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UNITED STATES NUCLEAR REGULATORY COMMISSION'S
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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697TH MEETING

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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WEDNESDAY

JULY 6, 2022

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The Advisory Committee met via hybrid Video Teleconference, at 8:30 a.m. EDT, Joy L. Rempe, Chairman, presiding.

COMMITTEE MEMBERS:

JOY L. REMPE, Chair

WALTER L. KIRCHNER, Vice Chair

DAVID A. PETTI, Member-at-Large

RONALD G. BALLINGER, Member

VICKI M. BIER, Member

DENNIS C. BLEY, Member

CHARLES H. BROWN, JR. Member

VESNA B. DIMITRIJEVIC, Member

GREGORY H. HALNON, Member

JOSE MARCH-LEUBA, Member

MATTHEW W. SUNSERI, Member

DESIGNATED FEDERAL OFFICIAL:

DEREK WIDMAYER

ALSO PRESENT:

BOB BEALL, NMSS

AMY CUBBAGE, NRR

ROBERT DAVIS, NRR

RAYMOND FURSTENAU, RES

MATTHEW HISER, RES

WILLIAM JESSUP, NRR

BRUCE LIN, RES

STEVEN LYNCH, NRR

JESSE SEYMOUR, NRR

MARTY STUTZKE, NRR

C-O-N-T-E-N-T-S

P R O C E E D I N G S

(8:30 a.m.)

CHAIR REMPE: Good morning. This meeting will now come to order. This is the first day of the 697th meeting of the Advisory Committee on Reactor Safeguards. I'm Joy Rempe, Chairman of the ACRS. Other members in attendance are Ron Ballinger, Vicki Bier, Charlie Brown is not yet here, but we anticipate he'll make it when he gets through the traffic. Vesna Dimitrijevic, Greg Halnon, Walt Kirchner, Jose March-Leuba, Dave Petti, and Matt Sunseri. I note we do have a quorum.

Today the committee is meeting in-person and virtually. The ACRS was established by the Atomic Energy Act and is governed by the Federal Advisory Committee Act. The ACRS section of the US NRC public website provides information about the history of this committee and documents such as our charter, bylaws, Federal Register notices for our meetings, letter reports, and transcripts of all open portions of our meetings, including all the slides presented in such meetings.

The committee provides its advice on safety matters to the Commission through its publically available letter reports. The Federal

Register notice announcing this meeting was published on June 16th, 2022. This announcement provided a meeting agenda, as well as instructions for interested parties to submit written documents or request opportunities to address the Committee. The designated federal officer for today's meeting is Mr. Derek Widmayer.

A communications channel has been opened to allow members of the public to monitor the open portions of the meeting. The ACRS now invites members of the public to use the MS Teams link to view slides and other discussion materials during these open sessions. The MS Teams link to view slides and other discussion materials during these open sessions. The MS Teams link information was placed in the Federal Register notice, along with the agenda on the ACRS public website.

We've received no written comments or requests to make oral statements from members of the public regarding today's session. Periodically, the meeting will be open to said comments from participants listening to our meetings. Written comments may be forwarded to Derek Widmayer, today's designated federal officer.

During today's meeting, the Committee will consider the following topics: The proposed rule language for 10 CFR Part 53, Framework B and Framework A, Subpart F, the NRC Office of Regulatory Research activities to prepare for advanced manufacturing technology submittals, the SHINE Medical Isotopes operating license application.

I would like to ask members of the public out on the MS Teams link to be sure and mute your microphone. I am hearing some noise coming in from you.

A transcript of the open portions of the meeting is being kept. And its requested that speakers identify themselves and speak with sufficient clarity and volumes so they can be readily heard. Additionally --

Again, participants should mute themselves when they're not speaking. So at this time, I would like to ask other members if they have any opening remarks. And so if not, I'm going to ask Dave Petti to lead us through our first topic for today's meeting.

MEMBER PETTI: Okay, thank you. We're going to hear about Part 53. And to kick things off, Steve Lynch is going to begin things.

MR. LYNCH: Yes. Good morning, everyone.

My name is Steve Lynch, the Chief of Advanced Reactor Policy Branch in the NRC's Office of Nuclear Reactor Regulations. The NRC staff is pleased to meet with the ACRS today to continue discussions on the development of Part 53. The technology includes a regulatory framework for commercial nuclear plants.

Today the NRC staff is going to provide an overview of Part 53, Framework B, a technology-inclusive, risk-informed licensing alternative for new commercial nuclear plants where risk insights are used in a supporting manner, similar to the established licensing paradigms in Parts 50 and 52. Included as part of this discussion is a first of a kind, optional, alternative evaluation for risk insights approach, also referred to as AERI that can serve as a replacement for a probabilistic risk assessment for designs where the projected consequences of potential accidents are very small. The AERI approach is responsive to stakeholder feedback to provide flexibility in leveraging qualitative risk insights to inform design and licensing decisions.

Presenting today on Framework B and the AERI approach are William Jessup, Chief of the Advanced Reactor Licensing Branch I and Marty Stutzke, Senior Technical Advisor for Probabilistic Risk

Assessment. Part 53 continues to benefit from a robust dialogue with a diverse set of stakeholders, including the ACRS. An enhanced common understanding of key issues, supports and foreign changes to the preliminary proposed rule language that increases clarity, promotes reliability, and enhances efficiency.

We thank the members for your time today and look forward to hearing your perspectives and feedback. Thank you.

MR. JESSUP: Thank you, Steve. Thank you, Chairman Rempe, Member Petti, and other members of ACRS for the opportunity to present today. As Steve said, my name's Bill Jessup. I'm Chief of the Advanced Reactor Licensing Branch I in (audio interference) Division of Advanced Reactors and Non-Power Production and Utilization Facilities or DANU.

We know the members have had several opportunities to hear about Framework A. This will be a condensed version of the robust discussion we had on Framework B during the subcommittee meeting a couple weeks ago. We appreciated the feedback that we got during that meeting. We've already started working a lot of it into what will be an integrated version of the rule and talk about some of that in some later slides here.

As Steve mentioned this morning, the first presentation will focus on a broader overview of Part 53 Framework Bravo or B. And then the presentation will transition over to Marty Stutzke to go through the AERI approach.

Billy, could you move to Slide 3 please? Thank you. This is the agenda for this morning's presentation. I'm going to start with the broad overview again of the Part 53 structure as it exists today. Do a comparison of the Part 53 Frameworks Alpha and Bravo. Do some compare and contrast between the frameworks. And then get into a discussion of some of the key subparts and the highlights of Framework Bravo. And then finish up with a discussion of the guidance that's being developed for Framework Bravo. And looking forward at how we're going to integrate Framework A (audio interference).

Billy, could you move to Slide 4 please? Thank you. So on Slide 4 -- We did go over this slide in the subcommittee meeting two weeks ago, but I think it's worth revisiting to provide some context and set the stage for this morning's discussion as well. Again, this is a broad overview of what Part 53 as a whole looks like right now in its current form, which is a series of subparts Alpha through Uniform or A through U. Where Subpart Alpha is general provisions, including some common definitions that are applicable to both frameworks. After Subpart Alpha, the frameworks split. So currently Framework Alpha is made up of Subparts Bravo through Kuo or B through K. And Framework Bravo is made up of Subpart November or N through Subpart Uniform or U.

The frameworks are distinct. There is no mixing and matching between the frameworks again, unless there is specific direction within the rule that would permit the use of certain provisions between the frameworks.

MEMBER HALNON: Just a quick question. This is Greg Halnon, Court Reporter. I know that you've tried to consolidate the language so that you didn't have a lot of crosstalk between frameworks, there's a lot of repetition. Similarly, Part 50 and 52, there is some crosstalk there. So how did you decide when to allow crosstalk between the parts and repeat -- just repeat the language over (audio interference)?

MR. JESSUP: We tried to strike the right balance. I'd actually say there's two ways that Framework Bravo crosstalks. One is within Part 53, so talking to Framework Alpha. Where we could -- and certainly in Subpart F, Subpart P, the operator licensing, the staffing requirements, there's an area where the original language in Subpart F was drafted really in a way that it was independent of, you know, other cross references.

One of the difficulties we've ran into is if I send you over to Framework Alpha and say this section -- use this section. There are other internal references that start kicking into other places throughout the rule. And so we ended up deciding that in some cases, it's best -- decommissioning again is the perfect example. There's nothing about the analysis approaches between the frameworks that, you know, would prevent you from using the decommissioning rules in Subpart G. But there are so many internal cross references to other parts of Framework Alpha that we said, it just makes sense to copy those requirements over into Framework Bravo, which is now Subpart Quebec. And that way, you're not sent to other places of the rule.

And so what happens is -- It actually, I think, adds an element of clarity because now when you're in Framework Bravo, you really have your own set of consolidated requirements. There's not too much bouncing back and forth. Notwithstanding that, we did seek in some areas, you know, to make some efficiency gains and just point back. But we were limited by the way Framework Alpha was drafted in the first place.

The other part that I don't think we touched on a lot is that there are references back to Part 50. And we did that on purpose to make it technology-inclusive. We recognized that there are certain requirements, particularly for light water reactors that exist today. We tried to pull some of those over if size permitted. But we ran into some areas like codes and standards in Section 5055 Alpha. If anybody's familiar with that section, it's huge. It wouldn't make any sense to part it all over into Part 53 Framework Bravo. And so that size became a real limit issue. And so again in those cases, we just referenced back to Part 50. And we have conforming changes proposed that would say, you know, applicable to Part 50, Part 52, and now Part 52 Framework.

MEMBER HALNON: Okay. So administratively, I mean I guess the concern I have is, you know, the change -- have a revision in one spot and you miss the daisy chain. How are you administratively maintaining that big picture to make sure that they stay aligned and synchronized?

MR. JESSUP: That's a good question. I think that Part 50 and 52 alignment rulemaking is a perfect example of how that happens. That is the value of bringing over things into the framework where we can. But I think there is a fact of life element of this that things may change. I think we, and I think you, Member Halnon, made a comment about making sure we maintain all these job aids and tools we've developed. We actually have a very robust set of tools and crosswalks for where things came from. I think you saw some of it in Enclosure 1, the white paper that was issued with the draft rule text.

So I think that we have a really good method for traceability at least into Part 53 Framework Bravo, which should help alleviate those future synchronization concerns. So I would offer that as one, but it was a balance approach overall for what do you reference, what do you not.

MEMBER HALNON: Okay, thank you.

MR. JESSUP: So I walked through kind of the left-hand side of the slide. I want to walk through the right-hand side of the slide. Again, just to provide some context. Do some contrast between the frameworks. So Framework Alpha -- Again, a lot of discussion's been had on Framework Alpha. It's a Probabilistic Risk Assessment or PRA-led approach centered around really the idea of functional design criteria and that top down approach for meeting high level safety criteria where you're defining the low level safety functions. And then ultimately using that iterative design approach to develop your functional design criteria.

And that's the key contrast with Framework Bravo where you have -- as Steve acknowledged in the opening, a traditional use of risk insights and that they're supporting or complimentary. But then we're also leaning heavily on the principal design criteria, the way that the current frameworks in 50 and 52 are structured. And those principal design criteria, they serve as the more specific set of safety criteria grouped into those safety functions, but a start -- you start at the beginning with those PDC, as opposed to the top down approach where you work toward functional design criteria.

And then the last bullet there, again the Framework Bravo, it does include the AERI approach, which Marty's going to talk about in the subsequent presentation, including, I believe an evaluation of the actual rule text that brings in the AERI approach.

MEMBER PETTI: So just a question -- clarification. Framework B still requires the development of a PRA unless you meet the entry criteria for AERI, in which case it's optional. Is that correct?

MR. JESSUP: That's correct.

MEMBER PETTI: Okay. So basically it's consistent with 50 and 52 in Part A. Everybody -- PRA is there unless you can get into the AERI framework.

MR. JESSUP: That's correct. We pulled those provisions directly from 50 and 52 and that's where the 52 (audio interference).

MEMBER PETTI: Right. Thank you.

CHAIR REMPE: So again, I want to make sure that we're clear here. Because 50 and 52 after they're aligned will require a PRA no matter what. Right?

MR. JESSUP: Right.

CHAIR REMPE: Even in the figure you're going to be showing in the slides here, you say do you want to do a PRA? And if the answer is no, you try for AERI. So you are allowed to not do a PRA with Framework B.

MR. JESSUP: Well, that is a unique

aspect. But the overarching requirement is that you would have a PRA unless you meet the AERI entry requirement.

CHAIR REMPE: Yeah, but you don't' do the PRA unless you're a very rich applicant. If you think you can get to AERI, you may say I don't need to do one. And you're going -- you have to look at some sequences and do the accident analysis, but it's not necessarily required to do a PRA.

MR. JESSUP: That's correct. And that's a good -- that's a good caveat.

MEMBER PETTI: Now you've confused me. The baseline is -- If I come in and I'm a sodium reactor -- I'm a 1,000 megawatt electric sodium reactor anyway, I'm going to get into AERI. I mean the light water reactor, you said when we scaled it down, it won't make it. So the baseline is you're doing a PRA whether you go Framework A or Framework B.

` MR. JESSUP: That's correct.

MEMBER PETTI: I think it just depends on how you think about Framework B -- how you think about it. Is the PRA part of the baseline, and then there's this option to not have it? Or whether you come in, thinking you don't need to.

CHAIR REMPE: But if I have a small

microreactor --

(Simultaneous speaking)

MEMBER PETTI: I know. I completely agree. That's what AERI is all about is the microreactor. I'm talking about though that there's this -- that there are others that may want to come into Framework B that are larger. And I mean the whole rule is written sort of for spec.

MR. JESSUP: Yeah, I want to be clear. The baseline requirement is directly pulled from essentially 52.79 Alpha (audio interference), 6, I believe.

MEMBER PETTI: Okay.

MR. JESSUP: But there is the alternative evaluation for risk insights if you meet those entry criteria. And Marty, feel free to expound or clarify if you want. Does that make sense?

CHAIR REMPE: I think we (audio interference), even though we sound we disagree. Again, it's the only way after a 50.52 alignment in Lessons-Learned if that goes forward is passed. That will be the only way someone could not have a PRA is through Framework B with AERI.

MR. JESSUP: That's correct.

MEMBER BROWN: This is Charlie.

Fundamentally once you've aligned 50 and 52 with 53 -- I guess that's the way you're doing it -- Today Part 50 doesn't -- that's not a required PRA. That's just my memory from the past stuff we've done. So we're effectively -- You've realigned. You're effectively the increasing requirements for an applicant if they want to do a Part 50 approach. So we're making it more difficult. In the old days, they didn't have to do -- They may do one for their own use, but it wasn't a "requirement".

MR. JESSUP: Following the 50.52 alignment rule -- I don't remember the exact text -- but I believe a PRA would be required of all application times.

MEMBER BROWN: So we're effectively increasing requirements?

MR. JESSUP: I think we're aligning --

(Simultaneous speaking)

MEMBER BROWN: I'm just (audio interference) -- We're adding more stuff in that people are now required to do. It's a difference. I just wanted to make sure -- I'm not saying I agree or disagree. I'm just saying that is what the net effect will be.

MS. CUBBAGE: This is Amy Cubbage, NRC

staff. I'd like to just interject that the Commission's policy is that new reactors, whether they come in under 50 or 52 would do -- or a PRA, the alignment is to implement that commission policy. So you know, we would fully expect that an applicant today under 50 would be expected to do a PRA. And that we wouldn't be able to complete that review until that's completed. Because you don't -- you certify a design to the rules and effect of the time of certification. We fully expect the 50.52 alignment to be done before a new certification will be completed.

MEMBER BROWN: Is the policy the same thing as a rule or no?

MS. CUBBAGE: No, but I could pull up the references to the SRM for the 50.52 rulemaking where the commission has set that expectation that the same technical requirements would apply whether you come in under 50 or 52.

MEMBER BROWN: So it's not in the rule, the way it will be now once you do the alignment. I'm just trying to be clear so we know --

(Simultaneous speaking)

MEMBER BROWN: That's fine. It's not currently in the rule. But it is policy, but it's not in the rule. So it is subject to some type of interaction if you wanted to fight the policy. I'm not saying they would, I'm just saying it's a difference. So that is -- I didn't understand that totally before, but now I do. So thank you.

MR. JESSUP: Appreciate it. Thank you for your comment. With no further questions on Slide 4, Billy, could you move to Slide 5 please?

So we have the risk informed continuum or the risk spectrum here on Slide 5. And again, I just wanted to touch on kind of the -- a little bit of background -- a little bit of motivation for why we're talking about Part 53, Framework Bravo here. And that is in response really to stakeholder feedback on what was initially just Part 53, now Framework Alpha and the desire for more flexibility and use of PRA.

And so if you look kind of on the right-hand side of this continuum or this spectrum, you've really got the -- the results from PRA are used to inform a lot of what you do in design and licensing space in issuing event selection, SSE classification. And so what we've done here in Framework Bravo again as I've hit on, on the last slide is we've really gone back and looked at, you know, how do we traditionally use PRA and risk insights? And we've tried to address that and you know, cover the remainder of the spectrum to the extent that we could by looking back and adopting an approach that's similar, but represents kind of an evolution from what's in the current regulatory frameworks. And then, you know, on the left-hand side, you've got something where -- you've got more bounding analyses with more deterministic inputs. And that's somewhere we would seek out an area approach fitting (audio interference).

Billy, could you move to Slide 6 please? Okay, so this is another overview or a tabulation of what you saw on Slide 4. Again, very similar to what we talked about in the subcommittee meeting, but we did make some modifications based on some comments. And really good feedback about optics, you know, why are certain things here and why are certain things there? So what you'll see here is that Framework Alpha and Framework Bravo, they're largely mirrored. They have a lot of equivalent subparts, a few differences. And that's what we really tried to convey in the -- in the green shaded areas, which are subparts that are very similar between the frameworks where they use surrogate requirements and I'll get to those in a minute.

But if you look at Subparts November, Papa, Romeo or NPR on Framework Bravo, which of the definitions, requirements for operation, the licensing processes, these are really where the key differences between the frameworks lie. And these are the highlights that I'm going to focus on today.

But a couple other things to call out because I know we spent a lot of time on them a couple weeks ago are, you know, the corollaries to Subparts Bravo and Charlie, the safety and design requirements that are in Framework Alpha. Again, those are really embedded in Subpart R as technical requirements or part of the technical content of the application requirements in the same manner that they're treated today in Parts 50 and 52.

So it's not that we don't have the same requirements -- We don't have the exact same requirements, but we have similar requirements that serve the same purpose, they're just located in a different place. And then for citing right now, we currently adopt the requirements from Part 100, similar to the existing frameworks. But that's an area that we're working on.

MEMBER PETTI: Just a question on -- you talked about the technical contents of the submittal. TCAP and RCAP are only Framework A concepts then?

MR. JESSUP: Currently -- and somebody can step in if I, you know, don't say this correctly. I before they're actually written for 50 and 52, but also they would be looking forward to Framework Alpha. But we do have a separate activity going on at least to develop some advanced reactor content of the application for Framework Bravo as well.

MEMBER PETTI: Oh, okay. So they'll be accepted.

MR. JESSUP: That is our intent.

MEMBER PETTI: Okay, thank you.

MS. CUBBAGE: This is Amy Cubbage, NRC staff. Just to clarify that TCAP certainly was, you know, developed to incorporate the portions of the safety evaluation report or safety analysis report that are coming out of the LMP process. As Bill mentioned, that could be either 50, 52, or 53. But RCAP is broader than TCAP. And there are portions of RCAP that could be useful to an applicant using Framework Bravo.

MR. JESSUP: Thank you, Amy. Yeah. So just to expound on that one little bit more. We did look at the RCAP format and we had, you know, kind of studied it to see what in RCAP as it exists today, could we take forward to Framework Bravo. So we kind of used that as a starting point, to Amy's point as well.

MEMBER DIMITRJEVIC: This is Vesna Dimitrjevic. I have a simple question. Why did you decide not to repeat(unintelligible) in the -- in the Framework B?

MR. JESSUP: Thank you for the questions. So we looked at the safety and design and analysis requirements that are in Subparts Bravo and Charlie in Framework Alpha. Sorry, a lot of letters here. And we looked at those, but we also looked back at the existing frameworks in 50 and 52 and how those requirements are captured. And when you look at the existing frameworks, a lot of those requirements, they're captured as technical content of application requirements.

Something like Section 52.17 for an early site permit, that is where you would find a lot of the analogous requirements. And so that's the reason currently we've adopted that same structure in Framework B where those requirements, they really live as technical content of application requirements in Subpart R. And Subpart R has all of your application requirements, not just the technical content of application requirements. Does that answer your question?

MEMBER DIMITRJEVIC: That has a lot in common, you know, in the -- with the Subpart A. You know, there is -- Just (unintelligible) I was curious, why couldn't use separate the things so they could match other things. You know? Because now you have Subpart R, which is -- Also, you know, you can compare the parts with Subpart H. Right? Most of them. And then you have a few which are different. And I guess that covers for B and C. I was just curious.

(Simultaneous speaking)

MEMBER DIMITRJEVIC: It doesn't really look really logical if you just plain look at this. And you don't have, you know, safety requirements in both parts, you know, of the design analysis requirements. Just optically -- optically (unintelligible) my comment. Okay.

MR. JESSUP: No, we appreciate the feedback. And that's the reason there's -- We at least put Subpart R in the cell this time and not a dash because we appreciate the optics are different. We tried to establish as much as parallelism as we could between the frameworks. But we appreciate the feedback and understand the optics.

Okay. Billy, could you move to Slide 7 please? Thank you. So this is the first subpart that we're going to walk through, Subpart N. So these are definitions that are specific to Framework Bravo. There's only four of them right now. We talked through these during the subcommittee. Anticipated operational recurrence, again, this definition that we pulled into Framework Bravo, it's essentially taken from Part 50 of Appendix Alpha. And it's only here because in Framework Alpha, they also have this term defined, but it is defined differently. I think as Bill, directly from the NRC staff acknowledged during the subcommittee, Framework Alpha is actually looking to adopt a different term. So we may not have to bring this over.

AOO in Framework Bravo, it's used in the same context that it is in the existing or the traditional regulatory frameworks. Design bases and reactor coolant pressure boundary, we pulled these terms over from Section 50.2, the existing definitions for Part 50 because we do use these terms in Framework Bravo. Again, really in the same context that they're used in the existing regulatory frameworks, but they're not used in Framework Alpha.

And then safety-related SSCs, this is a term again that's shared between the frameworks. Not shared, I shouldn't say that. Framework Alpha defines this term differently than we would define it. And that's largely a product of the different approaches for SSC classification between the frameworks.

So in Framework Bravo, we actually split it. For light water reactors, we adopt the same definition that's currently in Part 50. For non-light water reactors, we adopt a more broad definition that's really focused on any SSC that's used in DBA mitigation, including those that would be part of a blocking containment concept.

Then the last bullet here is really just talking back to kind of an integration between the frameworks. So common definitions, so the terms that are going to be shared between the frameworks, those will be -- will remain in Subpart Alpha in Section 53.20 most likely.

Billy, next slide please. Thank you. So Subpart P, again to hit the highlights of the requirements for operation, structured very similar to Subpart F in Framework Alpha, those requirements for operation. When you look at a lot of the key programmatic requirements for things like security, emergency preparedness, radiation protection, they're essentially aligned directly with those in Framework Alpha. We look at staffing, training, human factors

-- I think that, you know, we talked about this already this morning from an administrative or a structural perspective, but we were able to adopt essentially all of those provisions from Framework Alpha in Framework Bravo with the exception of the generally licensed reactor operator concept, which we all heard about two Fridays ago during Jesse Seymour's presentation. The staff is working to see whether we can adopt those provisions in Framework Bravo, but that's currently under consideration -- a work in progress.

The last major bullet there, other requirements. So where we couldn't look at Framework Alpha and you know, use certain provisions over there, we did look back to the existing regulatory frameworks to see whether those requirements could inform what we were trying to do in Framework Bravo. So if you look at things like maintenance effectiveness, technical specifications, fire protection, you know, these requirements were really informed by things like Section 50.65, 50.36, 50.48 respectively.

And then we have a couple of specific items; primary containment leakage. So we pulled those programmatic requirements over because for a light water reactor, that would come in under

Framework Bravo, we still adopt the same requirements from something like Part 50 of Appendix Juliet such that you would have a requirement for pressure retaining -- a structural containment as opposed to a functional containment.

And then also environmental qualification of electrical equipment. We pulled these over because the way special treatments are developed and implemented certainly differs between the frameworks. A bit more restrictive in Framework Bravo, consistent with the treatment that they get in existing regulatory frameworks.

MEMBER PETTI: So Bill just to comment here. This concept of generally licensed reactor operator, I think it needs to be here in Framework B, particularly for facilities that can get in under AERI. Right? They're going to also want relief from having large operating fees, et cetera, et cetera. I mean there seems to be a synergy there if we didn't have it, would be, I think disappointing. You probably get that comment from industry, but it seems like there's an alignment there in that thought process.

MR. JESSUP: No, I appreciate the comment, Member Petti. It is an item we're actively working on. I think it was more of a timing consideration. And Jesse Seymour, I'll ask him if he would like to speak further about how that's being integrated and worked on right now.

MEMBER PETTI: Well, you just might see a comment in the letter.

MR. JESSUP: I understand.

MR. SEYMOUR: This is Jesse Seymour from the Operator Licensing and Human Factors Branch. And yeah, just harping back to some of the comments that I made last week in front of the committee. You know, our intention is to, you know, work through the developments of provisions for the general license reactor operator within Framework B. So it's not a matter of whether we do it or not, it's how we implement that at this point. So that's one thing I wanted to point out.

And then also as we work through, you know, what that next version of our requirements look like, you know, I just want to kind of go back to a comment made by Member Halnon earlier. And that has to do with, you know, kind of the consolidation of requirements where possible. So we're also looking at, you know, can we streamline and consolidate those operation requirements such that we just have one comment set that's applicable to both frameworks.

VICE CHAIR KIRCHNER: This is Walt Kirchner. Is the GLRO concept just to follow up on Member Petti's comment -- is that -- Do you have to pass the AERI test to have a GLRO?

MR. SEYMOUR: So what we're currently looking at -- And again --

(Simultaneous speaking)

VICE CHAIR KIRCHNER: And if not, what is the test?

MR. SEYMOUR: This is Jesse Seymour again. What we're currently looking at is -- and again, this is a work in progress -- but our intent right now is to develop provisions that would allow for, you know, facilities whether or not they are, you know, falling within the scope of AERI to potentially be considered for the general license reactor operator alternative. Now that's a complicated matter because you're talking about, you know, two potentially very different types of facilities. So again, you know, going through and developing those criteria is something we're having to approach very carefully. But our present intent is to develop criteria that would address both AERI and non-AERI facilities within Framework B.

MEMBER HALNON: So Jesse, where you're

going to run into trouble is defense and depth because so much defense and depth is dependent on the operator taking action. And that's part of the criteria you gave was that the operator was not needed for defense and depth. And I have a hard time seeing a facility that will say operator, you're not allowed to do anything when you see, you know, layers of other problems come in such as a safety system failure or something, which is where defense and depth has to come into play.

So I'd be interested in seeing how you maneuver through that portion of it, if any facility could ever pass the test of no (audio interference) required for defense and depth, which is the way it seems to be written right now. But anyway, that's your challenge, I think -- one of the challenges.

MR. SEYMOUR: Yes. And it's a -- it's a difficult problem to navigate. Our current takeaway -- and you know, I did appreciate the comments, you know, that were made by the Committee last week. And what we're currently looking at is can we refine the defense and depth criteria, such that you really are looking at, you know, what is credited to meet the defense and depth requirements? What we don't want to do is we don't want to, you know, hamper the ability of an operator that's there, that's qualified, you know, to some degree to be able to do things that are reasonable above and beyond that credited dense and depth scope. However, what we want to do is, you know, be able to draw some kind of a clean line with what needs to be done for analytical purposes on the front end.

MEMBER HALNON: And then your next challenge having said that is what if the operator doesn't do a reasonable action? You know, so that's the other problem you have to deal with is the operator inaction or error -- error interaction.

MR. SEYMOUR: I agree. Again, you know, not an easy set of criteria to develop. You know? And again, as we work through our iterations, you know, particularly as we went through and we looked at we looked at the new criteria of, you know, 53.800. As you go through those five criteria that are there, the fifth criteria, you know, is really aimed at addressing, you know, what the nature of the system structure components that are needed to meet safety functions? And what is that human capability to credibly, you know, take away their ability to do their jobs through an appropriate action? And then, you know, beyond that the question becomes as we, you know, move from rule language in the guidance space, you know, how do we approach that in a way that's going to allow for some reasonable, you know, approach to be made?

MEMBER HALNON: Yeah.

MEMBER BALLINGER: This is Ron Ballinger. I've been working through what I consider to be an extreme example of how this would work. And I can't get an answer. I can't figure out an answer. Let's say somebody wants to produce a fission battery. That's one of these concepts. How does that fit into -- into this AERI structure? Because there technically is no operator. Well, there's an operator, but how does that -- how does that work? As an example, how would a fission batter located in a steel mill or some place like that, how would that work out within AERIs?

MR. SEYMOUR: So I can -- I can speak to the operational portion.

MEMBER BALLINGER: Yeah. I mean that's really the important thing.

MR. SEYMOUR: Okay. Yeah.

MEMBER BALLINGER: I've concluded that it can't be done. But maybe somebody can tell me -- tell me that it can be done.

MR. SEYMOUR: Yeah. And so what I think

is important here is, you know, to take a step back and look at, you know, what we were really doing at a basis level when we developed, you know, the criteria that falls into the general license reactor operator criteria. And the question that we began with was the question of (audio interference) -- the reactor that doesn't need anyone to do anything operationally from a safety standpoint.

So we began with this hypothetical of, you know, if you could just delete all the licensed operators from the picture, you know, what would the result of that be? And what we found was that even if you could answer that from a purely operational standpoint, you know, you were still left with an issue from an administrative standpoint. And that was, you know, who would do things like the technical specifications, authorized departures from the licensing basis in the event of an emergency?

You know, in general, if we were going to summarize all that, you know, maintain that facility and be responsible for maintaining, you know, its licensing basis within analyzed state. And so what we found was that, you know, even if you could hypothetically delete the operator, you can never fully delete the administrator. You know, you were left with this administrative, you know, set of items that generally would have been assigned to a senior reactor operator.

And so what we did was we began saying okay, what are the qualifications of the individual that we needed to, you know, fulfil this? And reasonably, you know, how can you -- how can you have a gradation of that so that, you know, it's reasonable? So that it doesn't require, you know, necessarily a full-blown, you know, senior reactor operator program for example?

And as we worked through that problem, we encountered other things too that you really had to add onto that pool of stuff. Right? One of them was, you know, who would perform manual reactivity manipulations if they were needed? So even for this hypothetical facility that's fully autonomous, you may still have things like the initial physics testing facility where someone has to come in and do some, you know, manual reactivity manipulations. Even if once you're up and running -- once you started up, it runs itself.

Additionally, you know, in talking about something perhaps more complicated to where you actually go through a field core (phonetic), who will be responsible for supervising core alterations and things of that nature? So what we found was that, you know, really you needed an individual that was qualified to do these important things. Then the question became, you know, who can fulfil this?

And so what we've done with the general license reactor operator criteria is beyond just the qualification aspect, we've also incorporated some, you know, gradations of staffing and monitoring requirements that allow for additional flexibilities. And really what it's targeted to is the fact that, you know, this person won't be in a position to where they necessarily need to anything for safety. But someone needs to be doing the monitoring function and someone needs to have that administrative oversight of the facility.

So again, if we go back to that fission battery example. Right? You know, a microreactor, right, you know, something that is relatively, you know, small and comparatively simple. You know, you essentially need to have someone who's minding the shop.

MEMBER BALLINGER: An administrator doesn't have to be on site though.

MR. SEYMOUR: Well and this is where --

this is where, you know, I have to -- I have to qualify my comment here with the operational requirements that we've developed under Subparts F and Subparts P. You know, and again I speak purely to the staffing operator licensing human factors requirements, we have by design neutral in our wording and in our requirements in regards to the location of those operators. Everything is driven either by, you know, the capabilities of those operators to filter safety functions for the plants that require that. Or by the capabilities to fulfil the monitoring and oversight that needs to be done.

So in the case of, you know, the facility that we're talking about here, this hypothetical that would have a general license reactor operator, I'll give an example. The wording that we use in one particular requirement is that they need to have the capability to initiate a reactor shutdown from their location. Right? So what we don't do is we don't in our wording restrict that to any given location. The onus would be on the applicant to show how they're going to do that in a way that's reliable.

But what I can't do is I can't speak to the broader context of Part 53. So again, I can only speak for the operation requirements. So it becomes a question of remote operations and what is allowed in that domain. Again, I would have to, you know, field that back to Bill Jessup indirectly.

(Simultaneous speaking)

MEMBER BALLINGER: This is the equivalent of NASA (audio interference) nuclear-powered (audio interference) base application.

MR. SEYMOUR: I would say it's a little more involved than that. You know, there was some future-focused research that was done by our Office of Research on the topic of remote operations. And again, I'm not prepared to, you know, fully discuss what they -- what they worked, you know, through in the scope of that project. But one of the, you know, data sources they looked at -- I don't remember or recall was, you know, NASAs work, you know, that had been done in terms of, you know -- I think things that are being sent off into space. Right? And I think if memory serves me, I think that was part of their scope. And there are some different considerations. Obviously if you're sending something off into space from a safety standpoint, that's not located --

(Simultaneous speaking)

MEMBER BALLINGER: Well, but what if it's a man that's sent off into space?

MR. SEYMOUR: That's a good consideration. But again, you know, it's something -- it's something much different than what we're, you know, necessarily looking at.

(Simultaneous speaking)

MEMBER BROWN: My mind is just absolutely being blown. You know, after so many years of a reactor operator being known as the ultimate safety position (audio interference) the actual backup for a safety system -- you know, shutting down the plant. And now we're just weighing it with these hypothetical autonomous operations from all over the country, I guess brings it back to some solid ground. Any remote system like that is going to be so automated and so computerized that it will be grossly, you know, susceptible to being taken over.

You know, a prime example is you know, the simple system that we pointed out in one of our letters was the water treatment plant that some hacker got in, started pumping sodium hydrochloride or something like that into it to take care of -- kill all the bacteria. And if an operator hadn't been passing by or taking his occasional look or whatever his circumstance was and noticed, hold it. This concentration is just ballooning up -- and manually shut it down. He bypassed all that stuff and shut it down. Brought it back to where it was under control. Otherwise you would have had hundreds of thousands of people poisoned to death, you know, with a carcinogenic substance.

MEMBER MARCH-LEUBA: That was a good example. But you remember this liquefied natural gas (unintelligible) explosion in Texas last month, almost doubled the price of gas in Europe? As rumor goes that it was an internet attack -- a hacker (unintelligible) with a Russian. I read somewhere that you can go to the dark web and purchase with -- with a credit card, you can (audio interference) -- for $50, you can buy a denial of service attack. So whatever server you have (unintelligible), I can deny service for $50.

(Simultaneous speaking)

MEMBER SUNSERI: We're getting into (audio interference). Can we go back to the (audio interference)?

MEMBER MARCH-LEUBA: No, this is important. If you allow the mode of operation in your rule, you need to tell me how you're going to do it and put strict controls on how they're going to do it. Because you could say well, we're going to use (unintelligible) encryption on VPNs. Do you know what (unintelligible) VPNs? All those planes flying -- all those planes flying over Ukraine, which were so effective two months ago. Now not a single one makes it through because they just send (unintelligible) operations. So even the most robust form of communication, the Russians are jamming. So whatever you say that you are going to allow, you have to tell me how you're going to (audio interference).

MEMBER BROWN: Even if I don't -- I can't restrain myself.

CHAIR REMPE: But pretty soon, we're going to need to because we do have a limited time.

(Simultaneous speaking)

MEMBER BROWN: I understand that. But sooner or later somebody has to try to bring this thing back to ground zero again. Forget the (audio interference) operation. Just the autonomous operation, and now we're calling the operators administrators. They don't have to have that many qualifications. If that sucker -- even if it's autonomous, it's going to be connected somehow now if you look at all the stuff that's being put out. It's going to be able to be hacked. And there ought to be some manual means by somebody to come in, grab a stitch, turn it, bypassing all of the automated systems to shut the plant down. You may not solve all the problems, but you stop the critical process. And we seem to be abandoning that thought process. It just blows my mind. And I'm the resident skeptic. I am just not happy with this general, we don't need operators anywhere because we're so smart now. It's just --

MEMBER PETTI: Time out. The rule doesn't say that. Okay? We're talking about potential situations that are really outside the scope of the rule at this point. So I think we should just, you know, put this to the side. I think a lot of us have concerns about autonomous operations. But again, it's currently in the rule, that's not in there. But even if --

(Simultaneous speaking)

CHAIR REMPE: So also in addition to moving on, I'd like to ask whoever has a phone line ending with 92, I believe, to put themselves on mute because I believe that's where we're getting some sound. Okay? And then, I'm sorry to interrupt you.

MEMBER SUNSERI: I have one more comment, David. So this goes back to Part 53 and the changes you want to make to it, which I think conceptually I can get in line with. My question is, it seems like an unnecessary complication of the Part 53 rule to be including operator certification in it when I consider the fact that the existing rules or license operators take into account the training and the evaluations of the knowledge, skills, and ability that a person needs to possess to operate a certain design.

And for the light water reactors that are currently in operation, that's a lot of knowledge, that's a lot of skills, and that's a lot of little buildings. For one of these reactors that you're talking about, there might be very few knowledge, very few skills, and very few abilities. So applying existing framework would seem to be much more practical than to try rewrite a whole new rule. That's just my comment.

MR. SEYMOUR: There's a few points that I want to speak to if I could. I understand the Committee wants to move on, but if I -- if I could, I want to take a moment to step back (audio interference) around the discussion events. When we're talking about remote operations, right, that is not something that is specifically, you know, addressed (if I could put it like that). Right? What we tried to do with our rule was to, you know, with our operational requirements. Right? So we're talking about strictly, you know, the operational stuff here. We tried to, you know, write requirements that are durable. Right?

So we talk about requirements that are neutral in a lot of regards, so that we could accommodate, you know, future technological developments. Right? What we aren't trying to do with our requirements is to necessarily, you know, drive an agency stance on the broader question of remote operations. Right? We just tried to take a technologically neutral stance there. And again, you know, if there's a question about what the -- what the intent is -- the broader approach to remote operations, I would have to defer that to --

MEMBER SUNSERI: Yeah. But you're looking at me, so I think you're addressing my comment, but I'm not talking about remote operation. I'm just talking about certifying to operate a plant. And if it's a very simple plant, the licensing of that particular individual should be very straightforward. Not as complicated as what we do today. That's all I'm trying to say. And I don't see why the current framework couldn't be used to accommodate that with maybe some modification that would be less complex than the modifications you want to do with this.

If you want to think of an example -- a parallel example, the FAA certifies aircraft. They have a whole -- in 14 CFR on how to do the design. And they have a separate CFR for certification of pilots because there's a whole list of pilots, you know, that they try to accommodate. And instead of trying to blend those two together, just keep them separate. And it makes a lot of sense. It keeps it simple. And I think there's a parallel here.

MEMBER BROWN: I would echo Matt's comment. If the existing rules for developing certified operators have a lot of requirements, capabilities, everything built into them, if one of these reactors -- if we ever built one of them -- actually came to fruition and you determine that hey, look. Twenty of these -- Twenty of these 25 don't apply. You just ask for that as an exception. And you go forward with that, instead of trying to, you know, crank in all these hypotheticals into some new rule.

I totally agree with Matt from that standpoint. If this same framework has worked quite well, we know how to do it, don't throw it away. Adapt it. But don't try to put it in the rule. Adapt it on the fly as we build claims. That's my thought.

MEMBER SUNSERI: You could accommodate the regulatory uncertainty because it has certainty in the (audio interference) process and durability because it would be flexible enough to be durable for whatever you bring forward in the future. I'll stop talking.

MR. SEYMOUR: I would -- And again, this is Jesse Seymour. I would have to, I guess challenge the notion that, you know, what we've presented in Part 53 in any way does not facilitate that greater flexibility and adaptability. And what we've done specifically is we've taken, you know, a number of prescriptive requirements within Part 55.

And within Part 53, taking this approach, what we've done is we've driven a lot of our language to a higher level just to allow more things to be relegated to guidance. To allow for greater flexibility without the need for the extensive use of exemptions. And again, I think that's an important point to note is that, you know, to accomplish a lot of, you know, these flexibilities within -- you know, the relatively prescriptive framework in Part 55, it might be necessary to utilize exemptions. And that inherently is not an efficient process.

So again by having a rule that allows for a tailorable operative licensing approach and is built from the ground up to allow that, you know, I think you accomplish that same end in a much more efficient ways. Everything too that we've attempted to do is via building in a gradation as you move from the specifically licensed reactor operator (audio interference) operators to the generalized reactor operators is we recognize the facilities that can meet, you know, a certain technological pedigree, that you can remove a lot of the regulatory burden without any reduction of safety.

So again, that's something that we've attempted to do. One is to do design a rule that allows for that exact tailoring of the operating licensing process, you know, and does so in an efficient way. And also that allows for reduction in regulatory burden where there's no commensurate increase in safety.

MEMBER HALNON: Just to end this -- I think we need to probably to move on -- but just two things. One is you chose to address our original comment of moving beyond a certified operator and to just adapting the Licensed Operator Program that was in our first letter. And you chose it with the general licensed operator. I think it resolves some concerns, obviously not all.

But what I -- what I go back to is there will be a submitted staffing point that has to justify and provide for approval to the staff of how you could satisfy all these criteria that you're talking about -- the terms that Matt's talking about and Charlie. And all these things have to be taken -- And that's why the guidance that you put out for that staffing plan, how it looks, what it has to satisfy is extremely important, along with the criteria on how you get to being able to -- not being able to -- but having JLROs.

So you know, as we move on, those two things are going to be of high interest to us that we'll want to see the development of those at your earliest possible time, so we can provide the comments back to you on that.

MR. SEYMOUR: And it's our -- This is Jesse Seymour again -- It is our intent to bring that guidance, you know, to the committee. What I can say is that the staffing review guidance is being derived from the existing NUREG-1791, which is the, you know, established means of how you develop and request exemptions for staffing models that don't meet the existing requirements of 50.54. So again, that uses the human factors engineering-based approach that goes through a number of stages to determine what, you know, what the staffing compliment needs to be. And you know, using performance-based data show that it's suitable.

So again, we -- you know, that's the established processes out there right now. It's been applied by the staff previously. And what we're doing is we're essentially just adapting that to this new context because it's tried and true.

MEMBER BROWN: I would disagree with the thing that exceptions are a problem. I think exceptions are a very efficient way to take care of a wide ranging set of possible applications that you don't know all the details when you start. When I first started introducing computer-based systems into the Naval Nuclear Program in 1979, we didn't have any (audio interference) standards. We had no design specs. We had nothing. We went out with the analog specs. Brought all the equipment to the analog specs. And then guess what? We developed software requirements. And where things didn't work, we wrote approvals to say yeah, you don't have to do that. Exceptions are a very efficient way and don't get you all tied up in detailed rulemaking and everything else.

I just think you're not looking at exceptions in the right way. One way to look at it is if you didn't have exceptions, you wouldn't need rules.

(Simultaneous speaking)

MEMBER PETTI: Okay. Charlie, understand that industry, one of their top priorities is to not have to go through a licensing process with exemptions. Because in their mind, it's incredibly obvious.

MEMBER BROWN: I understand the point. But the NRC is the focal point for where these rules comes up. They ought to be able to write in and say hey, look. This doesn't apply. And then you ought to be able to get a decision process or NRC is responsible for putting in a decision process that allows that to be (audio interference) used. It's not the applicant's -- He knows, I don't think this applies. Send it in. Get it evaluated.

They should have a more efficient process instead of taking there years to figure out whether it's okay or not. It's very cumbersome now. I agree with you. You're tied up in all kinds of legal hoggle boggle and everything else to try to get something through. You need to streamline the process. That's where you ought to go about for the efficiency of doing this, instead of burying it in tons of word salad inside of a rule.

MEMBER MARCH-LEUBA: Yeah. In short, 10 CFR -- 10 CFR 53.1 to the exceptions unexpected when applications are submitted. That should be point one.

MEMBER BALLINGER: Yeah. I mean -- But I think I agree with Dave. Exceptions to me means subjectivity. In other words, if you take exception to something, then that means somebody's going to have to interpret whether or not that exception is a valid exception. And that opens up Pandora's Box because it depends on the (audio interference).

MEMBER PETTI: So let's move on, guys. We have only until the agenda, basically 11:30 to lunch. And we still have to hear from Marty and we have to read our letter. And I'd like to get it a little bit more than just read in.

CHAIR REMPE: Yeah, we're supposed to be done with the presentations by 10:30.

MEMBER PETTI: Right.

CHAIR REMPE: Okay. It's not your fault. I know that. I'm talking to the staff. It seems to be member fault. Okay?

MR. JESSUP: This is Bill Jessup again, NRC staff. Good discussion. I think to put a bow on it, there's a lot of work going on, on that topic in Framework B. I think that was where the initial comment came from.

Okay. Billy, could you move on to Slide 9 please? Thank you, Jesse. Thanks, Billy. So Subpart R, again this is one of the subparts I highlighted on an earlier slide as having some differentiation between Framework Alpha. However, the structure of Subpart R, it mirrors Subpart Patel and Framework Alpha. Again, covers all the various application types that would expect from early site permits, construction permits, operating licenses, et cetera.

All the process-related subparts in Subpart R, they're identical between the frameworks. And again, these are things like finality, the duration of a license, referral to ACRS, those provisions. As you would expect, they're identical between the frameworks. Really their distinguishing factor is those technical requirements, the technical content of application sections that I referred to earlier.

So again, in Framework Bravo, when we

looked at these sections, we actually used the existing frameworks to set up our starting points for Framework Bravo since we're really trying to -- this is really an evolution of the existing frameworks. And so again, something like 52.79, we use are our starting point for the combined license technical requirements. We recognize -- and I know we discussed two weeks ago, the staff recognized that there's a lot of duplication between the requirements in the existing frameworks.

Many of the requirements were something like a design certification. They look very similar or identical to those for a combined license. So this is an organizational point, but we did consolidate those requirements into one section, which I think everyone recognizes now, 53.47.30 is really the heart of Subpart R. And so the remaining sections, they really just reference back to Section 53.47.30. But in the process of, you know, looking at the requirements and existing frameworks, we did do some updates and modifications to those requirements to ensure that it was technology-inclusive to address kind of one of those four issues we were talking about earlier relative to the exemptions.

I wanted to call out two sets of technical requirements that we had a lot of discussion on. I think Boyce Travis did a phenomenal job talking about these during the subcommittee meeting. Those were initiating event accident analyses and containment requirements. So again, if you look in Section 53.40.730, Paragraph Alpha 5, those are the requirements that cover the various classes in chemical hazards. And they're really an evolution from what was initially the Part 5 (audio interference) that was started last year.

Again, the idea here was to generally align with the current requirements. You know, DVAs and something like 50.46. But as appropriate, also incorporates some international concepts on defense in-depth. And this all goes back to one of the things we talked about during the subcommittee meeting. The motivation for this effort was to try and draw some line of sight to the international approaches to accommodate or develop a pathway for those vendors or designers that may approach the domestic market following an international licensing approach.

The last item there is on containment. So again, this -- the requirements for containments, they're technology-inclusive. We pulled over many of the requirements for light water reactors. But we also set up a set of alternatives for non-light water reactors that may need or want to adopt the functional containment concept. So again, you'll see those in 53.47.30, Paragraph Alpha 36.

Billy, next slide please. Oh, go ahead.

MEMBER BLEY: Yeah. This is Dennis Bley. I think at our subcommittee meeting, you told us you had a public meeting coming up. Either you've already had it or it's about to happen. If it's already happened, can you tell us anything about the feedback you got there?

MR. JESSUP: Sure. So we had what was an -- it was an advanced reactor stakeholder meeting last week. There was, I believe 2 to 2-1/2 hours set aside for public comments and presentations, all in Part 53. All of the specific feedback that we got focused on areas that external stakeholders thought to be more performance-based. And also they gave a couple of examples where they thought that the rule language that's currently been drafted could be more technology-inclusive.

So they specifically called out requirements for mitigation of beyond-design-basis events. So we actually directly referenced the requirements in 51.55 -- excuse me -- Section 51.55

and we talked about that during the subcommittee building during the loss of large area discussion. So they cited that as one example that they thought we could look at and perhaps make it more technology-inclusive.

Relative to the performance-based commentary, they focused on -- they gave examples like higher protection and also environmental qualification. They thought that there could be ways the staff could develop something that's more performance-based.

MEMBER BLEY: Thanks. One other area I'm curious about cause I had a little trouble sorting out the -- how the responsibility of the licensee changes when they're doing the general license and they're overseeing all the effectively certification of operators compared with when the NRC is giving individual licenses. Were there any comments about that?

MR. JESSUP: So there was a -- there was a subsequent presentation to the general Part 53 commentary that I just mentioned that was held on that topic. And I'll ask Jesse Seymour if he can respond to your question. He's the right individual.

MEMBER BLEY: Okay, thanks.

MR. SEYMOUR: Yes, this is Jesse Seymour from the Operator Licensing and Human Factors Branch again. With regards to, you know, the overall comments that we've been receiving. Again, you know, as we've shifted over from the certified operator to general licensed reactor operator, you know, we've seen kind of a swath of commentary, I think from, you know, from industry and you know, various stakeholders.

And I think -- I think the general tenor of that has been, you know, questions about, you know, the implementation and I think really targeted towards gaining a better understanding of how it would work and the underlying mechanism. And you know, the general licenses, you know, definitely something's that much different than what we've done in the past. I think that there has been an appreciation of the overall intent to provide a gradation of operative qualifications that's consistent with the nature of the facility. That's how I would -- I would characterize the overall, you know, flavor of what we've seen.

MEMBER BLEY: Okay. I'm kind of hung up on what Greg says. You know, when things go wrong, it happens one way now. If we have the general licenses, it seems to me, there's much more onus on the owner operator for the individual operator's activities. But we already have some of that, so maybe I'm wondering about things that aren't real. But thank you.

MR. SEYMOUR: Yes. And if I could though, you know, I think something that's a substantive change is we've gone to the generalized licensed reactor operator is that it's placed more onus on the individual in lieu of the previous non-licensed certified operator, you know, that we had proposed. And something to keep in mind is that those general licensed reactor operators, even though they are generally licensed, still are on the hook from a regulatory standpoint. So again, you know, there are conditions of license that they're required to meet. They do have responsibilities that again, from a legal standpoint, you know, might not necessarily be the case for a non-licensed individual.

So again, you know, the nature of that program as you look at is that there is -- there is, you know, a great deal of onus placed on the facility licensee -- you know, on the owner operator if you will. However, it is important to recognize that those individuals are still licensed. So you know, again, that is a substantive change from what we initially, you know, had proposed.

MEMBER BLEY: Yes, it is. Thanks.

MR. JESSUP: Thank you, Jesse. Billy, could you move to Slide 10 please? This is Bill Jessup from NRC staff again. So looking forward to guidance development for Framework Bravo. So what we've really got here on this slide is kind of a three-pronged approach. If you think back to the tabulation of the two frameworks and recognize there is a lot of overlap similarity between the two frameworks in many areas. So a lot of the guidance that's been developed or under development for Framework Alpha, it will be applicable to Framework Bravo as well.

We also think there's a set of guidance -- existing guidance that will likely be updated or supplemented due to the fact that we do leverage a lot of the concepts from the traditional or existing regulatory frameworks. So we think there will be an opportunity there to re-look at the guidance that's already out there. And again, update it or supplement it such that Framework Bravo -- MEMBER SUNSERI: person to could get through Framework Bravo could make use of it. In some cases, this just may be simple applicability statement updates.

And then there's the last bucket of unique guidance that will need to be developed for Framework Bravo. And I think we touched on this earlier already, that we are working on -- we called it RCAP Volume 2. I'm not sure if that name is going to stick. But we are looking at developing a set of content of application guidance for Framework Bravo, again using Framework Alpha as kind of a template. You know, what's been developed there? What can we use? What's unique and what do we need to develop under that same RCAP umbrella?

MEMBER HALNON: Do you have a list or knowledge of what NEI and the industry may be working on that you could endorse, rather than developing your own guidance from scratch?

MR. JESSUP: If I understand it correctly, Member Halnon, we have gotten some early interest from NEI in particular about engaging on this topic. But I don't think I have any specifics on that. But they have expressed interest in engaging in you know, Framework Bravo (audio interference) Framework Alpha. So those discussions are just getting started. But there is some intent. I mean like NEI 180 whatever. You know? Because they do pretty good at developing guidance. Obviously you have your shot at getting it revised. But it's an inefficient way of getting things going.

MR. JESSUP: That's correct. As I understand it, they have expressed interest in engaging on this.

MEMBER HALNON: Thanks.

MR. JESSUP: And Billy, could you move to Slide 11 please? So this is the last slide I've got. Again, it's a forward looking slide. Again, another kind of review from the subcommittee meeting. Looking past just Framework Bravo, but looking again at Part 53 as a whole. And what we're doing right now to integrate the two frameworks, I mentioned there's a lot of things that between the frameworks they need -- they need to be the same. If they're not the same, we're putting them side by side literally and ensuring that some of these provisions, they're identical. We don't want there to be misalignment.

We're looking at other areas, particularly things that have been done in Framework Alpha that are innovative. You know, risk-informed, performance-based approaches to things like seismic. We're looking at seismic requirements for operation. And we talked about the generally licensed reactor operator.

We are looking at things and working on a number of items to see if we can adopt some of those innovations in Framework Bravo.

Another area that we're working a lot on is Subpart Alpha. And the commonalities that are going to be in that subpart, in particular definitions and general provisions. If folks have read Subpart Alpha, part of the language is specific to what is now Framework Alpha. So we're going back, working to adopt some of those provisions, such that they're applicable to both frameworks.

And then the last item there is continuing to get stakeholder feedback on the draft proposed rule language. We talked about the Advanced Reactor Stakeholder Meeting a few minutes ago. We talked about it at the Subcommittee Meeting. We got a lot of good feedback over those two days that we've already taken and kind of worked into what will be a merged or integrated version of Part 53.

CHAIR REMPE: I have a question. When is it that we're going to see the preamble? And there will just be one preamble for all of 53. Right?

MR. JESSUP: That is correct. And Bob Beall, if you could speak to the schedule for the preamble and the proposed rule package.

MR. BEALL: Sure. This Bob Beall with the Rulemaking Branch at NMSS. The committee will see the preamble and the rest of the rulemaking package in mid-October. So we'll present the whole package to you then.

CHAIR REMPE: Okay. So we have a meeting scheduled mid-October and we're supposed to get things 30 days in advance.

MR. BEALL: Right. I talked to Member Petti about that after our June meeting. And we did have some internal discussions with you on how we can provide those documents to you in a timely manner because it will be quite a bit of pages to review.

CHAIR REMPE: Right. So hopefully like your discussion said that they'll show up mid-October for us to --

(Simultaneous speaking)

MR. BEALL: That's what we're looking towards.

CHAIR REMPE: Thank you.

MR. JESSUP: Thank you, Bob. So Billy, with that, you can move to Slide 12. That's the end of my presentation. I'll open it up for discussion and questions. I'll turn the presentation over to Marty Stutzke now.

MR. STUTZKE: Hi. I'm Marty Stutzke, the Senior Technical Advisor for PRA and NRR. Billy, can we go to Slide -- Let me get my glasses so I can read this -- So to talk briefly, we'll discuss the evolution of the AERI first. As Bill had talked, it came from this notion back in the Spring of 2021 where the task was considering how to grade the technical content of PRA. And by technical content, we were thinking about ways to limit the degree of plant representation, the level of detail. And perhaps illuminate some of the initiating events, that type of thing. Only to find out industry was interested in grading the use of the PRA itself, which is how Part 53 was currently structured at the time -- or had hard requirements.

To address that you were discussing earlier, it's true, Part 52 requires a description of the PRA and its results, but it never tells you, what to do with that PRA. Rather, that falls back on various commission policy statements. The commission expects the PRA to be -- well, it can be used for following purposes like that. My understanding of Part 5o.52, Lessons Learned Alignment Rulemaking, will then convey that over in Part 50 applicants.

So we spent some time thinking about well how is PRA actually used? Specific PRA-led approach like Framework Alpha currently has, supportive of the Licensing Modernization Project -- LMP. Or should PRA be used in a more supporting, you know, or a confirmatory type of roles that it currently is.

We'll talk briefly about the area entry conditions. Keep my fingers crossed that it's brief. And a summary of two pre-decisional draft reg guides, PDG-1413, the technology inclusive of identification of the licensing events in commercial nuclear plants. PDG-1414 AERI framework document. In a few slides, I'll explain exactly why there are three decisional draft reg guides.

Let's go to Slide 15 please. So what we're trying to achieve here is an aspect of a modern risk-informed regulation. We want to assure that we achieve the underlying purposes of various commission policy statements. With respect to the role of the PRA, I'd point you to the advanced reactor policy statement that in turn references the safety goal policy statement, the severe accident policy statement, and the PRA policy statement. So the goal here is can we do something that is less than a full scope PRA and still achieve the underlying purposes of these things.

Secondly, it would provide sufficient information to help inform licensing decisions. And that leads one to consider through the right size, the amount of effort required to evaluate risk. So if you look at it this way, what the AERI approach does it trying to improve regulatory efficiency by focusing on the risk.

So as I said before, we had developed three decisional draft reg guides to present our logic to potential applicants with expectations of the staff and to address ACRS recommendations in what we call "start with a blank sheet of paper". And you all had written four letters on that in some detail like that. And we're trying to address it. When we did so, we realized the recommendation, "start with a blank sheet of paper" is broader than the AERI approach. It's broader than the Framework Bravo and Part 53. In fact, it should touch on all licensing aspects, including Parts 50 and 52. So we divided the guidance into two portions; the technology-inclusive search for licensing events were applied to Parts 50, 52, and 53. Whereas the AERI framework is only applicable to Part 50, Framework B.

Let's go to Slide 16 and I'll show you the flowchart. The flowchart doesn't do a great deal of justice to the actual process of how this is done. If I were to incorporate all the potential feedback loops on this diagram, we'd be unable to read it. I've tried it before. There's not a white board big enough and One White Flint to let me draw this thing. So you have to bear with me imperfect as it is. I'll confess, every time I look at it, I want to -- I have this urge to tear it up and start over. Bear with me.

So starting in the left under Box A -- Box Alpha, that's the comprehensive systematic search for initiators sequence delineations without preconception and reliance on predefined lists. And that's put in there specifically to address those ACRS letters on the topic like that. So it's independent of the licensing framework like that.

Then an applicant under the process would proceed under Bravo to select a licensing framework. Taking the up branch, which points towards Framework A and the voluntary use of LMP under either Parts 50 or 52. The PRA would then be finished. The licensing events selected and the DBA is selected, et cetera, et cetera. And all of that would be done using NEI 18-04 as endorsement Reg Guide 1.233.

Assuming they don't want a PRA-led approach, take the down branch out of Box Bravo into selecting licensing events, Box Juliet. And we've developed guidance on how to do that. The concept is this. We have a broad set of information developed in Box A that was (audio interference) events on the issue of the accident sequences. And we're trying to, for lack of a better word, spill it down into the categories of licensing events that would then be analyzed in the traditional manner, say SRP Chapter 15, type of analyses. So Box J doesn't tell you how to do that, it just tells you what events you should be looking at.

Sitting then under Box Kilo and Lima, those are the additional deterministic type approach to analyze the accidents, including the consequences. Those consequences again are focused on the 50.34 requirements. These are the 25 REM requirements. It goes to the exclusionary boundary we all can see like that.

So progressing out of Box Lima into Box Mike, we provided this option. Either continue with the PRA development and just the PRA and its customary supporting informatory type of role or come down into the AERI approach. And AERI works by identifying and analyzing the boundary developments shown in Box Oscar and Box Papa to confirm that the AERI entry conditions are actually met like this. Then into Box Quebec for subsets demonstrate (audio interference) QHOs by using the demonstrative conservative approach. Look at all of the event sequences, all the information you have prior to this search for severe action of vulnerabilities.

Develop risk insights by considering all of this information. And risk insights is a broad term. Generally, I think of it as identify what's important to risk and identify what is not so important to risk like that. And then, Box Q4, event four there, look up the information and use it to help assess the adequacy of the defense in-depth. So the diagrams is color-coded and I'll explain a little bit later. The yellow boxes Alpha and Juliet are Predecisional Draft Guide-1413s, search for licensing events. And the orange boxes are specific to the AERI approach under Framework B of Part 53.

Now I'd like to point out a little nuance. And it has to do with Box Alpha and this idea of reliance on the predefined list. Currently if you go into Part 50 and 52, there is a requirement that says you will compare to the standard review plan. And if I go to Chapter 15 of the SRP, I find predefined was transience and accidents. Okay? So we've left that in there now to follow up confirmatory sort of process in the selection of licensing events and be certain that nothing has been omitted. Again, we try to retain the idea of starting with a blank sheet of paper.

The other thing I would point out is that the Parts 50 and 52 of Lessons Learned Rulemaking is proposed to delete the requirement that compare against (audio interference). Currently, that's the way that it is and it's currently in Framework Bravo as well.

MEMBER MARCH-LEUBA: Can I ask you a question about (audio interference) event?

MR. STUTZKE: Yes.

MEMBER MARCH-LEUBA: Is that expected to be one of the VBAs?

MR. STUTZKE: Not necessarily.

MEMBER MARCH-LEUBA: What does the guidance say? Do you have -- Do you have to perform all the DBA analysis first? And then (unintelligible)?

MR. STUTZKE: In reality, you would be performing them in parallel with identifying them in bounding event and the DBA type of analysis. But be careful when using the language, "bounding event" so that it's not construed or misinterpreted to be a maximum accident -- like a maximum credible accident per maximum hypothetical. What we need for PRA uses different doses over different time periods. In other words, when I calculate individual latent cancer fatality risks, I'm looking at the 50-year dose. Whereas in a DBA type of analysis, I'm looking at the words "two-hour dose" --

(Simultaneous speaking)

MEMBER MARCH-LEUBA: I was asking at the higher level like a hover reactor concept in which I can estimate or the worst thing that can happen is everything breaks and only my isotopes comes out. Why do I have to do the other ones? That was clearly (audio interference). That will be a temptation to me as a licensee to save money. Would that be allowed?

MR. STUTZKE: Well, the same sort of bounding event would credit only the inherent features (audio interference) but that's somewhat of a -- part in our guidance that would probably need to amplify because there are different opinions about what is an inherent feature? For example, when I think of inherent features, I'm thinking of things like reactivity feedback shut down the reaction like that. Or the use of things like natural convection, like do we have any cooling systems, things like that, conduction of the heat out into the earth itself.

But being a good PRA analyst, I can always come up with a way to break the system with that type of thing. For example, natural circulation requires gravity differences. Suppose I have an earthquake. The plant is no longer vertical. It's camped into the side. What does that do? Or the reactor is sited underground and it's fueled -- it's back-fueled with gravel and dirt and things and the soil liquefies during an earthquake. And the longer I may lose my convection -- conduction capabilities, that type of thing. So I will admit I think that we have some work on what features are to be credited and not credited in the analysis like that.

MEMBER MARCH-LEUBA: Yeah. Speaking of features, SSCs under Framework B, where do I decide what is safety-related component?

MR. STUTZKE: Starting with the traditional manner under Framework B.

MEMBER MARCH-LEUBA: Okay. So it's under accident analyses?

MR. JESSUP: This is Bill Jessup, NRC staff. That is, I believe explicit under the accident analyses and initiating the requirements.

MEMBER MARCH-LEUBA: And do we require a single failure criteria?

MR. JESSUP: Single failure criterion is -- it is what we say implicitly required through the establishment and satisfaction of PC. So if you look at --

(Simultaneous speaking)

MEMBER MARCH-LEUBA: Single failure in Part 50 goes on GDC-10.

MR. JESSUP: I think single failure criteria -- while it's defined at the front of Appendix Alpha, the single barrier at least. And then mentioned, I believe, in several criteria. And then also mentioned in Reg Guide 1232. So we don't have single failure criterion explicitly in the rule text, but we expect that would be captured the way it is now --

(Simultaneous speaking)

MEMBER MARCH-LEUBA: You would expect anybody using Framework B to do the safety analyses with a single failure criterion?

MR. JESSUP: Consistent with the way the design criteria is structured.

MEMBER MARCH-LEUBA: I'm not understanding (audio interference) everything failing together.

Right?

MR. JESSUP: Correct.

MEMBER MARCH-LEUBA: Okay, thank you.

MEMBER DIMITRJEVIC: This is Vesna. I have a question for you between the two decision boxes, B and M. Actually what in your -- because, you know, this is -- First, B says he's going to go with doing PRA. And then second one's also, he selects to develop PRA. So the applicant actually is choosing is he going to go traditional approach or he's going to do advanced sort of -- almost reason-based approach? And what is the difference in your opinion? Because the applicant can choose to do the PRA two different ways. Right? He can choose to do PRA in the Framework Alpha and he can choose to do PRA in Framework Baker. It's just a different role of the -- of the deterministic information. So what's the difference -- you think that the selection of the licensing events and you know -- obviously things are going to look different how he chooses to -- when he chooses to do PRA.

(Simultaneous speaking)

MEMBER DIMITRJEVIC: Do you understand my question? Because he can choose to do PRA afterward or he can choose to do -- when he's entering this, he already has idea that he has to do the PRA. He can just choose where to enter.

MR. STUTZKE: Yeah, I believe I understand the question and that's an important point. If they're preceding in Framework A or under the LMP process, PRA is important to the selection of the licensing basis events and the SSE classification. So we would expect the PRA to be evolving as the design is evolving. That being said, the PRA policy statement implies that PRAs should be used in the design process, whether or not you're under LMP.

So we would expect the PRA to be evolving at the same time as the design is evolving as well. The difference is -- coming out of Box Bravo in the diagram is you know you're going to use the PRA up-front in a PRA-led approach to help define the set of licensing basis events to classify the SSEs. Or taking the down branch where the PRA would become more confirmatory. That's the decision the applicant would need to --

(Simultaneous speaking)

MEMBER DIMITRJEVIC: Yeah, I know. But the thing is you're not asking this. You know that he's going to use the PRA. He can know that he's going to use PRA, just select a different path. You know, this is what -- because when you start introducing this area and you say this is a moderate risk-informed approach, much more risk-informed is Framework Alpha. Right? Or it could be -- It's almost risk-based, right, how much risk involved in this. So you know, we said that these two approaches are different on there because there is a risk-informed, you know, spectrum, which goes between the deterministic and risk-based. And that one of those is in the middle. The bottom one is (unintelligible) now. And the one up is, you know, closer to the risk part.

So the applicant can actually make this how he wants to do the things. He can make the selection at the front. And you know, and say okay, I'm going to sort of pretend I don't know. I'm going to do the -- It's not good work. But you know, I want to do more traditional mix of deterministic and PRAs, so I'm going to the Framework Baker. There's nothing to stop him to select the PRA in M, instead of the B. You know?

(Simultaneous speaking)

MEMBER DIMITRJEVIC: You know, but I just want to say there is not really any more between A and A. Not B and A. It's more between traditional and more risk-driven.

MR. STUTZKE: Yeah. Thank you for the comment. I appreciate, you know, the potential confusion of the diagram.

Let's go to Slide 17, which the inset and the --

MEMBER DIMITRJEVIC: Sorry. Sorry. Sorry. But because you said there is not really confusion of the diagram. It's difference of the approach. And the question is how much different selection of licensing events which we'll have. We will definitely have a different classification of the SSCs. And so basically, this is what applicant is choosing. It's not just confusion. It's sort of like essential question. You know?

MR. STUTZKE: Well the confusion comes as to when the applicant would decide what licensing framework he wants to pursue up-front. In other words --

(Simultaneous speaking)

MEMBER DIMITRJEVIC: That's result is two different (unintelligible) SSCs and two different license-based (unintelligible). It's not just -- You know, it is like -- it's not clearly like what is the PRA. He's selecting role of the PRA.

MR. STUTZKE: Yes, I agree. And that's --

(Simultaneous speaking)

MEMBER DIMITRJEVIC: Okay. I just wanted to make this point to make sure that my colleagues understand that this application is not a renewing PRA or not the sort of selecting how (unintelligible) PRA --

MR. STUTZKE: Yes. Thank you. Okay. So the inset on Slide 17 is our current preliminary proposed rule text AERI entry condition. And let me walk you through how it works. This is part of the required technical content of application. When you look at Part 52, what it says is "Provide a description of the PRA and its results." So what we did was to modify that to cite the description of the risk evaluation and its results. And then we come down and say, the risk evaluation must be based on either a PRA or AERI if the entry condition is met.

So an applicant always has the option to develop a PRA here like this. But we've given him an alternative that if they can meet this entry condition, then they can do the AERI approach, which is in lieu of the PRA. The idea is to provide some flexibility to applicants on whether they want to do the PRA or they're not so interested in the uses of the PRA. For example, like under the LMP, to use it to identify the licensing events, things like that.

The other thing to be emphasized with this entry condition is this is not a safety or citing criteria. This is not a replacement for 50.34 or Part 100 like this. You don't see the word "citing" anywhere in this language like this. This is merely a condition to decide could you do AERI in lieu of the PRA? And I had shown the subcommittee there's some simple mathematics of how we came up with the 100 meters by their calculation to the QHO for individual latent cancer fatality risks like this. And I was told and I promised I won't do any math during this meeting like that. What I did want to show you on the following slide, different ways -- you get different conclusions, depending on how you state this entry condition.

So if we can to Slide 18, this is something I hadn't shown the subcommittee, but was motivated like this. The upward curve makes the assumption that I would specify a reference dose -- you know, reference doses and stage it in the, you know, preliminary proposed rule effects for AERI. But I would require that dose only at the exclusionary boundary, not in the fixed 100 meters. And what you find is when you run through the calculation, as the exclusionary radius increases, conditional risk number increases as well.

And that makes sense because I've required the dose to be constant and now I'm moving exclusionary, the boundary further away from the site means I'm dealing with a much larger source term. Okay. The other thing that happens is, is the farther away I move from the site versus the distance correlation becomes less. So I get less effect the farther away I move it from the site.

So you can see that intersects at approximately 100 meters of QHOs. What we decided to do is to anchor the AERI entry condition at 100 meters and that ensures that we meet the QHO like this. The applicant then still has some flexibility. They can decide whatever EAB radius that they want. It can be over 100 meters, less than 100 meters. They will still meet this criteria.

Now part of this is tied up in the (audio interference), but it's feasible to identify a bounding event such that the consequence of any event sequence is less than the consequence of a bounding event like this. What that does is allow me then to separate frequency component of risk consequence component of risk, which is our goal.

So it says I don't need to develop a PRA, which is a very good technique for estimating the frequency of each individual event sequence. But by under this AERI approach, all I need to do is to estimate some of all of the event sequences. Well, in any given event period, the sum of the event sequence frequencies is in fact the initiating event frequency for that event entry. And I sum up overall the event entries and what I get is the total reactor trip frequency.

So that's the key assumption that allows me to create this bounding event for this AERI approach. And therefore, remove a great deal of the burden of quantifying frequency of all of the individual event sequences.

MEMBER MARCH-LEUBA: Let me give you an example and see if you can clarify in my mind. Like we see in a car. Facing a brake is one of my four tires. (unintelligible) accident and I will crash the car. Right? And I have four tires, four brakes. And then all have the same frequency and the same consequence. If I consider only the bounding event, which is facing the left front tire, which is no worse than the left back tire, I will get the risk. But my risk is four times larger.

MR. STUTZKE: Yes, that's true. And then the frequency would be four times the frequency of failing --

(Simultaneous speaking)

MEMBER MARCH-LEUBA: But if I use an MHA, with a quarter of the risk --

MR. STUTZKE: Correct.

MEMBER MARCH-LEUBA: -- what would Framework B tell me for (audio interference)? Framework B, if I analyze my -- the risk of driving my car under Framework B, what would the risk be?

MR. STUTZKE: If I were to develop a PRA, I would have four separate sequences.

MEMBER MARCH-LEUBA: Yeah, yeah, yeah. But under the AERI thing?

MR. STUTZKE: But under the AERI thing, I would come up with the consequence of failing a single tire. But then the frequencies of what we'd multiply would be four times higher.

MEMBER MARCH-LEUBA: Okay. So I'll have to do a PRA anyway. If I want to know the risk, I'd bring it to the PRA.

MR. STUTZKE: We don't.

MEMBER MARCH-LEUBA: You don't disagree

with that?

MR. STUTZKE: No, I don't disagree with that necessarily.

MEMBER MARCH-LEUBA: Yeah, okay. That was an example that just popped in my mind of this video with --

(Simultaneous speaking)

MR. STUTZKE: It's a good example.

MEMBER DIMITRJEVIC: Marty, this is Vesna. But you're always having sequences which lead to favor. Right?

MR. STUTZKE: Yes.

MEMBER DIMITRJEVIC: So that should (unintelligible) frequency. Right?

MR. STUTZKE: Yes.

(Simultaneous speaking)

MEMBER DIMITRJEVIC: -- sequences. You don't (unintelligible) successes and failures. Right?

MR. STUTZKE: Well right now, you're actually summing all the successes because you don't know which event sequences are success or failure necessarily. See if it goes through -- Imagine if I were to develop a whole event for you and I could go through each sequencing and say is this a sequence or is it failure? Okay? And I know I'm interested in the risk. My success will say that means there's no releases. There's no consequences to this. For failure, there is some consequences like this. So it's true, if I added up all of the sequences that involve consequences -- failure sequence, that's the frequency that I really want. Okay? But you don't know how to do that without doing a PRA. So what I'm saying is I know how to find the sum of the successes, plus the failure sequences and reasonably approximate that (audio interference) . So it's true, the --

(Simultaneous speaking)

MEMBER DIMITRJEVIC: Well (unintelligible). I mean the frequency said not rems. They can be -- You know, like the usual frequency of these, you know, events now in the (unintelligible) like 1.9 or 2, but it could be higher in some cases. I saw somewhere four times per year. Why rem?

(Simultaneous speaking)

MEMBER DIMITRJEVIC: I mean there's some challenges to the events that you know, that was (unintelligible), loss of power. I mean those things happened more than once. I don't know why (unintelligible) good example of that.

MR. STUTZKE: The one specifically comes -- I looked at the SPAR models at the Office of

Research and Developments. And you add up their initiating event frequencies, and it's approximately once per year over all the different types of initiating events like that.

MEMBER DIMITRJEVIC: Well I mean, I don't think that's (unintelligible) true today in industry. But anyway, before you know, the new design, who knows it's going to be. I mean every (audio interference) like that, you know, tell me initiating events per the AERI challenge, you know, the mitigating systems.

MR. STUTZKE: Yeah, I appreciate the comment that way. And we've had considerable deliberation of what is the magic number for the sum of the initiating event frequencies that are possible? But realize, there's a compensatory approach here that says what I've assumed every time an event sequence occurs, it is the maximum (audio interference) consequence. So that makes it conservative. Tends to offset my over or under estimation of the event --

(Simultaneous speaking)

MEMBER MARCH-LEUBA: Being realistic, if you own a plant -- if you own a plant and you have an event that produces 1 rem or a member of the public outside your fence, you're shutting down the plant. You're not going to have a -- you're not having to --

you're not going to have a chance to have a cycled event. So really what I want as a member of the public outside the plant is the consequence not be fatal. Because when you have one severe event and it closes the -- you don't have a chance or running (audio interference).

MR. STUTZKE: Yeah.

MEMBER MARCH-LEUBA: And probably all the other licensees with the same design. Yes (unintelligible). Greg, you wanted to say something? In summary, really knowing mathematically what the risk is for all the events is an interesting topic of conversation, but it's not a real life implication. The big event is what counts.

MR. STUTZKE: And the AERI entry conditions are crafted. You know, they're -- I can't say they're based on, but they're inspired by the protective action and guidelines published by EPAs. In other words, it includes the short-term and the intermediate phase protective action guidelines. Which in the short-term phase says 1 to 5 rem over the first four days of an accident. And then it goes on and it says, "2 rem additional in the first year, plus ½ of a rem thereafter." So I can bound that and make an argument that says if you met the AERI entry conditions, likely you would not need to take protective action. And protective action means things like sheltering in place, evacuation, long-term relocation away from the site and things like that. That's the basis behind the dosage.

So anyway, Slide 19. I'm going to wrap up here quick. The emphasis on PDG-1413, the identification licensing events, again it applies to Parts 50, 52, 53, Framework A , Framework B, LWRs, non-LWRs, design certification, standard design approval, manufacturing licenses, buying licenses, construction permits, and operating licenses replied to all of those things.

We've provided some discussion in there about the rationale behind SERP. Then we've provided the guidance on how to actually conduct the systematic and comprehensive search for initiators and (audio interference) and sequences. And for those plants that are not using an LMP or Framework Alpha, we've provided guidance on how to group that information and set up initiating events and sequences into the actual licensing event categories like that.

Appendix A provides any number of techniques for how to actually search for initiating events. And as I'm fond of saying, Appendix A is not a textbook (audio interference). We're trying to point the user to what we think are helpful resources.

MEMBER HALNON: Marty, since this applies across the board with I guess everything, but an ESP. Do you normalize the language in it for the difference license events -- license-based events, MHA, MCA, all those things?

MR. STUTZKE: We have sincerely tried and it's frustrating.

MEMBER HALNON: I guess sincerely is good enough for me.

MR. STUTZKE: I coined this phrase, "licensing event is a writing convenience". When you actually look under LMP, licensing events are licensing basis events consisting of AOOs, DBE, BDDEs. When I come to Framework A under Part 53, they are AOOs, unlikely event sequences. And very unlikely event sequences. When I go to Part 50 and I do a literature search, I find licensing bases events, design basis accidents, AOOs. There's even an -- in one part, in Part 50 where they talk about station blackout is a non-DBA. So I know what it's not, but I don't know what it is. So we tried to provide some guidance on what all of these things are. But it is -- it's a little frustrating.

Okay. To hurry along here, let's go to Slide 20, which is specific to the AERI framework under Framework B. We've tried to provide guidance on what is the bounding event and how one selects it based on the information available. And the results of the search for initiators and the event sequences, the recognition. You may not know what the bounding event is, so you need to do multiple. You need to consider several (audio interference).

After you confirm that you meet the AERI entry conditions, I guess as simple as once you get the bounding event, you can know its source term. And then you could treat it like you would normally in a PRA. In other words, you've inserted into the max code, calculate the conditional consequences. And that would be a site-specific or an application-specific bounding site type of calculation. Much more sophisticated than my elementary arithmetic like that.

Again, talked about the conservative risk estimate and the assumed frequency of once per year. Guidance would allow an applicant to use a lower frequency if they can justify it. The search for severe action vulnerabilities. We've considered what is a severe accident in a technology-inclusive manner. The current severe accident policy statements license says a severe accident is substantial damages done to the reactor core, whether or not there is serious off-site consequences. But you need to broaden that to consider non-core sources. For example, reactors and things like that. I have a hard time understanding how the damage of molten salt core. It's already molten. Just the normal --

(Simultaneous speaking)

MR. STUTZKE: So like that. And then the definition of severe accident vulnerability. That's precisely what we're looking for like that. Then how it goes through the identification, risk insights, and evaluates the defense and depth adequacy. So following the Steering Committee meeting, I compiled a big to-do list of things to think about, upgrading our Predecisional Draft Reg Guides. Any number of items on there.

On Slide 21 -- Billy, if we can go to that slide. This is in an effort to try to address one of the comments on the workability of QA and PRA standards and things like that to try to clarify the scope. So the search for initiating events and (unintelligible) sequences or follow the guidance under PDG-1413. If the search for initiators and event sequences is being done as part of the PRA, either under Framework B or Framework A under Parts 50 and 52, then the acceptability of analysis would be controlled by the corporate PRA standards, which addresses PRA configuration control and fair reviews and that sort of thing.

Under Framework B, under AERI, that acceptability would have to be controlled under the formal Quality Assurance Program, which is Appendix Uniform here. The licensing event identification of the middle column, if they're implemented in LMP or they would be in Framework A --

MEMBER BLEY: I'm sorry, Marty.

MR. STUTZKE: Yes?

MEMBER BLEY: I like this. This introduces some clarify. But can you talk a little more about that last box you had for acceptability of the search the QA Program has to provide? Is that already in there? I wasn't thinking about it quite that way when I read this before. I have to go back and read Subpart U.

MR. STUTZKE: Subpart U is based on Part 50 (audio interference), so it's the classic (audio interference) Quality Assurance Program. And what's being implied here is that the design control criteria would apply. So it needs to be reviewed, so forth and so on.

MEMBER BLEY: Okay. I'm going to think about that a little bit. I guess that makes sense. Okay, go ahead.

MR. STUTZKE: So we're returning to it because the search for initiators is being done outside of a PRA, so we can't fall back on the standard necessarily.

Anyway, so in the middle column, the licensing event identification that's being done under LMP. Then we refer you to NEI 18-04. It's endorsed in Reg Guide 1.233 on how to identify the licensing events? Which as we know is based on the frequency consequence target curve, so forth and so on. Otherwise, we've tried to develop guidance in PDG-1413 on how to again collapse that set of initiating events and event sequences into the different types of licensing events appropriate from the framework you're in. Realizing all the problems with the language in Part (audio interference) like that.

MEMBER MARCH-LEUBA: Yeah. Can I interrupt you?

MR. STUTZKE: Yes.

MEMBER MARCH-LEUBA: The issue, I think, the Committee has or simply I do is what they call the white piece of paper. So how do we know that the PRA is complete? It's true that you've spent a lot of time and a lot of effort and money developing a PRA and to have a standard. But how do you know you've covered every possible event? It is an impossibility. A PRA, you can claim it to be complete or you can claim it to be scientific, but you cannot claim it to be both. So there should be under guidance, the fact that you have to spend a lot of time during the review time to ensure your PRA or your licensing selection is as complete as possible.

And we have example where people forgot something and the tsunami and Fukushima. Small Break LOCA in Three Mile Island or the events more recent. So under guidance, there should be a lot of emphasis like completeness. Don't forget -- especially for new reactors where we don't have experience because with large light water reactors through crowd sourcing (unintelligible) Taiwan have been looking at these reactors for 50 years, trying to figure out what can go wrong. I have a new crazy concept. I have three graduate students working on it. And they have to come up with everything that can possibly can wrong with it. The possibility of them being wrong is very high. Okay, I just put it on the record. You don't need to answer.

CHAIR REMPE: I have a question about this box on the far right bottom. Okay, so AERI doesn't need to have a PRA, but I think it says -- it talks about conservative risk assessments, see the PRA standards. Can you explain what you mean on that box?

MR. STUTZKE: We actually refer for example to do things like Matt's calculations, like that. We're referring back to the non-LWR PRA standard because it's the best, most compact source of guidance or requirements on how to do that type of analysis that we have. So I didn't see any reason to duplicate it.

CHAIR REMPE: I agree with what you're saying, but I think the end -- I think for the dose consequence calculations to use the PRA standards, it would make sense. But what does the AND (phonetic) demonstrate (audio interference) conservative risk assessments? You're going to have to do a conservative risk assessment now in AERI?

MR. STUTZKE: Yes. That's always been part of the mix that under AERI, they need to demonstrate that they actually meet the QHOs. It could be as simple as taking the consequence from the bounding event and multiplying it by once per year.

It's below QHOs and it's fine. The other thing to realize is there are two QHOs. And so we would expect the consequence calculation to address both of those.

CHAIR REMPE: But this is what we're talking about with your math thing at the subcommittee week and how to expand it. But I guess I didn't realize that was called a demonstratively conservative risk assessment. It's more to try and meet the AERI criteria or something like that. It's just the word kind of really bothers me.

MR. STUTZKE: Yeah, I agree. It's a little perhaps not as clear as it could be. The AERI entry conditions here in terms of those -- those set of reference points. For the same way that you get into AERI, you need to actually calculate and demonstrate the (audio interference).

CHAIR REMPE: I get that part. I guess I just didn't quite get that was the terminology. Thank you.

MR. STUTZKE: Yeah. And so with that, a little bit long. I'll turn it back to you.

MEMBER PETTI: Okay, thank you. So we've been doing this for two hours, so perhaps we need a short break.

CHAIR REMPE: A couple of things. First

of all, we need to ask for public comments. And you can do that or I can do it. It's up to you. But at this point, are there any members of the public who'd like to provide comments? Hearing no sounds, at this point then, before we go into -- I believe you do have a draft letter you want to read in, but we are going to go on a break. But we'd also like to tell the Court Reporter that he can go -- we're going to go off the record and we'd like him to come back 1:00 p.m. Is that understood, Mr. Court Reporter? Yes, sir. Thank you very much.

So at this time, we're going to --

MR. BROWN: Ms. Chairman, may I make an administrative announcement? So for everybody in the room other than the members, there's a sign-in sheet next to the door. And we'd ask that you please sign the sign-in sheet. Thank you.

CHAIR REMPE: So I guess we want to bring the letter up. It's around 10:35 or so. Do you want to take a break for 15 minutes or do you want less?

MEMBER PETTI: I could go with less.

CHAIR REMPE: Okay. We're going to do a ten-minute break and come back at 10:45. Okay? If you're not here, you lose. Thank you.

(Whereupon, the above-entitled matter went off the record at 10:35 a.m. and resumed at 1:00 p.m.) off the record at 2:32 p.m.)

CHAIR REMPE: Okay. We're going to resume our meeting. At this time we're going to be hearing about how RES is preparing the Agency to be ready for advanced manufacturing technology submittals.

As you may recall our bi-annual report identified this topic as one that we'd like to follow. And unless a member has some specific concerns, we're not planning to write a letter on this topic at this time.

But rather we're just going to continue to follow the topic and report on it in our next biennial or triennial research review now. I'd like to ask members though to send your comments to me and Jose Harbash, our lead ACR staff member for the research reviews.

I'd like to have you send your comments to us and we're going to keep those comments as background material for our next formal review that we perform.

And I also today want to thank Ray Furstenau and his staff for the willingness to prepare and give us this briefing. And at this time, I'd like to call on Ray for his opening remarks.

MR. FURSTENAU: Great, thank you Chairman Rempe. Can you hear me okay?

CHAIR REMPE: Yes, we can.

MR. FURSTENAU: All right. Well thanks for inviting us to this to have this briefing. As you mentioned, you know, it's a follow up to what was the biennial, you know, now triennial review and on research activities and this particular topic the Committee had interest in.

So we really appreciate your interest in this topic and these information briefings really help as your feedback is valued by us so please by all means as we get into the briefing, ask questions and I know you and Committee aren't shy to do that.

When we talk about advanced manufacturing technologies, we're really talking about techniques and material processing methods that haven't been traditionally used by the nuclear industry or really formally standardized by in codes by that nuclear industry and maybe used in other industries already, but not particularly with the nuclear industry.

So these technologies, these AMTs, they can be applied to new or replacement components, repair activities of existing components or fabrication of elements of a component to provide benefit either, you know, performance operation while -- or a possibly a safety benefit.

We started preparing the NRC did, for adoption of AMTs in nuclear applications back in 2017 really before the technologies and targeted nuclear applications were fully known.

The NRC has adapted or adopted an engagement strategy to try to identify technical and regulatory issues early on in the development of AMT. And that approach really helps us be ready for the future for the licensing activities that may be ahead of us.

The initial activities related to AMT were organized and planned through an AMT action plan. And the initial draft of that plan came out in early 2019 and Rev -- Revision 1 to that was published in June of 2020.

And it really ties in the activities, the research and regulatory activities that have been done or are ongoing or are planned. And that's really what you'll hear today is the status of our actions in that plan.

Based on interest we've heard from industry and the potential of near-term application, the NRC's focused on five major AMT processes and that's the laser powder bed fusion, laser directed energy deposition, cold spray electron beam welding and powder metallurgy hot axial static pressing.

And we've completed the technical per Per dis activities that help us focus on developing the technical information we may need to identifying gaps, knowledge and tools that help prepare our staff for review in AMTs.

So again, we appreciate asking, the Committee for asking for this briefing and we'll appreciate any feedback we receive from you from the presentation.

So with that, I think I'll turn it over to folks from my staff and the NRR and I think Matt Hiser, I believe you're up.

MR. HISER: Thank you, Ray. Everyone hear me okay, hopefully. My name is Matthew Hiser. I'm a materials engineer in the materials engineering branch of the Division of Engineering in the Office of Research.

And I've had the pleasure of being involved with the AMT program going back to the end of 2019 so almost three years. And I am pleased to have the opportunity to brief you all.

We've had a lot of activities. I think a lot of deliverables and products we've been able to pull together in a fairly short time period. And so we're looking forward to being able to share what we've accomplished and where we think we're heading. Next slide, Hussain.

So first off, I'd just like to acknowledge the number of staff and managers that have been involved in this program. This has been a collaboration between the Office of Research and the Office of Nuclear Reactor Regulation.

There's been a number of staff you see listed there. A sort of a project team staff that have met on a weekly basis throughout the last two to three years continue to make progress and move this effort forward.

There's also been several additional staff noted in the upper right corner of the slide. Meg Audrain, Amy Hull and Shah Malik who helped support specific tasks within the Office of Research.

And then in addition there's been three of the materials related senior level advisors at the agency have been actively involved in this program as well as the steering committee which is our represented branch chiefs from the Office of Research and the Office of Nuclear Reactor Regulation.

So myself, Bruce and Rob have all, you know, been involved in the project team or the technical advisory team and had a, you know, continuous involvement.

I'd also like to point out on this slide, Mark, you have actually led the coordination putting together the materials for this briefing. Unfortunately, came down with COVID over the weekend and is still recovering.

So he would be here presenting alongside us, but I want to acknowledge, you know, the effort that he put to help prepare this presentation, but he wasn't able to help give it. So next slide.

So I just wanted to start out by introducing how the NRC staff have sort of identified or defined advanced manufacturing technologies. And we've defined these not as necessarily entirely new technologies in every situation, but technologies that either have not traditionally been used in the nuclear industry or have not been formerly standardized or codified by the nuclear industry.

And so AMTs, you know, can include new ways to fabricate or join components. They can include surface treatments or codings or other processing methods that might provide a performance or operational benefit to materials, components used in nuclear power plants.

And so I point that out because some of the AMTs we've looked at are not necessarily new technologies and have not existed out there for some period of time if even decades.

But they may not have been brought into our industry and therefore really looked at and scrutinized from application in the nuclear industry so that's how we have tried to define, clarify.

And the other point I would just to make is, you know, as we approach this we are, you know, we've approached this from, you know, them -- go ahead, innovation transformation mindset.

And I would say, you know, one way that's been summarized in some sense of the agency is sort of making safe use of new technology possible. And so that's how we're trying to approach this is that we're trying to be ready, proactive, in step with where industry's moving to implement these things, not necessarily behind, not necessarily ahead, but sort of ready.

You know, and doing the things that we need to on a technical and regulatory basis to prepare ourselves to be able to license and effectively regulate these new technologies.

So we're not holding up industry, but we're also making sure that they're using things, you know, safely and with sufficient basis. Next slide. And so this slide just wanted to cover a little bit of background on what are the drivers for activities.

As I just mentioned, you know, we're trying to be in step and in line with where the industry's going and so, you know, we have a lot of interactions with folks outside the agency to gather information, to exchange information, to be aware of new things happening as, you know, new AMT news is happening on a weekly, monthly basis.

Between research and development and, you know, using things in trial applications and plants and in the real world. So there's a variety of stakeholders that are moving in this direction and so first and foremost, sort of vendors and licensees, utilities and they're identifying, you know, candidate applicants, starting to put some of these into low or non-safety significant places and plants.

They're also working to develop the technical basis for regulatory acceptance. Now whether that's developing code cases or white papers to put together the necessary information that would enable the NRC to review and approve the use of these materials or these manufacturing methods, in addition to the Nuclear Energy Institute, helps to organize the industry's efforts and effectively sort of communicate industry's positions and information that NRC should be aware of.

Several years ago, actually, NEI developed a road map and then communicated by a letter to the NRC and that helped to sort of frame our initial activities on AMTs and helped us to understand where industry saw these and how we could and should engage.

Next, the Electric Power Research Institute obviously performs a lot of the research for the industry. They are developing techniques for, they really have had a lot of focus on a couple of the techniques we look at, electron beam welding and powder metal or hot isostatic pressing or PM-HIP.

They've also developed a data package for draft code case that's been presented to the ASME code and has been addressing comments and making some changes to address feedback to the ASME code process so EPRI has a big role in this as well.

And finally, the Department of Energy has multiple programs that are doing work in the advanced manufacturing technologies area. They recently reorganized a little bit into their AMMT or advanced methods or advanced materials and manufacturing technologies.

But they're performing both basic and applied research as well as technology development that really helps to support where the industry's trying to move with AMTs. So next slide.

Now to shift gears from sort of the environment or the context that led us to move into this area and to what sort of some of the vision and background for what NRC has been doing.

So as Ray introduced in the 2019 and then sort of with the revision in 2020, NRC put together an action plan for AMTs that would try to allow us to be prepared and ready with the technical and regulatory tools we would need to effectively regulate these new technologies.

So that included assessing the safety significance of some of the differences between AMTs and traditional manufacturing perspectives or manufacturing processes.

And using a performance based perspective so we don't want to be adding new burden that's not necessary, but we do recognize that there are some significant differences in how these materials and fabrication processes produce a component or coding.

And we need to understand that well enough to be able to have assurance that it will perform as expected in service. In addition, one of the more time-critical aspects was to prepare the staff for industry implementation of AMT components to the 50.59 process which is, most of you are probably familiar is a process by which licensees can put a new and make changes without prior NRC approval.

It is subject to NRC inspection, but not a licensing process in advance. And so that's obviously, that's a way that industry has started to use AMTs and one that's, you know, available to them, but we needed to make sure that NRC staff, particularly inspectors that may be encountering this would sort of have some understanding of how AMTs would work with the 50.59 process.

So that's one of the deliverables you'll see out of this initial action plan activities. And then next was sort of to look at each of the AMTs and what are some of the key characteristics that are pertinent to safety?

Again, trying to keep a risk-informed and performance based perspective on it that are not managed or addressed by codes, standards, regulations, is just to help answer the question of do we need to make changes to our regulatory processes or to our regulations or do we need to recommend that codes and standards are developed in certain areas?

And finally, we wanted to look at providing guidance and tools to ensure consistency in any NRC reviews that may occur in this area as well as to ensure there's clear communication and knowledge management.

As you can imagine, with a new area, you know, four or five years ago, NRC staff probably had little to no knowledge of any of these technologies so we've been, knowledge management has been a big part of what we've tried to do, increase our knowledge, make sure that staff and different roles around the agency have enough familiarity.

We've done some trainings and seminars that will get touched on later on that have helped us to increase our knowledge as a staff on these new technologies that are likely -- that are coming.

And finally, we'd like to, you know, make sure that we have transparency with stakeholders. There's been a number of public meetings on this topic. Yes, with different folks to roll out some of our products and share information and exchange information.

And we also held a workshop about a year and a half ago that was very helpful for us to get more knowledge and hopefully disseminate some of NRC's thinking on AMTs and then yes, I'll think I'll leave it there. Next slide.

MEMBER BROWN: Okay.

CHAIR REMPE: So hold on.

MEMBER BROWN: I just have a question. How can you risk inform a new welding procedure? It's either got to pass the follow-up test to make sure it's a complete weld as opposed to not.

I'm having a little difficulty with performance-based risk informed words being applied to making sure a pressure boundary is intact. I mean there's a lot of different ways to weld stuff.

The old arc stuff and where you could have the lasers to do it or what have you, but you still always follow up with a very definitive inspection process where you're, you've virtually verify that you don't have any inclusions or other voids or other type stuff.

So I'm not quite sure how risk informed performance-based falls into this category.

MR. HISER: So I think we'll --

MEMBER BROWN: Unless that's just a buzz word. I'm getting a little bit --.

MR. HISER: No, I --

MEMBER BROWN: If everybody says that for everything now.

MR. HISER: Yes, so maybe I'll just touch on it real briefly now. I think we touch on it a little more in our slides.

MEMBER BROWN: Well you can wait then.

MR. HISER: Okay.

CHAIR REMPE: So --

MR. HISWER: And if we don't actually address it, please bring it back up.

MEMBER BROWN: I appreciate it.

MR. HISER: Okay.

CHAIR REMPE: I had a couple of questions. First of all, I really like the website you guys are doing. I think that's great to have all of those documents there.

And I may have missed some documents and so just educate me if I am missing something, but I'm curious about the status of the codes. The ASME appears to be the only organization that I can see that was developing a nuclear code case for implementation and is that still true?

I'm curious about the, sometimes we've had issues, we've heard of issues where the staff isn't pushing through, you know, endorsing the code as fast so as could so could you talk a little bit about how you're being ready to endorse or have problems, you know, reviewing and endorsement possible this code case when it's prepared.

And then I'm curious. There's a big difference is this is going in a rad environment. And so I did see like some venders have inserted things and I assume it was just in plants.

In fact, they mentioned one plant that was where they have put some material in. They've not done anything in a materials test reactor to do an accelerated radiation testing.

So it's only in prototypic conditions and so I guess that you're not going to allow them to go further than what they've inspected if for a risk important component.

If it's not risk important, then you'd obviously have less focus on the component that's AMT or developed with AMTs, but anyway, those are the questions I had for the slide. You can take your choice of which one to answer first.

MR. HISER: Okay. Maybe I'll start with

the most recent one and I might circle back to make sure I get all aspects of the codes and standards one. So there have been some efforts duly funded I know to do some test reactor radiations.

Ion radiation as well as neutron radiation, I know in particular, there's one that stands out to me. I know there's a Colorado School of Minds funded performing work and I see one of your colleagues is familiar with that and maybe more.

And I know there's, I know that the Department of Energy is funding at least that and probably multiple other efforts.

CHAIR REMPE: Can you say what type of components and materials are being --

MR. HISER: So --

CHAIR REMPE: -- tested?

MR. HISER: -- generally it's been stainless, 316L stainless steel has sort of been the primary material that's been looked at the most. And again, this is more focused on the additive manufacturing, 3D printed so to speak components.

That's really the sort of newest technology, the one that's really just come into existence over the last 10 to 15 years, but there are efforts to look at, yes, both ion and neutron irradiated components.

Then there are also right efforts to put them in plants and get some real, more practical experience and lower non-safety significant components.

So I think just as you indicated and it kind of touches to Charles' question. I think the risk informed piece we really look at it sort of on a, what's the component or application so we look at it as risk informed in terms of pressure boundary component would have a different level, you know, of scrutiny and expectation to it.

Then a non-pressure boundary or lower safety significance component so that's where sort of the risk informed piece comes in. And that's what we've tried to reflect through some of the guidance and guidelines that we've developed at this point. To the codes and standards, --

CHAIR REMPE: Yes.

MR. HISER: Go ahead. Okay.

CHAIR REMPE: I'm sorry. Second questions.

MR. HISER: Yes.

MR. DAVIS: Can I? I just --

MR. HISER: Just whenever, Robert.

MR. DAVIS: -- I just want to, we've also funded, we had a grant project that we funded last year in 2021 that's looking at doing high throughput irradiation experiments to help with rapid certification of AMT types of materials. So that's another effort that we funded as well so.

CHAIR REMPE: So stainless steel 316 or --?

MR. DAVIS: I believe that's what they're using, yes. Although it's more, the material is not important with that one. It's just understanding if they can, they've got a technique where they want to use ion or radiation to do more advanced high throughput testing to help with certification or rapid qualifications.

So it's really more of a proof of concept than it is a focal point on any particular material.

MEMBER BALLINGER: This is Ron Ballinger. I have a sort of a general question. This whole presentation is related to light water reactors. Have you got a branch that's going out to SMR's, the non-light water reactors where once the temperature starts rising now you have different windows that you can go through.

But I don't see it here. There were some presentations in one of your workshops from guys from NASA and stuff like that so I'm sure that's there, but I don't see it here.

MR. HISER: So what, my answer would be and I'm curious if Rob wants to chime in here or add to it, but I would say, yes, we've been focused firstly on light water reactors with the understanding someone could start putting components into plants, you know, in the very near future.

But I, we've been trying to structure things such that they would not be precluding or not open to, you know, we've been trying to analyze these technologies or make more application and material generic respective to understand the key aspects of the manufacturing processes than could be applied to different materials.

And, you know, and in application environments. So the guidelines that we've developed are sort of, we call them the generic guidelines. It could really be even considered beyond AMT. Sort of be a new material generic guidelines in some sense.

And that we would try to look at aspects of process qualification and performance monitoring. And we'll get to this in one of the later slides that ties to that, but we've been trying to make it focused on LWRs or exist today and components could be put into them today, but also not well limited to LWRs explicitly.

Yes, there does tend to be more data on LWR relevant materials and LWR relevant environments so, you know, when we look at material specific considerations, that's where there's information, but I think we're trying to structure things such that we're ready for advanced reactor applications and materials as well if you want to add anything on it.

MR. DAVIS I just quickly, we see three distinct areas were AMTs we think are going to be used.

MR. HISER: Sure.

MR. DAVIS: The first area is fuels. Right? Fuels are usually an early adopter of advanced technology for a variety of reasons that are obvious. And then with the existing LWRs, it will be potentially as repair replacement activities.

Especially with, you know, we talk a lot about supply chain issues and wherein that generically being challenging for several industries. We think AMTs have a unique role in being able to alleviate some of those issues because you don't need these large global supply chains.

Parts can be made locally. They can even be made potentially onsite if you've got the right facilities. And I think for some of these things like these unique nuclear components, I think that potentially will be very attractive for the existing plants.

And then the other application as you touched on, Professor Ballinger, is the new reactor applications. They're especially advanced on like water reactor applications as well as SMRs and things like that.

They have a unique advantage because they're still in the design phase. So they're in a position where they can uniquely take advantage of some of the really unique helpful design and material considerations that I think can really unlock the power and promise of some of these things.

MEMBER BALLINGER: But you know, you've got Division 5 materials so there's a 316 stainless steel which is 316 dash whatever the heck they call it, which is good for higher temperature.

Whereas if you go use some of these processes, you could probably get properties at an even higher temperature. Therefore, get that stainless steel to operate at a higher temperature.

MR. DAVIS: Many of these techniques, as you well know, are really, they allow processing and development of materials that are much harder to process than others. Right?

ODS strengthened materials which I think we all know have traditionally, yes, have good radiation resistance. I mean, they're more, you can fabricate them much easier using so than you could using conventional technique.

MEMBER BALLINGER: You could go on the web and type GRX-810, you'll get two classes of responses. One is a new material that they're developing and the other is a Shimano Bicycle derailleur.

MR. DAVIS: There's a lot of money in bicycling.

MR. BALLINGER: If you stick to the GS, stick to the NASA.

MR. DAVIS: And more money in bicycling than nuclear to be honest with you so.

CHAIR REMPE: Oh, is there a hand up? Let me see if I can --

MR. HISER: I was going to say I didn't want to forget Joy's first question about codes and standards.

CHAIR REMPE: Oh, yes, please don't forget that one.

MR. HISER: Yes. So maybe I'll -- it looks, okay, our colleague --

MR. DAVIS: Ron Davis.

MR. HISER: -- our colleague Bob wants to chime in on codes -- maybe I'll offer something and then I'll see if Bob wants to correct or offer anything else.

So you had pointed, asked about ASME code I think and other standards so a lot of these standards start at the ASTM and a lot of ASME codes standards on your materials start from an ASTM standard.

And then ASME references that and sort of brings it to a more applied environment that the NRC tends to endorse. So that's where there's more maturity at the ASTM alone.

A lot of the work is at the ASTM level. There is, this is moving to the ASME code level. NRC staff tend to participate more at the ASME code. That's the code that we endorse.

We have some awareness of activities at ASTM. We don't generally have another resources bandwidth to be attending ASTM code meetings on a quarterly basis the way we do ASME.

But so that's where we have been focused and that's where the industry has been focused. The other point I just wanted to make are the impetus for this whole action plan relative to codes and standards was a potential concern, criticism that codes and standards are too slow and it takes time. Right?

It takes time for the code process and it takes more time for the NRC endorsement process, you know, on the order of years. Right? For maybe starting out at, you know, it may take a year or two at least to go through code.

And then it may take another two to three years to move through the NRC's process to be endorsed in a reg guide and that reg guide be finalized after the public comment process.

So one of the reasons we have developed the guidelines that we have here and we may, you know, move those into more formal guidance is to try to give the industry opportunities and options to come to the agency outside of codes and standards.

Now we certainly value codes and standards. We think it's a very useful process. Right? And industry is moving in that direction on some of the early adoption things.

But again, in the interest of not being a roadblock or not saying we've got to wait four or five years for ASM, you know, to go through the code, we're trying to give opportunities for industry to feel like they have some guidelines they can use and come to the agency in the nearer term if that's their desire.

CHAIR REMPE: Just so I understand, though. ASTM might be doing something in radiation environment, but you're not following? Because I guess I --

MR. HISER: Okay, so --

CHAIR REMPE: -- thought ASME was the only one even thinking radiation find with other conditions.

MR. HISER: Yes, so I'm not as familiar with ACM, but I would guess they're not as focused on the radiation environment. They're focused on the materials processing fabrication qualify assurance. Right? Of just producing the materials.

CHAIR REMPE: Okay.

MR. HISER: That's going to come in ASME or even beyond.

MALE PARTICIPANT: Do you --

MR. BALLINGER: That's a good way to look at it. The ASME is more focused on performance.

MEMBER PETTI: Right.

MR. BALLINGER: ASCM is --

MEMBER PETTI: But it doesn't --

MR. BALLINGER: I, you get the start of --

MEMBER PETTI: But ASME doesn't have rules that say you have to radiate something. They say that's environmental considerations. And depending on if you're nuclear, obviously, that means radiation. If you're --

MR. BALLINGER: I, okay. I thought there was a --

MEMBER PETTI: No.

MR. BALLINGER: -- code case that --. Okay.

MEMBER PETTI: No, so.

MR. DAVIS: There's an ASME code other than creed, then high temperature does not consider environmental considerations.

MEMBER BALLINGER: It says you have to.

MR. DAVIS: It says you have to, but it doesn't explicitly.

MEMBER BALLINGER: That doesn't give you --

MR. DAVIS: Tell you explicitly how to do it.

MEMBER BALLINGER: Right.

MR. DAVIS: And then it lumps the radiation in with those other environmental considerations like environment.

MEMBER BALLINGER: Okay, and it's a big lump.

MR. DAVIS: And just to finish up the question about code, you know, we're -- staff's incredibly active in code so these code cases are being developed.

There's staff on all of these members and we're getting early engagement with the code so we've seen several drafts of the 316 code cases that EPRI's put together.

It had a lot of what I consider to be very constructive criticism that we provided back to ASME because we're trying to excel, we're trying to work outside of the code, but then also within the code.

So again, so if we can support this process as best as possible.

MEMBER PETTI: So this question on this, you know, everything takes too long in the mind of too many people today. I always thought that the time it took to get through the code was not about any vagaries of the code.

It was the time it took to get all the

data assembled. I mean and to get enough data. You need a fairly large quantity of data. Statistically, you know, across multiple heats, et cetera, et cetera.

And multiple, the range of temperatures being above the temperature of use, I mean you know, those are pretty descriptive rules and that the actual, you know, getting the rules done and voted on was not a major part of the overall process.

Am I wrong? I mean, is the process incredibly bureaucratic?

MEMBER BALLINGER: Lock to lock, it's about seven years.

MEMBER PETTI: Right, but is it, but how much of that is driven by data?

MEMBER BALLINGER: It's the data.

MEMBER PETTI: Yes.

MR. HISER: Yes, and, two thoughts I'll just offer on that. One is on the qualifications side particularly for added manufacturing. Their, you know, their traditional heat to heat variability sort of thing, it's a we'll touch on hopefully I think in our slides.

It's a fundamentally different way of producing material and there's a lot more sensitivity to geometry than with conventional manufacturing. And so it is, there may need to be different ways of thinking about how we qualify new materials without additive manufacturing in particular.

But the other piece I just say in terms of us putting out guidelines, the intention is the code, you know, they tend to write a code case and want to have pretty broad, you know, ability to then use the material and a number of different applications.

What we've tried to lay out with our guidelines is ways that people could use it in a more limited basis. You know, maybe they say we're going to put it in and we're going to do extra inspections.

Or we're going to maybe pull some pieces that, you know, put 10 of them in and pull one of them out after five years and look at it and, you know, and gather more data.

So we've tried to be more creative to sort of allow industry if they would like to take this option, you know, to be able to move in a more conditional basis, you know, before they've done the seven years as, you know.

As Ron said to sort of build up all the data and then get through the code process. So we're trying to be a responsive to industry, but not sacrifice safety or --

MEMBER PETTI: So in the regulatory context, have you guys looked at how other industries are incorporating additive manufacturing from a regulatory perspective to help guide thoughts of how you could accelerate some of this stuff while you're waiting for it?

MR. HISER: We have had discussions as particular to the workshop. A year and a half ago, we had a lot of good participation from outside the nuclear industry.

One of the tasks we're planning to do, focus on in the next phase, is having some more interactions with other agencies such as NASA, FAA, FDA, you know, that right, are in different industries.

But these new technologies are percolating, you know, not just in nuclear and in a lot of the industries, particularly aviation, it's further ahead so we can sort of learn from their approaches,.

You know, maybe approaches, challenges, you know, and how we can do things better. So that's definitely something we want to look at.

MR. DAVIS: Well, just and DoD has really taken --

MR. HISER: Yes.

MR. DAVIS: -- a big step in the last three or four years, especially as it, there's always been a good synergism between commercial nuclear and specific and Naval applications.

I mean, we've seen particularly Naval applications with AMPs have really increased. In fact, we had a workshop in 2017 and they were just dipping their toe in it in terms of light NASE.

And then we had a, and then back in 2020 we were shocked at the number of applications that they put in, in the three years since the first workshop. But no, we're definitely trying to keep our sort of finger on the pulse of what other agencies are doing that have regulatory responsibility.

Like Matt said, we'll draw that out in some of the slides assuming we can get through them.

MR. HISER: And if it's all right, I'll keep moving forward. So this slide sort of overviews the action plan and we have actually continued this format into our follow on user need request that we just started very recently.

But we broke it down into three overarching tasks and then each of these tasks has subtasks that help to implement the vision or the scope of that task.

So Task One is technical preparedness and focuses on technical information, knowledge and tools to prepare the NRC staff to review applications. And I want to point out at this point just to staff.

Before you and, you know, the focus of this presentation is more on the technical and research side of things. This has been an integrated program. We have technical and regulatory staff working together, but this briefing is not intended to focus as much on the regulatory side of things.

We do have staff, you know, from the regulatory office I see in the room as well as online. You know, from NRR if needed, but we definitely tell in our slides and to be honest, a lot of our activities have been more technical preparedness comes first and then regulatory.

You know, regulatory preparedness follows a little bit, so you know, we have tasks in both of these areas, but I just want to emphasize kind of the folks you're talking to and a lot of the activities to date have been more on the technical preparedness area.

So Task Two is focused on regulatory preparedness in developing guidance and tools from a regulatory perspective to prepare the staff for the efficient and effective review of AMT components that may be submitted to the NRC for review and approval.

And I should broaden that to also, you know, 50.59 applications. One of the subtasks in Task Two is the 50.59 report that was produced. And then finally, Task Three is communications and knowledge management.

And so this is internal interactions, external interactions, seminars for staff, you know, growth and development rotations. We actually have some staff starting rotations in this currently to get hands-on experience with doing, using additive manufacturing tools and 3-D printing.

And then also, interactions with codes and standards and then as I mentioned, the workshop that we had a year and a half ago so. Go to the next slide.

So just to overview Task One. There's three subtasks within Task One. The first subtask covers -- looks at AMT processes individually. So by the five AMT processes that I think I'll touch on in the next slide.

We perform technology specific assessments and reviews of each of those processes under Subtask

1A. Then Subtask 1B covers inspection in NDE. Actually, Bruce led that task and will take over it at the point once we get closer to the inspection NDE.

And so that looked at sort of conventional inspection methods, ultrasonics, things like that, that can be applied, how they can be applied to AMT components so questions of, you know, the types of defects that may exist.

And whether they can be caught by the conventional NDE methods we've used traditionally. And then finally, the final subtask in Task One is looking at modeling and simulation of microstructure and properties.

And this gets to what I was talking about a little earlier that the manufacturing process is a bit different so there may be and there's a lot more digital aspects to the control and the fabrications of these components .

And so you have greater opportunities to leverage modeling and simulation tools to inform your understanding and your assurance of the final product that you're getting.

It doesn't mean that, you know, some of the traditional methods of, you know, confirming that your component or your fabricated part is good or in part useful, but that we be able to balance them and optimize where we use them. So move on to the next slide.

CHAIR REMPE: I had a question. And maybe later would have been better for you too, but I thought I'd bring it up early. When I think about inductions and NDE techniques, I saw a lot of things about looking for flaws or defects and voids.

I didn't see anything about changes in composition. And some of the AMT processes could have a change in composition whether it's intentional or not intentional. And has that come up and I just didn't see that in what I was reviewing to prepare for this meeting?

MR. HISER: I would say most of the applications that are talked about right now, there is talk in more academic circles of doing sort of functionally graded components or, you know, changing composition through it.

I would say that's not something that has seemed to have gotten a lot of sort of near term industry interest. So our focus has sort of been more on, you know, more monolithic compositionally consistent, you know, components of the fabricated --

CHAIR REMPE: Okay. It also happened

unintentionally. Right? The, something, the way that they're --

MR. HISER: Yes.

CHAIR REMPE: -- like depositing material could have a variation in composition and compute it, the CT scanning methods could detect that and that is something I didn't notice when I was looking at the material.

And I am interested in CT processes because of prior experience.

MR. LIN: Yes, and that NDE and that inspection with prereading really focuses on, I'm looking at the composition change. It was mostly focused on UA spec, if you have a crack or you have void or you have velocity and yes, we didn't focus on the --.

MR. DAVIS: What you'll see in this upcoming, the next phase of the work. We're looking at in process evaluation techniques. There are many techniques that people are using to do and process.

Mainly for quality control and process control purposes. But maintaining compositional, you know, requirements is part of that.

CHAIR REMPE: Oh really. Okay. I guess I missed that part.

MR. DAVIS: Yes.

CHAIR REMPE: But yes. I just thought it was VME'd applications.

MR. DAVIS: Yes, yes, yes.

CHAIR REMPE: It's something that obviously the AMT processes during the composition is kind of a neat contribute people --.

MR. DAVIS: Well the one thing that's nice about many of these techniques because they're really built from the ground up at the microscale. You've got much better compositional control than you do in these bulk processes like forging or plate or plate manufacturing or some of these more testing, some of these more conventional methods that we use to produce components.

You have much better control of your composition when you sort of, at least all of these techniques that we're going to be talking about here, compositional variability does not tend, it hasn't tended to be a huge issue.

Now microstructural variability and property variability, those have been big issues, but they're not typically related to compositional differences among the build or within the build itself from build to build.

MR. HISER: Yet. And to build on what Rob was saying, you know it is more, a lot of these processes start with powder and so, you know, having your composition control in your powder production process really is critical.

But yes, it tends to be less of a concern as long as you have the right starting materials in your powders. And as soon as Bob put his hand up at some point here in the discussion about compositions, I know Bob, if you want to chime in.

MR. DAVIS: Oh, actually I wanted to make a comment before so as long as you're done with the compositional discussion, I want to make a comment about something.

MR. HISER: This is Bob Davis. He's a senior materials engineer in the Division Unit of Renewed Licenses in NRR.

MR. DAVIS: Okay, and so you know, when you look at all of these AMTs, they're not all created equal. You know, if we look at the bottom of this list, caulk I suspect pressing has been around since the '50s and was actually invented at the direction of the AEC as Patel to figure out the new ways to clad fuel.

So that's been around for a long time and it's progressed into an extremely mature process that's used in many, many, many critical applications and military aircraft and probably most of the aircraft that you ride on for high tech components that are traveling at high RPMs and high temperature.

So it's a very mature process, there's currently an ASME code case, code case NA-34 that was approved by ASME to make 316-L pressure retaining components. ASME approved that code case.

hat code case was based on an AMTM-8 STM standard. And I believe approved it. It's in the regulatory guide so anytime somebody can, anytime anybody wants to make a 316-LPN head valve or tube fitting or anything like that, they can make it without regulatory, without coming to the regulator at all.

Then that process is great for very mature for nickel-based alloys that's used in several different industries. Not so mature for alloy steel which is what every EPRI's investigating right now.

At lot of work needs to be done in that area, but it's been around since the '50s. Electron beam welding's been around since the '50s too. The first electron beam welding machine that was purchased for the United States was for welding fuel assembly I think for the Polaris submarines.

That's a very mature process. It's very limiting because it's very expensive item and they're trying to work ways around that. No regulatory approval is required to use electron beam welding to weld anything in nuclear currently.

And then so these and cold spray's been around for a long time. As long as it's not being used as a fresh structural application, then it's a fairly mature process.

And then, in when you get into the additive, there's also an additive manufacturing gas metal art basically used weld metal, weld wire to build up parts and there's a lot of work in that area and people are making a lot of components for a lot of different industries with that process.

So when you look at these AMTs really where most of the challenges are, are in these laser powder bed fusion and this laser direct energy deposition where you're depositing a powder in a small layer and melting it and going over it and over it and over it.

And there's a lot of microstructural differences on a lot more variables that you have to control than these other processes. Or rather, as somebody mentioned some of these what could they be used for, for advanced reactors?

Well, currently there's a non-nuclear proved code case for grade 91 which is a material that's approved in Division 5 although PM-HIP was not an approved product form.

With all the information that's available for that if someone chose to use that material and write a nuclear code case, I believe that they would probably have sufficient information to do that.

So I just want to point out the differences between these and where we're really, where the real that problem that where a lot of the challenges are and that would be in these top two that present more challenges than the bottom three.

MR. HISER: Thanks, Bob. So I think Bob did a good job of presenting this slide for me, but I'll go ahead and move forward on this slide. So the thing I wanted to emphasize here, I think Bob's introduced you to some of these technologies, the top two, laser powder bed fusion, laser directed energy deposition, are sort of in the newest stage of development or it may be considered additive manufacturing.

A cold phrase technology that's been used primarily for codings and ware applications in the defense industry really going back actually a few decades, primarily in the Army, but it's something that the industry is looked at for corrosion resistant codings or ware codings more recently.

And it's something that can be done in situ. It's low temperature so there's some advantages there. And then finally, as Bob pointed out, the electron beam welding and PM-HIP are both being focused on now for potentially producing small modular reactor, reactor pressure vessel components.

So, you know, PM-HIP to produce the actual sections and then electron beam welding to weld them together into the whole vessel, that's the idea vision that EPRE and DOE are working towards.

And so we've looked at those technologies recognizing the safety significance of that, you know, that potential component that would be used. The other point I just want to make here, we're not trying to pick winners and losers, we don't like these technologies more than other technologies.

Through the NEI letter, through interactions, you know, we understand where industry's going. We've tried to identify the technologies that seem to have the most near term, you know, likely use by industry and so that's how we came to look at these five.

We do have some additional ones that we're planning to look at in the next few years. But we're also trying to be flexible to recognizing that these things are evolving over time.

And we may also be going back and proposing to go back and update some of these prior assessments recognizing that three or four or five years can be, a lot can change, particularly in the added manufacturing world.

And so we may need to update our assessments and our knowledge. The next slide. I'm just going to touch on, I'll cover the, briefly this one and then cut out.

So I'll be covering the first two of these technologies, the added manufacturing ones. And then Bruce will cover the remainder and the inspection in the E and then we'll turn it over to Rob for the last part of Task One.

So this is just to cover our approach and you'll see this figure again in a later slide tying it into the regulatory documents that, or guidelines that we've developed.

But we just wanted to sort of graphically show what we've put together. So you'll notice the color coding on these boxes. This sort of a blueish color, bluish, purplish color box indicates a contractor developed product.

And then the more reddish, pinkish box is a staff, NRC staff produced document. And so what we've done for each of these technologies is gone to experts at the national labs.

In this case, all of these are produced either Oak Ridge National Lab or Pacific Northwest National Lab where they have a good knowledge of these manufacturing methods.

And they've performed a literature of you, you know, use expert knowledge of these processes to perform a gap analysis and develop the technical basis information to inform the NRC staff.

And then what we've done is produce what we'll call it a technical assessment. That sort of builds off of that technical letter report. And it references some of the gaps to identify the technical letter report, but adds the NRC staff perspective on understanding the philosophy of use in nuclear applications.

And it's a bridge as you'll see in a later slide to sort of the guidelines. We've tried to show to you that we have the technical basis from the contractor.

And that technical assessment doesn't touch so much on regulatory topics, but focuses on the technical. And then that bridges to sort of regulatory guidelines that have been put together.

I just wanted to sort of establish that and put a little graphic in front of you that you'll see, you'll see a larger graphic later. It's somewhat after this. Next slide.

Just moving to the first specific AMT, laser powder bed fusion and just for those that aren't familiar, this, you know, this is sort of I think the traditional 3-D printing process people think of so you have a bed of powder.

You lay out one layer and then you selectively melt the parts based on the three-dimensional component you're trying to produce. Then you lay another layer of powder and selectively melt with a laser the parts that you want to melt.

And then at the end, all that excess powder is removed and you just are left with the consolidated melted part that you were looking for. This process is generally used for smaller components.

It's challenge is you have to have a

powder bed and so it gets impractical to have very large powder beds. So it has limitation in terms of size. However, it is really useful for more complex geometries.

It can produce fairly precise features and then sort of the bottom bullet there I've got on the slide is for some of the key takeaways. I'm going to try to boil down, you know, a 100-page report and a 20-page technical assessment to sort of just a few bullets here.

But really the key takeaway that we got from the laser powder looking at laser powder bed, is as I mentioned earlier, component geometry and the build process.

Perimeters do play a significant role in the material properties. A feature that's very thin is going to have a different cooling rate than a thicker feature based on the build process.

And that can lead to significant differences in the microstructure and then the resulting properties. In addition, a layer by layer build process leads to anti-solder piece so, you know, you have different layers built up on top of each other.

And you're going to have different

properties in that, across the build layer versus through the thickness or through that vertical dimension.

The next point I just want to make thermal post processing is a way that can help to resolve some of these issues doing a heat treatment. That's pretty standard and materials fabrication, that is a way to reduce some of the residual stresses that may build up in the build process as well you may not eliminate, but you may reduce the anisotropy and make a more isotropic microstructure and properties that exist at the end.

And then finally, just a comment on standards. There are some laser powder bed fusion specific standards that are under development. There are also a lot of existing standards related to aspects of the laser powder bed process such as powder production and other pieces of the powder meteorology that are applicable to laser powder bed.

And you know, we're aware of some of the standards. Particularly, at the ASME code level that are being put forward. So laser powder bed infusion is moving ahead, but still you know, not necessarily a fully matured technology particularly for the nuclear application or nuclear field.

VICE CHAIR KIRCHNER: So this gets you ready to look at components that are fabricated with this process. What I was wondering was how does the, how do you, the staff, get out of a situation where how shall I say it?

If it's a safety-related component, it becomes of one off, even though this is a general technique, when it comes to the actual application, you've got to actually review the component in its functional, the functional requirements or safety requirements for that component.

So it becomes, it still becomes a one off review. It's hard to imagine, yes, I could see where ASME, for example, could have certain standards with regard to the patterns and so on and so forth, but the variability there, you know, in terms of applications is huge.

So it almost forces you into a one-by-one kind of review doesn't it? When, the components are used first, an application important to safety?

MR. HISER: I think potentially I think it would depend on, you know, there are different codes in non-nuclear industries that are looking at ways to frame that.

You know, I think you're maybe you're

referring to the geometry piece of the properties change. There are ways that have been looked at to qualify the process and have met, you know, thinnest and thickest features, the sort of range that the gamut of you know, the geometries that you may see.

And then qualify the process that way. So that's something, that's an approach that, you know, develops and matures and that we could accept and that there could be a way, you know, probably through the ASME code, you know, that you could handle it more broadly.

But if someone wanted to come in and do something in the near term maybe with less data, yes, it would probably, it may need to be bounded by the component.

VICE CHAIR KIRCHNER: So how is the ASME approaching this? They'll do it for a particular powder like some powder used for say, a stainless steel application or something?

MR. HISER: Correct. Right so the one code case that's most far ahead is specific to 316-L stainless steel manufactured by laser powder bed fusion.

And so they've kind of locked down the manufacturing method that, you know, the process and then the material that will be used and then they bound, you know, the thickness, the features that can be the size of the component, you know.

And the features that can be used to fabricate the thickness for instance. And then the process perimeters, you know, are -- there's ranges that have to be qualified.

MR. DAVIS: Well and for that particular code case, they lock down the material, but then they've had different vendors produce parts. And then they measure the properties and look at how much uncertainty, how much vendor to vendor uncertainty they're getting in the production.

So that's part of it as well and it gets to, you know, as Dr. Petti said, it gets to qualifications. If you're going to qualify a material under Section 2, you've got to fulfill all of the Section 2 rules in terms of sampling and variability and things like that.

So that requires a lot of lot production to do that. And then also, then once you've done your qualification, you have to have had process control in place to demonstrate that whatever the critical process perimeters are that you're maintaining those within the acceptable limits.

And then if you've demonstrated that things made with those acceptable limits produce acceptable properties, then you should be able to have a broad application of that particular technique.

But it really just gets down to, as Matt said, how they decide to qualify it. If they want to do a very narrow qualification then, yes, we're going to have to do a specific review of that particular application.

If they want to do a broader qualification, we should be able to do a review of that broad qualification and say, no this is good for, you know, much more generally as long as they stay within the confines of that qualification plan and procedure as documented by whatever, ASME code or whatever other standardized method they happen to be following.

CHAIR REMPE: They have to worry about cyber security?

MR. DAVIS: Yes, oh, yes.

CHAIR REMPE: And as part of the qualifications?

MR. DAVIS: Yes, that's it so yes, no demonstrating that you've got proper process control and because these are based on digital, you know, footprints or blueprints, yes.

Maintaining the integrity of those digital instructions is a vital component of the qualification process. It has to be.

MR. HISER: Next slide Hussain. Okay so the next two slides I just want to highlight a couple of the examples that I mentioned earlier that have been used in the 50.59 process to put components.

As I mentioned laser powder bed fusion is a bit leading the pack in terms of these applications. So these two applications are both using laser powder bed fusion components.

This first one was installed actually over two years ago now in Byron Unit 1 as a thimble plugging device is the name of the component. It sort of goes down the top of a fuel assembly and to some of the water-filled nonfueled rods.

It's a very low, in fact depending on the plant, non, you know, non-safety or very low safety significant component. So something that, you know, we would not say encourage, but you know, it's a good way to gather data and experience on these in a real operating plant without really posing significant safety or risk concerns.

So it's a PWR environment with a radiation and was done in accordance with the 50.59 process which does not require approval. And I've put a link to the article about this and a figure that's shown there is at that link.

MEMBER MARCH-LEUBA: It's probably or duplicative, but are there any plans to inspect it after five years when they take the fuel out?

MR. HISER: I'm trying to remember. I think they have not committed to doing that, but they certainly said --

MEMBER MARCH-LEUBA: Not important.

MR. HISER: -- that maybe they would seek the Department of Energy or other sources of funding, but yes, I don't think they've committed Westinghouse nor the utilities committed to that. But I think they are planning to pull it out.

MEMBER MARCH-LEUBA: That's the only thing that they should pay Oak Ridge more or less.

MR. HISER: I would hope and suspect that's what would happen. Okay, next slide. Oh, this is just second application also in the U.S. and this was a fuel channel fastener as is installed in a VWR at Brownsberry Unit 2.

And this was about a little over a year ago so last spring. Also 316-L stainless steel, laser powder bed fusion. In fact, Oak Ridge National, I've arbitrarily actually worked with Framatome to fabricate these components.

And similarly, it was done under the 50.59 process. These are a non-code class component. And will go fairly low safety since I think the one distinction is I recall reading one of the articles.

I think they identified it as maybe considered a safety-related component in the licensing basis for this plant which was different than the Byron example where it was a non-safety related component in there.

But in any case, it's not a high safety significance component. And again, there's a link there to the website with the figure and some more information on that.

The other one I just wanted to highlight or mention, just in the last month or two, I know there was headlines about Westinghouse leading a fuel debris filter that was made, I believe by laser powder bed fusion into a couple of mega one reactor, maybe two filters and one reactor in Sweden.

Or maybe it was a, I can't remember whether it was two reactors or one reactor, but --

MEMBER MARCH-LEUBA: When we visit the

Framatome probably three or four years ago, they showed us a new filter for a generator fuel that was mis-operated.

MR. HISER: Yes. And that to me seems like, you know as I mentioned earlier, it's useful for complex geometries, but small parts or a fuel debris refilter is these prototypical where you see a benefit here.

MEMBER MARCH-LEUBA: You couldn't do it any other way.

MR. HISER: Right. Yes, and I imagine you could make a better fuel debris filter come with better geometries than you could before and more effectively a filter.

MEMBER MARCH-LEUBA: Well this one you have in the picture is this for a new fuel type of was it replacement for something that pending in the --?

MR. HISER: Yes, so this one here is a channel fastener. That's not the fuel debris filter there.

MEMBER MARCH-LEUBA: Oh.

MR. HISER: And yes, and this was, it's on a fuel so I think it came with the new fuel assemblies. They put --

MEMBER MARCH-LEUBA: So it's part of a new fuel line?

MR. HISER: New fuel load. Yes. And they just put I think in maybe two or three fuel bundles.

MEMBER MARCH-LEUBA: Then it's not --

MR. HISER: Not, they didn't, not the whole, you know, core or the whole new fresh fuel. Just a couple.

CHAIR REMPE: So colleagues and presenters, I apologize, but we only have a half hour and we're about halfway through this or not even halfway and so we're going to have to hold our questions again and ask you to, as best as you can --

MR. HISER: Yes.

CHAIR REMPE: -- speed up. I apologize.

MR. HISER: No, we just figured --

CHAIR REMPE: It just seems to go --

MR. HISER: -- it would go slowly early so I think the --

CHAIR REMPE: Okay.

MR. HISER: -- hopefully the end will --

CHAIR REMPE: Good.

MR. HISER: -- the slides will flow quicker.

CHAIR REMPE: Thank you.

MR. HISER: Okay, next slide. And I'm

almost done so I'm sure Bruce will be more efficient that I was. So laser direct energy deposition, this is, there's a lot of similarities to laser powder bed fusion, but the difference is you don't have a powder bed.

You're really feeding your feedstock whether it's through a wire or a powder. It's sort of getting fed through a nozzle and so it, the sort of the build is free standing.

And so it's really kind of fundamentally just welding using robotics and computer controls. We ended up focusing on laser directed energy deposition, but actually one of our next plans is to look at arc directed energy deposition so arc welding is really very similar to current welding.

It, there are different, the big difference I would say was laser powder bed fusion is you can use larger components and do some faster productions and greater, you know, build volumes because you don't have a, you're not building with powder all around.

You're sort of just providing the wire or powder as you build. And so sort of the key take aways is it's similar to laser powder bed fusion, the microstructure and properties do depend on the geometry.

That's a significant difference than sort of conventional manufacturing. You do have some enhanced geometric flexibility and you can also use hybrid manufacturing more readily.

So that would mean you might build some and then do some subtractive machining and then continue building more. That's what's sort of commonly termed hybrid manufacturing, a mixture of additive and subtractive manufacturing during the build process.

And then I would just highlight, you know, the codes and standards are a bit more sparce for laser DED than laser powder bed fusion, but there are some of the supporting standards and there are efforts to develop standards for LDED as well.

So with that, I'll pass it on to Bruce to cover the last few AMTs under Task 1A.

MR. LIN: Thank you, Matt. Yes, Bruce Lin, I'm a material engineers with the Office of Research and Division Engineering. We have the engineering branch.

Yes, I'm going to talk about the next three AMTs and ROTs we look at as part of AMT action plans. And I'm also going to touch on the inspection in NDE or multi-study immunizations.

So you see the AMT components. So on part of the routine highlights are steady pression of PM-HIPs is being considered of application of large, heavy section.

We have to purchase vessel components and the process basically consists of, you know, during EMT cache or with metal powders, then you expose the powder to very high temperature and pressure during the HIP process.

You intensity the powder and they see into a shell of the components. And after densification, then the capsule is removed and then you and end up with an near next-shaped component and then you can do your final machining and it's action as needed.

The PM-HIP can be used to make any size of the class one, two or three components or reactor internals and some of the potential application include large bow bodies, pump casing or vessel shells.

I think I already mentioned, there's a project that's underway at EPRI and DOE to look at illustrating the use of PM-HIP along with electronic beam welding to fabricate the new skill reactor vessels.

Some of the key takeaway from the gap analysis are, I think this is already mentioned, that there's a code case ASME code case allow you to use PM-HIP with 316 neuro stainless steel.

Study has shown that component can enable 316 standard steel powders in half. Again with the properties that is similar or better than traditional manufacture stainless steel components.

Some of the key challenges for PM-HIP of heavy section low alloy steel component include, you know, scaling up the process. A lot of the application in the past has been for smaller components.

I mean, you know, using PM-HIP or fabrication of very large heavy section reactor vessels is the first kind of applications and it certainly presents some challenges including to scale on up to the size and weight of the reactor components.

Some of the other challenges include, you know, if you establish the procedure how you do your other production, you know, establishing the process perimeters and you know, the understanding to optimize the process, the HIP process by such temperature, pressure, and time is important to ensure you are, you meet the required property in microstructures.

And next slide please. Yes, there. Electron beam welding is infusion welding process that use a beam of high velocity electrons to join the materials.

The beam or electrons basically creates a connectivity heat when it impacts a work piece and causes them to melt and they basically bond together. Next, EB welding is, you know, typically a single pass welding with no fuel or materials.

And it can be completed much more quickly due to very deep penetrations. Some of the demonstration by EPRI has shown that you can weld some of those RPV, difficult welds in under an hour, sink or pass.

Some potential applications is looking at for welding of medium and large components, as I mentioned, there's an ongoing project to look at demonstrating and establish EB welding as a survival and largely for welding large every section after pressure vessel components.

Then I think we only touch on this EB welding as a premature process and it's allowed by ASME code. However, there's still a lot of work that need to be done to demonstrate sufficient performance for large PM-HIP components.

EBW application is pretty limited as to the safe is due to very high equipment costs and has to be done in a vacuum, especially with large components and very large vacuum chambers and associated facility requirements.

Because no fuel material is used in the weld as a potential that, yes, you can do a post-weld heat treat to basically turn the weld fusing on to base material properties and they did that and allowed to potentially to seek credit for believing inspection with these or I think in those cases, additional demonstration will likely be needed. Next slide please.

Again, codes play I think already mentioned is being used for a long time and it's the process they seem using preheat and pressurized gas typically nitrogen or helium or sometimes air is used to assimilate a powder at really high velocity at supersonic speed or onto the substrates of this and you form a mechanical bond basically, a bond in between the powder and the substrate.

The closest place is very, it's a solid base metal process. It doesn't get any newer than metal. This process can be used to either, you know, use as a field or shop applications to repair system parts or as a mitigation process.

Most of the application today has been nonstructured. I merely for close and resistance or wear resistance or to restore dimensional torrents. Potential application in nuclear, you know, or for mitigation or repair of care induced stress growths and cracking, dispenser cannisters, I think there's that active pass will be when AMSE is looking at developing a code case for this applications.

Other potential applications include for mitigation repairs fresh screws and cracking and reactor components and obviously you can use it for corrosion resistance and real resistance or a lot of times for just to restore the dimensions.

Again, cold spray has been I guess some of the key takeaways is so far it's been used primarily for non-structural application where the structure is not ready to, does not claimed to provide any structure performance.

And I think there are ongoing effort within other industry. I think in DoD's looking at using cold spray for structure applications. Honestly, for those, you know, for when you use instructor application, they would likely be, you know, application specific data that need to be provided to demonstrate sufficient performance.

MEMBER PETTI: Just a question.

MR. LIN: Yes.

MEMBER PETTI: You know, given so many of these AMTs that basically process these, do you see anything that makes you concerned that you might have to regulate the process and not just over the product specification to get, you know, to get what you need?

MR. LIN: Well I think they're going to have to demonstrate the process, the entire process qualification. Right? For depending on this application for a specific application.

They're going to have to say I'm, if I maintain my process, good thing so within perimeters and I'll verify that I'll get the same properties and they're going to have to maintain that as a certification by a process.

So if it will be, you know, it's almost like a welding process. So you've got to have a really descriptive, specific process range that you've demonstrated that will meet that, that will get you the properties.

MR. DAVIS: Yes, it just that, you know, any fabrication technique is processing specific so there's nothing you need here. Right? From my perspective I can qualify within a range of acceptable critical processes and as long as you stay within that, you're okay.

And that's why processes fall in the qualification program are so important parts of the process.

MR. LIN: Yes.

MR. DAVIS: They're unique things that we haven't had to consider historically that's true. But the process itself I think doesn't need to change just because these are new ways of making components than we have in the past.

MR. LIN: Okay. Also as part of Subtest 1B, we also conducted an initial review looking at the sale of volume NDE for inspection of AMT components. That review basically focused on, you know, whether the assisting NDE techniques can be used to detect the kind of defect that we anticipate to see in some of the AMT components.

And a report basically prepared by Pacific, the TNL Pacific or what's National Lab identified 21 Notis gaps related to NDE or AMT components. We also rank the Notis gaps based on the penetrating need of NDE for the AMT components.

Yes, some of the notable Notis gaps include, you know, by the dates of NDE techniques with destructive testing. You know, it always going to verify the true space and the other gap that is identified is a defect acceptance standard.

What type of defect do you expect to see in AMT components? What are the critical flaws that the NDE technique need to detect?. Those are still unknown at this stage.

It's not a lot of Notis standards out there. And the other gaps are listed as determination of the effect of the grand structure on all the standard testing. I think that's it. I'm going to turn it over to Rob for just a moment.

MR. DAVIS: And I'm going to be quick. I know we've got 15 minutes.

MR. LIN: Yes.

MR. DAVIS: And I vow to stay within the allotted time so I'm going to try to move rapidly and not read the slides, but just hit the high points if that's okay.

So this next, this last hub subtask was in the technical preparedness activities was a really fun one because we got to locate modeling and simulation techniques.

And again, I think we touched on previously we think modeling and sim really has a unique role to help accelerate material certification. And we believe that modeling and sim, again, a lot of this stuff's been around forever.

And so you're going to see a lot of these challenges, things that we still need to do are no different than they've been in the last 10 to 20 years.

But we really think that we're seeing sort of a new age where these things are starting to coalesce where they start to become more viable. So with this subtask, we split it down and this was done by Argonne National Lab.

It's a two-report series. And the first report looks at which is summarized on this first slide, how you go from the processes that we looked at to the microstructures and how can you simulate that part of the process of going from I'd say laser powder bed fusion to whatever microstructures are formed for that particular process.

And so the report looked at the state of the art as well as some of the gaps that are associated and some of the more significant gaps. In terms of key considerations and they looked at two different types of modeling and sims.

One was physics based models, the others were data driven models. And really this, they treated them separately, but I think there's an expectation.

But ultimately these things are going to be merged and used synergistically in a way because each of them has unique advantages and disadvantages to working on different scales of the problem.

So some of the key conclusions from this report again, none of this is surprising, but this notion that we need to bridge length and time scales in the physics-based models to go from let's say atomistic up to continuum based models has been a long-standing issue.

And I think the recognized challenge is there of even committing to more of a focus so there was just, again, another plea that we need better methods for bridging these gaps between different levels of physics-based methods.

If we're going to use the data-driven methods, we've certainly recognized that they need a lot of data. So we need to identify what types of data are important and then we need to start developing these databases for training.

Not only training, but then verification at the end of the day. And of course, modeling and sim, you always need to appropriately benchmark and there's only been a few benchmarks that have been conducted in AMCT space so developing a standardized commonly accepted benchmark or series of benchmarks is something that I think the community recognizes as really needs to be done. Next slide please.

But then the second report said, okay now give me a microstructure that's produced by AMTs. How can I go from that microstructure to predict based on that microstructure what the physical mechanical properties will be for that particular material?

So it's the other half of the modeling and simulation picture. I'll just touch on the key gaps from this part of the report or this volume of the report.

Again, this notion that we need to be able to more efficiently bridge length and time scales and determine sort of optimally which model length and time scale is appropriate or which problem that you're looking at. Right?

If you're looking at basic tensile properties or short-term high temperature crete for properties, that's one sort of length and time scale.

If you're looking at long-term radiation performance for stress growths and cracking performance, that can be decades longer.

So it's a challenge for modeling to try to incorporate modeling to understand all of those different properties. There's a recognition that we don't have a good way to just from first principals to say okay, I'm in a modeling and sim, I'm going to do a modeling and sim and come up with a new material that thinks I could, that looks like it's going to fill a gap.

We still rely heavily on experimental trial and error and validation so that's an area that long standing difficulties, but it's recognized that we need to continue to make progress there.

And again, the final piece of it and this touches on what Dr. Rempe talked about, was right now we're still seeing a relative dearth of AMTs and nuclear applications and that needs to pick up so that we can understand a radiation performance and some again, is other long incubation time mechanisms that are so important for certain nuclear components. Next slide please.

All right, this, so the bulk of the presentation as Matt talked about covered Task One, the technical preparedness activities. I just want to give you guys a flavor in just a few slides on what we've been doing in the regulatory preparedness activities.

We've had three separate subtasks. Subtask 2A is focused on implementation using the 50.59 process. I think we've already seen with the first two applications and I think we expect more of this, 50.55 for non-pressure boundary and non-safety significant applications remains a very viable and easy mechanism for introducing these materials into the fleet.

So what we focused on were giving tools to the inspectors. If you're familiar with 50.59, licensee has to do an evaluation of the technology to demonstrate that it's appropriate.

And then they need to do a screening evaluation to makes sure that technology is appropriate withing 50.59. But we don't review those, but what happens is periodically the license, the inspectors will license them or will audit them as part of an inspection.

But we focus on in Subtask 2A was providing inspectors with guidance. But they're looking at an AMT evaluation. They sort of know what some of the critical things they need to be looking for to make sure that evaluation was done correctly.

So that was focused on providing an inspector tool. Subtest 2B was staff and NRR taking a look broadly at our regulations as well as regulatory guidance and specifically the standard review plan to see if there's any barriers existing in our regulations for incorporating AMTs.

At least in all of the regulations and guidelines that they looked at, we haven't found any barriers, but we have recommended and recognized that better guidance on how to faithfully adopt AMTs and get AMTs approved, that would potentially be helpful.

But based on that recommendation from Subtask 2D, that sort of fueled the Subtask 2C activities which were to develop some AMT guidelines. And again, these are meant to be generic as well as technology specific guidelines that would help not only staff, but then also provide transparency for submitters and what types of things we're looking for in a potential application. Next slide please.

So I'll go quickly through this because, but this was sort of the philosophy and this is when we talked about risk informed, I think this is what we're meaning when we talk about risk informed in terms of guidelines.

We were trying to develop guidelines which are both, which are sufficient so they could contain all of the important things that need to be addressed. Especially in the safety related application.

But they're flexible, they rely, they allow both a variety of methods and mechanisms to demonstrate sufficiency and then we use the word minimize technical and regulatory burden, but I really think we're trying to optimize it. Right?

We're trying to have the right requirements and regulatory things in place depending on the safety significance of the application itself. So that's been the overarching goal that we've had or that we're trying to maintain, we, when we develop these guidelines. Next slide please.

You've seen part of this before. Matt put up the left half of this which shows the technical bases for the guidelines so he talked us through the blue and I guess that's the pinkish, salmon colored locks on the technical that shows how we went from contractor reports to technical assessment documents which as Matt said, are the staff's spin on what we think the important gaps are that need to be addressed in an application.

The regulatory guidelines views spills on that. There's a general guidelines that's really depicted by really the blue area that's surrounding everything.

We have a set of general guidelines which provide some general criteria and areas that need to be addressed. And then there are technology specific draft guidelines documents that we put together. We put together the first three of them now.

We put together one on laser powder bed fusion, one on laser DED and one on cold spray. We've submitted those as drafts for public comment and we've also had public meetings on those documents.

The last two DGDs or draft guidance documents are waiting for the technology to become a little bit more mature on ED welding and PM-HIP because EPRI is doing, over the next year to 18 months, they're doing quite a bit of technology development.

So we decided it would be best to wait until that work was done so that we had a better basis for really developing this draft guideline documents. Next slide please.

CHAIR REMPE: I just --

MR. DAVIS: Yes.

CHAIR REMPE: What's the DOE EPRI demo project?

MR. DAVIS: Go back. And look at the slide. I didn't even read my slide.

MR. HISER: I think it's the same one we've referred to before.

CHAIR REMPE: Oh, okay.

MR. HISER: We'll be doing PM-HIP and electronic beam welding to produce small module reactor pressure vessel.

CHAIR REMPE: Okay.

MR. DAVIS: Yes, I'm sorry, that's the, yes, that's the EPRI unit.

MR. HISER: Yes.

MR. DAVIS: Sorry. Next slide. And then I just want to, I'll be incredibly brief here. This is our final task to sort of wrap up what's in the action plan and it's related to communications and knowledge management.

So there's three subtasks that are related to internal activities and in terms of trainings and seminars as well as knowledge management. We have the Subtask 3B specifically on external activities where we try to make sure that we've got the pulse not of just the codes and standards community, but then also the various external take upholders that are either working on developing these techniques or they're looking to apply them.

And then we have a specific subtask on public workshops. We've done two. We did one in 2017 and then one on 2020. You'll see the, those are active links of the summary as well as the website for the 2020 public workshop.

You can get more information by clicking on the links. Next slide please, Hussain. I think we've touched this, but this is just a single slide that talks about the codes and standards activities.

So I think, Chairman Rempe, between your questions and Bruce and Matt and Bob's elaboration, I think we've covered just about everything on this slide.

I think Professor Ballinger mentioned what are we doing for high temperature nonlight water reactor applications and there is a special ASME task group that's specifically looking on that, at that issue and we have representation on that task group as well. Next slide please.

This is just a quick summary of the workshop itself. The only thing I want to stress here is this is where we're trying to get there's a question about how are we reaching out to the other Government organizations.

You'll see here with the participants, we really tried to be inclusive. We included not only industry representatives, but representatives from DOE as well as the National Labs that are developing many of these technologies.

And then we also have some vendors and some licensees to try to understand how they're looking at applying these technologies. And then you'll see we specifically had contributions from NIST, FAA, NASA, FDA.

This is to try to get us to understand how other Government agencies that have a regulatory authority like the NRC, how they're addressing AMT applications. And the surprising thing to me at least is being kind of naive.

I was, FDA really there's a lot more parallels between what FDA is doing and what the NRC is doing in terms of processes so I think we really have a lot to learn from FDA and that's not an agency that we typically interact with a lot.

So it's, but it's something that we want to try to mature and develop as we move forward in this area. Next slide please.

MEMBER BALLINGER: Excuse me, this is Ron Ballinger again. Have you thought about when you have the next workshop which obviously there probably will be one.

MR. DAVIS: You should be my straight man that's coming up in a slide that I'm trying to get to.

MEMBER BALLINGER: And I don't see GE, Bratton Whitney or Rolls Royce anywhere.

MR. DAVIS: Yes, we've --

MEMBER BALLINGER: These are vendors for aircraft parts that have to deal with the bureaucracy.

MR. DAVIS: Yes, we've had Rolls -- and we didn't list everyone. Rolls Royce was at both workshops and GE --

MEMBER BALLINGER: Okay.

MR. DAVIS: -- as well so yes, we, believe me, we've made sure that yes, your point is well taken. And I think that's a good point. The next two slides I'm not going to spend any time on them.

These are, this is the, if you look at the action plan Rev. 1, these are all the deliverables under the action plan. And they're subdivided by subtasks that Matt and Bruce have talked about.

And then the second column shows you what the actual deliverable is and then you've got a link in that status column to get you that report or that deliverable. So this slide and then the next one, go ahead, Hussain.

This gives you all the different products that are associated with Rev 1 of the action plan. And if we didn't say it, we've completed the action plan.

So we just completed the action plan just formally about a month or so ago. And I think we're still waiting for the official closeout, maybe not. But it --

MR. HISER: Yes.

MR. DAVIS: -- was.

MR. HISER: I'm just, would they said we know for sure about --

MR. DAVIS: Yes, so --

MR. HISER: -- the reasons. So, yes.

MR. DAVIS: So yes, so we've really, yes, that's right. We did just have that final public meeting. That was the last part of the action plan. Everything is documented here.

You can find more information about anything that we talked about by clicking on one of these links. Next slide. I've got two minutes so I want to talk about what we're doing next.

Because I think this is really exciting. And I think it's designed really to build off some of the initial work that we've done under Rev. 1. So we're going to look at -- the next work's going to be done not under an action plan.

We're going back to the user need process and we've already got a user need in place for the next iteration of work. We're going to look at least two additional AMTs. One is hard paste DED which we should just say micro-welding because that's effectively what it is. Right?

And this is a technique that has already seen great use and we're seeing rapid deployment of this. And it's got, it's very flexible. It's good to couple with hybrid methods so it could be used with conventional machining processes as well.

And it can be used to make very large-scale parts. So we've seen it, people have used something like this to make rocket casings and things like that so very large.

And at Space X and other companies that are looking at employing similar technologies. And then diode laser cladding is another one. This is what they're planning or at least what they propose to use for NuScale cladding. It's used as a laser cladding so we'd like to investigate that as well.

MR. HISER: Cladding a vessel just to be clear.

MR. DAVIS: Yes.

MR. HISER: Not fuel cladding. I just caused Ron make a, have a funny look.

MR. DAVIS: Yes, sorry. Thanks for, yes, I'm still a structural person at heart so when I think cladding I'm always thinking of structural cladding.

MEMBER BALLINGER: Can you find somebody that deals with ODS?

MR. DAVIS: That's a vague and leading question. What do you mean?

MEMBER BALLINGER: Outside distribution --

MR. DAVIS: No, but what do you mean is deals with ODS?

MEMBER BALLINGER: -- that uses these advanced techniques to make ODS material?

MR. DAVIS: So we don't specifically highlight that in -- that's not what we're looking at in the next phase of the plan, but we're tracking that through other means.

Like I said, we have a grant that's looking at that as well. And like you're aware, that's been an explosive area in terms of academic research over the last six or seven years I think.

MEMBER BALLINGER: That's where the biggest bang for your buck is --

MR. DAVIS: Yes.

MEMBER BALLINGER: -- in properties.

MR. DAVIS: Yes. So we, and you're not going to see anything about functionally graded materials on here either. That's another area that we think, I call those cousins to AMT.

That we're sort of watching them on the periphery as they continue to mature and develop as well. I mentioned, Dr. Rempe, the first NDE work that we looked at was looking at NDE or AMT components.

We're actually going to get some components that were made during AMT processes and we're actually going to inspect them to see how, you know, what the defects are if we can characterize and how big they are.

We can find them so we'll be able to couple nondestructive with destructive evaluation. That's going to be incredibly helpful. And then we're going to continue to build on this modeling and simulation piece.

But more specifically, looking at the data and the metadata that's needed to help improve and validate models as part of the build process. We're going to be looking at in-process NDE techniques and capabilities which we touched on earlier.

But we're also going to be looking at, because you have the possibility for terabytes of data, accumulating that much data per individual bill. And we may or may not need all of that data, but it's available so we want to try to understand what data do we need to make sure we capture.

What data's most valuable and then how potentially should that data be structured so that we can get some commonality and some requirements and some specifications in place?

And finally, how can we use that data to help validate and accelerate our modeling and simulation efforts? And finally we have another effort that's looking at, as Matt mentioned, you get some very unique microstructures in some of these processes.

We want a, and we've touched on that in some of our gap assessment. We want to more rigorously assess these microstructural differences and understand what their impact are to aging related issues and things like radiation performance as well as stress furs and cracking, fracture toughness.

Those are going to be some of the things that we're going to be looking at in that particular subtask. Next slide please, Hussain. Almost done. I just am a minute over.

And then we're going to continue doing workshops. We're targeting our next one probably for 2023, Mr. Ballinger. So that puts us about on that every three-year cycle though I think we've already started talking about that internally.

And then we're going to continue to do knowledge management and external outreach. So all of that work's going to continue in much the same way that we started it under the action plan. Next slide please. That's it.

I don't think I need to take any time on this, we're going to, you know, we've summarized technical regulatory AM and communications activities, more of the same in the future.

And I think as Matt said, I look at where we are compared to where we were two years ago as a result of the action plan and I think the staff is really in a really good place.

In fact, we're in danger of getting a little bit too far ahead. As Matt said, we don't want to get ahead, we want to be in the right stage. So I think we're prepared if an application came in.

We would know how to handle it, we'd know the questions to ask, we'd know the things to look for, but I think we recognize, we still need to work in somebody's existing processes like ASME code and elsewhere to make sure that we're, you know, as the agency's maturing, they understand that the NRC perspective is being brought in early in the process.

So that again, by the time they come to us with an application, hopefully we're able, I don't want to say rubberstamp, but hopefully we'll have been able to work out a lot of the issues before they actually come in and submit us with, you know, an actual formal application. I think that's it.

CHAIR REMPE: Thank you. I apologize we had to hurry the latter part, but --

MR. DAVIS: We knew when we led off with Hiser, --

CHAIR REMPE: -- it's another topic. You're going to continue. Right?

MR. DAVIS: -- he likes to talk and we knew if we led off with him, we were going to have trouble, but it was okay.

CHAIR REMPE: I need to ask the public and see if there's any members out there in the public who would like to provide comments at this time. All you have to do is unmute yourself or punch star six.

I'm not hearing anyone. I'm going to assume that there are no members of the public who would like to make comments. I'll offer members a last chance realizing that we're a little over time, but if there's any final comments.

Not hearing anything from the other members, I want to give thank you for a very interesting presentation. It looks like you guys are doing a good job of what you need to do to get ready for these metals.

We're going to take a break and we're going to go off the record now, Mr. Court Reporter. Okay? Is this Jim, by the way who's the Court Reporter today? I'm not sure if I found out your name? Okay. Hi, Jim.

Anyway, we're done for this meeting so we don't need your help anymore and thank you very much.

(Whereupon, the above-entitled matter went off the record at 2:32 p.m.)

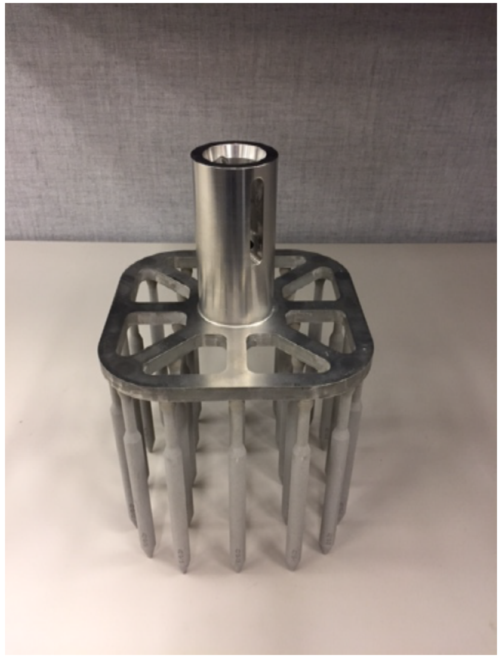
NRC Activities on Advanced Manufacturing Technologies (AMTs)

NRC Office of Nuclear Regulatory Research
Division of Engineering

July 6, 2022

Advisory Committee on Reactor Safeguards Full Committee

The Team



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Technical Advisory Team
Allen Hiser
David Rudland
Robert Tregoning

Steering Committee
Angie Buford (Chair)
Steve Ruffin
Raj Iyengar
Matthew Mitchell

Advanced Manufacturing Technologies

- Techniques and material processing methods that have **not** been:
  - Traditionally used in the U.S. nuclear industry
  - Formally standardized/codified by the nuclear industry
- AMTs can include new ways to fabricate or join components, surface treatments, or other processing techniques to provide a performance or operational benefit.

Drivers for NRC Activities

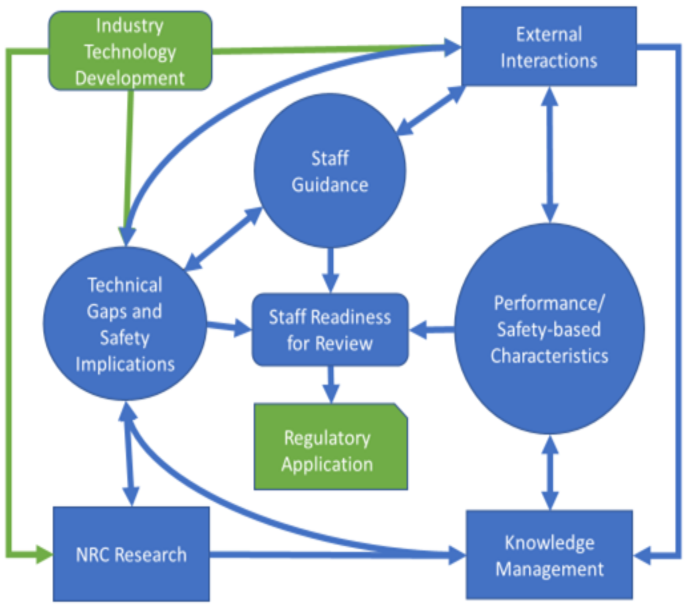
- Variety of stakeholders are working towards more widespread use in both existing and future nuclear applications
  - Vendors and licensees/applicants
    - Identifying candidate applications
    - Developing technical basis for gaining regulatory acceptance
  - Nuclear Energy Institute – Developed roadmap to understand industry needs/interests and assist with regulatory acceptance
  - Electric Power Research Institute – Developing techniques for large components in small modular reactors, developed data package for 316L L-PBF ASME draft Code case
  - US Department of Energy – Performing basic and applied research and technology development to support AMT implementation

NRC Action Plan for AMTs

- NRC activities related to AMTs have been organized and planned through the AMT action plan with the following objectives:
  - Assess the safety significant differences between AMTs and traditional manufacturing processes, from a performance-based perspective.
  - Prepare the NRC staff to address industry implementation of AMT-fabricated components through the 10 CFR 50.59 process.
  - Identify and address AMT characteristics pertinent to safety, from a risk-informed and performance-based perspective, that are not managed or addressed by codes, standards, regulations, etc.
  - Provide guidance and tools for review consistency, communication, and knowledge management for the efforts associated with AMT reviews.
  - Provide transparency to stakeholders on the process for AMT approvals.
- Revision 1 was published in June 2020 (ML19333B980)

Action Plan – Rev. 1 Tasks

- Task 1 - Technical Preparedness
  - Technical information, knowledge and tools to prepare NRC staff to review AMT applications
- Task 2 - Regulatory Preparedness
  - Regulatory guidance and tools to prepare staff for efficient and effective review of AMT-fabricated components submitted to the NRC for review and approval



- Task 3 - Communications and Knowledge Management
  - Integration of information from external organizations into the NRC staff knowledge base for informed regulatory decision-making
  - External interactions and knowledge sharing, e.g., AMT Workshop (held in Dec. 2020)

Task 1 – Technical Preparedness Activities

Subtask 1A: AMT Processes under Consideration

- Perform a technical assessment of selected AMTs
- Gap assessment for each selected AMT vs traditional manufacturing techniques

Subtask 1B: Inspection and NDE

- Assess the state of technologies in the testing and examination of AMTs
- Will inform staff decisions related to use of NDE on AMT-fabricated components

Subtask 1C: Modeling and Simulation of Microstructure and Properties

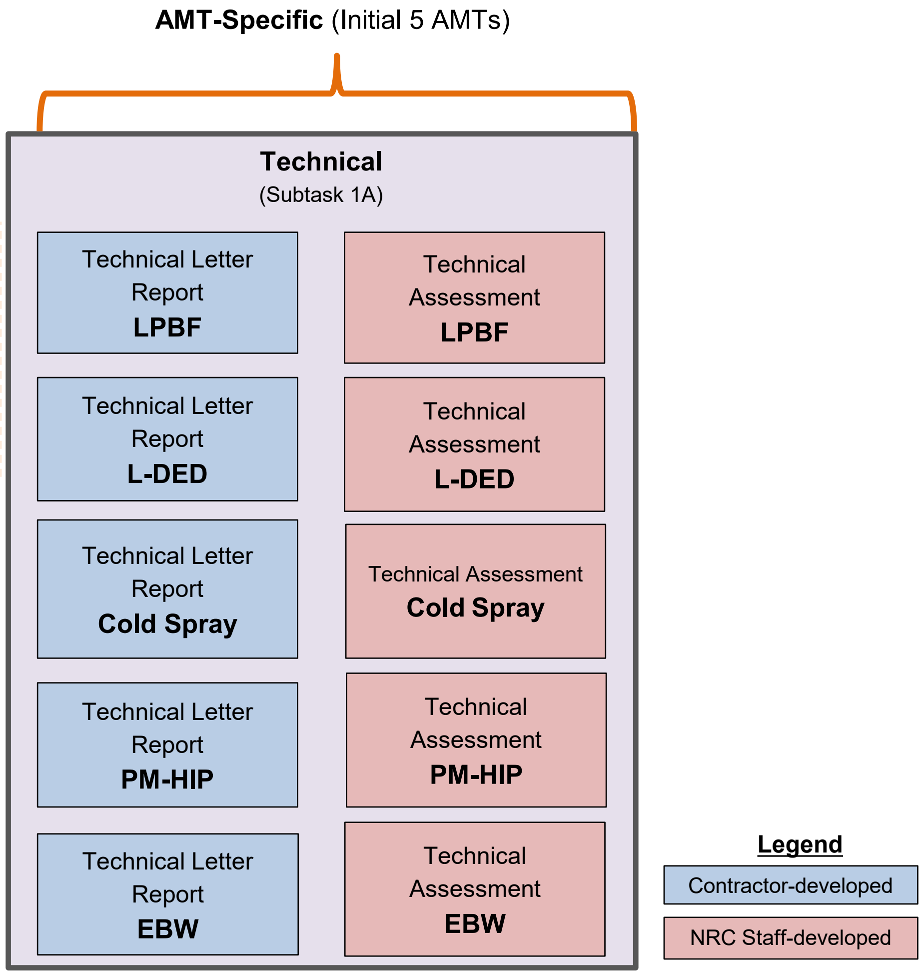
- Evaluate modeling and simulation tools used to predict the initial microstructure, material properties and component integrity of AMT components
- Identify existing gaps and challenges that are unique to AMT compared to conventional manufacturing processes

Subtask 1A – AMT Processes under Consideration

- Initial AMTs based on industry interest:
  - Laser Powder Bed Fusion (LPBF)
  - Laser Direct Energy Deposition (L-DED)
  - Cold Spray (CS)
  - Electron Beam Welding (EBW)
  - Powder Metallurgy - Hot Isostatic Pressing (PM-HIP)

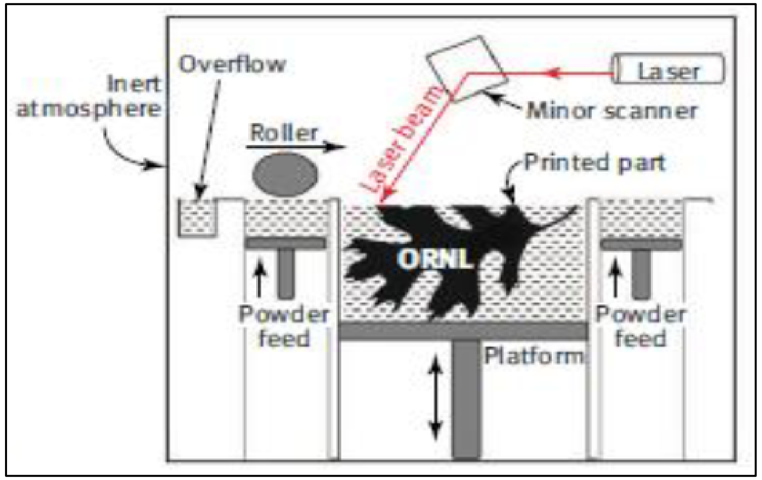
Task 1A Approach

- A Technical Letter Report (TLR) is produced for each of the initial five AMTs
  - Provides technical basis information and gap analysis
  - Written by NRC contractor (to date, DOE labs)
- A technical assessment (TA) is produced for each TLR by NRC staff that provides the NRC staff perspective on key aspects of the AMT for safety and component performance



Laser Powder Bed Fusion

- Process:
  - Uses laser to melt powder particles together within a bed of powder through layer-by-layer build process
  - Generally most advantageous for more complex geometries
- Potential LWR Applications:
  - Smaller Class 1, 2 and 3 components, fuel hardware, small internals
- Key takeaways:
  - Component geometry and build process parameters plays a major role in resulting material properties, e.g., significant anisotropy
  - Thermal post-processing can help to reduce residual stress and anisotropy
  - LPBF-specific standards are under development to buttress existing standards related to aspects of the LPBF process (e.g., powder production)



Schematic of LPBF process*

*https://www.osti.gov/pages/servlets/purl/1437906

First US NPP Application of Additive Manufacturing

- Thimble Plugging Device
  - Installed in March 2020 in Byron Unit 1
  - 316L stainless steel -LPBF
  - Very low safety significant component (Non-ASME B&PV Code class)
  - PWR environment with irradiation
  - Installation done in accordance with 10 CFR 50.59, which does not require prior NRC approval

https://www.neimagazine.com/news/newswestinghouse-produces-3d-printed-component-for-us-nuclear-plant-7911951

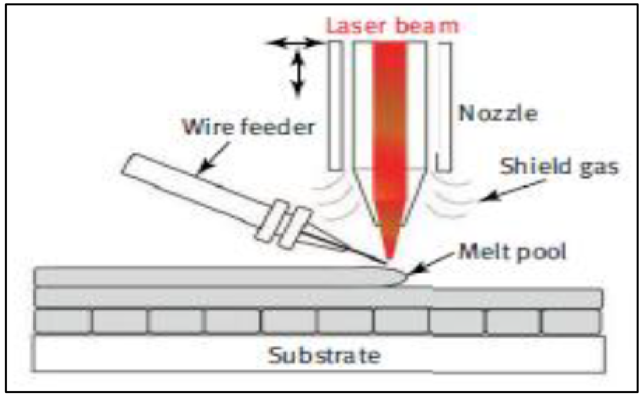
Second US NPP Application of Additive Manufacturing

- Channel Fastener
  - Installed in April 2021 at Browns Ferry Unit 2
  - 316L stainless steel - LPBF
  - Non ASME B&PV Code Class
  - BWR environment with irradiation
  - Installation done in accordance with 10 CFR 50.59, which does not require prior NRC approval

https://www.ornl.gov/news/additively-manufactured-components-ornl-headed-tva-nuclear-reactor?utm_source=miragenews&utm_medium=miragenews&utm_campaign=news

Laser-Directed Energy Deposition

- Process:
  - Wire or powder fed through nozzle into laser for melting
  - Fundamentally welding using robotics / computer controls
- Potential Applications:
  - Similar to LPBF, although larger components possible due to faster production and greater build chamber volumes



Schematic of DED process*

- Key Takeaways:
  - As with LPBF, component microstructure and properties are geometry dependent
  - L-DED offers enhanced geometric flexibility compared to LBPF, and it can more easily be incorporated into hybrid manufacturing approaches
  - L-DED-specific codes and standards are generally sparse, but some supporting standards do exist

*https://www.osti.gov/pages/servlets/purl/1437906

Powder Metallurgy – Hot Isostatic Pressing (PM-HIP)

- Process:
  - Metal powder is encapsulated in a form mirroring the desired part
  - The encapsulated powder is exposed to high temperature and pressure, densifying the powder and producing a uniform microstructure
  - After densification, the capsule is removed, yielding a near-net shape component where final machining and inspection can be performed
- Potential Applications:
  - All sizes of Class 1, 2 and 3 components and reactor internals
  - EPRI / DOE focused on use with electron beam welding to fabricate NuScale reactor vessel

Scaled down PM-HIP Upper vessel head assembly*

- Key Takeaways:
  - PM-HIP 316 stainless steel nuclear components are allowed via ASME Code Case
  - Key challenges for PM-HIP of heavy-section low alloy steel components include scaling up the PM-HIP process and producing components with consistent properties, including sufficient fracture toughness

*ML22164A438: The Use of Powder Metallurgy and Hot Isostatic Pressing for Fabricating Components of Nuclear Power Plants

Electron Beam Welding

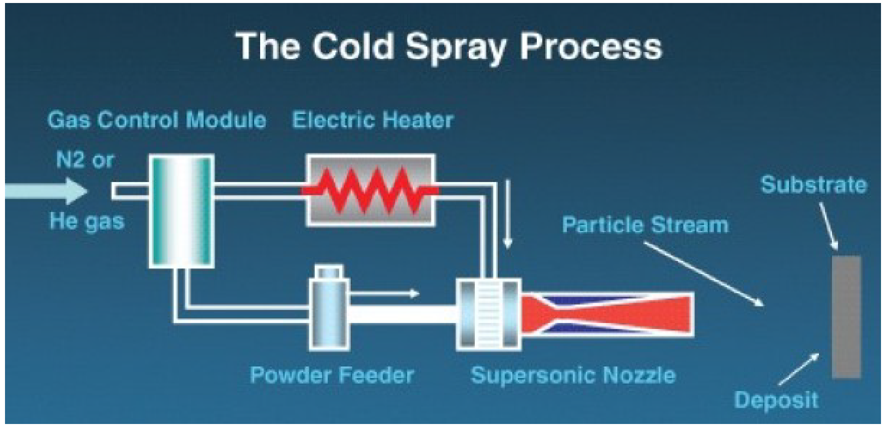
- Process:
  - Fusion welding process that uses a beam of high-velocity electrons to join materials
  - Single pass welding without filler metal
  - Welding process can be completed much more quickly due to deep penetration
- Potential Applications:
  - For welding medium and large components, such as NuScale upper head
- Key Takeaways:
  - EBW is a mature process and is allowed by ASME Code, however significant work is still needed to demonstrate sufficient performance for large PM-HIP components.
  - EBW application is limited due to high equipment costs, vacuum chamber, and facility requirements
  - Additional demonstration is likely needed if specific post-weld heat treatment will be used to garner inspection credit

EBW of scaled down PM-HIP lower head assembly*

ML22143A929: Review of Advanced Manufacturing Techniques and Qualification Processes for Light Water Reactors – Electron Beam Welding

Cold Spray

- Process:
  - Powder is sprayed at supersonic velocities onto a metal surface and forms a bond with the part
  - This can be used in either field or shop applications to repair existing parts or as a mitigation process



Schematic of cold spray process*

- Potential Applications:
  - Mitigation or repair of potential chloride-induced stress corrosion cracking (CISCC) in spent fuel canisters
  - Mitigation or repair of stress corrosion cracking (SCC) in reactor applications
- Key Takeaways:
  - Generally has been used in coating applications where structural credit is not claimed
  - Coating porosity and coating/substrate adhesion strength are important indicators of quality
  - Use in structural applications would likely need additional data to demonstrate performance

*https://www.army.mil/article/148465/army_researchers_develop_cold_spray_system_transition_to_industry

Subtask 1B – Inspection and NDE

- Literature survey of the current state of the art of NDE of components made using AMTs
- Evaluates knowledge gaps focused on the issue of whether NDE methods are capable of detecting the types of pre-service and inservice defects anticipated in AMTs
- The report identifies and ranks 21 knowledge gaps that are relevant to NDE of AMT components and the related ASME inspection code
- Notable knowledge gaps include:
  - Validation of NDE techniques with destructive testing
  - Defect acceptance standards
  - Determination of effects of AMT grain structures on ultrasonic testing

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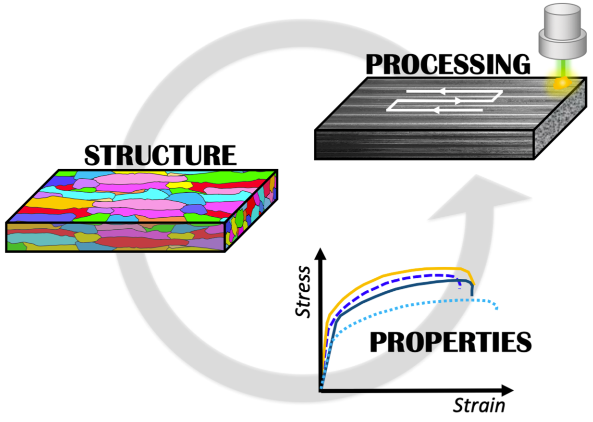
Subtask 1C: Modeling and Simulation of Microstructure and Properties

- Two report series that describes the current state of modeling and simulation techniques for predicting the properties of materials fabricated with advanced manufacturing techniques, given the initial microstructure of the material.
- First report summarizes the current state-of-the art in predicting the initial microstructure of materials resulting from AMTs
  - Describes current modeling and simulation techniques and available software
  - Provides a gap analysis and list of recommendations
- Key conclusions include:
  - Better methods of length- and time-scale bridging for the physics-based methods recommended
  - Collation or generation of larger microstructural databases for the data-driven methods
  - Development of community accepted validation benchmarks for the different AMTs of interest

Subtask 1C: Modeling and Simulation of Microstructure and Properties

- Second report surveys the current state of modeling and simulation methods for predicting key material properties of AMT materials given a description of the initial material microstructure when the component goes into service.
  - identifying key gaps and recommendations on applying microstructure-properties models to nuclear reactor structural materials and components.
- Key gaps include:
  - the lack of automated methods for bridging length and time scales
  - difficulties in ab initio modeling of new materials
  - a general lack of application of AMTs and materials for nuclear applications



Task 2 – Regulatory Preparedness Activities

Subtask 2A: Implementation using the 10 CFR 50.59 Process

- Provide guidance and support to regional inspectors regarding AMTs implemented under 50.59

Subtask 2B: Assessment of Regulatory Guidance

- Assess whether any regulatory guidance needs to be updated or created to clarify the process for reviewing submittals with AMT components

Subtask 2C: AMT Guidelines Document

- Develop guidelines which describe the generic technical information to be addressed in AMT submissions

Subtask 2C: AMT Guidelines Document

- Provides draft guidelines to assist NRC staff reviewing requests to use AMTs and identifies the range of information that could be necessary in a submittal
- General Philosophy:
  - **Sufficient**: all important (i.e., safety-significant or safety-related) attributes for the specific application of an AMT are addressed in sufficient technical depth to justify its use.
  - **Flexible**: a variety of both technical and regulatory approaches can be used to demonstrate that these important attributes are addressed.
  - **Minimize technical and regulatory burden**: the level of detail in which a submittal must address the applicable requirements and technical basis varies depending on the safety significance of the application and the maturity of the AMT.

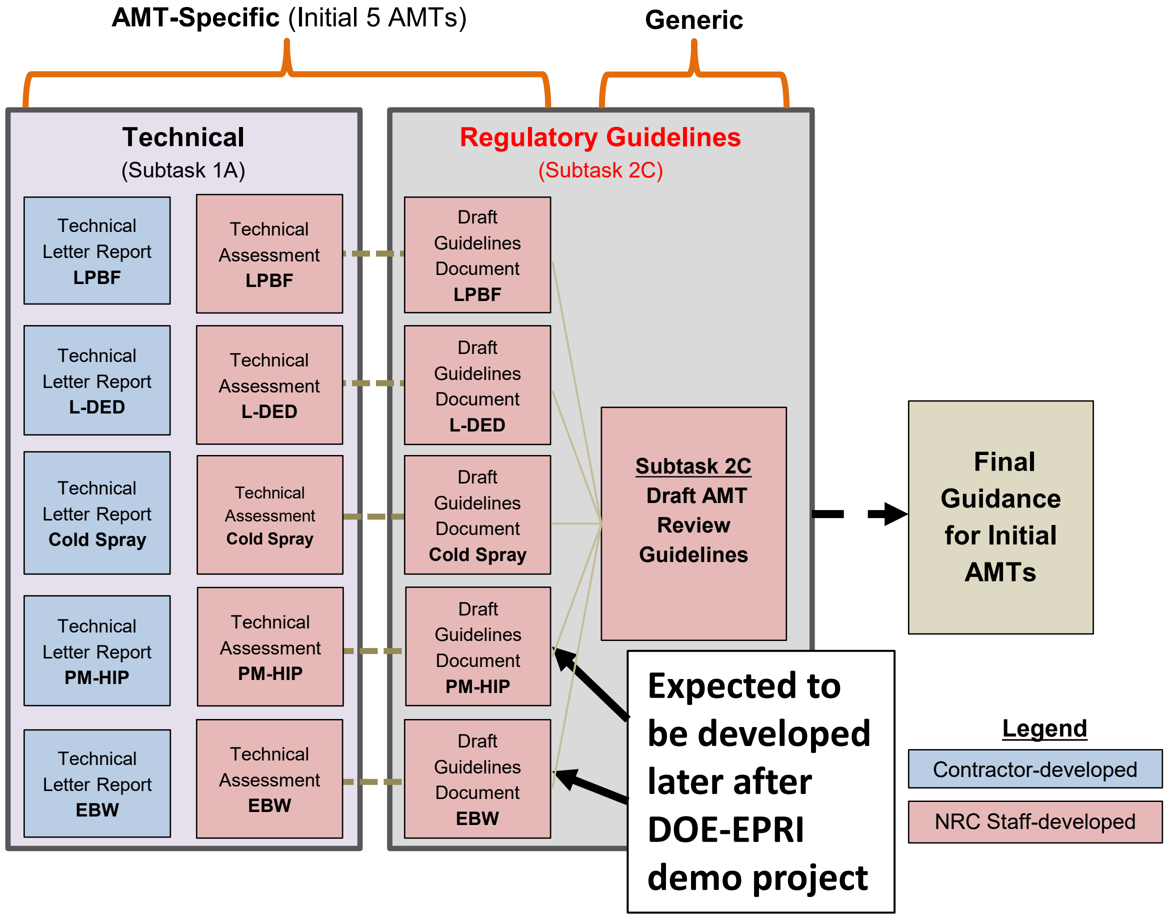
NRC AMT Guidelines Development

- A Technical Letter Report (TLR) is produced for each of the initial five AMTs
  - Provides technical basis information and gap analysis
  - Written by NRC contractor (to date, DOE labs)

- A technical assessment (TA) is produced for each TLR by NRC staff that provides the NRC staff perspective on key aspects of the AMT for safety and component performance

- Draft Generic AMT Review Guidelines

- A draft guidelines document (DGD), informed by the TA and TLR, will be generated by the NRC staff for each AMT.



Task 3 – Communications and Knowledge Management

Subtasks 3A, 3C, 3E: Internal Activities

- Knowledge Management Plan to support future NRC staff unfamiliar with AMT processes
- AMT training and seminars

Subtask 3B: External Activities

- Codes and Standards activities
- Periodic information exchanges with external stakeholders

Subtask 3D: Public Workshop

- 2017 Public Workshop on Additive Manufacturing: summary
- 2020 Public Workshop on AMTs for Nuclear Applications: https://www.nrc.gov/public-involve/conference-symposia/amt-workshop.html

Codes and Standards

- Codes and Standards Organizations (e.g., ASTM, ASME) – addressing standardization gaps, Code Cases (PM-HIP, LPBF)
  - ASME Special Working Group –
    - Developing guidelines for use of additive manufacturing (AM), “Criteria for Pressure Retaining Metallic Components Using Additive Manufacturing.” Published as an ASME Pressure Technology Book
    - 316L L-PBF Data Package and Code Case under development
  - ASME Task Group on AM for High Temperature Applications
    - Developing Code actions for incorporating AM materials/components in ASME Section III, Division 5 (high temperature reactors) for elevated temperature nuclear construction
  - ASME PM-HIP Code Case approved for use by US NRC
    - Code Case N-834 allows use of ASTM A988/A988M “Standard Specification for Hot Isostatically-Pressed Stainless Steel Flanges, Fittings, Valves, and Parts for High Temperature Service” in Section III, Division 1 Class 1 components
    - October 2019 - RG 1.84, Revision 38 approved this Code Case as acceptable for use without conditions

2020 AMT Workshop

- Location/Dates: Virtual, December 7-10, 2020
- Objectives:
  - Discuss ongoing activities related to AMTs, including nuclear industry implementation plans, codes and standards activities, research findings, and regulatory approaches in other industries.
  - Inform public of NRC's activities and approach to approving use of AMTs.
  - Determine, with input from nuclear industry stakeholders and other technical organizations, areas where NRC should focus to ensure safe implementation of AMTs
- Participants:
  - ASME, US DOE, NIST, FAA, NASA, FDA, EPRI, NEI, Westinghouse, GE Hitachi, Kairos, VRC Metal Systems, Exelon, ORNL, PNNL, ANL, INL
- Workshop website:
  – https://www.nrc.gov/public-involve/conference-symposia/amt-workshop.html

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Status of Deliverables – Task 1

Subtask	Actions/Deliverables	Status
1A AMT processes under consideration	Additive Manufacturing (AM) – Laser Powder Bed Fusion	Complete - ML20351A292
	AM – Directed Energy Deposition (DED)	Complete - ML21301A077
	Cold Spray	Complete - ML21263A105
	Powder Metallurgy (PM) – Hot Isostatic Pressing (HIP)	Complete - ML22134A437
	Electron Beam (EB) welding	Complete - ML22143A927
1B Inspection and NDE	NDE gap analysis	Complete - ML20349A012
1C Modeling and Simulation of Microstructure	M&S gap analysis to predict microstructures	Complete - ML20269A301
	ANL M&S gap analysis to predict material performance	Complete - ML20350B550

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Status of Deliverables – Tasks 2 and 3

Subtask	Actions / Deliverables	Status
2A 50.59 process	Finalize document incorporating feedback from Regional staff regarding the 10 CFR 50.59 process	Complete - ML21200A222
2B Assessment of regulatory guidance	Path forward on guidance development or modification	Complete - ML20233A693
2C AMT Guidance Document	Draft AMT Review Guidelines	Complete - ML21074A037
	Draft Guidelines Documents for specific AMTs	AM-Laser Powder Bed Fusion - ML21074A040 AM-Laser-Directed Energy Deposition - ML22143A950 Cold Spray - ML22143A950
3A/3B External / Internal Interactions	Continued communication with NRC staff and external stakeholders for AMT-related activities	Ongoing as needed
3C Knowledge Management Plan	Develop Knowledge Management Plan	Complete - internal
3D Workshop	Hold public workshop	Complete - Public Meeting Summary: ML20357B071 RIL: Part 1 Part 2
3E Material Information course	Training course and course materials	First 6 seminars complete - internal

Current and Future Activities

- Assessment of additional AMTs
  - Arc-DED, diode laser cladding
- NDE of AMT components
  - Confirmatory testing and examination of AMT components
  - Verification of NDE methods
- Data and modeling for qualification:
  - In-process NDE techniques and capabilities
  - Capturing and integrating information from data and modeling to support qualification
- Materials performance of AMT components
  - Assess microstructure differences in AMT components for impact to aging mechanisms

Current and Future Activities

- Continue to support AMT guidance development
  - Includes additional AMT-specific DGDs
- Knowledge management and external interactions
  - Workshops
  - Staff training seminars

Summary

- NRC began preparing for the adoption of advanced manufacturing technologies in nuclear applications in 2017 and has taken a proactive engagement strategy to prepare for implementation of AMT components.
- The NRC has completed its initial set of technical and regulatory deliverables as documented in Revision 1 of the AMT Action Plan.
  - Developed the technical information, knowledge, and tools
  - Developed draft regulatory framework for AMT submittals
  - Conducted communications and KM activities to integrate information from external stakeholders and be transparent in NRC activities
- The NRC will continue to further technical preparedness, regulatory preparedness, and communications and KM activities to prepare for industry implementation of AMTs

NRC Public Site for AMTs

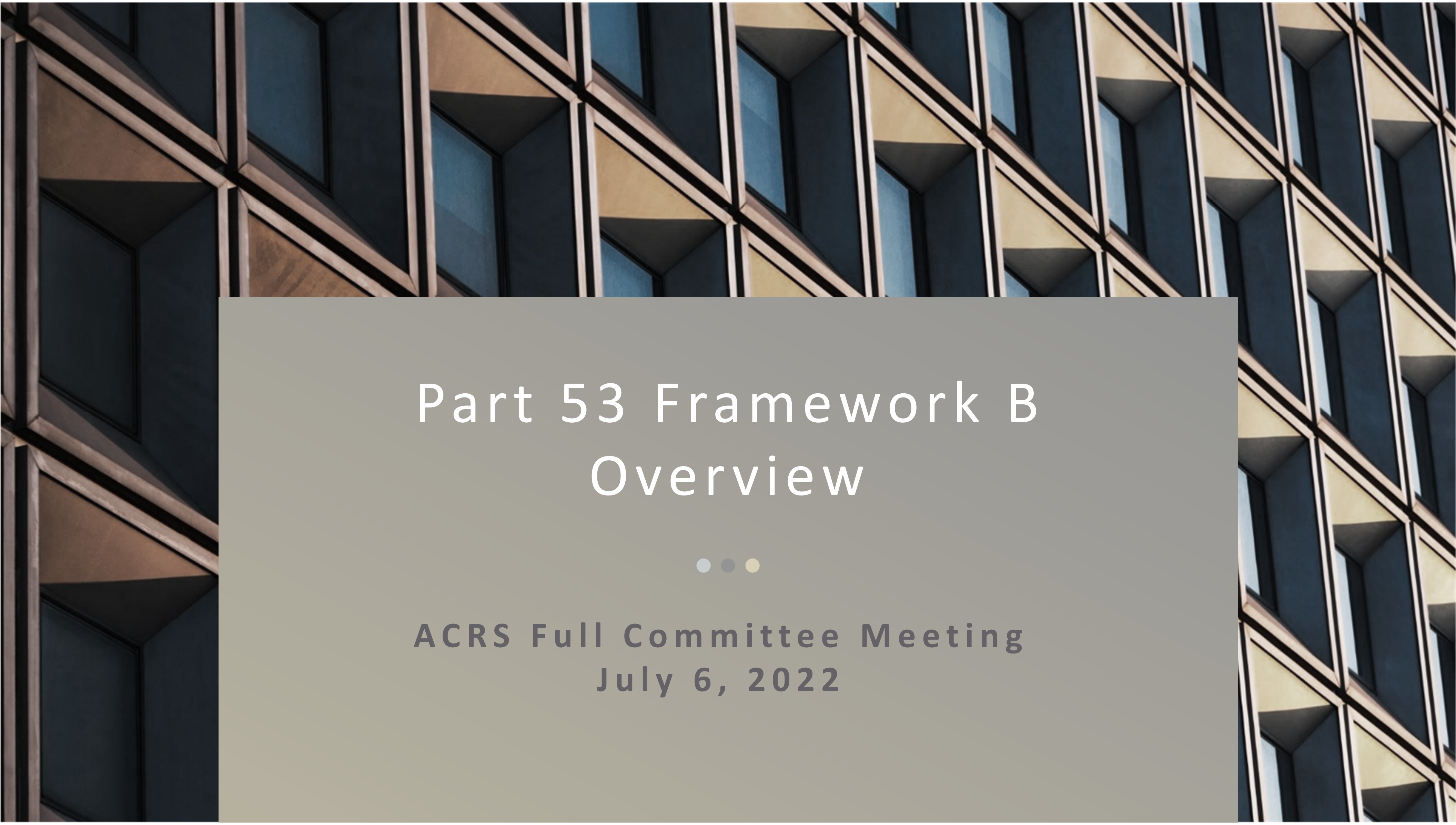
https://www.nrc.gov/reactors/power/amts.html

Advisory Committee on Reactor Safeguards (ACRS)

Full Committee Meeting

10 CFR Part 53 "Licensing and Regulation of Advanced Nuclear Reactors"

July 6, 2022



Part 53 Framework B Overview

ACRS Full Committee Meeting
July 6, 2022

Agenda

- Overview of Part 53 Structure
- Comparison of Part 53 Frameworks
- Discussion of Key Subparts
- Guidance Development
- Framework Integration

Part 53 Licensing Frameworks

Subpart A - General Provisions

Subpart B - Safety Requirements
Subpart C - Design Requirements
Subpart D - Siting
Subpart E - Construction/Manufacturing
Subpart F - Operations
Subpart G - Decommissioning
Subpart H - Application Requirements
Subpart I - License Maintenance
Subpart J - Reporting
Subpart K - Quality Assurance

Framework A

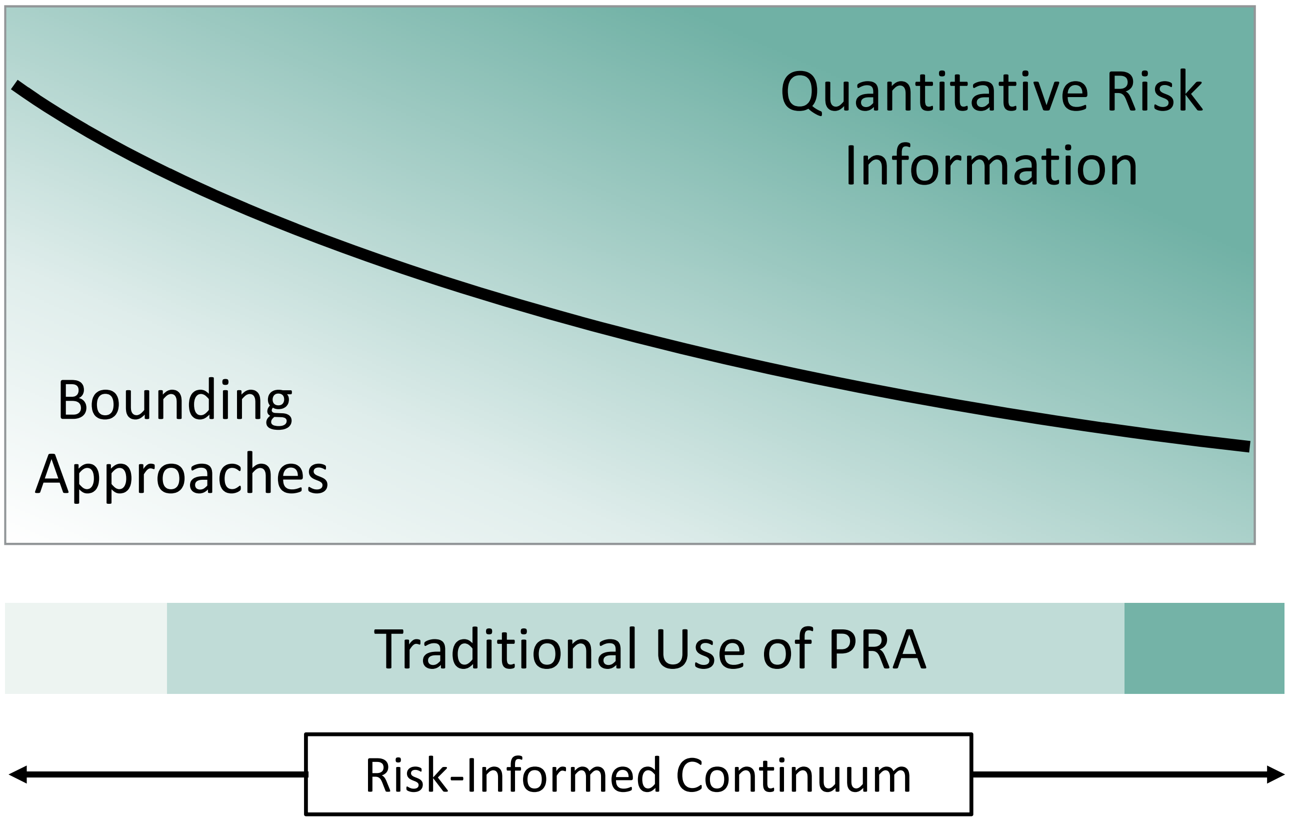
- Probabilistic risk assessment (PRA)-led approach
- Functional design criteria
- Top-down approach for meeting high-level safety criteria and defining key safety functions

Subpart N - Definitions
Subpart O - Construction/Manufacturing
Subpart P - Operations
Subpart Q - Decommissioning
Subpart R - Application Requirements
Subpart S - License Maintenance
Subpart T - Reporting
Subpart U - Quality Assurance

Framework B

- Traditional use of risk insights
- Principal design criteria
- Bottom-up approach based on well-established safety functions
- Includes an Alternative Evaluation for Risk Insights (AERI) approach

Part 53 Licensing Frameworks



Part 53 Subpart Comparison

Subpart Title	Framework A Subpart	Framework B Subpart
General Provisions	Subpart A (Common)	
Technology-Inclusive Safety Requirements	Subpart B	(Subpart R)
Design and Analysis Requirements	Subpart C	
Siting Requirements	Subpart D	(Part 100)
Definitions	-	Subpart N
Construction and Manufacturing Requirements	Subpart E	Subpart O
Requirements for Operation	Subpart F	Subpart P
Decommissioning Requirements	Subpart G	Subpart Q
Licenses, Certifications, and Approvals	Subpart H	Subpart R
Maintaining and Revising Licensing Basis Information	Subpart I	Subpart S
Reporting and Other Administrative Requirements	Subpart J	Subpart T
Quality Assurance Criteria	Subpart K	Subpart U

Subpart N – Definitions

- Definitions specific to Framework B
  - Anticipated operational occurrence (AOO)
  - Design bases
  - Reactor coolant pressure boundary
  - Safety-related structures, systems, and components (SSCs)

- Common definitions remain in Subpart A (§ 53.020)

Subpart P – Requirements for Operation

- Structured similar to Subpart F in Framework A
- Programmatic requirements for security, emergency preparedness, and radiation protection aligned with those in Framework A
- Provisions for staffing, training, personnel qualifications, and human factors are largely equivalent between frameworks with the exception of generally licensed reactor operators.
- Other requirements for operation informed by existing requirements applicable to applicants and licensees under Parts 50 and 52
  - Maintenance, repair, and inspection programs
  - Technical specifications
  - Fire protection
  - Primary containment leakage
  - Environmental qualification of electrical equipment

Subpart R – Licenses, Certifications, and Approvals

- Structured similar to Subpart H in Framework A
- Process-related requirements in Subpart R are identical between the frameworks
- Technical requirements informed by existing regulatory frameworks
  - Requirements captured in content of application sections
  - Technical content of application requirements consolidated in § 53.4730
  - Many requirements from Parts 50 and 52 translated to Framework B with select updates and modifications for technology-inclusiveness
- Initiating event and accident analyses requirements evolved from initial "Part 5X" effort
  - Requirements in § 53.4730(a)(5) cover AOOs, design basis accidents (DBAs), beyond design basis events, severe accidents and chemical hazards
  - Generally aligned with current requirements and, as appropriate, incorporates international concepts on defense-in-depth.
- Requirements for containment address the need for functional containment alternatives that may be employed by non-LWRs

Framework B Guidance Development

Many Framework A and B guidance development activities are linked

May involve updates or supplements to existing guidance covering existing regulatory frameworks

Guidance for technical content of application requirements now part of Advanced Reactor Content of Application Project effort

Areas of Focus for Integration of Frameworks A and B

Ensure consistency between parallel provisions

Evaluate other provisions for potential alignment

- Siting
- Seismic Design Criteria
- Requirements for Operation

Commonalities in Subpart A

- Definitions
- General Provisions

Continue consideration of stakeholder feedback

Final Discussion and Questions

Part 53, Framework B, Subpart R: Alternative Evaluation for Risk Insights (AERI)

ACRS Full Committee Meeting
July 6, 2022

Agenda

- Evolution of the AERI Approach
- AERI Entry Condition
- Summary of PDG-1413, “Technology-Inclusive Identification of Licensing Events for Commercial Nuclear Plants”
- Summary of PDG-1414, “Alternative Evaluation for Risk Insights (AERI) Framework”

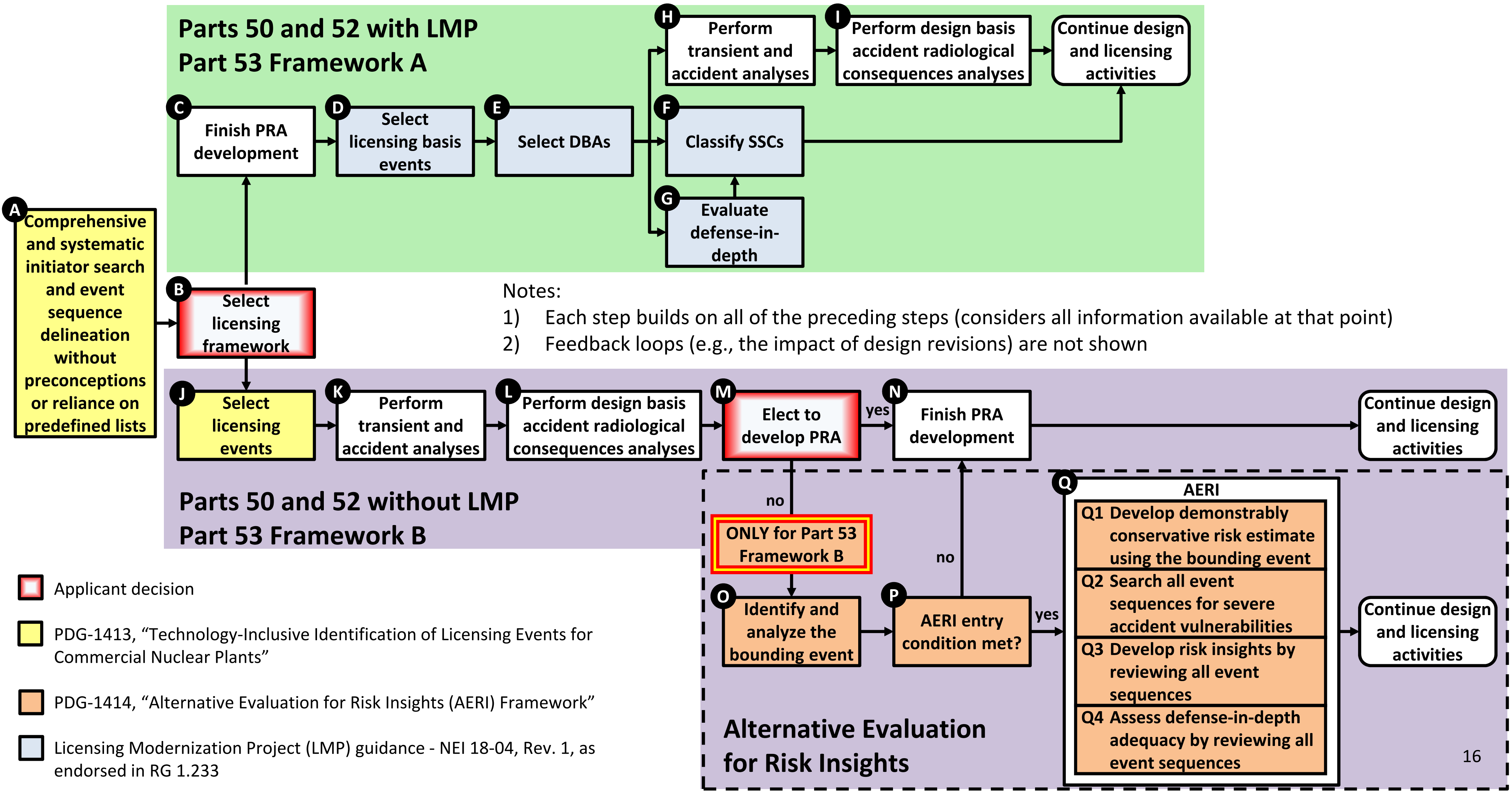
Evolution of the AERI Alternative Approach

- Evolution of the AERI approach is an example of modern risk-informed regulation:
  - Achieves the underlying purposes of Commission policy statements:
    - Policy Statement on the Regulation of Advanced Reactors (73 FR 60612; October 14, 2008)
    - Safety Goals for the Operation of Nuclear Power Plants (51 FR 28044; August 4, 1986 as corrected and republished at 51 FR 30028; August 21, 1986)
    - Severe Reactor Accidents Regarding Future Designs and Existing Plants (50 FR 32138; August 8, 1985)
    - Use of Probabilistic Risk Assessment Methods in Nuclear Regulatory Activities (60 FR 42622; August 16, 1995)
  - Provides sufficient risk information to inform licensing decisions
  - Right-sizes the effort required to evaluate risk

Uses risk insights to enhance regulatory efficiency.

- Two pre-decisional draft regulatory guides (PDGs) have been developed to:
  - Clarify for potential applicants the logic and the expectations of the NRC staff
  - Address related ACRS recommendations to "start with a blank sheet of paper" (10/7/2019, 10/21/2020, 5/30/2021, and 10/26/2021)

Licensing Frameworks – Risk Evaluation Perspective



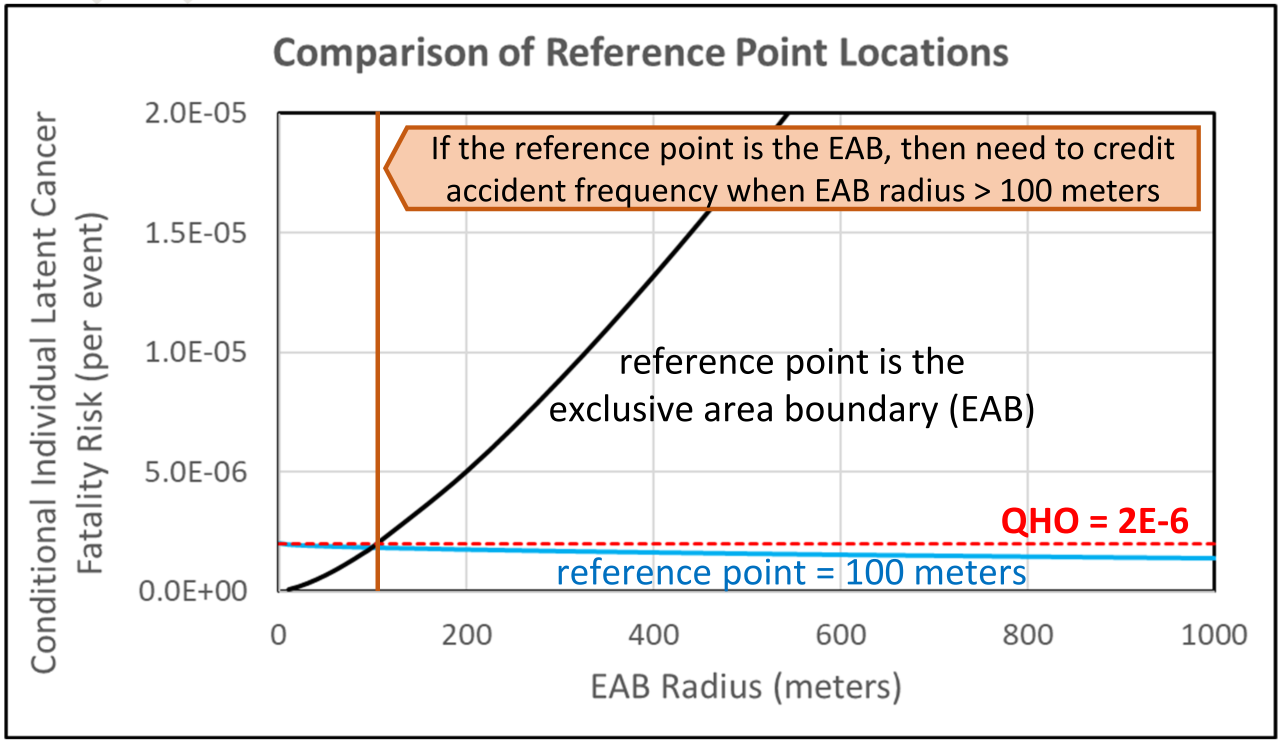
Proposed AERI Entry Condition

The AERI entry condition is not a safety or siting criterion!!!

53.4730(a)(34) ***Description of risk evaluation*****.**
A description of the risk evaluation developed for the commercial nuclear plant and its results. The risk evaluation must be based on:
(i) A PRA, or
(ii) An AERI, provided that the dose from a postulated bounding event to an individual located 100 meters (328 feet) away from the commercial nuclear plant does not exceed 1 rem total effective dose equivalent (TEDE) over the first four days following a release, an additional 2 rem TEDE in the first year, and 0.5 rem TEDE per year in the second and subsequent years.

- Provides plants with flexibility in establishing their exclusion area boundaries (EABs) if the bounding event's source term is small.
- The 100-meter reference dose location was back-calculated from a scoping consequence model:
  - 50-year dose = 27.5 rem TEDE
  - Conditional individual latent cancer fatality risk $\leq 2 \times 10^{-6}$ per event
  - Meet the quantitative health objective (QHO) without developing a PRA to credit accident frequency in the risk estimate

Development of the AERI Entry Condition



- **Premise:** It is feasible to identify a bounding event such that the consequence of any event sequence is less than or equal to the consequence of the bounding event.
- **Implication:** Risk is less than or equal to the product of the sum of event sequence frequencies and the consequence of the bounding event.
- **Note:** It is only necessary to estimate the sum of the event sequence frequencies; it is not necessary to estimate each individual event sequence frequency using a PRA.

Technology-Inclusive Identification of Licensing Events for Commercial Nuclear Plants (PDG-1413)

- Formatted like a regulatory guide; currently a pre-decisional draft regulatory guide
- Section A: Applies to light water reactors (LWRs) and non-LWRs licensed under Parts 50, 52, and 53 (Frameworks A and B)
- Section B (Discussion):
  - o Identifies licensing events for each licensing framework
  - o Provides historical perspectives (early licensing, development of the standard review plan)
  - o Addresses ACRS recommendations to "start with a blank sheet of paper" (10/7/2019, 10/21/2020, 5/30/2021, and 10/26/2021)
- Section C (Staff Guidance) provides an integrated approach for:
  - o Conducting a systematic and comprehensive search for initiating events
  - o Delineating a systematic and comprehensive sets of event sequences
  - o Grouping the lists of initiating events and event sequences into licensing events
- Appendix A (Comprehensive Search for Initiating Events):
  - o Reviews techniques for searching for initiating events and points the user to helpful references
  - o Does not endorse or recommend any specific technique

Alternative Evaluation for Risk Insights (AERI) Framework (PDG-1414)

- Formatted like a regulatory guide; currently a pre-decisional draft regulatory guide
- Section A (Introduction): Only applies to LWRs and non-LWRs licensed under Part 53 Framework B
- Sections B (Discussion) & C (Staff Guidance) - Components of the AERI approach:
  - Identification and characterization of the bounding event
    - Definition of a bounding event
    - Multiple events may need to be considered as bounding events
  - Determination of a consequence estimate for the bounding event to confirm that the reactor design meets the AERI entry condition
  - Determination of a demonstrably conservative risk estimate for the bounding event to demonstrate that the QHOs are met
    - Assumed frequency of 1/yr consistent with frequency of all event sequences for LWRs
    - Applicant may use a lower frequency with justification
  - Search for severe accident vulnerabilities for the entire set of licensing events
    - Definitions of severe accident and severe accident vulnerability
  - Identification of risk insights for the entire set of licensing events
  - Assessment of defense-in-depth adequacy for the entire set of licensing events

Revision to Improve Clarity: Applicability of Guidance to Licensing Frameworks

<table>
<tr><th rowspan="2">Licensing Framework</th><th colspan="2">Initiating Event Search and Event Sequence Delineation</th><th colspan="2">Licensing Event Identification</th><th colspan="2">AERI</th></tr>
<tr><th>Approach</th><th>Acceptability</th><th>Approach</th><th>Acceptability</th><th>Approach</th><th>Acceptability</th></tr>
<tr><td>Parts 50 and 52 with LMP</td><td rowspan="5">PDG-1413</td><td rowspan="4">PRA Standards
• LWR – RG 1.200
• NLWR – RG 1.247</td><td rowspan="2">NEI 18-04, Rev. 1, as endorsed in RG 1.233</td><td>QA Program
Part 50, App. B</td><td rowspan="4">n/a</td><td rowspan="4">n/a</td></tr>
<tr><td>Part 53, Framework A</td><td>QA Program
Part 53, Subpart K</td></tr>
<tr><td>Parts 50 and 52 without LMP</td><td rowspan="3">PDG-1413</td><td>QA Program
Part 50, App. B</td></tr>
<tr><td>Part 53, Framework B (PRA)</td><td rowspan="2">QA Program
Part 53, Subpart U</td></tr>
<tr><td>Part 53, Framework B (AERI)</td><td>Quality Assurance (QA) Program
Part 53, Subpart U</td><td>PDG-1414</td><td>QA Program, Part 53, Subpart U

For dose/consequence and demonstrably conservative risk assessments, use PRA Standards
• LWR – RG 1.200
• NLWR – RG 1.247</td></tr>
</table>

Discussion

Acronyms

ACRS	Advisory Committee on Reactor Safeguards
AERI	Alternative evaluation for risk insights
AOO	Anticipated operational occurrence
CFR	Code of Federal Regulations
DBA	Design basis accident
EAB	Exclusion area boundary
FR	*Federal Register*
LMP	Licensing Modernization Project
LWR	Light water reactor
NEI	Nuclear Energy Institute
NRC	U.S. Nuclear Regulatory Commission
PDG	Pre-decisional draft regulatory guide
PRA	Probabilistic risk assessment
QA	Quality assurance
QHO	Quantitative health objective
RG	Regulatory guide
SSCs	Structures, systems, and components
TEDE	Total effective dose equivalent