessment, especially in the areas where graded compliance is suggested."

ACRS COMMENT – MHTGR Fuel Design Limits

"MHTGR Design Criterion 10, as presently written, is cryptic. The phrase, 'specified acceptable system radionuclide release design limit' (SARRDL), needs to be clearly defined. Replacing the GDC specific acceptable fuel design limit (SAFDL) concept with the proposed SARRDL concept in the ARDCs is acceptable. However, during design, reactor designers will need to develop their own design-specific limits in order to characterize and evaluate their reactor design. The new SARRDL concept requires additional analysis that the staff will have to review and approve. Later, during operation, licensees will monitor both circulating activity and plate-out activity to ensure acceptable fuel performance, i.e., as evidence that the SARRDLs are being met."

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Containment – ARDC 16, SFR-DC 16, and MHTGR-DC 16

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February 7, 2018

ACRS COMMENT - Containment

"ARDC 16, the functional containment performance requirement, is vague and needs to be defined. For example, the phrases 'essentially leak tight' or 'low leakage' are not adequately defined. An examination for the possibility of reactor pressure boundary failure to induce containment failure should be included explicitly."

ARDC 16 Containment Design

ARDC Content: Same as GDC 16

NRC Rationale for Adaptations to GDC:

- For non-LWR technologies other than SFRs and MHTGRs, designers may use current GDC to develop applicable principal design criteria.
- However, non-LWR designs could share common features with SFRs and MHTGRs. Hence designers may propose using SFR-DC 16 or MHTGR-DC 16 as appropriate.
- Use of MHTGR-DC 16 will be subject to a policy decision by the Commission.

ARDC 16 Containment Design

First Part of ACRS Comment: "ARDC 16, the functional containment performance requirement, is vague and needs to be defined. For example, the phrases 'essentially leak tight' or 'low leakage' are not adequately defined. "

NRC Staff Response:

- The phrase 'essentially leak tight' is used in current GDC 16.
- Appendix J defines the testing requirements for the "essentially leak tight" barrier.

SFR-DC 16 Containment Design

SFR-DC Content:

- A reactor containment consisting of a ~~high-strength,~~ low-leakage, pressure-retaining structure surrounding the reactor and its primary cooling system shall be provided to control the release of radioactivity to the environment and to ensure that the reactor containment design conditions important to safety are not exceeded for as long as postulated accident conditions require.

- The containment leakage shall be restricted to be less than that needed to meet the acceptable onsite and offsite dose consequence limits, as specified in 10 CFR 50.34 for postulated accidents.

SFR-DC 16 Containment Design cont.

NRC Rationale for Adaptations to GDC:

- The Commission approved the staff's recommendation to restrict the leakage of the containment to be less than that needed to meet the acceptable onsite and offsite dose consequence limits in SECY 93-092, "Issues Pertaining to the Advanced (PRISM, MHTGR, and PIUS) and CANDU Designs and their Relationship to Current Regulatory Requirements."

- Therefore, the Commission agreed that the containment leakage for advanced reactors, similar to and including PRISM, should not be required to meet the "essentially leak tight" statement in GDC 16. Reference NUREG-1368, "Pre-application Safety Evaluation Report for the PRISM Liquid-Metal Reactor."

MHTGR-DC 16 Containment Design

MHTGR-DC Content:

- A reactor functional containment, consisting of multiple barriers internal and/or external to the reactor and its cooling system, shall be provided to control the release of radioactivity to the environment and to ensure that the functional containment design conditions important to safety are not exceeded for as long as postulated accident conditions require.

MHTGR-DC 16 Containment Design cont.

NRC Rationale for Adaptations to GDC:

- The term “functional containment” is applicable to non-LWRs without a pressure retaining containment structure.
- A functional containment can be defined as “a barrier, or set of barriers taken together, that effectively limit the physical transport and release of radionuclides to the environment across a full range of normal operating conditions, AOOs, and accident conditions.”
- The MHTGR functional containment safety design objective is to meet 10 CFR 50.34 (52.79) dose requirements at the plant’s exclusion area boundary (EAB) with margins.

MHTGR-DC 16 Containment Design cont.

NRC Rationale for Adaptations to GDC:

- The NRC staff has brought the issue of functional containment to the Commission, and the Commission has found it generally acceptable, as indicated in SRM to SECY 93-092 and SECY 03-0047, "Policy Issues Related to Non-Light Water Reactor Designs."
- In the SRM to SECY 03-0047, the Commission instructed the staff to "…develop performance requirements and criteria working closely with industry experts (e.g., designers, EPRI, etc.) and other stakeholders regarding options in this area, taking into account such features as core, fuel, and cooling systems design," and directed the staff to submit options and recommendations to the Commission for a policy decision.

ACRS COMMENT - Containment

Second Part of ACRS Comment

"…An examination for the possibility of reactor pressure boundary failure to induce containment failure should be included explicitly."

MHTGR-DC 71 Reactor Building Design Basis

MHTGR-DC Content:

- The design of reactor building shall be such that, during postulated accidents, it structurally protects geometry for passive removal of residual heat from reactor core to ultimate heat sink and provides a pathway for release of reactor helium from the building in the event of depressurization accidents.

NRC Rationale for Adaptations to GDC:

- The reactor building functions are to protect and maintain passive cooling geometry and to provide a pathway for release of helium from building in case of a line break in reactor helium pressure boundary. This new criterion ensures that these safety functions are provided.
- It is noted that the reactor building is not relied upon to meet the offsite dose requirements of 10 CFR 50.34 (10 CFR 52.79).

MHTGR-DC 72 Provisions for Periodic Reactor Building Inspection

MHTGR-DC Content:

- The reactor building shall be designed to permit (1) appropriate periodic inspection of all important structural areas and the depressurization pathway, and (2) an appropriate surveillance program.

NRC Rationale for Adaptations to GDC:

- This newly established criterion on periodic inspection and surveillance provides assurance that the reactor building will perform its safety functions of protecting and maintaining the configuration needed for passive cooling and providing a discharge pathway for helium depressurization events.

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Electric Power Systems – ARDC 17

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February 7, 2018

ACRS COMMENT - Electric Power Systems

"The staff should improve the clarity of ARDC 17 with respect to the term 'vital functions.' Even if electric power is not needed for operational equipment, reliable power is still needed for monitoring plant status, habitability, lighting, and communications."

Draft Final ARDC 17 (1)

- **Electric power systems** shall be provided **when required** to permit functioning of structures, systems, and components. The safety function for **each power system** shall be to provide sufficient capacity and capability to ensure that (1) that the design limits for the fission product barriers are not exceeded as a result of anticipated operational occurrences and (2) safety functions that rely on electric power are maintained in the event of postulated accidents.

(Bold for discussion purposes)

Draft Final ARDC 17 (2)

- The electric power systems shall be comprised of an onsite power system and **an additional power system**. The onsite electric power system shall have sufficient independence, redundancy, and testability to perform its safety functions, assuming a single failure. **An additional power system shall have sufficient independence and testability to perform its safety function.**

(Bold for discussion purposes)

Draft Final ARDC 17 (3)

- If electric power is not needed for anticipated operational occurrences or postulated accidents, **the design shall demonstrate that power for important to safety functions is provided**.

(Bold for discussion purposes)

Draft Final Rationale (1)

- The electric power systems are required to provide reliable power for SSCs during anticipated operational occurrences or postulated accident conditions when those SSCs' safety functions require electric power. The safety functions are established by the safety analyses (i.e. design basis accidents). **Where electric power is needed for anticipated operational occurrences or postulated accidents, the electric power systems shall be sufficient in capacity and capability to ensure that safety functions as well as important to safety functions are maintained. The electric power systems provide redundancy and defense-in-depth since there would be a minimum of two power systems**.

(Bold for discussion purposes)

Draft Final Rationale (2)

- Compared to GDC 17, more emphasis is placed herein on requiring reliability of the overall power supply scheme rather than fully prescribing how such reliability can be attained. For example, reference to offsite electric power systems was deleted to provide for those reactor designs that do not depend on offsite power for the functioning of SSCs important to safety or do not connect to a power grid.

Draft Final Rationale (3)

- **The onsite power system is envisioned as a fully Class 1E power system and the additional power system is left to the discretion of the designer as long as it meets the performance criteria in paragraph one and the design criteria of paragraph two. For example, the additional independent power source could be from the electrical grid, a diesel generator, a combustion gas turbine or some other alternative, again, at the discretion of the designer**.

(Bold for discussion purposes)

Draft Final Rationale (4)

- **Important to safety functions include post-accident monitoring, control room habitability, emergency lighting, radiation monitoring, communications and/or any others that may be deemed appropriate for the given design. The electric power system for important to safety functions could be non-Class 1E and would not be required to have redundant power sources**.

(Bold for discussion purposes)

Conclusion

The staff has added specificity to ARDC-17 (SFR-17 and MHTGR-17) in response to prior suggestions by the ACRS.

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Reactivity Control Systems – ARDC 26

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February 7, 2018

ACRS COMMENT - Reactivity Control Systems

"ARDC 26 eliminated the GDC 26 requirement for controlling the rate of reactivity changes resulting from planned, normal power changes. For harder spectrum reactors, particularly for liquid fuel systems, control of the rate of reactivity insertion can be very important and should be retained."

ARDC 26

- As previously discussed, GDCs 26 and 27 have been combined into ARDC 26 and deal with reactivity control under AOO and postulated accidents.
- In part, ARDC 26 was rewritten as the term “reliably controlling reactivity changes” in GDCs 26 and GDC 27 was ambiguous.
  - Revised ARDC 26 provides explicit performance criteria on rate and amount of negative reactivity insertion.
- ARDC 26 was significantly revised based on ACRS and public comments of the draft guide.

Draft Final ARDC 26

A minimum of two reactivity control systems or means shall provide:

1) A means of inserting negative reactivity at a sufficient rate and amount to assure, with appropriate margin for malfunctions, that the design limits for the fission product barriers are not exceeded and safe shutdown is achieved and maintained during normal operation, including anticipated operational occurrences.

2) A means which is independent and diverse from the other(s), shall be capable of controlling the rate of reactivity changes resulting from planned, normal power changes to assure that the design limits for the fission product barriers are not exceeded.

3) A means of shutting down the reactor and maintaining, at a minimum, a safe shutdown following a postulated accident, with appropriate margin for malfunctions, shall be provided.

4) A means for holding the reactor shutdown under conditions which allow for interventions such as fuel loading, inspection and repair shall be provided.

ARDC 26 AOO Mitigation Criteria

1. A means of inserting negative reactivity at a sufficient rate and amount to assure, with appropriate margin for malfunctions, that the design limits for the fission product barriers are not exceeded and safe shutdown is achieved and maintained during normal operation, including anticipated operational occurrences.
   - Modified to address comments that draft guide ARDC 26 only focused on shutdown and did not address the rate of reactivity insertion
   - Establishes the performance criteria that safe shutdown is achieved and maintained during and following an AOO
2. A means which is independent and diverse from the other(s), shall be capable of controlling the rate of reactivity changes resulting from planned, normal power changes to assure that the design limits for the fission product barriers are not exceeded.
   - Added to address ACRS concern about controlling reactivity changes during normal plant operation which is independent and diverse from the means in ARDC 26 criterion (1)
   - The purpose is to provide additional protection of the fission product barriers and limit challenges to protective actions

ARDC 26 Postulated Accident Criteria

3) A means of shutting down the reactor and maintaining, at a minimum, a safe shutdown condition following a postulated accident, with appropriate margin for malfunctions, shall be provided.

   - The word “following” was included to establish that the shutdown should be achieved in the long term, equilibrium state
   - Allows re-criticality in the short term consistent with some licensed PWR postulated accidents if sufficient heat removal capability exists

ARDC 26 “Cold” Shutdown

4) A means for holding the reactor shutdown under conditions which allow for interventions such as fuel loading, inspection and repair shall be provided.
   - ARDC criterion 4 replaces the last sentence in GDC 26 which states, “one of the systems shall be capable of holding the reactor core subcritical under cold conditions.”
   - Received public comments that cold implies below 212 ^{o}F and is very design dependent (e.g., SFR)
   - SECY 94-084 and Regulatory Guide 1.xx state the desire to achieve cold shutdown is driven by inspection and testing concerns, therefore the criterion 4) was modified to eliminate the word “cold” and reflect the primary performance criteria

Public Comment Summary

- NRC received 127 comments from 10 stakeholders
- Of the 127 comments, staff agreed with 64 of them and made the appropriate changes to the RG.
- The most significant comments were in the areas discussed today and during the August 24 and November 2 public meetings.

Next Steps

- NRC Staff believes that we have addressed all of the public comments satisfactorily.
- Looking forward to ACRS feedback.

Acronyms

ACRS	Advisory Committee for Reactor Safeguards
ARDC	Advanced Reactor Design Criteria
AOO	Anticipated Operational Occurrence
CFR	Code of Federal Regulations
DiD	Defense in Depth
DOE	U.S. Department of Energy
DC	Design Criteria
EPRI	Electric Power Research Institute
EP	Emergency Planning
EAB	Exclusion Area Boundary
GDC	General Design Criteria
LBE	Licensing Basis Event
LWR	Light Water Reactor
MHTGR	Modular High Temperature Gas Reactor
ONT	Other Nuclear Technologies
PDC	Principal Design Criteria
PRA	Probabilistic Risk Assessment
PRISM	Power Reactor Innovative Small Modular
RG	Regulatory Guide
SMR	Small Modular Reactor
SFR	Sodium-Cooled Fast Reactor
SAFDL	Specified Acceptable Fuel Design Limit
SARRDL	Specified Acceptable System Radionuclide Release Design Limit
SRM	Staff Requirements Memorandum
SSC	Structures, Systems, and Components

Back-Up Slides

MHTGR-DC 70 Reactor Vessel and Reactor System Structural Design Basis

mHTGR-DC Content:

- The design of the reactor vessel and reactor system shall be such that their integrity is maintained during postulated accidents (1) to ensure the geometry for passive removal of residual heat from the reactor core to the ultimate heat sink and (2) to permit sufficient insertion of the neutron absorbers to provide for reactor shutdown.

NRC Rationale for Adaptations to GDC:

- New MHTGR design-specific GDC are necessary to ensure that the reactor vessel and reactor system (including the fuel, reflector, control rods, core barrel, and structural supports) integrity is preserved for passive heat removal and for the insertion of neutron absorbers.

Revised ARDC 26 Postulated Accident Criteria

3) A means of inserting negative reactivity at a sufficient rate and amount to assure, with appropriate margin for malfunctions, that the capability to cool the core is maintained and a means of shutting down the reactor and maintaining, at a minimum, a safe shutdown condition following a postulated accident