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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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652nd MEETING

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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OPEN SESSION

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THURSDAY

APRIL 5, 2018

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ROCKVILLE, MARYLAND

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The Advisory Committee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B1, 11545 Rockville Pike, at 1:30 p.m., Michael Corradini, Chairman, presiding.

COMMITTEE MEMBERS:

MICHAEL L. CORRADINI, Chairman

RONALD G. BALLINGER, Member

DENNIS C. BLEY, Member

CHARLES H. BROWN, JR., Member

MARGARET SZE-TAI Y. CHU, Member

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PETER RICCARDELLA, Member
JOHN W. STETKAR, Member
MATTHEW W. SUNSERI, Member

DESIGNATED FEDERAL OFFICIAL:
GIRIJA SHUKLA

ALSO PRESENT:
CLINT ASHLEY, NRO
AMY CUBBAGE, NRO
DON HABIB, NRO
ZACHARY HARPER, Westinghouse
WILLIAM RECKLEY, NRO
SHAYAN SINHA, Westinghouse
BOYCE TRAVIS, NRO

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P-R-O-C-E-E-D-I-N-G-S

(1:30 p.m.)

CHAIRMAN CORRADINI: Okay. Why don't we get started. So our first topic of the afternoon is review of the draft SECY paper on functional containment performance criteria for non-light water reactor designs. And our illustrious speaker is Bill Reckley. Bill? Well, he's all yours. Oh, I'm sorry. Excuse me. I apologize. I first should turn it over to the Chairman of the Subcommittee, Dr. Bley.

MEMBER BLEY: Thank you, Mr. Chairman.

CHAIRMAN CORRADINI: I apologize. I'm sorry.

MEMBER BLEY: Well, that's okay. Well, he'll lead us through this, I apologize. We're going to hear more, and, Bill, I guess you have a part on here where you're going to tell us about any changes that have been submitted since the last time we talked with you. I think almost all the members who were here at the subcommittee are here now.

So we look forward to hearing what you have to say, and okay.

MR. RECKLEY: Thank you. As Dr. Bley mentioned, what the staff will be looking for out of the day is a letter on the SECY. We did provide a redline strikeout that was --

MEMBER POWERS: For the letter?

(Laughter.)

MEMBER BLEY: No, sir. They didn't give us a draft letter.

(Laughter.)

MR. RECKLEY: It's funny that you mention that because among the things we have talked about, the staff would offer up to write your letters.

(Laughter.)

MR. RECKLEY: If you were willing to start with the letter the staff wanted, we would -- we would offer to draft it for you, so --

MEMBER POWERS: And why -- and what deterred you on this? Obviously --

MR. RECKLEY: No, I'm saying that as a joke.

MEMBER POWERS: -- a very perspicacious undertaking.

MR. RECKLEY: We did provide a redline strikeout version, but there weren't very many changes to the -- to the draft SECY that we had talked about during the subcommittee meeting.

I'll go a little faster today than we did during the subcommittee, so some of this I'll just largely skip over. I will -- I will touch on background, and then we'll get into the structure of the paper and a couple of the key topics like the relationship to Reg Guide 1.232 on advanced reactor design criteria.

I will mention that was actually issued on Tuesday, so it's finalized and released. It ties in closely with the efforts we currently have underway with the licensing modernization project, and we are on ACRS Subcommittee schedules, at least tentatively, for June and October, and hopefully maybe a full committee meeting in December on the guidance that is being developed there. And, again, I'll touch on the relationship to that.

This gets a little complicated because we're trying to develop a licensing framework, if you will, and so we're bringing pieces to you today on -- on functional containment performance criteria, but we'll explain how it fits into the longer term effort. But we just thought it was necessary to try to resolve this long-standing issue, so that we could free up, if you -- if you will.

As we go through this, the more uncertainty there is in terms of our degrees of freedom to work within, the harder it is or easier it is to work out a framework. If -- if anyone is going to tell us this is fixed, you cannot -- this is a parameter or this is a regulatory area that's fixed, you can't propose any revisions, then we have to develop the whole framework around that.

So as I'll get into later, what we're largely looking to do here is make sure that functional containment is in play, along with everything else associated with advanced reactor designs.

MEMBER BLEY: Bill, you set up the question for me there. As I read the second enclosure and look for performance criteria, it seems that what you're really doing is asking the Commission to continue what they told you to do some years ago and develop those criteria. I don't see any real criteria set up already.

MR. RECKLEY: There won't. And as I'll talk about -- and even actually on the next bullet, we tried to -- to make a couple changes to the language to emphasize that this paper is laying out a methodology.

MEMBER BLEY: Okay.

MR. RECKLEY: Doesn't lay out criteria in terms of a leak rate or some other physical parameter.

It lays out a methodology, and so I'll touch on that some more.

One of the reasons that we think that's as far as we can go in order to support the developers at this time is on the background slide, the one down in the -- in the corner that was included in the status paper, SECY-18-0011, but it just lays out the number of different technologies and sizes of reactors that are in play.

And we're striving to come up with one framework that can address any of these non-light water reactors, ranging from potentially less than a megawatt micro-reactor or mini-reactor, whatever terminology one wants to use, up to more full-scale hundreds of megawatt plants, and ranging in technologies from liquid metal to gas-cooled to molten salt or -- or the fluoride high-temperature reactors.

So all of those, we're trying to come up with a methodology or approach that will work for any of those designs, the technology-inclusive approach. So that's the landscape slide that we used in the SECY paper to show all the different designs and sizes and technologies in play.

The other thing in terms of background is -- and we have come and talked to the ACRS in the past about our vision and strategies for addressing non-light water reactors, and our implementation action plans and the various strategies in play, and then, again, I'll mention that all of that is summarized in a relatively recent Commission paper, SECY-18-0011, Advanced Reactor Program Status.

So the rest of this presentation will talk about one area, which is an issue that was resolved, was identified in terms of functional containment. And then, as I mentioned, everything in highlight there is in play on this particular issue, the policy issues under strategy 5, and the licensing framework under -- under strategy 3, in our implementation action plans.

So just quickly on the format or layout of the paper, the paper is a summary of the two enclosures, and the two enclosures are, one, a background, and then number two, the paper that describes the approach or methodology for any particular non-light water reactor design to define for themselves the performance criteria for a functional containment.

So in terms of Enclosure 1, which I'm not going to talk a lot about here because it was -- it just basically provides background, the key documents are the terminology "functional containment" and issue was brought before the Commission in the -- in the paper SECY-93-092, one of the earlier papers on issues for advanced reactor designs following the development of the advanced reactor policy statement and the receipt of some preliminary designs, such as SAFR and PRISM and the MHTGR in the late '80s and early '90s.

That paper basically had the Commission agree that a functional containment was -- could be thought of as in lieu of a pressure-retaining containment like is used for light water reactors. The staff came back to revisit that in SECY-0347. And the Commission said it was a little premature at that time, given the state of the development of the -- of the reactors, to make a final decision, but asked the staff to come back with performance criteria.

We come back -- there is about a decade gap. As we go through these periods of interest and waxing and waning of advanced reactor programs, we come back in the -- in the 2000s, under the NGNP, Next Generation Nuclear Plant. And, again, functional containment is one of the key licensing issues for that project.

The staff, even at that time, comes and presents to the ACRS and sends a letter to DOE summarizing where we are. Again, emphasizing, we think, functional containment as a concept is okay, and -- but not fully resolving what the performance criteria would be for -- for the functional containment.

We revisit most recently again in Reg Guide 1.232 the advanced reactor design criteria. Again, the staff had several meetings with ACRS on that topic, and we -- and we did issue that on Tuesday.

That reg guide reflects within the high temperature reactor -- high temperature gas reactor technology, the MHTGR design criteria, basically the concept of functional containment and the performance criteria that was laid out for NGNP. For the generic or non-technology-specific advanced reactor design criteria, we basically stuck, as you are aware, with the existing general design criteria.

But there is terminology within the reg guide that says another technology like molten salts may want to look at the design criteria established either for fast reactors, or in this case the MHTGRs for functional containment concepts. And the reg guide points out that there is a remaining policy issue which this paper is intended to -- to resolve.

But just, again, going kind of through the format of the enclosure, it simply starts out why we're addressing this at this time within the paper. It addresses strategy 3, the regulatory framework for non-light water reactors; and strategy 5, the identification and resolution of technology-inclusive policy issues.

I'll just leave it there. I think we talked about that last time. But that's -- what we're trying to do within -- within the framework and within strategies 3 and 5, as well as all of the strategies, to be honest, but we're probably a little further along in strategies 3 and 5 to say how we're trying to develop an integrated approach to support the developers or designers of these non-light water reactors.

That community is -- is a very diverse community in terms of it ranges from very established long-standing companies that have designed, built reactors, gone through licensing processes, and so forth.

It also includes some much smaller companies trying to take maybe a more entrepreneurial approach to this. They're relatively small. They're trying to fund it through a combination of private capital and, where possible, maybe some support, technical or financial, from the Department of Energy.

But a little different in terms of what they're asking the NRC to do is to interact earlier in the process. So even in the conceptual or preliminary design processes, to interact with the NRC to -- to make sure they're on the right track because the complaint has historically been that regulatory uncertainty is resolved at the eleventh hour, but the financial investment by the eleventh hour has already been substantial.

And so the general complaint was to try to reduce the regulatory uncertainty kind of in a line going down as the cost escalated. And so that -- that really did call for us to take this more integrated approach.

We tried -- we have tried to represent that using this bowtie diagram where you map out under this approach the threats as identified on the -- on the left, the plant -- and these are just the traditional segregation of events, plant, internal events, external events, and then malicious acts.

And any of those can lead to the plant damage state or could potentially lead to a plant damage state where you start to get the migration of radionuclides or fission products from the core or, in the case of a molten salt, at least out of the configuration they are intended to be in.

So in terms of the light water community, this -- this fits very well. The top-level event is core damage, and -- and you have a whole bunch of measures that are taken to prevent it, and you have defined severe accident design features, emergency planning, siting restrictions, a number of things on the mitigation or recovery side of the bowtie diagram. So --

MEMBER POWERS: You say the concern is core damage.

MR. RECKLEY: The methodology allows you to define whatever top-level event you really want to concern yourself with. I would say traditionally in light water reactors we have defined the top-level event in most of the things we do as significant core damage -- core melt.

MEMBER POWERS: I mean, it seems to me that that's -- that's the faux pas in looking at these unusual reactors. It seems to me that you really end up having to say it's radionuclide releases, and then you come to a debate, is it radionuclide releases from boundary 1 or boundary 2 or outside the exclusion area? That's where the debate is.

For instance, we have molten salt reactors that really don't have a defined core. And you have various overly optimistic individuals in the gas reactor community that says, "Our core doesn't get damaged."

I mean, don't you want to just automatically say, "We're going to quit doing this core damage thing" and start saying, "It's radionuclide release," and we will debate which boundary we -- we draw the line at, because I don't know what it -- you know, I don't know where it is, but, I mean, I -- I would think that that's -- that's almost required in this context.

MR. RECKLEY: And you can do it. And I'll be honest, the first time I -- the first time I drew the bowtie my top-level event was radiological release as opposed to core damage or some rough equivalent, which I came up with the language of unplanned migration of fission products because, again, that's not core damage or core melt per se. It's just a loss of control of the radioactive material within its normal state or configuration.

The reason I ultimately changed it was to better -- actually to better align it with traditional approaches and, for example, the IAEA five levels. If you say radiological release, you're almost by -- your top-level event is already at level 4 or 5.

And traditionally in the IAEA language, mitigation is the things you take like a core spreader or a core catcher or other severe accident design feature is usually a mitigation measure on the right-hand side of this diagram, on the mitigation side.

So I was trying to align it. You could draw it exactly as you're describing it. I mean, the methodology lets you define whatever top-level event. I was trying to align it with more in line with the light water reactor and IAEA standard five levels in which you would have more than just emergency planning as a mitigation measure.

You would have -- are you going to do something other than emergency planning, like a severe accident design feature on the light water reactor side.

MEMBER MARCH-LEUBA: Focusing on what we're doing today, which is reviewing the functional containment --

MR. RECKLEY: Right.

MEMBER MARCH-LEUBA: -- the function of the containment is to prevent radioactive release even in the core.

MR. RECKLEY: Right.

MEMBER MARCH-LEUBA: So if you remove that function, then you don't need a containment. So if you are willing to limit yourself to I will never melt the core --

MR. RECKLEY: And one of the reasons I actually kind of -- I like the bowtie diagram is, if you look, it considers not only the damage state but the extent of the hazard.

So when you get, for example, to a very small reactor or potentially as a fuel form where a loss of the normal safety functions, like cooling, does not lead to radioactive materials going airborne or in some other releasable form, then your top-level event really doesn't have much consequence, and you wouldn't need all of the mitigation measures on the other side.

I compare it to if you have, either because of its size or a technology, that a power-producing device that were treated as the reactor, is as safe as a radiography machine in terms of it's a threat. I mean, there's radioactive material there. It's not as if you can ignore it, but it doesn't require things to keep it safe, other than shielding.

If you had a reactor that was as safe as that, then you wouldn't need all of those things. You'd need shielding, but you wouldn't need all of these emergency functions.

And this -- this -- I don't want to overstate the usefulness of the representation, but it lets you take into account the hazard in terms of the source term, the amount of radioactive material you are dealing with.

But, again, to Dr. Powers' point, it's -- this is a way to draw it. I wouldn't say it's the only way to draw it, but it does -- it does let you define those actions or barriers or controls, whatever structures, systems, and components that you're putting into the design to keep the radioactive material in place, and those things that you might add if you lose control of it, assuming that the loss of control puts it in a form that might be releasable. So --

MEMBER MARCH-LEUBA: This is a little bit of semantics. Whether you call the containment a blue prevention, it prevents the radionuclides from leaving, or you call it a mitigation after it melts the core is the same thing.

MR. RECKLEY: I don't disagree with you.

It just -- it's an accounting measure. It doesn't result in any difference in terms of --

MEMBER MARCH-LEUBA: And also there will --

MR. RECKLEY: So, but what it allow us to do, going back to the integrated activities, is what we were trying to make sure -- and this is more applicable perhaps to some of the early developers or less experienced developers, to make sure they were thinking about the total -- the total picture.

That two -- and this is the way light water has actually evolved, and that was because we were learning and imposing additional restrictions as we went along. But to make sure we incorporate all of those lessons learned, all of those activities into the initial design.

And one example is if I'm -- an easy example on the structural side is if I'm going to have a wall that is providing my wind protection, tornado or hurricane protection, I don't want to go way into the design and then decide later on now I'm going to do my aircraft impact assessment and find out the wall is not thick enough.

I want to take an integrated look at my design as I'm going through the process and say, "What am I going to credit for external events? What am I going to credit for security? What am I going to credit for aircraft impact?" And come up with the best design. And from a designer standpoint, the more you can take credit for the same thing for multiple -- for multiple external hazards or internal events, the better in terms of the simplicity of the design.

So that's just laying out the backdrop. And then, on the consequence side, also look at it for all the regulatory decisions that we need to make, not only health effects but also the societal and environmental decisions that we need to -- to make during the review.

So I mentioned how this plays into the ARDC. You just had a recent meeting on this, but this -- this slide defines for design criteria 16 for the modular high-temperature gas reactor, MHTGR, and you can see that the term "functional containment" is included and defined, and the definition is there.

It can be a barrier or set of barriers taken together that limitly effect -- or effectively limit the physical release of radionuclides for all of the event categories. And we're going to get to that in the next slide or two.

MEMBER MARCH-LEUBA: I don't have any

problem with your definition of functional containment or the use of a functional containment. As long as it functions and it retains radioactivity, it's a good -- it's a good containment.

But, however, I have a problem with the previous paragraph. In the write-up, you say that to accommodate defense-in-depth will require multiple barriers. I would have liked to say that there are multiple independent barriers, be specific about it, because if the failure of barrier 1 automatically fails barrier 2, you will have multiple barriers.

MR. RECKLEY: Right.

MEMBER MARCH-LEUBA: So we need to be more specific in saying that when we -- when we say multiple barriers, we mean multiple independent barriers.

MR. RECKLEY: Okay.

MEMBER MARCH-LEUBA: Definitely I would like to call them diverse also, but I won't push it that hard.

MEMBER POWERS: I'll echo here, and say it should be multiple independent barriers of increasing conservatism.

MEMBER MARCH-LEUBA: That's the way it used to be. It doesn't need to be that. I mean, you have a very good one at the beginning. I don't see the increasing concern about this and being a requirement. Multiple independent, I think it is.

MEMBER BLEY: Independent under what condition?

MEMBER MARCH-LEUBA: That's the --

MEMBER BLEY: See, we thought we had independent barriers, and then we had PWR-1 and we found out the same thing that broke the core broke the containment.

MEMBER MARCH-LEUBA: Yeah.

MEMBER BLEY: And we said, "Gee, they're not so independent." And any set of barriers will be not independent under some external insult if it's big enough. So, you know, we dream of independence, but we don't get it ever.

MEMBER MARCH-LEUBA: Yeah. But we should at least try.

MEMBER BLEY: We can try, but when we say it must be independent, it never is.

MEMBER MARCH-LEUBA: You put a call related to it.

MEMBER STETKAR: No. Because when you say "independent," they are truly independent. That's the problem -- that's the dichotomy that you run into, that you will find people who say unless there is precisely a zero percent joint probability of their failure, they are not independent.

MEMBER MARCH-LEUBA: So because they have 10 to the minus 6 probability --

MEMBER BLEY: No.

MEMBER MARCH-LEUBA: -- they won't be independent, we give up?

MEMBER BLEY: No. But --

MEMBER STETKAR: You characterize it --

MEMBER BLEY: -- you get yourself in a box when you say they must be independent and you can't do it. So as independent as possible, independent under --

MEMBER STETKAR: Not linked functionally. Something like that, such that a single --

MEMBER BLEY: And that's really where I think --

MEMBER STETKAR: -- failure of a single function --

MEMBER BLEY: -- Jose, you were coming from, is that they are -- they are not linked internally such that one automatically fails the other. And that's okay. I mean, that's something we want.

MEMBER MARCH-LEUBA: I have serious --

MEMBER BLEY: That we can do.

MEMBER MARCH-LEUBA: I have serious problems in that I -- let's pick up in one of these sites. With two of the barriers -- two of the other barriers are within a millimeter of each other and enclosed by a burnable material?

MEMBER BLEY: Then an earthquake will break them when they bang together.

MEMBER MARCH-LEUBA: Yeah. You're never going to be perfect, but removing the -- at least the goal, making them as independent as possible --

MEMBER BLEY: We've heard from some of us and from other people, once we define something, then we think we have to meet the definition, absolutely. And that gets us into --

MEMBER MARCH-LEUBA: Let's define --

MEMBER BLEY: -- silliness, a word I heard earlier today.

MEMBER MARCH-LEUBA: Let's define it properly. But giving up the goal of independence because you cannot achieve it perfectly is not --

MEMBER BLEY: Would be silly.

MEMBER MARCH-LEUBA: That would -- well, that's what we're doing. We're being silly.

MEMBER BLEY: No, I don't think so.

MEMBER MARCH-LEUBA: With those independent --

MR. RECKLEY: Okay. We did add -- and we'll get -- we'll get to it later and we'll see -- we tried to add something. We'll see if it's -- it's enough to scratch your itch.

The other thing I'll mention is that we will revisit this in the June and October meetings, as we talk about the overall framework and the incorporation of defense-in-depth as a specific activity or process within that framework in order to do not only the containment design but all of the safety functions really that are -- that are associated with -- associated with reactors.

And so I'm not trying to punt all together, but the concept of defense-in-depth and independence, and so forth, we can come back in a more general sense under the framework discussions that we'll -- that we'll have. So --

MEMBER KIRCHNER: Bill, before you go on --

MR. RECKLEY: Yeah. I'm not --

MEMBER KIRCHNER: -- of the three choices you could have made, I know that implied behind the functional containment is the HTGR design and the unique design aspects and challenges they have for certain events, design basis events and postulated accidents.

And blowdown gives them a particular challenge. It's really an economic challenge. It would be very expensive to build a building that could be essentially leak-tight against a blowdown of a high-pressure helium system of that size. But I wanted to go back to -- so you're going forward with the HTGR advanced reactor design criterion as the basis for functional containment.

But as we went through previously, and Dana mentioned early on, it -- it does imply, because you change an important word from the more generic advanced reactor design criteria, and that is you go from uncontrolled release, essentially a leak-tight barrier against uncontrolled release, to one that provides a controlled release, and that begs the question of -- I know you said you're not going to have the metric in this paper. That I guess would come later, but it -- it really refers you back to 10 CFR 50.34 for offsite dose consequence limits.

So that -- that would come in conjunction with your definition down the road when you --

MR. RECKLEY: Yeah. It actually got -- well, let's go to the next slide. The approach will be to have event categories. And so for most of the time, if you -- if you're going to be talking about ultimately the blow of containment to limit the public dose, the performance criteria is going to be for design basis accidents or design basis events in that middle category of frequency -- it's going to be the 50.34 limit.

MEMBER KIRCHNER: Limit.

MR. RECKLEY: As you get lower in frequency into the beyond design basis event, it ends up being the safety goals that -- that establish the performance criteria.

The other line on this slide that becomes important is the EPA, Environmental Protection Agency, Protective Action Guidelines dose guidance levels at one rem. And you will hear in the future about a general goal which has existed all along for Generation IV reactors to not rely on offsite emergency planning as much.

And so most -- I'll get in trouble. Some designs, many designs, are establishing as a goal that they won't exceed the protective action guidelines beyond the fence, 400 meters, 800 meters, such that the offsite emergency planning provisions of alert notification, drills, evacuations, all of those things can be relaxed.

So to the degree that a design strives to reduce the offsite emergency planning, the performance criteria could be much lower than the 50.35 number. But assuming that they keep the existing requirements in terms of offsite emergency planning, it would be the 50.34 number or the safety goal if it's dealing with sequences much lower in -- in frequency.

So, but the introduction of this frequency consequence target figure within the paper is in large part just to describe the general framework. And this is -- this is not really new, and it's -- it's not dramatically different than light water reactors, if you look at some of the later ANS standards that adopt event conditions or event categories based on frequencies.

Most of the light waters were -- were actually licensed before that version of the ANS standard. But it's not -- it's not a new -- not a new concept, and so basically -- and the categories will found familiar, anticipated operational occurrences, design basis events are the middle category, and then beyond design basis events.

MEMBER BROWN: Before you go -- go back to the other one again. I guess I'm still struggling -- and this follows from the previous meeting that we had. I'm echoing Walt a little bit, and we've gone from some specificity in terms of when we did the advanced reactor design stuff to meet the 10 CFR whatever it is, 50.34. But yet this goes to the point that we're going to control it to ensure conditions important.

But there is no -- there is no illusion or no alluding to some type of criteria, not even a more generic criteria such as onsite/offsite exposures as defined by the Commission, or something that's not referring to a rule, but what isn't currently in place is acceptable.

This makes it sound like that plant to plant to plant we can have a vastly different set of exposure, either onsite/offsite exposure criteria, than what -- than you would -- than I would envision. It seems to me you can't have inconsistent requirements or different requirements from plants -- from the standpoint of onsite and offsite dose consequences to the public.

MR. RECKLEY: And I -- again, outside of the introduction of the potential to set up emergency planning as another threshold, in order to reduce offsite emergency planning you've got to lower the radiological releases. Outside of that being introduced, the criteria are basically the same as light water reactors, which is 10 CFR 50.34, the 25 rem for the worst two hours, the 25 rem for --

MEMBER KIRCHNER: Population zone for the entire event.

MR. RECKLEY: Right. So those two are also in play here. You can back up and say basically the analysis that was done for the existing fleet, in terms of the leak rates and performance of the containments, are basically the same. They were set up, and the calculations showed that they remain below those regulatory thresholds or guidelines.

Then, as severe accidents or beyond design basis events were introduced increasingly into the light water reactor licensing arena, the safety goals ended up being used indirectly as acceptance criteria because that's what we use as the backfit threshold.

And so requirements were put in place when an action was needed -- and simplifying a little bit. But since we use the safety goals as the threshold for the backfit determinations, it became a kind of de facto acceptance criteria for the light water fleet.

So I don't -- it's a little different in the way that you will address the releases will vary a lot by technologies because what they're going to rely on as the functional containment will look different. But in terms of ultimately the acceptance criteria, it will be basically the same, which is that 25 rem number, for design basis accidents and the safety goal for very infrequent accidents.

MEMBER MARCH-LEUBA: The other problem I have with that approach -- and let me just put it on the record -- is that you will judge the acceptance criteria for a set of events that you define. And what we have found in severe accidents in the past is there was an event that we didn't consider.

And, therefore, the releases that you are going to calculate are -- by the way you calculated, a lower bound, non-conservative bound of what the release frequency is going to be, because you forgot some events. And that's where defense-in-depth comes along.

You put another barrier in there just in case you didn't consider everything. And if you do a probabilistic analysis of everything you have, and you are right at the limit, you will say it's okay. I will say it's not, because you didn't catch every possibility.

MR. RECKLEY: Right. I -- again, I think when we come back and talk to you about the defense-in-depth approach in the summer, I hope you'll see that -- that it's not as simple as what you just laid out. And this is not the case, but if there were no uncertainties, you could do what you were saying. You could do that PRA, and you could say, "We know how things behave, and, therefore, we'll -- we'll establish things right to the -- to the acceptance criteria."

The methodologies that we'll be presenting to you in the summer recognize that that's not the case, and there are a lot of uncertainties and you have to take actions to -- to address those.

MEMBER MARCH-LEUBA: I'm eager to see -- I'm eager to see those. Can you move to the next slide?

MR. RECKLEY: Uh-huh.

MEMBER MARCH-LEUBA: Okay. If -- I know that we haven't defined this, but if we define the blue line as our acceptance criteria, right now we have the DOE and all the other reactors that have been built for the last years, which are fantastic, super safe, and incredible because the requirements from DOE were it has to be critical, so you can produce power, and it has to be safe.

So they are orders of magnitude to the left of that line. I mean, you cannot even -- But the moment you put venture capital to design a real reactor to be licensed, then the requirement change. It has to be critical, so we can produce power, and it has to be cheap. Safety doesn't count anymore because safety is sustained below the blue line.

And I guarantee you when those reactors designed by venture capitalists come, they will be right at the limit. So by defining criteria, they are going to get right there. And we are kind of in our mind thinking about the DOE reactors, which are not the ones that are going to come for licensing.

MR. RECKLEY: What we've seen --

MS. CUBBAGE: The dots will also have uncertainty bands. This is Amy Cubbage from NRC staff.

MEMBER REMPE: In fact, if I look at the Y-axis, it has mean frequency. It doesn't have point estimates. That implies you need to consider uncertainties, right?

MR. RECKLEY: Well, if the --

MEMBER BLEY: Excuse. Amy, when you chime in, we need your name on the record.

MS. CUBBAGE: I did.

MEMBER BLEY: Oh, did you? I missed it. Thank you.

MS. CUBBAGE: I did it fast.

MR. RECKLEY: The figures that we've seen for the analysis that has been done would tend to show that the doses tend to be very -- the consequences are on the -- to the far left, close to the axis, and you don't get that effect.

I understand what you're saying, and I can't dispute it. I would simply say that, from the regulatory perspective, the closer you get to the line the more attention you get, the more safety systems you're likely to have to add, and so there -- it's not quite as simple as design to the line, because the closer you are to the line the more expensive your machine is going to be for that purpose.

Now, I understand what you're saying. There's a tradeoff there, and that's really up to -- that's up to the designer to really say what kind of strategy they -- they want to take, and there's always tradeoffs in the design process.

MEMBER MARCH-LEUBA: My concern is on the record.

MEMBER BLEY: No, no.

MEMBER MARCH-LEUBA: And the moment you draw the line.

MEMBER BLEY: I've got to throw one on the record, too, because the claim that DOE reactors sit way down here is -- is -- when we -- if it's my reactor, I know it's way down low until I analyze it. There have been a few DOE reactors that have been analyzed impartially, and I suggest you are overly optimistic.

MEMBER REMPE: And, in fact, some of them don't operate at their full rate of power because of that concern.

MEMBER BLEY: Yes, indeed. Or they don't operate at all anymore.

MEMBER MARCH-LEUBA: I didn't want to criticize the existing reactors. I'm thinking about the future.

MEMBER BLEY: I know, but it's the context there. It's overstated.

MR. RECKLEY: And you -- one can argue you had this -- the same thing with the operating fleet. And that is, as PRAs were introduced, and maybe not only PRAs but other analytical improvements were made, they were taken advantage of, right? You had power uprates, you had other -- you had other things to try to take advantage of that -- of that identified margin.

So I understand what you're saying. It's not something I can really answer, other than it's up to the designer.

CHAIRMAN CORRADINI: But I guess I want to get to this, because you -- this is somewhere where you had a -- you had a redline addition. I thought you were going to mention something in the text. This is the closest thing to a concept of how you would establish this from a process standpoint.

But as I remember from the subcommittee meeting, you were hesitant to say this is what you want the Commission to consider. But this is getting perilously close to a process.

MR. RECKLEY: No. I --

MEMBER BLEY: I want to chime in on that one, too. It is, and it's similar to ones that were used in a number of previous applications, not exactly the same.

But the one thing I'll point out, and we'll follow this later because I don't think it applies right now, I mean, this is a concept, when you actually try to apply it to a real reactor, you have to start thinking about how you do that without -- you know, analysts can drop things smaller and smaller, and you can get every scenario down low.

And what they had to do on 1860 when they looked at an existing light water reactor was figure out a way to group these, and they did it by looking at systems and not looking at little contributors but aggregating them at the systemic level, so that you compare one plant with another. And in a sensible way, you could apply such criteria, if this would become a criteria.

CHAIRMAN CORRADINI: And I don't want to get to your end, but I'm still trying to -- the way I at least interpret the -- the policy paper is that -- don't go back a slide, but if I were to look at the slide before, all containments essentially are functional containments. Current containments are functional containments because there is a defined tech spec leak rate, which means it's a controlled release of radiation. It is not a zero release.

MR. RECKLEY: Right.

CHAIRMAN CORRADINI: That's point one. Point two is that what I think you're asking is just permission to proceed, and we're not sure what you're going to proceed with because we still don't have the concept you're going to proceed with, but we have a sense of how you might attack it.

MR. RECKLEY: Right. That's generally true. On this particular figure, I would say we're making the Commission aware that we're going to more officially formally adopt this kind of approach. What the foot -- what the footnote on the slide and the text in the SECY is saying is we're going to use this approach, this methodology, or we're proposing to.

What we're not ready to ask the Commission to weigh in on is where the lines are. Ten to the minus four, okay, that -- that's a line on that graph. It may stay there over the summer as we work with licensing modernization on the -- on this next approach. Maybe it changes. I'm not predicting. It has been -- since NGNP and a lot of other projects, these lines have been fairly steady and unchanging. But we weren't being asked yet at that time to officially endorse them in regulatory guidance.

The document we'll be preparing over the summer will include a graph like this that we will endorse or propose to endorse in regulatory guidance, and we just wanted the summer to work out whether we want to tweak any of these lines. So that's -- that's the disclaimer we were putting into the paper.

The concept we're ready for. The specifics give us to the next reg guide, which we plan to develop over the summer.

MEMBER BLEY: When you get to that reg guide, I'd recommend you look back at 1860's application.

MR. RECKLEY: Yes.

MEMBER BLEY: Because how in this reg guide you tell people to use this is not transparent without a fair amount of work.

CHAIRMAN CORRADINI: And that was the time where there was debate amongst the committee that caused it to kind of stop in the midst of preparation. I mean, because I -- I seem to remember, as we went back to 1860, the question was really, what are the -- as you said, where do you draw the lines? What's the access supposed to be? How do you bundle these so you don't, by fractionation, make them look --

MEMBER BLEY: What I can say is, at some point -- because I was involved in that process. At some point in that, it looked like there was going to be a volunteer of a new design to actually apply -- try to apply those approaches and that disappeared. And then there was the suggestion, why don't you apply it to an existing LWR, and in fact, yeah, that probably took another six months or longer before that got worked in.

MS. CUBBAGE: So this is Amy Cubbage again. Just to refresh that we're coming in June to the subcommittee for the preview of these topics, and so we'll be able to get into a lot more specifics of where the staff is headed on that, and then again in October the subcommittee, and then December full committee on that other draft reg guide.

MEMBER BLEY: So June is the modernization?

MS. CUBBAGE: That's what we're talking about.

MEMBER BLEY: And that's where you're talking about. These will all start coming together there.

MS. CUBBAGE: Absolutely.

MR. RECKLEY: The other note is, again, this isn't the first proposal to use this, hopefully. In that that's the reason for the subcommittee visits, we have -- we have addressed some of those concerns or the -- the industry has in their guidance that we hope to endorse.

But our message in the previous white papers is, you know, stop calling it a limit line, for example. It's not an acceptable line. It's a judgment call, and what we're planning to use it for, the further away you are, the more comfortable we are. Not if you're on one side you're okay and if you're on the other side you're not.

In terms of other measures -- and then I'll move on -- it's not just this line. You do have to consider aggregating all of the events, so that you don't end up doing some maneuvers to say I don't have any event that's -- that's over -- that's of concern.

You also look at aggregate measures to say that all of the -- all of the events put together, but that's a preview, a trailer for the -- for the June meeting that -- that we'll be in for.

MEMBER KIRCHNER: For the record, too, 10 CFR 50.34 makes it clear that it's not that point. That's an --

MR. RECKLEY: It's not a point.

MEMBER KIRCHNER: It's not a point. That the expectation is below.

MR. RECKLEY: Yes.

MEMBER KIRCHNER: And I think the Commission's prior statements on advanced reactor expectations would drive you in the same --

MR. RECKLEY: Push it even further away.

MEMBER KIRCHNER: Yes.

MR. RECKLEY: Right.

MEMBER DIMITRIJEVIC: Well, this is what I was going to suggest. It would be very interesting because I have a tough time imagining where the current light water reactor -- because I'm not sure of the meaning of some of those regions.

So it looked to me the current light water reactor would be farther on the left based on this curve, and we want to design for better performance than that. So it would be interesting actually to look where the current light water reactor fit on this curve. You know, why I have a problem, because anticipated operational occurrence are initiating events, not sequences.

So I am not sure, does this mean every sequence would start to an anticipated initiating event or what does it mean in the -- in the PRA world of the life of the reactor? So for me it will be interesting to see how these compare -- how this current fleet fits on this curve.

MS. CUBBAGE: So one way -- this is Amy Cubbage again. One way I -- just thinking about it as you were talking -- good points is that, yes, the current LWR, we would expect all to be inside of those lines because those are bounded in regulatory requirements like 50.34.

However, they may need a lot more safety systems and components to get there, whereas these new plants may have more inherent safety characteristics, passive, et cetera, such that in a more simpler way they can achieve the safety. I mean, that's just one way to think about it.

MEMBER DIMITRIJEVIC: Well, but in the end, we still talk about frequency. So it doesn't matter how did you get there, but --

MS. CUBBAGE: Oh, yeah. That -- yeah, I wasn't speaking to that part of it, but --

MEMBER DIMITRIJEVIC: Yeah.

MS. CUBBAGE: And, you know, just to get -- drill down a little on the advanced reactor policy statement, there is not an explicit expectation that they be quote/unquote "safer," but they are supposed to use simplified inherent passive means to achieve safety with less reliance on power, operator actions, et cetera, et cetera.

So the Commission policy really has the expectation of a different way of achieving safety.

MEMBER BLEY: Amy, I think when you made your statement about existing reactors you meant the design basis events for existing reactors.

MS. CUBBAGE: Yes. Yes.

MEMBER BLEY: Not all possible events beyond the design basis.

MS. CUBBAGE: That's a good point. Yes, I was focusing more on --

MEMBER BLEY: Which would be looked at on here, by the way.

MS. CUBBAGE: Yes. I was focusing more so on the -- the AOO DBA portion, that we would expect them to be below the line. You're right.

MR. RECKLEY: And this -- this approach is -- again, the light water approach evolved. And so one difference here is that there will be a much more structured look at those beyond design basis events, those events of lower frequency, than may have been done for the light water, not -- not in terms of the PRAs. The PRAs have probably caught up to look at those events. But in terms of the regulatory treatment of them, this is being built into this approach.

CHAIRMAN CORRADINI: So let me ask a -- maybe -- I know we asked you this question at the subcommittee, but maybe -- I guess I want to ask it again because I don't remember the answer, to be quite honest. All of these are design basis events which essentially would be looking at some sort of calculational approaches to what the mean is, what's the uncertainty in both directions.

But then if I go to Chapter 15, I have a set of required assumptions that make me bias -- forget about the Y-axis, makes me bias the X-axis in a -- in a direction. So is that still part of the anticipation is they will have to be --

MR. RECKLEY: Yeah.

CHAIRMAN CORRADINI: Okay.

MR. RECKLEY: Really, just --

CHAIRMAN CORRADINI: So I have -- so if I might say, you don't have to go back to the cartoon, but as you pepper this with what you have as a bundle of potential events, you would bias them towards the line based on the DBA assumptions.

MEMBER REMPE: Well, I thought maybe in our subcommittee meeting, but somewhere I've seen that it wouldn't quite be the same. One might say I'll only rely on safety-related equipment, structures, and components, instead of -- and call those to be design basis events. It's not the traditional way of doing things is what I thought I heard.

MR. RECKLEY: Well, the summary of this

curve, if you just put it in the bullets, is the events are looked at from a probabilistic standpoint, a PRA standpoint, and broken down by frequency into anticipated operational occurrences, design basis events, and beyond design basis events based on the event frequencies.

MEMBER DIMITRIJEVIC: Well, okay. This is what is very important for me. It is based on event sequence frequencies, not on event -- not on initiating event frequency.

MR. RECKLEY: Under this proposal, yes.

MEMBER DIMITRIJEVIC: Yes. So that's completely different because there is million event sequences that start with a different initiator.

MR. RECKLEY: Yes.

MEMBER DIMITRIJEVIC: Right.

MR. RECKLEY: Right.

MEMBER DIMITRIJEVIC: So, for example, when we talk about design -- beyond design basis events, let's say tsunami of 14 feet, that would not only influence so much my release and steam generator tube rupture, which is design basis event. So this is what I just want to say. This is very difficult to say what we are taking about, because from the PRA point of view we have like, for example, large release frequency, which all the initiating events contribute, but which ones contribute the most we don't know.

It doesn't have to be beyond design basis event. Not beyond -- it's not necessarily beyond design basis events which contribute most to large releases. And this is which we are talking about here is releases.

MR. RECKLEY: If the -- if the events result in releases, you -- yeah, they -- they --

MEMBER DIMITRIJEVIC: See, for example, the loss of offsite power, which is like, you know, one of the high frequency events often leads to the largest releases. So how -- so what we are talking, where does that fit on this curve? I mean, you know, or that's what I am asking. I mean --

MR. RECKLEY: Well, the --

MEMBER BLEY: Can I help you out, Bill?

MR. RECKLEY: Please.

MEMBER BLEY: And especially with respect to what Joy said earlier, if you look back at the MHGT -- MHGTR application and the way they approached it, if you look at 1860 and what they did, and if you look at the white papers and what they were proposing, all of those looked at whole PRA sequences, plotted those, and then looked at ways to aggregate them to make sure you were looking at the same thing. And that was the aggregations that dealt with these things.

But they all came up with this concept, and Dana argued against it at the subcommittee meeting, by the way. We ought to have something analogous to the current design basis accident, so you'll take those out of that PRA set, and for that small set, which sit over by the axis because they have no releases or no big releases, you'll apply the old rules of Chapter 15 to them and that adds a conservatism.

Dana was saying, well, why in the world should we do that? Should we still be going back to that? And that's something I think we'll talk about this summer.

MR. RECKLEY: Right.

MEMBER BLEY: That's a kind of definition. But that's where the thing you talked about was those they called licensing basis events, and they treated them the way we treat design basis accidents now and added a lot of conservatism into them and designed the systems so that they could still meet those kind of conservative criteria.

MEMBER REMPE: But, again, we can't apply all of the Chapter 15 things to a non-LWR. So, in some cases, perhaps the gas reactor --

MEMBER BLEY: The Chapter 15 kinds of assumptions.

MEMBER REMPE: Yeah, kinds. But I thought that they were trying -- some of the designers are trying to push back and say, okay, let's just say we're going to rely on safety-related equipment that's cost -- safety grade, and that's it, and that's where I thought they --

MR. RECKLEY: And that's the last bullet. So -- so the first sweep will be just looking at events and analyzing them kind of in normal PRA, what equipment do I have, how is it going to work, what equipment fails, that might put me on a different sequence, but you just do all of those assessments, and that's the first -- the anticipated operational occurrences, design basis events, beyond design basis events.

And the reason for largely coming up with those designations is the acceptance criteria could be different for those. For anticipated operational occurrences, there better be no releases basically or very small releases, and you shouldn't be failing even your first fission product barrier, right? I mean, that's the same concept as now. Anticipated operational occurrences should -- should be benign.

Then you get into design basis events less frequent. Well, they are less frequent. You can have -- in theory, rely on different systems, go a little further in your defense-in-depth, you are now relying on a backup system perhaps, and your offsite dose could be a little higher.

And then if you get into the very infrequent, again, you're starting to pick up doses that could be more significant, but you're comparing them to the -- to the safety goal as your -- as your criteria.

Now, all of that is done, and then in addition to that assessment you do another set of events that you're picking out of that design basis event category. So you're not going way down into the -- into the very unprobable events, but you're picking out of the design basis event category the events and saying, "For those I am going to now analyze them in a more traditional Chapter 15 sense."

And I'm only going to rely on design -- on safety-related equipment. The assumptions might be a little more conservative in terms of your initial conditions, and the computer codes that you're using might be more in line with Chapter 15. So you'd pick up all of that Chapter 15 conservatism.

And you're doing that for a number of reasons. Those are a little easier and more clear-cut historically to define engineering safety margins because you're now calculating temperatures, pressures, things you can compare, the ASME code requirements.

And that's also traditionally where you get your technical specifications from, so you can maintain that kind of historical connection between Chapter 15 and where you're getting other regulatory controls on your safety-related equipment.

So this really was kind of a compromise, bringing a large part of the regulatory structure for light waters or existing plants into this, trying to improve it, trying to make it more structured, more organized, but also keeping some continuity in terms of things like Chapter 15, technical specifications, and safety classification.

MEMBER BLEY: I just wanted to interrupt with two things. One is we're down to our last 55 minutes.

MR. RECKLEY: Right.

MEMBER BLEY: And we have more things to talk about on functional containment.

MR. RECKLEY: Right.

MEMBER BLEY: This I think is stuff we're going to address in the summer more. But if somebody wants to pursue it a little bit, I think we're okay. But we don't want to run out of time for the new things here.

MEMBER DIMITRIJEVIC: But this is in that paper.

MEMBER RICCARDELLA: I have a question. I'm just trying to understand that chart. Could you go back to the chart? So if I evaluated an existing operating light water reactor, and wanted to plot it up here, would I get a whole bunch of points for each event?

Or would I get a line that's the -- that, you know, presumably all the points, all the individual points for each event sequence would be below that line. But do I have to do some summing to get a line -- a bounding line for all of the events of that frequency and make sure that the -- I mean, that last one --

MR. RECKLEY: That's a valid point.

MEMBER RICCARDELLA: Is it a cumulative plot or a distributed plot?

MR. RECKLEY: It's a bunch of points.

MEMBER RICCARDELLA: Huh?

MR. RECKLEY: A bunch of points for events -- typically not individual because you're grouping them, but -- but families or small groups of sequences that are very similar.

MEMBER RICCARDELLA: But if I had a whole bunch of points that all had a frequency of 10 to the minus third, and if I had a thousand of them, then I've got a -- then I've got a much higher frequency, right?

MEMBER STETKAR: That's what Dennis was talking about earlier. This notion -- until we have the opportunity to see what they work through sometime in the summer about what is an event sequence, we don't -- it's difficult to implement this process because an event --

MEMBER BLEY: Two things --

MEMBER STETKAR: -- some people will say an event sequence is a cut set, and billions and billions and billions of cut sets are billions and billions and billions of sequences, and you run into your problem.

MEMBER BLEY: Go back.

MEMBER STETKAR: Other people will say it's a path through a stylized event tree, but people draw event trees differently. So that's not a sequence either. So until the staff and the industry have some coherent understanding of what you mean by a sequence, you can't answer your question about --

MEMBER BLEY: But to help a little bit, two things. If you looked at the design basis events for current light water reactors, they are all clustered along the Y-axis. They're all there. They aren't anywhere else. They're at different frequencies, but they're over there at almost no release. And if you want to see one way you could go --

MEMBER DIMITRIJEVIC: Wait, wait, wait, wait, wait.

MEMBER BLEY: If you want to see one way you could go at this, I'd recommend you look at Appendix E in 1860, NUREG-1860. And there are a couple of other sources to look at, but that's the easiest one to find. I'm sorry, Vesna.

MEMBER DIMITRIJEVIC: Okay. Because it's still important for me to understand what you just said, because design basis events with vessel failure, mitigating system --

MEMBER BLEY: No longer design basis event.

MEMBER DIMITRIJEVIC: Oh, what do you mean it's no longer --

MEMBER BLEY: I mean the things that are analyzed in Chapter 15.

MEMBER DIMITRIJEVIC: Okay. Then there is no single event, other than maybe vessel failure, which will actually result in releases.

MEMBER BLEY: Which is not analyzed in Chapter 15. That is definitely not a design basis event.

MEMBER DIMITRIJEVIC: Okay. So any additional failure makes an event?

MEMBER BLEY: Not a design basis event.

MEMBER DIMITRIJEVIC: Here, how it's interpreted, right?

MEMBER BLEY: Yeah. All of the -- all of the sequences in the PRA have to go here somehow, but you have to decide how you -- how you ought to arrange them to look at them here. But the design basis --

MEMBER DIMITRIJEVIC: All right. Well, that's completely strange for me. I mean --

MR. RECKLEY: But it's -- this is a little different than the -- than the light water approach because in light water -- in light water or existing -- this was all done after the fact. So this is --

this is trying to bring this concept into the regulatory framework and a little more organized.

So it will be -- it will be a little different. And, again, I -- in the summer we'll -- we're making notes that this will be an area that we have to explain a little better. And it was an issue when we were doing NGNP reviews, this -- this -- what's a family, what's a sequence. It was the same discussions.

MEMBER BLEY: I can give you three references that I mentioned, the old gas reactor submittal, the 1860, and the white papers. We wrote letters on those three or four years ago, yeah. So we have all of that we can look at.

MR. RECKLEY: So getting beyond the -- the events, the paper --

MEMBER DIMITRIJEVIC: Wait. Because I just thought about, if this isn't called event sequence, so then what is event sequence, for example, for unprecedented operational occurrence? What's -- or what is event sequence for, let's say, loss of offsite power? Because that is --

MEMBER BLEY: There are lots of them. You know that --

MEMBER DIMITRIJEVIC: Hmm?

MEMBER BLEY: There are lots of them. They all start with a loss of offsite power.

MEMBER DIMITRIJEVIC: Yes. But then you say if it's only additional -- if there is any additional failure, it is not anymore, that design basis event.

MR. RECKLEY: That would all depend on the plant and the -- and the reliability or whatever you have in place to -- to respond to it. So --

MEMBER DIMITRIJEVIC: But we just discussed the case, if I have event sequence, we have additional failure, loss of offsite power. These are failures to start for whatever, failure of recovery, blah, blah, blah, blah. That's not any more the event, design basis event. That's what that has just told me.

MEMBER BLEY: You've read Chapter 15. A large LOCA is analyzed as a large LOCA with -- in most reactors one loop not working, and one other active failure.

MEMBER DIMITRIJEVIC: So that's event sequence they are talking here about.

MEMBER BLEY: No.

MEMBER DIMITRIJEVIC: It's not the PRA sequence.

MEMBER BLEY: That is -- so that's makes a bunch -- a whole bunch of things I don't think I can answer at one time.

MR. RECKLEY: I think some of the --

MS. CUBBAGE: What I was going to say is this will be based on the PRA sequences, not a stylized deterministic approach to all of the different Chapter 15 things.

MEMBER BLEY: Selection of the events, yeah.

MS. CUBBAGE: Right.

MEMBER BLEY: It was --

MS. CUBBAGE: It was just certain events that were selected to be representative for the large light --

MEMBER BLEY: "Selected" is the right word. They were picked with some rationality.

MR. RECKLEY: We'll provide what Dennis was mentioning. We'll provide that background information, the 1860 and some of the NGNP papers that -- that describe how -- how this works a little better.

And, again, we'll be back in the summer, first -- first meeting in mid-June.

The other important item, or another

important item within the paper that we talk about because we have to mention it is -- is mechanistic source term, because obviously the purpose of the functional containment is to retain the radionuclides within the plant.

And the importance then of understanding the behavior of the reactor systems, the transport of the radionuclides for various events, is key, and that's -- there has been previous white papers talking about mechanistic source term.

This figure also, though, I like this figure that -- that originated in the NGNP papers and then goes forward is some of the topics we have been talking about, we're laying out the highest level regulatory kind of framework here. This -- this figure starts to show some of not only the high-level regulatory questions, but the technical work that has to get done. And we often get questions of how you can set out a regulatory approach before you've done some of the technical work.

And, you know, we'll be the first to admit that's a challenge. We're trying to lay out performance-based approaches such that we'll acknowledge all of these things need to be done, and in many cases they're only beginning for some designs and technologies. But they will need to be -- to be done ultimately.

But, again, what we're being asked is before there is a -- before there is a large expenditure of money on something like fuel qualification, to understand how fuel qualification fits into the whole plant design. And we'll talk a little later about I think it's obvious how those kind of things go together.

How much do I have to prove the fuel is going to retain the material, can be in a design aspect a function of what am I going to require in terms of additional barriers. And so, but what's key to this figure is even when we lay this out in a high-level regulatory context, we're -- you know, the designers work -- this is just freeing them up to know what they need to do, but they still will need to do fuel qualification work.

Dana had brought up last time the analytical codes and the validation work. That -- you know, we're assuming -- we don't talk about it very much in this paper. It's inherent in this, and if we need to clarify -- we tried, but we can just make it clear all of this work has to be done.

We're just laying out a framework, and all of the underlying technical work and understanding of the designs still needs to be -- to be done. We're just -- you know, we're -- when this paper goes up, it will be still the beginning process. This doesn't really enable anybody to just quickly move through.

It only enables them to know what they have to do in terms of all of this work, in terms of developing the equipment, the qualification of the materials, the qualification of the fuel, the qualification of the computer codes, and all of that. So --

MEMBER KIRCHNER: Bill, I would just throw out a caution that both the NGNP work and the -- their approach to functional containment was predicated on having robust solid fuel, not circulating fuel. I just --

MR. RECKLEY: And we're -- we're in the --

MEMBER KIRCHNER: So just --

MR. RECKLEY: No, no. And we're now in the midst of -- if you're alluding to molten salts, we're -- we're just in the process now of starting to say what does fuel qualification mean for a fuel that's -- that's going around the reactor coolant system. So we --

CHAIRMAN CORRADINI: You don't corrode the first barrier.

MR. RECKLEY: And that's -- that's a proposal. I mean, that's a first step. So -- so we had -- we had the event categories.

And, again, the structure that is being proposed in the paper, the reason we spent so much time on event categories is because it really does explain how we are proposing -- the methodology that is being proposed for defining performance criteria, because you have, just like you have now, different performance criteria for -- or acceptance criteria. Maybe I'll change the language. You have different acceptance criteria for each event category, and you have that now largely with the operating fleet. That will continue.

In general, the more you go down in terms of lower and lower frequencies, the more the -- the higher the acceptance criteria is in terms of allowable consequences, if you will.

MEMBER DIMITRIJEVIC: Well, what type of acceptance criteria?

MR. RECKLEY: And we'll go in the next slide --

MEMBER DIMITRIJEVIC: No, no, no. Currently, you compare it to current. So what type of acceptance criteria you are saying goes down with it?

MR. RECKLEY: Well, if you start with anticipated operational occurrences, in light water or current reactors, those are basically required to show that you don't fail the cladding on the fuel. Then, by the time you get to large break LOCAs, you are using the 2200. And this is in the Chapter 15 space. In --

MEMBER DIMITRIJEVIC: In the PRA space.

MR. RECKLEY: In the PRA space -- I'm not a PRA person, but in general you're going to aggregate those and compare them to the safety goals.

MEMBER DIMITRIJEVIC: Yes. But that's completely independent of this, and it doesn't change once you --

MR. RECKLEY: And that is one of the -- that -- to some degree it's one of the differences that will exist, in that large light water reactors -- man, I wish Marty or somebody was here to be my call a friend, but he has left. And I'm going to go beyond my station here.

But, and maybe I'll look at the PRA people here, but anticipated operational occurrences aren't going to get much attention in a light water reactor PRA, because you're ending it very early, saying I don't get core melt, I don't get core damage.

And so those event sequences are going to end relatively -- I mean, they're not addressed very much. In this sequence -- in this proposal --

MEMBER BLEY: They're in there, but they're not tracked.

MR. RECKLEY: Yeah, okay.

MEMBER DIMITRIJEVIC: Wait a second. Do you consider transient anticipated occurrence, plant transient? Yeah. I mean, therefore, we have to be mostly protected for --

MEMBER BLEY: There's a group of transients that are called anticipated events, but there are also some transients that are in the PRA that go well beyond those.

MEMBER DIMITRIJEVIC: Okay. Well, that's -- I just want to say that PRA has nothing to do, and actually you need to protect more against more likely events to, you know, prevent them to resulting --

MR. RECKLEY: And that's what this would show is that your first line of defense is going to work most often --

MEMBER BLEY: I've got to interrupt.

MR. RECKLEY: Yeah.

MEMBER BLEY: We're running out of time.

MR. RECKLEY: Yeah.

MEMBER BLEY: And we've been on this topic longer than we have time for.

MR. RECKLEY: Okay.

MEMBER BLEY: You've got to get us to anything that has changed.

MR. RECKLEY: Okay. So to go to the -- to the meat of the paper, then, that the proposed methodology is to take the acceptance criteria for each event category -- for example, the fuel design limits or the frequency consequence targets, which are different for each event category, and you see in the terms of the functional containment, which is those things that you're putting in place to retain radionuclides, what structures, systems, and components am I relying on to meet the acceptance criteria for that event category.

And so, for example, under normal operations, I'm operating under Part 20 as my acceptance criteria. Well, what, under normal operation, am I relying on to keep me under Part 20? And anticipated operational occurrences assume I set my acceptance criteria to be some fuel design limit like the specified acceptable radiological release, the SARRDL, or -- or on the molten salts maybe it's the integrity of the first barrier. Then that becomes my acceptance criteria for the event category. What am I relying on in order to retain those radionuclides?

And so that -- that just becomes the methodology for defining what is the requirements for functional containment. You aggregate, then, all the structures and systems and components that I'm relying on for all of the event categories, and then that becomes my performance criteria for the functional containment.

There is a separate discussion in the paper on physical enclosures or physical buildings, only because the history of this topic has always -- as soon as you say containment, what comes into people's minds is the structure. And so there's always -- often been discussions of what is the -- the purpose or the role of the physical enclosure, so we included a discussion within the paper.

Certainly, if there is a -- if there is a role for the building or the enclosure in retaining radionuclides for any event category, now that building is part of my functional containment. In some cases, it might be part of my functional containment for maybe only the last category.

So using that as an example, if I'm only using my reactor building as a last line of defense against a beyond design basis event, it's still now part of my functional containment. But how I define what the regulatory requirements are will be reflective of what are regulatory requirements for equipment serving beyond design basis events.

So it could end up being a reactor building that's non-safety-related, but credited within my mechanistic source term in a best estimate approach to how that building would help me retain the radionuclides. Whereas, I could also be crediting a reactor building or enclosure for my design basis accidents in order to retain the fission products, in which case now that enclosure will be a safety-related structure under the existing arrangement.

So it's just a way to organize and determine what is serving the role of retaining the radionuclides and then setting the regulatory requirements in line with which event category it's being credited for.

That's not dramatically different than how stuff is done for light water reactors where you just -- you aggregate, you go into a design basis document for some component and they have basically done this same thing to say, okay, is it serving any safety-related function? And then it's on the -- you know, it's on the cue list. If it's -- if it's not, it still may have requirements to meet some regulation or it may have a reliability goal within the PRA or the maintenance program.

So it's not dramatically different. We're just trying to be a little more structured and organized. Then, the other thing that is called out in the paper, again, just because it's so common, if you go into discussions of the physical enclosure --

MEMBER REMPE: Bill, before you leave that slide, when I looked back about our meeting last time, the only thing I didn't you that I wanted to was I looked at the June 2003 paper and how the Commissioners had not approved the recommendations related to the confinement building.

They cited you needed to have performance requirements and you should work with industry, and some things that they wanted to get back from you before they ever considered it. Do you have any feel about whether you think you've got enough now that they can make a decision? Because, frankly, I think their not making a decision has hindered progress in this area. And what do you think?

MR. RECKLEY: Well, what we're going to -- what we're going to say in the paper, and then there's a Commission meeting coming up, and we'll tell them this paper is coming, but in general the message that we're getting is there are too many questions about what is fixed and what's in play, what can a designer have under their control, and -- and that is the purpose of the paper.

So, yeah, I won't say that -- yeah. But a decision is needed now, so that we can incorporate functional containments into the next set of papers to say what the overall framework is going to be.

So, yeah, we're going to say a decision is needed as soon as the -- obviously, we don't dictate, but --

MEMBER REMPE: And you hope that you've got this --

MR. RECKLEY: We hope.

MEMBER REMPE: -- industry interactions indicate you probably -- they think you have enough stuff in there for them to --

MR. RECKLEY: Right. I mean, this -- this reflects -- and, really, it has been fairly continuous fits and starts. I shouldn't say continuous. It is over a long period of time with fits and starts, but this same basic approach is -- is not -- it's from the '80s all the way up to now. Even the paper in '93 said this approach would be built around event categories. This is -- again, it's not -- this whole -- this whole approach.

And then the most interaction lately that we would rely on in terms of this notion of the deal with stakeholders was NGNP, and then the follow-up more recently with this licensing modernization project. So, yes, we think we've done it.

MEMBER REMPE: We've matched the rear -- it's different commissioners, but you know --

MR. RECKLEY: Yes. We think -- we think we have, and we think -- and the underlying message is we need a decision on this in order to -- to move forward.

I already really talked about this in the previous, but -- but it just reinforces, for example, that there are related topics, and some of this will have to get worked out in an integrated fashion because you have all of these parts. And as soon as you try to answer one part in isolation, then it just cascades back.

And so one that was brought out in Reg Guide 1.232 was the use of specified acceptable radionuclide release design limits, or SARRDLs, and the role that -- the relationship between a SARRDL and the functional containment.

And so the -- you know, the designers are looking at an approach where they could set very restrictive SARRDLs, meaning there wouldn't be very many radionuclides in the inventory to be released, and then you can have a functional containment that works a certain way.

If you're going to -- if you're going to say all plants need to have basically the equivalent of a -- of a current pressure-retaining containment, it raises other issues, but it also would say, if I have another barrier, maybe my SARRDLs can be higher.

And so those tradeoffs are what the designers are looking for, and we're just -- we're just trying to basically, again, say as long as the integrated plant design considers all of these things and models them through, they have the flexibility to pick where they want to put the emphasis, provided the net result, which is public health and safety, is -- is provided or protected.

MEMBER KIRCHNER: Just Bill, one more cautionary note. On certain design concepts where you do have liquid fuel, you, in the traditional sense, have already eliminated one of the barriers. And I would suggest, I think your paper, although I didn't see it in the viewgraphs, talks about undue reliance on any one barrier.

MR. RECKLEY: That was --

MEMBER KIRCHNER: Because now the burden of proof, I would presume, would be much higher on how essentially leak-tight that barrier is for that kind of concept.

MR. RECKLEY: Right. And, again, you have to evaluate the fuel form, and assume it -- assuming it reaches your first barrier, what happens to the fuel? And, therefore, then what kind of barrier do I need given that it reached the first, right?

So, again, all of the molten salt discussions are preliminary. But there is -- there is some discussion about the ability of the salt, once it reaches the first barrier, to actually retain the fission products and, therefore, the role of the second barrier might not be as great as it sounds on first blush. Not that you don't need a second barrier, but what -- what it has to address in terms of the potential to retain nuclides --

MEMBER KIRCHNER: It's not just fission products. You have the actinides in circulation.

MR. RECKLEY: Oh, yeah, yeah. Okay.

So -- so, again, this is just summarizing basically the proposed approach, and I've gone through it before. The physical structures, the paper lays out some other possible uses, the protection against external events, weather, aircraft impact, potential delay in security scenarios, and so forth.

So in addition to whatever role it has in retaining radionuclides, the physical enclosure might be subject to any number of other regulatory requirements or asset protection requirements that the designer is -- is establishing.

And so to get to Dr. Bley's suggestion, we do want to point out what we changed in the -- in the paper, and it's not a lot, but -- but we did try to address some of the things that we heard. One is in a few places -- and I don't want to overstate, but in a few places we -- we made sure that it was characterized as a methodology.

These are not performance criteria if you're looking for physical parameters. This is a methodology by which a designer can determine those physical parameters based on all the discussion we just had about what are they relying on for functional containment. So --

MEMBER BLEY: By the way, you've still got approach in some places in the paper.

MR. RECKLEY: Yes.

MEMBER BLEY: The same thing that you used methodology for.

MR. RECKLEY: Yeah. I'll be honest, this didn't go through the technical editor, so I -- I was putting -- I put it in a few places.

MEMBER BLEY: I just wanted to let you know.

MR. RECKLEY: Okay. We added a sentence on validation of computer codes. As I talked about, you know, in this slide, there is -- we're laying out a framework.

The assumption, inherent assumption, is that all of this traditional work, like fuel qualification, validation of computer models, really everything you need to understand about the behavior of the plant and the behavior of how radionuclides go from one barrier to another or get stopped by a barrier, all that work, scientific work, has to be done to support the safety case.

We're just laying out kind of the regulatory structure. All the technical work still needs to get done to support the safety case argument.

We did add one sentence. We had -- we had alluded to we made it a little more clear that there will be future papers coming out of the licensing modernization project activities. Again, where -- where we're coming back to the ACRS in the summer to talk about the general framework and some of the things in more detail, our thinking is things like the frequency consequence target figure, once we make a move to say we're going to endorse it in a regulatory guide, we want to at least make the Commission aware of that.

It may be -- we haven't decided yet, but it may be that we have to ask the Commission to weigh in on that, so that we get something firm to move forward on. So there's an understanding that this will be the first paper and there will be a number of -- at least one -- in all honesty, there will be any number of papers that come out of this effort to go to the Commission to weigh in on specific aspects of the framework.

In a few places, we tried to change the wording just a little bit to tweak it, in that there were places we said the building -- should the building have this function. And it's likely the building is going to have some function in retaining radionuclides.

Once I build it, why would I not take advantage of it in the analysis. And so -- so we changed -- just tweaked the words to make it a little more clear that it's likely that the enclosure would serve -- would serve some purpose in at least some of the event categories.

MEMBER KIRCHNER: I would recommend that you add shielding. I think it's there, but now that I look at it again, I don't see it.

MR. RECKLEY: Okay.

MEMBER KIRCHNER: At least it -- I don't see it in the bowties list.

MR. RECKLEY: Okay. And then in terms of the defense-in-depth discussion, we had a couple of sentences. But the meat of it is here on the slide, that the performance criteria are met without exclusive reliance on a single element of a design or a program. I don't know if that goes as far as -- as you would propose. Probably not, but it --

MEMBER MARCH-LEUBA: No. I wanted diversity independence.

MR. RECKLEY: Okay.

MEMBER MARCH-LEUBA: If you put two pieces of paper, you have two but they are still the same thing. But it's a good try. It's a good try.

MR. RECKLEY: Part of the -- part of the problem -- I'll be honest, part of the problem is when you look at the spectrum of possible things we're trying to address here, it makes it even difficult for me to say straightforward anything that looks close to -- to what full size the existing plant looks like, I think no one would really argue the point, because as you get smaller and smaller, I don't know that you reach -- or some of these technologies, and we're trying to make sure that we don't unnecessarily start putting up restraints that may not be needed for some designs. But that -- this will be a discussion that we continue.

And then, so those are really kind of a summary. Again, we didn't change very much from the subcommittee.

And then, lastly, the recommendation stays basically the same, that we're asking the Commission to go ahead and approve the use of this kind of a methodology to define the performance criteria for a functional containment, and then we summarize that approach or methodology in terms of the event categories, and aggregating all of the credit that is taken for any particular SSC. And then that becomes the performance criteria for the functional containment for that design.

So that really is the end of the --

MEMBER MARCH-LEUBA: Can I make a philosophical comment? You started this presentation saying that one of the driving forces here was to reduce the regulatory uncertainty, which is a very good goal. I am worried that what we are adding here is a lot of regulatory burden, because if you follow this approach to the letter, you are going to have to require a perfect PRA with extreme detail, full of analysis, whereas the directors are expecting to write a single piece of paper saying, "We don't melt the core. We don't need nothing."

MR. RECKLEY: And we're having that discussion. What -- if we can -- if we can lay out that this -- that this general approach would work for the whole set, if any particular developer can say, for example, I don't want to do analysis of all of this stuff, I want to, for example, go back to a concept of maximum hypothetical accident and simply say -- well, it's used -- the reason it comes up is some of these reactors are getting in size comparable to research reactors, and research reactors still use a concept of maximum hypothetical accident that just says you take my inventory and treat it even non-realistically.

And I still don't get -- I still -- if any developer wants to make a similar argument, my point is they can make the argument and they can say, "Using that most conservative maximum hypothetical accident, I'm near zero, and that thing is way down there at 10 to the minus 7 or 8," and that's an argument that I don't need to do much other assessments.

What we're -- what we're trying to weave in is whether that's a different approach or it's a -- it's a different path within this same approach. And we're still working with the industry to say how they want to characterize that. Personally, I think --

MEMBER MARCH-LEUBA: Just make sure -- just make sure you don't preclude that simple approach.

MR. RECKLEY: No, no. And as Amy mentioned in the -- in the severe -- in the advanced reactor policy statement, it's a goal that when you do stuff simpler, the analysis and other aspects of the licensing is also made simpler. You don't want to have a simple design and then us not recognize it as also supporting a simpler approach in terms of the analysis and the licensing.

So, yeah, we're -- we're cognizant.

MEMBER BLEY: Okay. Anything from the members?

MEMBER RAY: Well, since I think we've got a minute here, we can't start --

MEMBER BLEY: Well, there is something else we can do.

MEMBER RAY: I see. All right.

MEMBER BLEY: But if you want to make a speech, that's fine.

MEMBER RAY: I don't plan that. I just want to take advantage of the time if we had it, but if you've got something else to do, I want to just say to Bill that there was a couple of times he made comments that I wondered about, but I didn't want to interrupt. And you talked about Chapter 15 items or Chapter 15 analyses, things that we rely on being on a cue list. A couple of times you mentioned tech specs.

If somebody has operated plant -- I'm not the only one here who has -- I just would like to be sure that the import of having some things -- the availability of something covered in tech specs is understood, and there isn't just this continuum of, oh, well, we'll set reliability goals and we have the maintenance rule and stuff like that, because it's a world of difference between having something available in accordance with the tech spec and having to have it available on any other basis you want to think about.

MR. RECKLEY: Yes. The -- yes, there will be those. The reason I hesitate or stammer here a little bit is because -- because you know what's going on in tech specs for operating reactors is -- as things like completion times and other things are less prescribed than they used to be.

And I don't want to say that approach won't be taken here, but I will -- I will say there will be limiting conditions for operations, and -- and requirements in terms of availability in the tech specs, maybe not as prescribed as they were originally in light water reactors, this is way beyond the discussions we're having yet with the community.

But the importance of that I share with you is that I look at that as another defense-in-depth kind of approach in that you're analyzing them different, you're treating them somewhat different. You know, one is over here in a reliability assurance program; one is over here in tech specs, and you get that kind of --

MEMBER RAY: Yeah. I mean, so often

people think of things that are on a cue list as just gold-plated. It's not necessary; it's a bunch of crap. But when you're running a plant around the clock, if it's a requirement -- and I'm not saying the requirements should be as they were in the past -- but if it's a requirement and you're going to get cited if you fail to meet that requirement, it's a big difference between that and what you assume about what we now call Chapter 19, beyond design basis, FLEX stuff, and all that. It's just a world of difference.

MR. RECKLEY: Right. All of the discussions to date, that is maintained.

MEMBER BLEY: Thank you. Anything else? Is there any -- yes, ma'am.

MEMBER DIMITRIJEVIC: I know you're not going to be happy to see me talking about this, and especially, you know, I can see history of the curve, but looking -- and I saw it before. And to me, it looks like, you know, this story about naked king and nobody wants to say the king is naked. But actually it's naked.

MEMBER BLEY: The Emperor's New Clothes.

MEMBER DIMITRIJEVIC: Well, the thing is, this is not the PRA curve. If it's a PRA-related curve, it should be really clear what event sequences we are talking about. Is that, you know, large releases, the Level 3, Level 2, and they are not really directly related to initiating events.

So if this is deterministic approach, that's fine, and I am getting all related things. If this is deterministic structure, that's a deterministic structure. But then let's don't discuss the PRA approach, and that's my point.

MEMBER BLEY: Is there anybody in the room who would like to make a comment? Is the phone line open? Ron, is there anybody on the phone line who would like to make a comment? Please identify yourself and do so.

Hearing no comments, I'm going to turn it back to you -- no, I'm not. I'm going to -- I'd like to go through my bullet points after we end this piece of the session.

At this point, we're going to go off the record and thank the staff for a great discussion.

(Whereupon, the above-entitled matter went off the record at 3:18 p.m. and resumed at 3:49 p.m.)

CHAIR CORRADINI: Okay. We'll come back into session. We'll take up our second topic of the day, which is the WCAP 17938.

And Harold, do you want to lead us through this, please?

MEMBER RAY: Yes. Thank you, Mr. Chairman. On February 7 the AP1000 subcommittee met on this topic, WCAP 17938, Revision 2.

And we will now be presenting it here to the full committee. The document is almost entirely proprietary, as is the staff safety evaluation.

And therefore, we will conduct an open meeting, which is what we're in now. We will take following the Westinghouse and staff presentations, we will take any public comments.

Then we will close the line. And the remainder of the meeting will be closed to include just those who are qualified to participate in the discussion of the proprietary material.

I think that's the -- all I need to say by way of introduction. Don, is there anything you wanted to say before Westinghouse begins?

MR. HABIB: No. We're ready on the staff side.

MEMBER RAY: Okay. Then in the interest of time, I'll turn it over to Westinghouse. And please proceed.

MR. SINHA: Okay. Good afternoon. My name is Shayan Sinha. I work in the AP1000 licensing group.

And here with me is Zach Harper. He's a manager of the AP1000 licensing group. And we're representing Westinghouse and will be -- we're very grateful also to be able to present this topic, WCAP 17938 to the ACRS full committee.

So, I just wanted to start by discussing a little bit about the background of GSI 191. And specifically the GSI 191 related design basis.

So as part of GSI 191 plans that are required to place limits on debris inside containment. And the purpose of these limits is to ensure that following a LOCA that the debris doesn't result in some cloggage.

It's part of the recirculation and long-term debris cooling. Long-term core cooling. So the AP1000 actually significantly reduces many of the limits compared to a lot of the generation two plants.

Essentially, this is because some of the GSI 191 related learnings can be incorporated into the design. And put into practice before construction and operation.

One of the limits that is considerably lower is the fibrous debris limit inside containment, which is 6.6 pounds per the AP1000 DCD. All this fibrous debris is attributable to latent debris.

So in other words, following the LOCA, the expectation is that no debris will be generated because of the LOCA.

MEMBER RAY: Well, and let me just quibble a little. I guess I would say it's a requirement, at least as far as we're concerned in this proceeding.

MR. SINHA: Correct. And that's how we're treating it again, in our evaluation of this topic.

MEMBER RAY: Yeah. That's right.

MR. SINHA: The metallic reflective insulation is used extensively inside containment including on the reactor vessel itself. And the DCD and the Vogtle FSAR provide requirements that must be demonstrated if you want to use an alternative fibrous debris rather as opposed to MRI.

And these requirements include that we need to demonstrate that this alternative insulation is a suitable equivalent for the purposes of GSI 191.

There needs to be testing that will demonstrate that this alternative insulation is a suitable equivalent to metallic reflective insulation. And will not generate debris or transport debris. And also that the testing must be approved by the NRC.

So the purpose of WCAP 17938 is three

items. The first item is we wanted to establish a zone of influence applicable to all AP1000 in containment cabling that would demonstrate that it would not produce debris following a LOCA.

We wanted to gain approval that nonmetallic insulation used in the reactor insulation system for AP1000 is a suitable equivalent to MRI for the purposes of GSI 191. And we also wanted to gain approval to utilize NEI 04-07 alternate methodology for defining debris generation break sizes.

Which is a methodology that is approved generically in the NEI 04-07 safety evaluation. However, it was not previously applied to AP1000 specifically.

And essentially the testing analysis that I'm going to describe is -- helps us demonstrate that neither in the cabling nor the nonmetallic insulation would contribute to post-LOCA debris.

MEMBER MARCH-LEUBA: Shayan, can you shortly for the record, tell us whether these are post-core cables? So if a cable has to penetrate the zone of influence, what happens?

MR. SINHA: So the -- essentially we would have to protect it. We'd have to incorporate a protection scheme that we think would prevent it from producing debris.

So yeah, I think that's something that's noted in the topical report that it's not specifically approved in the topical report. But essentially that's a criteria for cable that would go unprotected, is the 4D ZOI.

However, if it's inside the 4D ZOI, then we would have to come up with a different protection scheme.

CHAIR CORRADINI: So, can you slow down and say that again?

MR. SINHA: Sure.

CHAIR CORRADINI: So that if it's inside the zone of influence, it has to be protected?

MR. SINHA: Yes. That's correct.

CHAIR CORRADINI: Okay. Fine. And if it's outside, based on some methodology, it remains however it's normally -- the cable is normally supported in and installed?

MR. SINHA: Yes.

CHAIR CORRADINI: Okay. Great. Thank you.

MEMBER RAY: Let me just add one little thing here too actually in the staff safety evaluation. It's the responsibility of the licensee to, and they use the term various methods for providing protection, to demonstrate the adequacy of the protection provided within the zone of influence.

So, it's agreed outside the scope of what we're dealing with here.

MR. SINHA: Slide please. So a little bit of background of how this topical report came about. There were two items that essentially led to the creation of WCAP 17938.

The first item was that an issue was uncovered that the cabling inside the AP1000 containment may contain fibers and other materials -- fibrous materials and other materials that could potentially be debris. But it was not -- were not sufficiently evaluated previously as debris sources.

So, as part of the resolutions issue, corrective actions were taken. And they included the development of a test program to establish a zone of influence for in containment cabling.

The second item is that nonmetallic insulation is required in the reactor vessel insulation, because they are components that perform functions beyond the insulation function.

So for example, the three subcomponents are locations that are in the scope of this topical are shown in that figure to the right. And the CA 31 module, neutron shielding blocks are there for neutron shielding function.

They prevent neutron streaming upwards in the containment. The lower neutron shield is there to prevent neutron streaming into the reactor cavity to reduce some of the dose in the reactor cavity in the lower portions of containment.

And then the water inlet doors support the in-vessel retention function for the -- for the beyond basis accident scenarios.

CHAIR CORRADINI: Can you point to those again? I'm sorry.

MR. SINHA: The water inlet --

CHAIR CORRADINI: Well, you have the mouse. And you can do the mouse.

MR. SINHA: Right. So the water inlet doors are here.

CHAIR CORRADINI: Oh, okay. Thank you.

MR. SINHA: Yeah, so those are there to, you know, they need to allow water in like following a severe basis accident and when we are demonstrating the in-vessel retention capabilities.

So, some of the summaries of the results of our program that we -- that evaluated these nonmetallic insulation cables. So there was extensive large-scaled jet impingement testing that was performed to establish the zone of influence for in containment cables of 4 L/D.

This testing was performed at a laboratory that was used previously for a Pressurized Water Reactor Owners Group in their establishing of the zone of influence for other operating plants.

And essentially this 4 L/D ZOI was incorporated in as a design requirement, as a design criteria, as we evaluated the routing cables inside containment in advance of actually installing any cable or cable tray.

The WCAP invokes the alternate evaluation methodology from NEI 04-07 to determine the minimum break size when considering debris generation break in AP1000 components. And then the insights from the nonmetallic insulation, jet impingement, and submergence testing programs resulted in design changes that strengthen elements of the second points of the reactor vessel insulation.

So essentially the design was changed to use thicker and more robust encapsulation methods. So essentially, as part of these programs, we were -- the WCAP justified that no new debris was generated from the AP1000 cabling for nonmetallic insulation.

And then finally, so our conclusions. So a zone of influence of 4 ID is applicable to the AP1000 in containment cabling founded by testing analysis.

The application of the NEI 04-07 alternate break methodology was acceptable for use in AP1000. And the cabling does not contribute to AP1000 post-LOCA debris limits.

With regards to the nonmetallic insulation, the encapsulated nonmetallic insulation used in the AP1000 reactor vessel insulation, would not produce debris when subjected to jet impingement from limiting line breaks.

And then neither the cabling nor the NMI was found to contribute to the chemical debris when it's imposed by GSI 191.

And then finally, based on the consideration of the submergence testing and the jet impingement testing and analysis, the conclusion was that the nonmetallic insulation used in the reactor vessel insulation is suitable equivalent to MRI for the purposes of GSI 191.

And just to kind of reiterate the overall conclusion that the WCAP justifies that there's no new debris generation for AP1000 cabling for nonmetallic insulation.

MEMBER RAY: Questions? On this segment. Okay.

MEMBER SUNSERI: I had one. Just one question.

MEMBER RAY: Yeah. Sure, go ahead.

MEMBER SUNSERI: So I don't -- I remember we had the discussion. But I don't remember the outcome during the subcommittee meeting.

But, -- so the cables that were tested, I mean different manufacturers will have different insulation systems, different filament material, et cetera.

So, is this evaluation for that specific manufacturer for zone of influence of 4? Or is it a generic cable?

MR. SINHA: So, the -- essentially the -- well, we -- yeah, this cabling that we used from this vendor is a benchmark of sorts.

And we've added wording into the DCD markup that says that it's a 4D of ZOI is applicable -- it's essentially that the bullet that's there that says it's applicable to AP1000 containment cables founded by testing and analysis.

And I think -- I believe the staff has added some wording to the safety -- to the revised safety evaluation saying that really if, you know, it would need, the cable would need to be reassessed if there's a change in vendor.

So, I think the staff could expand on that more when they have their discussion. But, as an outcome of that comment from the last two meetings, those two changes were considered and made and we're moving forward with the topical.

MEMBER RAY: We'll follow up on that a little bit in the impression part of the meeting. Anything else?

(No response)

MEMBER RAY: Okay. Thank you very much. We will now ask the staff to come and give their corresponding presentation.

And then as I said at the beginning, we'll seek any comments that members of the public may have. Please proceed when you're ready.

MR. HABIB: Good afternoon. My name is Don Habib. I've been serving --

MEMBER RAY: Don, I question if you have your microphone on. Or if it's close enough to you. There you go.

MR. HABIB: Now we're good. Better. Thank you.

Good afternoon. My name is Don Habib. I've been serving as the project manager for the staff review of this technical report.

And I'm joined by Clint Ashley and Boyce Travis, who are members of the technical review team. And we'd like to thank you for the opportunity to present the draft safety evaluation topical report.

And look forward to answering your questions either in this public session or in a closed session for any proprietary matters.

Since the subcommittee meeting on February 7, the staff had made changes to the draft safety evaluation. And we've provided that revised draft to the subcommittee.

The staff inserted additional information partly in consideration of remarks from the subcommittee meeting. And we also revised it to address the change to the topical report submitted by Westinghouse.

And so in the next few minutes I'll provide an overview of the staff's review. And after that, Clint will talk about those key changes that we made.

The technical review team includes Clint Ashley, Boyce Travis, as well as Renee Li, Greg Makar, and Malcolm Patterson. They're all from the Office of New Reactors.

We also worked with our counterparts in the Office of Nuclear Reactor Regulation. So they also participated in the review.

As background, this topical report is a document that addresses a technical topic related to power plant safety. And these topical reports, they address generic issues.

They can affect multiple plants. And are intended to help make the licensing change process more efficient for those plants.

For example, when multiple plants will be addressing the same licensing issue. In this case the topic relates to GSI 191 and examines the assessment of debris and PWR sump performance.

And this topical report is specific too just the AP1000 design. So approval of -- a staff approval of this report would allow AP1000 licensees to use this in support of future licensing changes.

The AP1000 design as it's currently certified states that a loss of coolant accident, or LOCA, in the AP1000 does not generate fibrous debris due to damage to insulation or other materials in the AP1000 design.

Instead of using fibrous insulation around pipes and components, the AP1000 design uses metal reflective insulation. Which does not generate debris during the LOCA.

The AP1000 again, the design allows for substituting other materials that are considered suitable equivalents to metal reflective insulation. If the testing shows that they do not generate or transport debris, and if that testing is approved by the staff.

This topical report seeks NRC approval for three items related to the potential generation of debris. First it requests that a zone of influence be established for electrical cabling and containment.

The AP1000 as it's currently certified does not explicitly address cabling and cable insulation. Or the generation of debris from cable.

And so this topical report, under this certain cables could be used in containment if they are located outside the defined zone of influence.

Second, the report requests NRC approval for the use of nonmetallic insulation as a suitable equivalent to metal reflective insulation at certain locations within containment.

And as previously mentioned, the use of metal reflective insulation is a key design feature of the AP1000 design that supports a generation of zero debris in containment.

Finally, the report requests NRC approval of the use of NEI 04-07 PWR sump performance evaluation methodology. Which requests -- which provides an alternative methodology for plant specific evaluation of sump performance.

And that's already been approved by the NRC. And this would allow it to be applied specifically for the AP1000 design.

The main guidance that staff used in support of the evaluation included the NEI 04-07, as well a -- the staff safety evaluation that's written in approval of the NEI 04-07.

In addition, it included WCAP 16530, evaluation of post-accident chemical effects in containment sump fluids to support the PSI 191. And that takes the evaluation a further step, looking at chemical affects in addition to debris.

MR. ASHLEY: Hi. I'm Clint Ashley. These are just some of the updates that we made to the WCAP and the associated safety evaluation.

So when the subcommittee meeting was held on February 7, 2018, there was some discussion amongst the members about the potential for replacement cables to have a different construction and possibly performance when it came to zone of influence.

So in response to that, the applicant did strengthen the WCAP. And in particular that language that's incorporated in -- that will be incorporated by a licensee who adopts this WCAP.

In their updated final safety analysis report will clarify that that ZOI radius applicable to AP1000 in containment cables is bounded by the testing and analysis that's presented in the WCAP.

So that was one area that the applicant strengthened their WCAP. And in response to that same overall comment, the staff added a limitation.

And we recognize that there could be new or evolving cable designs that may have different cable construction. And these cables may exhibit a different zone of influences.

So the licensee or an applicant would need to evaluate those cable design changes to ensure that those new designs don't impact adequate and long term core cooling.

We also clarified a comment that Dr. Rempe had made, on the WCAP used the reference towards an ACRS letter when it talked about chemical affects and cables. So we clarified some of the language in the SE that talked about how the staff actually used that WCAP reference. Next slide.

In summary the staff reviewed the three items presented in the WCAP, and summarized on this slide. In the draft safety evaluation, the staff finds the approach described in the WCAP acceptable.

And approves and requests subject to limitations and conditions. I just sited a new limitation and condition that we added on the previous slide.

Just for rec -- to recall, we also talked about a limitation and condition about performance of cables within the zone of influence was outside the scope of the WCAP.

We also have a limitation on the quantity of aluminum in containment. We also have a limitation. It talks about the evaluation of the neutron shield block.

We didn't evaluate it for its neutron performance or shielding performance. It was merely an evaluation to look at it from a GSI 191 perspective, a debris generation perspective.

And I think that covers most of the limitations. That concludes the staff's presentation.

MEMBER RAY: Thank you Clint. Okay. Questions on this phase of the staff's presentation before we move onto the closed session?

(No response)

MEMBER RAY: Okay. And now then I will have to pause for a bit and ask for the comments that members of the public may have who are either here in the room. Are there any in the room who wish to make a comment?

(No response)

MEMBER RAY: If not, then I'll make a similar request to anyone on the telephone line. I'm assured that it's open. And if --

MR. BROWN: The line is open.

MEMBER RAY: Thank you Theron. If there is anyone who would like to make a comment, please merely identify yourself and make your comment.

(No response)

MEMBER RAY: Nothing then. In that regard we'll close the line and enter the proprietary section of the meeting today.

And in this case I'll ask that Westinghouse and staff verify that the room is occupied only by those who are authorized to participate or observe the proprietary discussion.

(Whereupon, the above-entitled matter went off the record at 4:12 p.m.)

Presentation to the ACRS Full Committee

Draft Safety Evaluation

AP1000 In-Containment Cables and Non-Metallic Insulation Debris Integrated Assessment

WCAP-17938-P, Revision 2

April 2018

Presentation Topics

- Introduction
- Overview
- Updates
- Summary

Introduction

- NRC Technical Reviewers

♦ Clint Ashley	Containment and Ventilation Branch
♦ Boyce Travis	Containment and Ventilation Branch
♦ Renee Li	Mechanical Engineering Branch
♦ Greg Makar	Materials & Chemical Engr. Branch
♦ Malcolm Patterson	PRA and Severe Accidents Branch

- NRC Project Manager

♦ Don Habib	Licensing Branch 4

Introduction (cont'd)

- A topical report is a document that addresses a technical topic related to nuclear power plant safety.
- In topical report WCAP-17938, Westinghouse updates the AP1000 plant safety analysis related to Generic Safety Issue 191 (GSI-191).
- Westinghouse seeks review and approval of WCAP-17938 by the U.S. Nuclear Regulatory Commission (NRC) for use in the licensing process by AP1000 licensees.

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

Overview

- The AP1000 design basis in part states that "a LOCA in the AP1000 does not generate fibrous debris due to damage to insulation or other materials included in the AP1000 design,…"
- As such, the WCAP seeks NRC approval for three items:
  1. A zone of influence (ZOI) for electrical cabling in containment.
  2. Use of non-metallic insulation (NMI) as a suitable equivalent to metal reflective insulation (MRI).
  3. Use of NEI 04-07 alternate evaluation methodology to assess debris generation.

Overview (cont'd)

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- Main guidance for evaluating WCAP-17938:
  - Nuclear Energy Institute (NEI) 04-07, "PWR Sump Performance Evaluation Methodology"
  - Safety Evaluation for NEI 04-07, "PWR Sump Performance Evaluation Methodology"
  - WCAP-16530-NP-A, "Evaluation of Post-Accident Chemical Effects in Containment Sump Fluids to Support GSI-191"

Updates (WCAP and SE)

- ACRS Subcommittee meeting held on February 7th 2018.
  - Identified the potential for replacement cables to have a different construction and performance (i.e., ZOI).
- In response, the applicant strengthened the WCAP:
  - ZOI radius is applicable to the AP1000 in-containment cables "…bounded by testing and analysis..."
- In response, the staff added a limitation:
  - "Because new or evolving cable designs may have a different cable construction that could exhibit a different ZOI, licensees or applicants must evaluate cable design changes to ensure that new designs do not impact adequate long term cooling."
- Staff also clarified the SE discussion (Section 3.2) on references used for assessing chemical effects due to cables.

Summary

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- The WCAP requests staff review and approval for three items:
  - the application of the proposed ZOI for cables
  - the determination that NMI located in the reactor vessel cavity is a suitable equivalent insulation
  - the application of the alternate evaluation for debris assessment
- The staff finds the approach described in the WCAP acceptable and approves the requests, subject to limitations and conditions.

WCAP 17938 Revision 2, ACRS Full Committee Meeting

April 5, 2018

Zachary Harper

Shayan Sinha

Background
AP1000 GSI 191 Design Bases

- **AP1000** design significantly reduces / eliminates debris sources that are typically found in Generation II plants
- Maximum allowable fibrous debris inside containment is 6.6 lbs
  - All fibrous debris is attributable to latent debris
  - There is no fibrous debris generated during a LOCA
- Metal reflective insulation (MRI) is extensively used in containment
- DCD/FSAR provides requirements that must be demonstrated if an alternative (fibrous) insulation to MRI is utilized
  - Insulation must be demonstrated to be a suitable equivalent insulation to MRI for the purposes of GSI 191
  - To qualify a suitable equivalent testing must be performed to demonstrate that debris will not be generated or transported
  - Suitable equivalent testing must be approved by the NRC

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Background
WCAP 17938 Purpose

Purpose of WCAP 17938 is to obtain approval of the following:

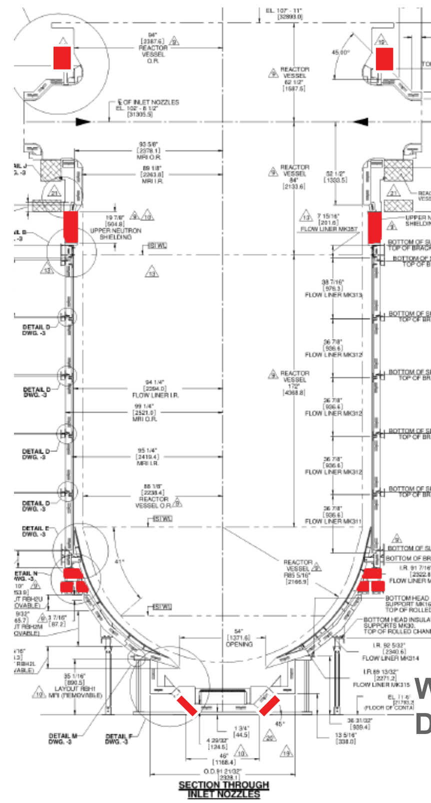
1. Establish a zone of influence (ZOI) applicable to all **AP1000** plant in-containment cabling to demonstrate cabling will not generate LOCA debris
2. Gain approval that the non-metallic insulation (NMI) utilized in the reactor vessel insulation systems (RVIS) is a suitable equivalent to MRI for the purpose of GSI 191 as applied in **AP1000**
3. Gain approval to utilize the approved NEI 04-07 alternative methodology for defining debris generation break sizes for **AP1000**

Testing and analysis is complete to demonstrate that neither cabling nor NMI will contribute to post LOCA debris

Background
WCAP 17938

- **AP1000** cabling may contain fibrous and other materials that were not considered in initial GSI 191 debris source term evaluations
  - Corrective actions included development of a test program to establish a ZOI for in-containment cabling

- NMI is required in RVIS because subcomponents of the RVIS perform functions in addition to insulation (such as shielding and in-vessel retention support)



Westinghouse

Summary of Results

- Extensive large scale jet impingement testing established a ZOI for in-containment cables of 4 L/D
  - Cabling ZOI design requirements were incorporated into the detailed design in advance of any cable or tray installation
- WCAP invokes the alternate evaluation methodology provided in NEI 04-07 to determine a limiting RCS break size in debris generation evaluation for certain **AP1000** components
- Insights from NMI jet impingement and submergence testing resulted in strengthening design for elements of the RVIS
  - Design was changed to use thicker and more robust encapsulation

WCAP justifies no new debris generation for AP1000 from cabling or NMI

Conclusions

Conclusions

- A ZOI radius of 4 IDs is applicable to the AP1000 in-containment cables bounded by testing and analysis
- Application of NEI 04-07 alternative break methodology is acceptable for **AP1000**
- Cabling does not contribute to **AP1000** post LOCA debris limits
- Encapsulated NMI applications utilized within the AP1000 RVIS will not produce debris when subjected to jet impingement from limiting line breaks
- Neither cabling nor NMI within the RVIS contribute to GSI 191 chemical debris limits
- NMI utilized as part of the RVIS is a suitable equivalent to MRI for the locations bounded by testing and analysis (for the purpose of GSI 191)

WCAP justifies no new debris generation for AP1000 from cabling or NMI