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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)

+ + + + +

WEDNESDAY

JULY 6, 2022

+ + + + +

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

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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

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

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

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

25 During today's meeting, the Committee will

1 consider the following topics: The proposed rule
2 language for 10 CFR Part 53, Framework B and Framework
3 A, Subpart F, the NRC Office of Regulatory Research
4 activities to prepare for advanced manufacturing
5 technology submittals, the SHINE Medical Isotopes
6 operating license application.

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

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

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

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

25 MR. LYNCH: Yes. Good morning, everyone.

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

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

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

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

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

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

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

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1 slides here.

2 As Steve mentioned this morning, the first
3 presentation will focus on a broader overview of Part
4 53 Framework Bravo or B. And then the presentation
5 will transition over to Marty Stutzke to go through
6 the AERI approach.

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

19 Billy, could you move to Slide 4 please?
20 Thank you. So on Slide 4 -- We did go over this slide
21 in the subcommittee meeting two weeks ago, but I think
22 it's worth revisiting to provide some context and set
23 the stage for this morning's discussion as well.
24 Again, this is a broad overview of what Part 53 as a
25 whole looks like right now in its current form, which

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1 is a series of subparts Alpha through Uniform or A
2 through U. Where Subpart Alpha is general provisions,
3 including some common definitions that are applicable
4 to both frameworks. After Subpart Alpha, the
5 frameworks split. So currently Framework Alpha is
6 made up of Subparts Bravo through Kuo or B through K.
7 And Framework Bravo is made up of Subpart November or
8 N through Subpart Uniform or U.

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

14 MEMBER HALNON: Just a quick question.
15 This is Greg Halnon, Court Reporter. I know that
16 you've tried to consolidate the language so that you
17 didn't have a lot of crosstalk between frameworks,
18 there's a lot of repetition. Similarly, Part 50 and
19 52, there is some crosstalk there. So how did you
20 decide when to allow crosstalk between the parts and
21 repeat -- just repeat the language over (audio
22 interference)?

23 MR. JESSUP: We tried to strike the right
24 balance. I'd actually say there's two ways that
25 Framework Bravo crosstalks. One is within Part 53, so

1 talking to Framework Alpha. Where we could -- and
2 certainly in Subpart F, Subpart P, the operator
3 licensing, the staffing requirements, there's an area
4 where the original language in Subpart F was drafted
5 really in a way that it was independent of, you know,
6 other cross references.

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

22 And so what happens is -- It actually, I
23 think, adds an element of clarity because now when
24 you're in Framework Bravo, you really have your own
25 set of consolidated requirements. There's not too

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1 much bouncing back and forth. Notwithstanding that,
2 we did seek in some areas, you know, to make some
3 efficiency gains and just point back. But we were
4 limited by the way Framework Alpha was drafted in the
5 first place.

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

22 MEMBER HALNON: Okay. So
23 administratively, I mean I guess the concern I have
24 is, you know, the change -- have a revision in one
25 spot and you miss the daisy chain. How are you

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1 administratively maintaining that big picture to make
2 sure that they stay aligned and synchronized?

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

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

21 MEMBER HALNON: Okay, thank you.

22 MR. JESSUP: So I walked through kind of
23 the left-hand side of the slide. I want to walk
24 through the right-hand side of the slide. Again, just
25 to provide some context. Do some contrast between the

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1 frameworks. So Framework Alpha -- Again, a lot of
2 discussion's been had on Framework Alpha. It's a
3 Probabilistic Risk Assessment or PRA-led approach
4 centered around really the idea of functional design
5 criteria and that top down approach for meeting high
6 level safety criteria where you're defining the low
7 level safety functions. And then ultimately using
8 that iterative design approach to develop your
9 functional design criteria.

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

22 And then the last bullet there, again the
23 Framework Bravo, it does include the AERI approach,
24 which Marty's going to talk about in the subsequent
25 presentation, including, I believe an evaluation of

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1 the actual rule text that brings in the AERI approach.

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

7 MR. JESSUP: That's correct.

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

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

14 MEMBER PETTI: Right. Thank you.

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

19 MR. JESSUP: Right.

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

25 MR. JESSUP: Well, that is a unique

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

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

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

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

19 MR. JESSUP: That's correct.

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

25 CHAIR REMPE: But if I have a small

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1 microreactor --

2 (Simultaneous speaking)

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

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

13 MEMBER PETTI: Okay.

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

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

24 MR. JESSUP: That's correct.

25 MEMBER BROWN: This is Charlie.

1 Fundamentally once you've aligned 50 and 52 with 53 --
2 I guess that's the way you're doing it -- Today Part
3 50 doesn't -- that's not a required PRA. That's just
4 my memory from the past stuff we've done. So we're
5 effectively -- You've realigned. You're effectively
6 the increasing requirements for an applicant if they
7 want to do a Part 50 approach. So we're making it
8 more difficult. In the old days, they didn't have to
9 do -- They may do one for their own use, but it wasn't
10 a "requirement".

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

15 MEMBER BROWN: So we're effectively
16 increasing requirements?

17 MR. JESSUP: I think we're aligning --
18 (Simultaneous speaking)

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

25 MS. CUBBAGE: This is Amy Cubbage, NRC

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

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

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

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

22 (Simultaneous speaking)

23 MEMBER BROWN: That's fine. It's not
24 currently in the rule. But it is policy, but it's not
25 in the rule. So it is subject to some type of

1 interaction if you wanted to fight the policy. I'm
2 not saying they would, I'm just saying it's a
3 difference. So that is -- I didn't understand that
4 totally before, but now I do. So thank you.

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

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

16 And so if you look kind of on the right-
17 hand side of this continuum or this spectrum, you've
18 really got the -- the results from PRA are used to
19 inform a lot of what you do in design and licensing
20 space in issuing event selection, SSE classification.
21 And so what we've done here in Framework Bravo again
22 as I've hit on, on the last slide is we've really gone
23 back and looked at, you know, how do we traditionally
24 use PRA and risk insights? And we've tried to address
25 that and you know, cover the remainder of the spectrum

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1 to the extent that we could by looking back and
2 adopting an approach that's similar, but represents
3 kind of an evolution from what's in the current
4 regulatory frameworks. And then, you know, on the
5 left-hand side, you've got something where -- you've
6 got more bounding analyses with more deterministic
7 inputs. And that's somewhere we would seek out an
8 area approach fitting (audio interference).

9 Billy, could you move to Slide 6 please?

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

24 But if you look at Subparts November,
25 Papa, Romeo or NPR on Framework Bravo, which of the

1 definitions, requirements for operation, the licensing
2 processes, these are really where the key differences
3 between the frameworks lie. And these are the
4 highlights that I'm going to focus on today.

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

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

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

25 MR. JESSUP: Currently -- and somebody can

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

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

9 MR. JESSUP: That is our intent.

10 MEMBER PETTI: Okay, thank you.

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

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

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1 well.

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

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

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

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

10 (Simultaneous speaking)

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

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

24 Okay. Billy, could you move to Slide 7
25 please? Thank you. So this is the first subpart that

1 we're going to walk through, Subpart N. So these are
2 definitions that are specific to Framework Bravo.
3 There's only four of them right now. We talked
4 through these during the subcommittee. Anticipated
5 operational recurrence, again, this definition that we
6 pulled into Framework Bravo, it's essentially taken
7 from Part 50 of Appendix Alpha. And it's only here
8 because in Framework Alpha, they also have this term
9 defined, but it is defined differently. I think as
10 Bill, directly from the NRC staff acknowledged during
11 the subcommittee, Framework Alpha is actually looking
12 to adopt a different term. So we may not have to
13 bring this over.

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

23 And then safety-related SSCs, this is a
24 term again that's shared between the frameworks. Not
25 shared, I shouldn't say that. Framework Alpha defines

1 this term differently than we would define it. And
2 that's largely a product of the different approaches
3 for SSC classification between the frameworks.

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

11 Then the last bullet here is really just
12 talking back to kind of an integration between the
13 frameworks. So common definitions, so the terms that
14 are going to be shared between the frameworks, those
15 will be -- will remain in Subpart Alpha in Section
16 53.20 most likely.

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

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

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

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

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

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

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

24 MR. JESSUP: No, I appreciate the comment,
25 Member Petti. It is an item we're actively working

1 on. I think it was more of a timing consideration.
2 And Jesse Seymour, I'll ask him if he would like to
3 speak further about how that's being integrated and
4 worked on right now.

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

7 MR. JESSUP: I understand.

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

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

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1 comment set that's applicable to both frameworks.

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

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

8 (Simultaneous speaking)

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

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

25 MEMBER HALNON: So Jesse, where you're

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

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

17 MR. SEYMOUR: Yes. And it's a -- it's a
18 difficult problem to navigate. Our current takeaway
19 -- and you know, I did appreciate the comments, you
20 know, that were made by the Committee last week. And
21 what we're currently looking at is can we refine the
22 defense and depth criteria, such that you really are
23 looking at, you know, what is credited to meet the
24 defense and depth requirements? What we don't want to
25 do is we don't want to, you know, hamper the ability

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1 of an operator that's there, that's qualified, you
2 know, to some degree to be able to do things that are
3 reasonable above and beyond that credited dense and
4 depth scope. However, what we want to do is, you
5 know, be able to draw some kind of a clean line with
6 what needs to be done for analytical purposes on the
7 front end.

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

13 MR. SEYMOUR: I agree. Again, you know,
14 not an easy set of criteria to develop. You know?
15 And again, as we work through our iterations, you
16 know, particularly as we went through and we looked at
17 we looked at the new criteria of, you know, 53.800.
18 As you go through those five criteria that are there,
19 the fifth criteria, you know, is really aimed at
20 addressing, you know, what the nature of the system
21 structure components that are needed to meet safety
22 functions? And what is that human capability to
23 credibly, you know, take away their ability to do
24 their jobs through an appropriate action? And then,
25 you know, beyond that the question becomes as we, you

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1 know, move from rule language in the guidance space,
2 you know, how do we approach that in a way that's
3 going to allow for some reasonable, you know, approach
4 to be made?

5 MEMBER HALNON: Yeah.

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

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

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

21 MR. SEYMOUR: Okay. Yeah.

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

25 MR. SEYMOUR: Yeah. And so what I think

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

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

19 You know, in general, if we were going to
20 summarize all that, you know, maintain that facility
21 and be responsible for maintaining, you know, its
22 licensing basis within analyzed state. And so what we
23 found was that, you know, even if you could
24 hypothetically delete the operator, you can never
25 fully delete the administrator. You know, you were

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1 left with this administrative, you know, set of items
2 that generally would have been assigned to a senior
3 reactor operator.

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

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

23 Additionally, you know, in talking about
24 something perhaps more complicated to where you
25 actually go through a field core (phonetic), who will

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1 be responsible for supervising core alterations and
2 things of that nature? So what we found was that, you
3 know, really you needed an individual that was
4 qualified to do these important things. Then the
5 question became, you know, who can fulfil this?

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

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

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

25 MR. SEYMOUR: Well and this is where --

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

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

23 But what I can't do is I can't speak to
24 the broader context of Part 53. So again, I can only
25 speak for the operation requirements. So it becomes

1 a question of remote operations and what is allowed in
2 that domain. Again, I would have to, you know, field
3 that back to Bill Jessup indirectly.

4 (Simultaneous speaking)

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

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

23 (Simultaneous speaking)

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

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

5 (Simultaneous speaking)

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

17 You know, a prime example is you know, the
18 simple system that we pointed out in one of our
19 letters was the water treatment plant that some hacker
20 got in, started pumping sodium hydrochloride or
21 something like that into it to take care of -- kill
22 all the bacteria. And if an operator hadn't been
23 passing by or taking his occasional look or whatever
24 his circumstance was and noticed, hold it. This
25 concentration is just ballooning up -- and manually

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1 shut it down. He bypassed all that stuff and shut it
2 down. Brought it back to where it was under control.
3 Otherwise you would have had hundreds of thousands of
4 people poisoned to death, you know, with a
5 carcinogenic substance.

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

17 (Simultaneous speaking)

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

21 MEMBER MARCH-LEUBA: No, this is
22 important. If you allow the mode of operation in your
23 rule, you need to tell me how you're going to do it
24 and put strict controls on how they're going to do it.
25 Because you could say well, we're going to use

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1 (unintelligible) encryption on VPNs. Do you know what
2 (unintelligible) VPNs? All those planes flying -- all
3 those planes flying over Ukraine, which were so
4 effective two months ago. Now not a single one makes
5 it through because they just send (unintelligible)
6 operations. So even the most robust form of
7 communication, the Russians are jamming. So whatever
8 you say that you are going to allow, you have to tell
9 me how you're going to (audio interference).

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

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

14 (Simultaneous speaking)

15 MEMBER BROWN: I understand that. But
16 sooner or later somebody has to try to bring this
17 thing back to ground zero again. Forget the (audio
18 interference) operation. Just the autonomous
19 operation, and now we're calling the operators
20 administrators. They don't have to have that many
21 qualifications. If that sucker -- even if it's
22 autonomous, it's going to be connected somehow now if
23 you look at all the stuff that's being put out. It's
24 going to be able to be hacked. And there ought to be
25 some manual means by somebody to come in, grab a

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1 stitch, turn it, bypassing all of the automated
2 systems to shut the plant down. You may not solve all
3 the problems, but you stop the critical process. And
4 we seem to be abandoning that thought process. It
5 just blows my mind. And I'm the resident skeptic. I
6 am just not happy with this general, we don't need
7 operators anywhere because we're so smart now. It's
8 just --

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

17 (Simultaneous speaking)

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

23 MEMBER SUNSERI: I have one more comment,
24 David. So this goes back to Part 53 and the changes
25 you want to make to it, which I think conceptually I

1 can get in line with. My question is, it seems like
2 an unnecessary complication of the Part 53 rule to be
3 including operator certification in it when I consider
4 the fact that the existing rules or license operators
5 take into account the training and the evaluations of
6 the knowledge, skills, and ability that a person needs
7 to possess to operate a certain design.

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

17 MR. SEYMOUR: There's a few points that I
18 want to speak to if I could. I understand the
19 Committee wants to move on, but if I -- if I could, I
20 want to take a moment to step back (audio
21 interference) around the discussion events. When
22 we're talking about remote operations, right, that is
23 not something that is specifically, you know,
24 addressed (if I could put it like that). Right? What
25 we tried to do with our rule was to, you know, with

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1 our operational requirements. Right? So we're
2 talking about strictly, you know, the operational
3 stuff here. We tried to, you know, write requirements
4 that are durable. Right?

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

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

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1 than the modifications you want to do with this.

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

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

22 I totally agree with Matt from that
23 standpoint. If this same framework has worked quite
24 well, we know how to do it, don't throw it away.
25 Adapt it. But don't try to put it in the rule. Adapt

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1 it on the fly as we build claims. That's my thought.

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

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

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

25 So again by having a rule that allows for

1 a tailorable operative licensing approach and is built
2 from the ground up to allow that, you know, I think
3 you accomplish that same end in a much more efficient
4 ways. Everything too that we've attempted to do is
5 via building in a gradation as you move from the
6 specifically licensed reactor operator (audio
7 interference) operators to the generalized reactor
8 operators is we recognize the facilities that can
9 meet, you know, a certain technological pedigree, that
10 you can remove a lot of the regulatory burden without
11 any reduction of safety.

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

19 MEMBER HALNON: Just to end this -- I
20 think we need to probably to move on -- but just two
21 things. One is you chose to address our original
22 comment of moving beyond a certified operator and to
23 just adapting the Licensed Operator Program that was
24 in our first letter. And you chose it with the
25 general licensed operator. I think it resolves some

1 concerns, obviously not all.

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

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

18 MR. SEYMOUR: And it's our -- This is
19 Jesse Seymour again -- It is our intent to bring that
20 guidance, you know, to the committee. What I can say
21 is that the staffing review guidance is being derived
22 from the existing NUREG-1791, which is the, you know,
23 established means of how you develop and request
24 exemptions for staffing models that don't meet the
25 existing requirements of 50.54. So again, that uses

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1 the human factors engineering-based approach that goes
2 through a number of stages to determine what, you
3 know, what the staffing compliment needs to be. And
4 you know, using performance-based data show that it's
5 suitable.

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

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

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1 else.

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

6 (Simultaneous speaking)

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

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

21 They should have a more efficient process
22 instead of taking there years to figure out whether
23 it's okay or not. It's very cumbersome now. I agree
24 with you. You're tied up in all kinds of legal hoggle
25 boggle and everything else to try to get something

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1 through. You need to streamline the process. That's
2 where you ought to go about for the efficiency of
3 doing this, instead of burying it in tons of word
4 salad inside of a rule.

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

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

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

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

22 MEMBER PETTI: Right.

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

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

6 Okay. Billy, could you move on to Slide
7 9 please? Thank you, Jesse. Thanks, Billy. So
8 Subpart R, again this is one of the subparts I
9 highlighted on an earlier slide as having some
10 differentiation between Framework Alpha. However, the
11 structure of Subpart R, it mirrors Subpart Patel and
12 Framework Alpha. Again, covers all the various
13 application types that would expect from early site
14 permits, construction permits, operating licenses, et
15 cetera.

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

25 So again, in Framework Bravo, when we

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

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

25 I wanted to call out two sets of technical

1 requirements that we had a lot of discussion on. I
2 think Boyce Travis did a phenomenal job talking about
3 these during the subcommittee meeting. Those were
4 initiating event accident analyses and containment
5 requirements. So again, if you look in Section
6 53.40.730, Paragraph Alpha 5, those are the
7 requirements that cover the various classes in
8 chemical hazards. And they're really an evolution
9 from what was initially the Part 5 (audio
10 interference) that was started last year.

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

22 The last item there is on containment. So
23 again, this -- the requirements for containments,
24 they're technology-inclusive. We pulled over many of
25 the requirements for light water reactors. But we

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1 also set up a set of alternatives for non-light water
2 reactors that may need or want to adopt the functional
3 containment concept. So again, you'll see those in
4 53.47.30, Paragraph Alpha 36.

5 Billy, next slide please. Oh, go ahead.

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

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

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

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

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

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

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

25 MEMBER BLEY: Okay, thanks.

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

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

23 MEMBER BLEY: Okay. I'm kind of hung up
24 on what Greg says. You know, when things go wrong, it
25 happens one way now. If we have the general licenses,

1 it seems to me, there's much more onus on the owner
2 operator for the individual operator's activities.
3 But we already have some of that, so maybe I'm
4 wondering about things that aren't real. But thank
5 you.

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

20 So again, you know, the nature of that
21 program as you look at is that there is -- there is,
22 you know, a great deal of onus placed on the facility
23 licensee -- you know, on the owner operator if you
24 will. However, it is important to recognize that
25 those individuals are still licensed. So you know,

1 again, that is a substantive change from what we
2 initially, you know, had proposed.

3 MEMBER BLEY: Yes, it is. Thanks.

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

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

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1 applicability statement updates.

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

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

17 MR. JESSUP: If I understand it correctly,
18 Member Halnon, we have gotten some early interest from
19 NEI in particular about engaging on this topic. But
20 I don't think I have any specifics on that. But they
21 have expressed interest in engaging in you know,
22 Framework Bravo (audio interference) Framework Alpha.
23 So those discussions are just getting started. But
24 there is some intent. I mean like NEI 180 whatever.
25 You know? Because they do pretty good at developing

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1 guidance. Obviously you have your shot at getting it
2 revised. But it's an inefficient way of getting
3 things going.

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

7 MEMBER HALNON: Thanks.

8 MR. JESSUP: And Billy, could you move to
9 Slide 11 please? So this is the last slide I've got.
10 Again, it's a forward looking slide. Again, another
11 kind of review from the subcommittee meeting. Looking
12 past just Framework Bravo, but looking again at Part
13 53 as a whole. And what we're doing right now to
14 integrate the two frameworks, I mentioned there's a
15 lot of things that between the frameworks they need --
16 they need to be the same. If they're not the same,
17 we're putting them side by side literally and ensuring
18 that some of these provisions, they're identical. We
19 don't want there to be misalignment.

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

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

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

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

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

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

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

6 CHAIR REMPE: Okay. So we have a meeting
7 scheduled mid-October and we're supposed to get things
8 30 days in advance.

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

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

17 (Simultaneous speaking)

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

20 CHAIR REMPE: Thank you.

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

1 MR. STUTZKE: Hi. I'm Marty Stutzke, the
2 Senior Technical Advisor for PRA and NRR. Billy, can
3 we go to Slide -- Let me get my glasses so I can read
4 this -- So to talk briefly, we'll discuss the
5 evolution of the AERI first. As Bill had talked, it
6 came from this notion back in the Spring of 2021 where
7 the task was considering how to grade the technical
8 content of PRA. And by technical content, we were
9 thinking about ways to limit the degree of plant
10 representation, the level of detail. And perhaps
11 illuminate some of the initiating events, that type of
12 thing. Only to find out industry was interested in
13 grading the use of the PRA itself, which is how Part
14 53 was currently structured at the time -- or had hard
15 requirements.

16 To address that you were discussing
17 earlier, it's true, Part 52 requires a description of
18 the PRA and its results, but it never tells you, what
19 to do with that PRA. Rather, that falls back on
20 various commission policy statements. The commission
21 expects the PRA to be -- well, it can be used for
22 following purposes like that. My understanding of
23 Part 50.52, Lessons Learned Alignment Rulemaking, will
24 then convey that over in Part 50 applicants.

25 So we spent some time thinking about well

1 how is PRA actually used? Specific PRA-led approach
2 like Framework Alpha currently has, supportive of the
3 Licensing Modernization Project -- LMP. Or should PRA
4 be used in a more supporting, you know, or a
5 confirmatory type of roles that it currently is.

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

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

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

8 So as I said before, we had developed
9 three decisional draft reg guides to present our logic
10 to potential applicants with expectations of the staff
11 and to address ACRS recommendations in what we call
12 "start with a blank sheet of paper". And you all had
13 written four letters on that in some detail like that.
14 And we're trying to address it. When we did so, we
15 realized the recommendation, "start with a blank sheet
16 of paper" is broader than the AERI approach. It's
17 broader than the Framework Bravo and Part 53. In
18 fact, it should touch on all licensing aspects,
19 including Parts 50 and 52. So we divided the guidance
20 into two portions; the technology-inclusive search for
21 licensing events were applied to Parts 50, 52, and 53.
22 Whereas the AERI framework is only applicable to Part
23 50, Framework B.

24 Let's go to Slide 16 and I'll show you the
25 flowchart. The flowchart doesn't do a great deal of

1 justice to the actual process of how this is done. If
2 I were to incorporate all the potential feedback loops
3 on this diagram, we'd be unable to read it. I've
4 tried it before. There's not a white board big enough
5 and One White Flint to let me draw this thing. So you
6 have to bear with me imperfect as it is. I'll
7 confess, every time I look at it, I want to -- I have
8 this urge to tear it up and start over. Bear with me.

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

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

24 Assuming they don't want a PRA-led
25 approach, take the down branch out of Box Bravo into

1 selecting licensing events, Box Juliet. And we've
2 developed guidance on how to do that. The concept is
3 this. We have a broad set of information developed in
4 Box A that was (audio interference) events on the
5 issue of the accident sequences. And we're trying to,
6 for lack of a better word, spill it down into the
7 categories of licensing events that would then be
8 analyzed in the traditional manner, say SRP Chapter
9 15, type of analyses. So Box J doesn't tell you how
10 to do that, it just tells you what events you should
11 be looking at.

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

19 So progressing out of Box Lima into Box
20 Mike, we provided this option. Either continue with
21 the PRA development and just the PRA and its customary
22 supporting informatory type of role or come down into
23 the AERI approach. And AERI works by identifying and
24 analyzing the boundary developments shown in Box Oscar
25 and Box Papa to confirm that the AERI entry conditions

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1 are actually met like this. Then into Box Quebec for
2 subsets demonstrate (audio interference) QHOs by using
3 the demonstrative conservative approach. Look at all
4 of the event sequences, all the information you have
5 prior to this search for severe action of
6 vulnerabilities.

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

19 Now I'd like to point out a little nuance.

20 And it has to do with Box Alpha and this idea of
21 reliance on the predefined list. Currently if you go
22 into Part 50 and 52, there is a requirement that says
23 you will compare to the standard review plan. And if
24 I go to Chapter 15 of the SRP, I find predefined was
25 transience and accidents. Okay? So we've left that

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1 in there now to follow up confirmatory sort of process
2 in the selection of licensing events and be certain
3 that nothing has been omitted. Again, we try to
4 retain the idea of starting with a blank sheet of
5 paper.

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

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

14 MR. STUTZKE: Yes.

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

17 MR. STUTZKE: Not necessarily.

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

22 MR. STUTZKE: In reality, you would be
23 performing them in parallel with identifying them in
24 bounding event and the DBA type of analysis. But be
25 careful when using the language, "bounding event" so

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1 that it's not construed or misinterpreted to be a
2 maximum accident -- like a maximum credible accident
3 per maximum hypothetical. What we need for PRA uses
4 different doses over different time periods. In other
5 words, when I calculate individual latent cancer
6 fatality risks, I'm looking at the 50-year dose.
7 Whereas in a DBA type of analysis, I'm looking at the
8 words "two-hour dose" --

9 (Simultaneous speaking)

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

17 MR. STUTZKE: Well, the same sort of
18 bounding event would credit only the inherent features
19 (audio interference) but that's somewhat of a -- part
20 in our guidance that would probably need to amplify
21 because there are different opinions about what is an
22 inherent feature? For example, when I think of
23 inherent features, I'm thinking of things like
24 reactivity feedback shut down the reaction like that.
25 Or the use of things like natural convection, like do

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1 we have any cooling systems, things like that,
2 conduction of the heat out into the earth itself.

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

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

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

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

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

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

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

7 (Simultaneous speaking)

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

10 MR. JESSUP: I think single failure
11 criteria -- while it's defined at the front of
12 Appendix Alpha, the single barrier at least. And then
13 mentioned, I believe, in several criteria. And then
14 also mentioned in Reg Guide 1232. So we don't have
15 single failure criterion explicitly in the rule text,
16 but we expect that would be captured the way it is now
17 --

18 (Simultaneous speaking)

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

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

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

1 Right?

2 MR. JESSUP: Correct.

3 MEMBER MARCH-LEUBA: Okay, thank you.

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

22 (Simultaneous speaking)

23 MEMBER DIMITRJEVIC: Do you understand my
24 question? Because he can choose to do PRA afterward
25 or he can choose to do -- when he's entering this, he

1 already has idea that he has to do the PRA. He can
2 just choose where to enter.

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

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

21 (Simultaneous speaking)

22 MEMBER DIMITRJEVIC: Yeah, I know. But
23 the thing is you're not asking this. You know that
24 he's going to use the PRA. He can know that he's
25 going to use PRA, just select a different path. You

1 know, this is what -- because when you start
2 introducing this area and you say this is a moderate
3 risk-informed approach, much more risk-informed is
4 Framework Alpha. Right? Or it could be -- It's
5 almost risk-based, right, how much risk involved in
6 this. So you know, we said that these two approaches
7 are different on there because there is a risk-
8 informed, you know, spectrum, which goes between the
9 deterministic and risk-based. And that one of those
10 is in the middle. The bottom one is (unintelligible)
11 now. And the one up is, you know, closer to the risk
12 part.

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

22 (Simultaneous speaking)

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

1 more risk-driven.

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

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

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

16 MR. STUTZKE: Well the confusion comes as
17 to when the applicant would decide what licensing
18 framework he wants to pursue up-front. In other words
19 --

20 (Simultaneous speaking)

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

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1 MR. STUTZKE: Yes, I agree. And that's --
2 (Simultaneous speaking)

3 MEMBER DIMITRJEVIC: Okay. I just wanted
4 to make this point to make sure that my colleagues
5 understand that this application is not a renewing PRA
6 or not the sort of selecting how (unintelligible) PRA
7 --

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

19 So an applicant always has the option to
20 develop a PRA here like this. But we've given him an
21 alternative that if they can meet this entry
22 condition, then they can do the AERI approach, which
23 is in lieu of the PRA. The idea is to provide some
24 flexibility to applicants on whether they want to do
25 the PRA or they're not so interested in the uses of

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1 the PRA. For example, like under the LMP, to use it
2 to identify the licensing events, things like that.

3 The other thing to be emphasized with this
4 entry condition is this is not a safety or citing
5 criteria. This is not a replacement for 50.34 or Part
6 100 like this. You don't see the word "citing"
7 anywhere in this language like this. This is merely
8 a condition to decide could you do AERI in lieu of the
9 PRA? And I had shown the subcommittee there's some
10 simple mathematics of how we came up with the 100
11 meters by their calculation to the QHO for individual
12 latent cancer fatality risks like this. And I was told
13 and I promised I won't do any math during this meeting
14 like that. What I did want to show you on the
15 following slide, different ways -- you get different
16 conclusions, depending on how you state this entry
17 condition.

18 So if we can to Slide 18, this is
19 something I hadn't shown the subcommittee, but was
20 motivated like this. The upward curve makes the
21 assumption that I would specify a reference dose --
22 you know, reference doses and stage it in the, you
23 know, preliminary proposed rule effects for AERI. But
24 I would require that dose only at the exclusionary
25 boundary, not in the fixed 100 meters. And what you

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1 find is when you run through the calculation, as the
2 exclusionary radius increases, conditional risk number
3 increases as well.

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

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

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

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1 component of risk, which is our goal.

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

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

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

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1 risk is four times larger.

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

5 (Simultaneous speaking)

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

8 MR. STUTZKE: Correct.

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

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

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

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

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

24 MR. STUTZKE: We don't.

25 MEMBER MARCH-LEUBA: You don't disagree

1 with that?

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

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

7 (Simultaneous speaking)

8 MR. STUTZKE: It's a good example.

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

12 MR. STUTZKE: Yes.

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

15 MR. STUTZKE: Yes.

16 (Simultaneous speaking)

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

19 MR. STUTZKE: Well right now, you're
20 actually summing all the successes because you don't
21 know which event sequences are success or failure
22 necessarily. See if it goes through -- Imagine if I
23 were to develop a whole event for you and I could go
24 through each sequencing and say is this a sequence or
25 is it failure? Okay? And I know I'm interested in

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1 the risk. My success will say that means there's no
2 releases. There's no consequences to this. For
3 failure, there is some consequences like this. So
4 it's true, if I added up all of the sequences that
5 involve consequences -- failure sequence, that's the
6 frequency that I really want. Okay? But you don't
7 know how to do that without doing a PRA. So what I'm
8 saying is I know how to find the sum of the successes,
9 plus the failure sequences and reasonably approximate
10 that (audio interference) . So it's true, the --

11 (Simultaneous speaking)

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

18 (Simultaneous speaking)

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

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

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

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

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

20 (Simultaneous speaking)

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

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

7 MR. STUTZKE: Yeah.

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

15 MR. STUTZKE: And the AERI entry
16 conditions are crafted. You know, they're -- I can't
17 say they're based on, but they're inspired by the
18 protective action and guidelines published by EPAs.
19 In other words, it includes the short-term and the
20 intermediate phase protective action guidelines.
21 Which in the short-term phase says 1 to 5 rem over the
22 first four days of an accident. And then it goes on
23 and it says, "2 rem additional in the first year, plus
24 ½ of a rem thereafter." So I can bound that and make
25 an argument that says if you met the AERI entry

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1 conditions, likely you would not need to take
2 protective action. And protective action means things
3 like sheltering in place, evacuation, long-term
4 relocation away from the site and things like that.
5 That's the basis behind the dosage.

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

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

23 Appendix A provides any number of
24 techniques for how to actually search for initiating
25 events. And as I'm fond of saying, Appendix A is not

1 a textbook (audio interference). We're trying to
2 point the user to what we think are helpful resources.

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

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

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

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

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

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

19 Again, talked about the conservative risk
20 estimate and the assumed frequency of once per year.
21 Guidance would allow an applicant to use a lower
22 frequency if they can justify it. The search for
23 severe action vulnerabilities. We've considered what
24 is a severe accident in a technology-inclusive manner.
25 The current severe accident policy statements license

1 says a severe accident is substantial damages done to
2 the reactor core, whether or not there is serious
3 off-site consequences. But you need to broaden that
4 to consider non-core sources. For example, reactors
5 and things like that. I have a hard time
6 understanding how the damage of molten salt core.
7 It's already molten. Just the normal --

8 (Simultaneous speaking)

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

18 On Slide 21 -- Billy, if we can go to that
19 slide. This is in an effort to try to address one of
20 the comments on the workability of QA and PRA
21 standards and things like that to try to clarify the
22 scope. So the search for initiating events and
23 (unintelligible) sequences or follow the guidance
24 under PDG-1413. If the search for initiators and
25 event sequences is being done as part of the PRA,

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1 either under Framework B or Framework A under Parts 50
2 and 52, then the acceptability of analysis would be
3 controlled by the corporate PRA standards, which
4 addresses PRA configuration control and fair reviews
5 and that sort of thing.

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

12 MEMBER BLEY: I'm sorry, Marty.

13 MR. STUTZKE: Yes?

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

21 MR. STUTZKE: Subpart U is based on Part
22 50 (audio interference), so it's the classic (audio
23 interference) Quality Assurance Program. And what's
24 being implied here is that the design control criteria
25 would apply. So it needs to be reviewed, so forth and

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1 so on.

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

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

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

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

23 MR. STUTZKE: Yes.

24 MEMBER MARCH-LEUBA: The issue, I think,
25 the Committee has or simply I do is what they call the

1 white piece of paper. So how do we know that the PRA
2 is complete? It's true that you've spent a lot of
3 time and a lot of effort and money developing a PRA
4 and to have a standard. But how do you know you've
5 covered every possible event? It is an impossibility.
6 A PRA, you can claim it to be complete or you can
7 claim it to be scientific, but you cannot claim it to
8 be both. So there should be under guidance, the fact
9 that you have to spend a lot of time during the review
10 time to ensure your PRA or your licensing selection is
11 as complete as possible.

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

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1 need to answer.

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

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

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

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

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

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

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

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

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

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

25 CHAIR REMPE: A couple of things. First

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

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

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

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

21 MEMBER PETTI: I could go with less.

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

25 (Whereupon, the above-entitled matter went

1 off the record at 10:35 a.m. and resumed at 1:00 p.m.)

2 off the record at 2:32 p.m.)

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

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

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

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

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

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

3 CHAIR REMPE: Yes, we can.

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

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

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

22 So these technologies, these AMTs, they
23 can be applied to new or replacement components,
24 repair activities of existing components or
25 fabrication of elements of a component to provide

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1 benefit either, you know, performance operation while
2 -- or a possibly a safety benefit.

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

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

13 The initial activities related to AMT were
14 organized and planned through an AMT action plan. And
15 the initial draft of that plan came out in early 2019
16 and Rev -- Revision 1 to that was published in June of
17 2020.

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

23 Based on interest we've heard from
24 industry and the potential of near-term application,
25 the NRC's focused on five major AMT processes and

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1 that's the laser powder bed fusion, laser directed
2 energy deposition, cold spray electron beam welding
3 and powder metallurgy hot axial static pressing.

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

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

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

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

21 And I've had the pleasure of being
22 involved with the AMT program going back to the end of
23 2019 so almost three years. And I am pleased to have
24 the opportunity to brief you all.

25 We've had a lot of activities. I think a

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

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

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

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

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

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

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

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

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

22 And so AMTs, you know, can include new
23 ways to fabricate or join components. They can
24 include surface treatments or codings or other
25 processing methods that might provide a performance or

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1 operational benefit to materials, components used in
2 nuclear power plants.

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

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

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

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

23 You know, and doing the things that we
24 need to on a technical and regulatory basis to prepare
25 ourselves to be able to license and effectively

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1 regulate these new technologies.

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

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

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

22 They're also working to develop the
23 technical basis for regulatory acceptance. Now
24 whether that's developing code cases or white papers
25 to put together the necessary information that would

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1 enable the NRC to review and approve the use of these
2 materials or these manufacturing methods, in addition
3 to the Nuclear Energy Institute, helps to organize the
4 industry's efforts and effectively sort of communicate
5 industry's positions and information that NRC should
6 be aware of.

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

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

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

23 And finally, the Department of Energy has
24 multiple programs that are doing work in the advanced
25 manufacturing technologies area. They recently

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1 reorganized a little bit into their AMMT or advanced
2 methods or advanced materials and manufacturing
3 technologies.

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

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

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

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

22 And using a performance based perspective
23 so we don't want to be adding new burden that's not
24 necessary, but we do recognize that there are some
25 significant differences in how these materials and

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1 fabrication processes produce a component or coding.

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

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

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

23 Again, trying to keep a risk-informed and
24 performance based perspective on it that are not
25 managed or addressed by codes, standards, regulations,

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1 is just to help answer the question of do we need to
2 make changes to our regulatory processes or to our
3 regulations or do we need to recommend that codes and
4 standards are developed in certain areas?

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

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

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

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

1 information.

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

7 MEMBER BROWN: Okay.

8 CHAIR REMPE: So hold on.

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

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

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

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

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

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

3 MR. HISER: No, I --

4 MEMBER BROWN: If everybody says that for
5 everything now.

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

9 MEMBER BROWN: Well you can wait then.

10 MR. HISER: Okay.

11 CHAIR REMPE: So --

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

14 MEMBER BROWN: I appreciate it.

15 MR. HISER: Okay.

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

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

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

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

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

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

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

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

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

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

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

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

15 MR. HISER: So --

16 CHAIR REMPE: -- tested?

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

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

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1 irradiated components.

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

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

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

19 CHAIR REMPE: Yes.

20 MR. HISER: Go ahead. Okay.

21 CHAIR REMPE: I'm sorry. Second
22 questions.

23 MR. HISER: Yes.

24 MR. DAVIS: Can I? I just --

25 MR. HISER: Just whenever, Robert.

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

7 CHAIR REMPE: So stainless steel 316 or
8 --?

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

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

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

25 But I don't see it here. There were some

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

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

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

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

22 And that we would try to look at aspects
23 of process qualification and performance monitoring.
24 And we'll get to this in one of the later slides that
25 ties to that, but we've been trying to make it focused

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1 on LWRs or exist today and components could be put
2 into them today, but also not well limited to LWRs
3 explicitly.

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

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

14 MR. HISER: Sure.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

25 CHAIR REMPE: Oh, yes, please don't forget

1 that one.

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

4 MR. DAVIS: Ron Davis.

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

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

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

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

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

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

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

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

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

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

25 But again, in the interest of not being a

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

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

10 MR. HISER: Okay, so --

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

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

19 CHAIR REMPE: Okay.

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

22 MALE PARTICIPANT: Do you --

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

25 MEMBER PETTI: Right.

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1 MR. BALLINGER: ASCM is --

2 MEMBER PETTI: But it doesn't --

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

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

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

11 MEMBER PETTI: No.

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

14 MEMBER PETTI: No, so.

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

18 MEMBER BALLINGER: It says you have to.

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

21 MEMBER BALLINGER: That doesn't give you
22 --

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

25 MEMBER BALLINGER: Right.

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

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

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

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

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

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

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

25 It was the time it took to get all the

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

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

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

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

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

15 MEMBER BALLINGER: It's the data.

16 MEMBER PETTI: Yes.

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

23 It's a fundamentally different way of
24 producing material and there's a lot more sensitivity
25 to geometry than with conventional manufacturing. And

1 so it is, there may need to be different ways of
2 thinking about how we qualify new materials without
3 additive manufacturing in particular.

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

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

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

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

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

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

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

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

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

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

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

1 MR. HISER: Yes.

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

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

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

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

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

23 But we broke it down into three
24 overarching tasks and then each of these tasks has
25 subtasks that help to implement the vision or the

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1 scope of that task.

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

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

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

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

24 So Task Two is focused on regulatory
25 preparedness in developing guidance and tools from a

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1 regulatory perspective to prepare the staff for the
2 efficient and effective review of AMT components that
3 may be submitted to the NRC for review and approval.

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

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

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

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

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

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

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

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

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

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

23 It doesn't mean that, you know, some of
24 the traditional methods of, you know, confirming that
25 your component or your fabricated part is good or in

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1 part useful, but that we be able to balance them and
2 optimize where we use them. So move on to the next
3 slide.

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

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

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

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

25 CHAIR REMPE: Okay. It also happened

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

3 MR. HISER: Yes.

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

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

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

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

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

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

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1 MR. DAVIS: Yes.

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

4 MR. DAVIS: Yes, yes, yes.

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

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

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

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

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

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

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

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

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

25 So that's been around for a long time and

1 it's progressed into an extremely mature process
2 that's used in many, many, many critical applications
3 and military aircraft and probably most of the
4 aircraft that you ride on for high tech components
5 that are traveling at high RPMs and high temperature.

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

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

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

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

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1 think for the Polaris submarines.

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

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

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

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

23 And there's a lot of microstructural
24 differences on a lot more variables that you have to
25 control than these other processes. Or rather, as

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1 somebody mentioned some of these what could they be
2 used for, for advanced reactors?

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

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

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

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

25 A cold phrase technology that's been used

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1 primarily for codings and ware applications in the
2 defense industry really going back actually a few
3 decades, primarily in the Army, but it's something
4 that the industry is looked at for corrosion resistant
5 codings or ware codings more recently.

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

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

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

22 Through the NEI letter, through
23 interactions, you know, we understand where industry's
24 going. We've tried to identify the technologies that
25 seem to have the most near term, you know, likely use

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1 by industry and so that's how we came to look at these
2 five.

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

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

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

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

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

25 But we just wanted to sort of graphically

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1 show what we've put together. So you'll notice the
2 color coding on these boxes. This sort of a blueish
3 color, bluish, purplish color box indicates a
4 contractor developed product.

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

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

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

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

24 And it's a bridge as you'll see in a later
25 slide to sort of the guidelines. We've tried to show

1 to you that we have the technical basis from the
2 contractor.

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

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

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

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

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

25 It's challenge is you have to have a

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

5 It can produce fairly precise features and
6 then sort of the bottom bullet there I've got on the
7 slide is for some of the key takeaways. I'm going to
8 try to boil down, you know, a 100-page report and a
9 20-page technical assessment to sort of just a few
10 bullets here.

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

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

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

25 And you're going to have different

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

24 And so they've kind of locked down the
25 manufacturing method that, you know, the process and

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1 then the material that will be used and then they
2 bound, you know, the thickness, the features that can
3 be the size of the component, you know.

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

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

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

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

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

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

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

18 CHAIR REMPE: They have to worry about
19 cyber security?

20 MR. DAVIS: Yes, oh, yes.

21 CHAIR REMPE: And as part of the
22 qualifications?

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

1 footprints or blueprints, yes.

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

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

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

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

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

25 So it's a PWR environment with a radiation

1 and was done in accordance with the 50.59 process
2 which does not require approval. And I've put a link
3 to the article about this and a figure that's shown
4 there is at that link.

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

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

11 MEMBER MARCH-LEUBA: Not important.

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

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

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

24 And this was about a little over a year
25 ago so last spring. Also 316-L stainless steel, laser

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1 powder bed fusion. In fact, Oak Ridge National, I've
2 arbitrarily actually worked with Framatome to
3 fabricate these components.

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

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

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

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

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

25 MEMBER MARCH-LEUBA: When we visit the

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

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

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

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

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

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

21 MEMBER MARCH-LEUBA: Oh.

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

25 MEMBER MARCH-LEUBA: So it's part of a new

1 fuel line?

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

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

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

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

13 MR. HISER: Yes.

14 CHAIR REMPE: -- speed up. I apologize.

15 MR. HISER: No, we just figured --

16 CHAIR REMPE: It just seems to go --

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

19 CHAIR REMPE: Okay.

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

21 CHAIR REMPE: Good.

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

24 CHAIR REMPE: Thank you.

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

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

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

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

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

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

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1 geometry.

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

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

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

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

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

23 Yes, I'm going to talk about the next
24 three AMTs and ROTs we look at as part of AMT action
25 plans. And I'm also going to touch on the inspection

1 in NDE or multi-study immunizations.

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

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

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

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

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

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

5 Study has shown that component can enable
6 316 standard steel powders in half. Again with the
7 properties that is similar or better than traditional
8 manufacture stainless steel components.

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

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

20 Some of the other challenges include, you
21 know, if you establish the procedure how you do your
22 other production, you know, establishing the process
23 perimeters and you know, the understanding to optimize
24 the process, the HIP process by such temperature,
25 pressure, and time is important to ensure you are, you

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1 meet the required property in microstructures.

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

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

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

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

22 Then I think we only touch on this EB
23 welding as a premature process and it's allowed by
24 ASME code. However, there's still a lot of work that
25 need to be done to demonstrate sufficient performance

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1 for large PM-HIP components.

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

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

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

23 The closest place is very, it's a solid
24 base metal process. It doesn't get any newer than
25 metal. This process can be used to either, you know,

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1 use as a field or shop applications to repair system
2 parts or as a mitigation process.

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

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

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

21 And I think there are ongoing effort
22 within other industry. I think in DoD's looking at
23 using cold spray for structure applications.
24 Honestly, for those, you know, for when you use
25 instructor application, they would likely be, you

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1 know, application specific data that need to be
2 provided to demonstrate sufficient performance.

3 MEMBER PETTI: Just a question.

4 MR. LIN: Yes.

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

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

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

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

24 MR. DAVIS: Yes, it just that, you know,
25 any fabrication technique is processing specific so

1 there's nothing you need here. Right? From my
2 perspective I can qualify within a range of acceptable
3 critical processes and as long as you stay within
4 that, you're okay.

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

8 MR. LIN: Yes.

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

14 MR. LIN: Okay. Also as part of Subtest
15 1B, we also conducted an initial review looking at the
16 sale of volume NDE for inspection of AMT components.
17 That review basically focused on, you know, whether
18 the assisting NDE techniques can be used to detect the
19 kind of defect that we anticipate to see in some of
20 the AMT components.

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

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

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

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

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

17 MR. LIN: Yes.

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

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

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

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

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

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

22 And so the report looked at the state of
23 the art as well as some of the gaps that are
24 associated and some of the more significant gaps. In
25 terms of key considerations and they looked at two

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1 different types of modeling and sims.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

24 All right, this, so the bulk of the
25 presentation as Matt talked about covered Task One,

1 the technical preparedness activities. I just want to
2 give you guys a flavor in just a few slides on what
3 we've been doing in the regulatory preparedness
4 activities.

5 We've had three separate subtasks.
6 Subtask 2A is focused on implementation using the
7 50.59 process. I think we've already seen with the
8 first two applications and I think we expect more of
9 this, 50.55 for non-pressure boundary and non-safety
10 significant applications remains a very viable and
11 easy mechanism for introducing these materials into
12 the fleet.

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

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

23 But we focus on in Subtask 2A was
24 providing inspectors with guidance. But they're
25 looking at an AMT evaluation. They sort of know what

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1 some of the critical things they need to be looking
2 for to make sure that evaluation was done correctly.

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

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

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

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

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1 terms of guidelines.

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

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

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

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

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

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

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

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

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

24 CHAIR REMPE: I just --

25 MR. DAVIS: Yes.

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

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

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

7 CHAIR REMPE: Oh, okay.

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

11 CHAIR REMPE: Okay.

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

14 MR. HISER: Yes.

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

20 So there's three subtasks that are related
21 to internal activities and in terms of trainings and
22 seminars as well as knowledge management. We have the
23 Subtask 3B specifically on external activities where
24 we try to make sure that we've got the pulse not of
25 just the codes and standards community, but then also

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1 the various external take upholders that are either
2 working on developing these techniques or they're
3 looking to apply them.

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

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

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

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

23 This is just a quick summary of the
24 workshop itself. The only thing I want to stress here
25 is this is where we're trying to get there's a

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1 question about how are we reaching out to the other
2 Government organizations.

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

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

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

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

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

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

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

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

9 MR. DAVIS: Yes, we've --

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

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

15 MEMBER BALLINGER: Okay.

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

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

24 And then the second column shows you what
25 the actual deliverable is and then you've got a link

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1 in that status column to get you that report or that
2 deliverable. So this slide and then the next one, go
3 ahead, Hussain.

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

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

12 MR. HISER: Yes.

13 MR. DAVIS: -- was.

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

16 MR. DAVIS: Yes, so --

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

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

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

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

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

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

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

21 And at Space X and other companies that
22 are looking at employing similar technologies. And
23 then diode laser cladding is another one. This is
24 what they're planning or at least what they propose to
25 use for NuScale cladding. It's used as a laser

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1 cladding so we'd like to investigate that as well.

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

4 MR. DAVIS: Yes.

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

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

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

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

14 MEMBER BALLINGER: Outside distribution --

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

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

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

23 Like I said, we have a grant that's
24 looking at that as well. And like you're aware,
25 that's been an explosive area in terms of academic

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1 research over the last six or seven years I think.

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

4 MR. DAVIS: Yes.

5 MEMBER BALLINGER: -- in properties.

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

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

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

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

24 But more specifically, looking at the data
25 and the metadata that's needed to help improve and

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1 validate models as part of the build process. We're
2 going to be looking at in-process NDE techniques and
3 capabilities which we touched on earlier.

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

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

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

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

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

5 And then we're going to continue doing
6 workshops. We're targeting our next one probably for
7 2023, Mr. Ballinger. So that puts us about on that
8 every three-year cycle though I think we've already
9 started talking about that internally.

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

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

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

23 In fact, we're in danger of getting a
24 little bit too far ahead. As Matt said, we don't want
25 to get ahead, we want to be in the right stage. So I

1 think we're prepared if an application came in.

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

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

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

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

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

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

24 CHAIR REMPE: I need to ask the public and
25 see if there's any members out there in the public who

1 would like to provide comments at this time. All you
2 have to do is unmute yourself or punch star six.

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

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

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

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

20 (Whereupon, the above-entitled matter went
21 off the record at 2:32 p.m.)
22
23
24
25

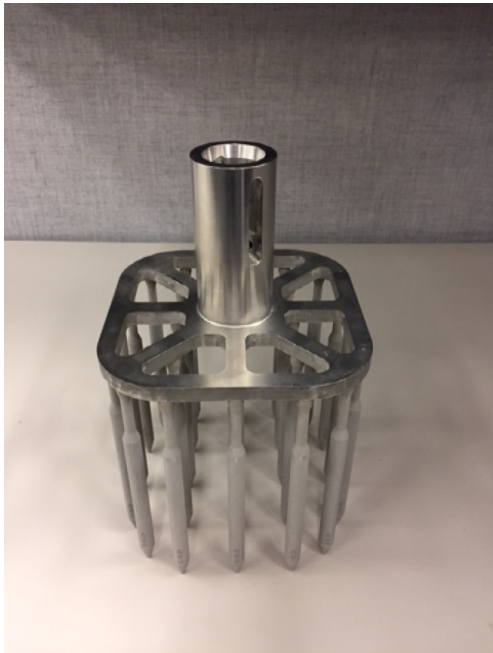
NRC Activities on Advanced Manufacturing Technologies (AMTs)

NRC Office of Nuclear Regulatory Research
Division of Engineering

July 6, 2022

Advisory Committee on Reactor Safeguards Full Committee

The Team



Project Team

Carolyn Fairbanks, Technical Lead
Robert Davis
Mark Yoo, RES lead
Matthew Hiser
Bruce Lin
Isaac Anchondo-Lopez, Project Manager

Technical Advisory Team

Allen Hiser
David Rudland
Robert Tregoning

Supporting RES Staff

Meg Audrain
Amy Hull
Shah Malik

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

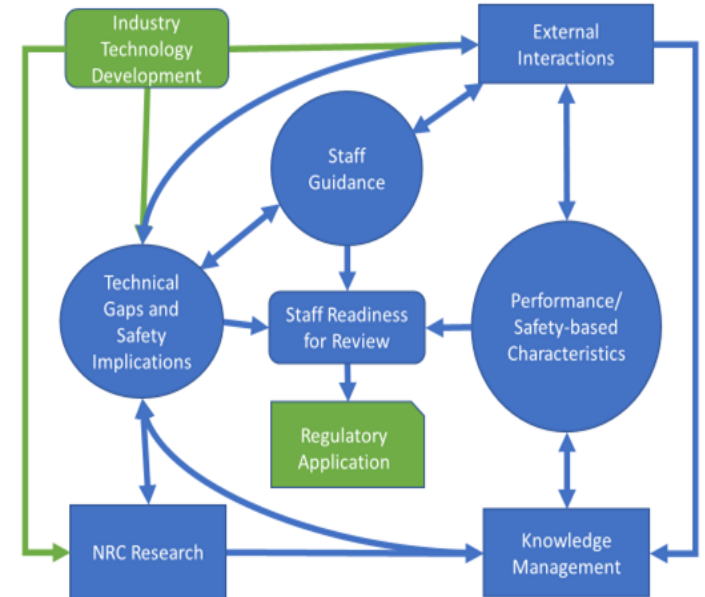
- Variety of stakeholders are working towards more widespread use in both existing and future nuclear applications
 - Vendors and licensees/applicants
 - Identifying candidate applications
 - Developing technical basis for gaining regulatory acceptance
 - Nuclear Energy Institute – Developed roadmap 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)
-
- ```
graph TD; NRC_Research[NRC Research] --> Tech_Gaps((Technical Gaps and Safety Implications)); Tech_Gaps --> Staff_Guidance((Staff Guidance)); Staff_Guidance --> Staff_Readings[Staff Reading for Review]; Staff_Readings --> Reg_Application[Regulatory Application]; Reg_Application --> NRC_Research; Tech_Gaps --> NRC_Research; NRC_Research --> Tech_Gaps;
```
- The flowchart illustrates the regulatory process for AMT applications. It begins with 'NRC Research' (a blue rectangle) at the bottom left. A green arrow points from 'NRC Research' to 'Technical Gaps and Safety Implications' (a blue circle) at the top left. A blue arrow points from 'Technical Gaps and Safety Implications' to 'Staff Guidance' (a blue circle) at the top right. A blue arrow points from 'Staff Guidance' to 'Staff Reading for Review' (a blue rectangle) in the middle right. A blue arrow points from 'Staff Reading for Review' to 'Regulatory Application' (a green rectangle) at the bottom right. A blue arrow points from 'Regulatory Application' back to 'NRC Research'. A blue arrow points from 'Technical Gaps and Safety Implications' to 'NRC Research'. A blue arrow points from 'NRC Research' to 'Technical Gaps and Safety Implications'.



# 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

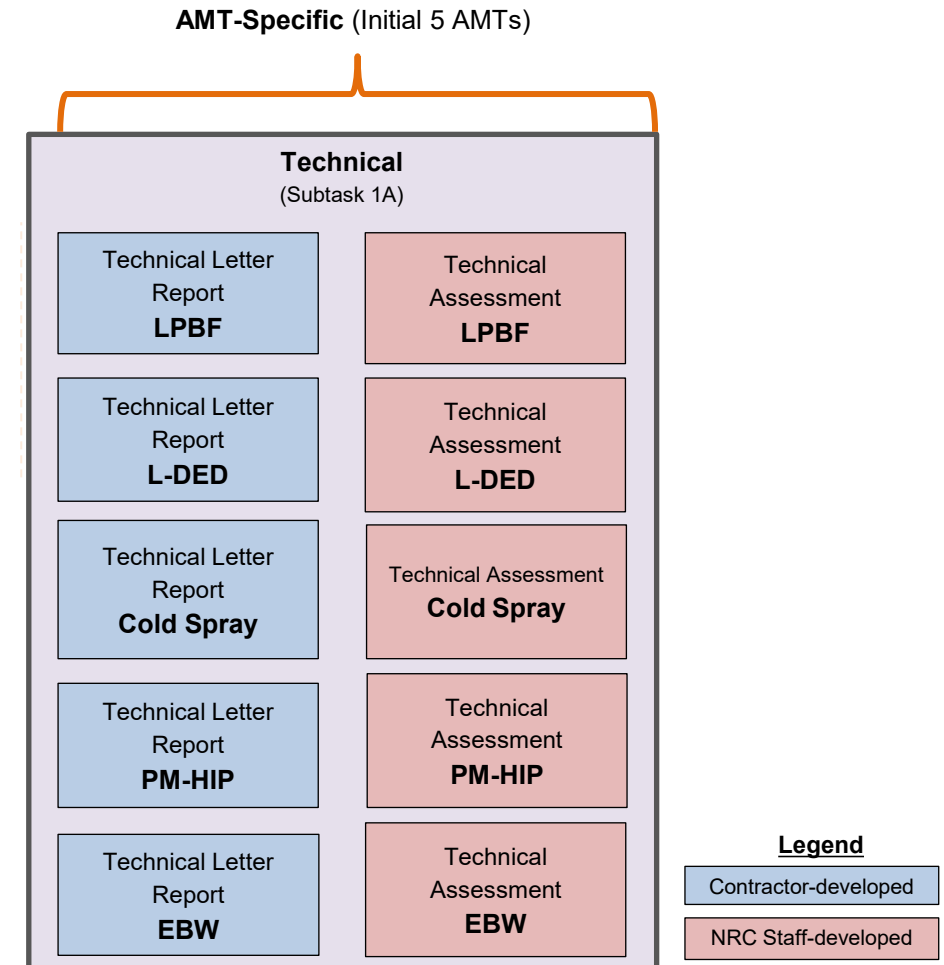
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# Subtask 1A – AMT Processes under Consideration

- 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)

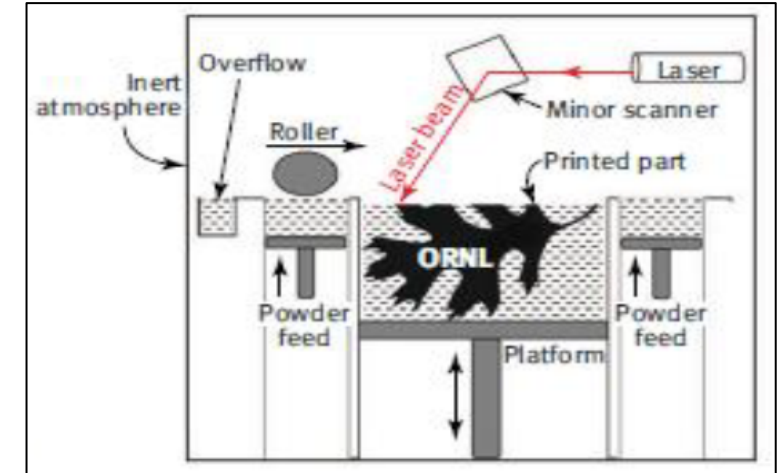
# Task 1A Approach

- 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>

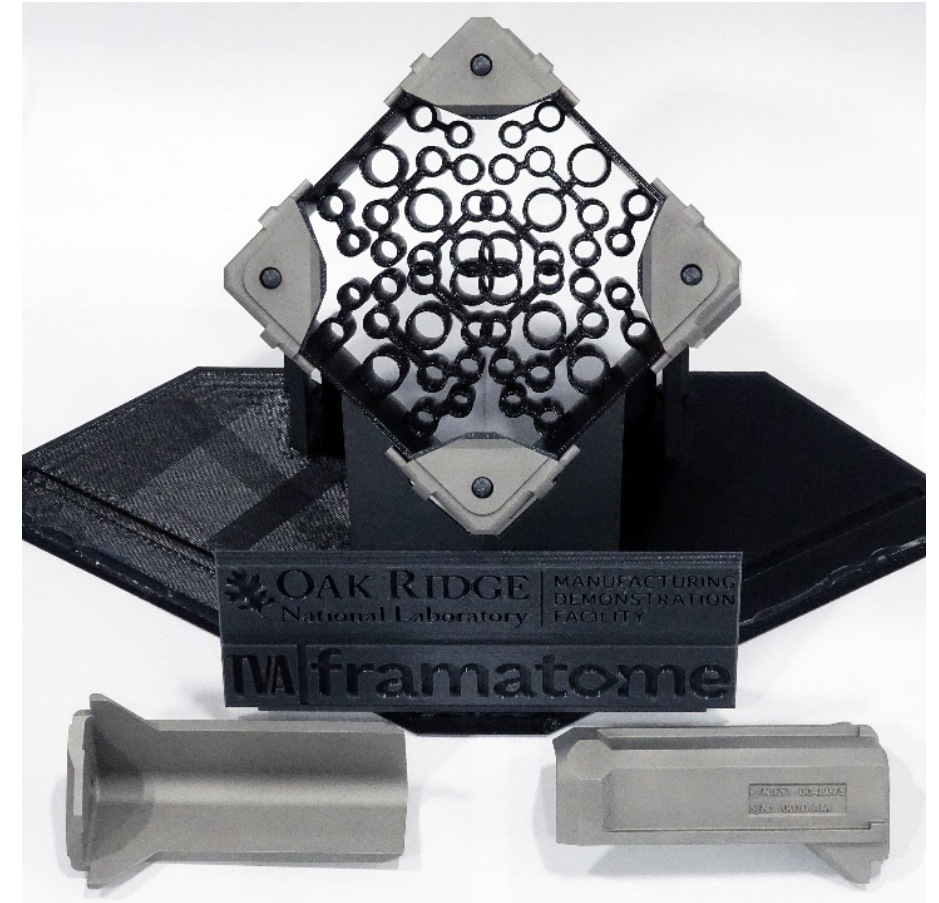
# First US NPP Application of Additive Manufacturing

- 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



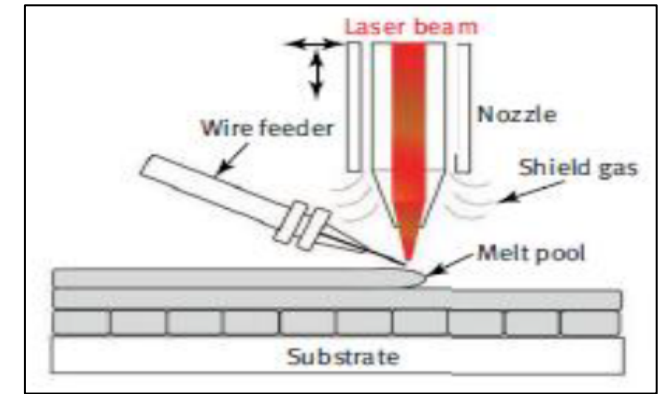
# Second US NPP Application of Additive Manufacturing

- 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



# 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
- 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



Schematic of DED process\*

\*<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
- 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



Scaled down PM-HIP Upper vessel head assembly\*

\*[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\*

# Cold Spray

- Process:

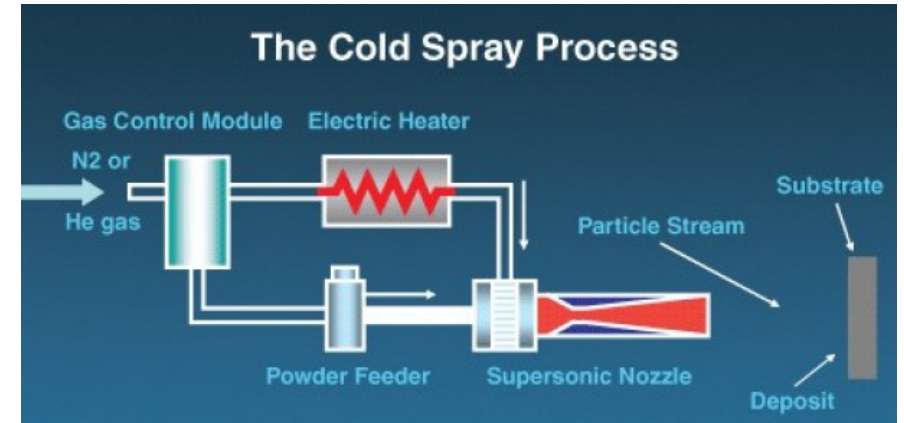
- Powder is sprayed at supersonic velocities onto a metal surface and forms a bond with the part
- This can be used in either field or shop applications to repair existing parts or as a mitigation process

- 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



Schematic of cold spray process\*

\*[https://www.army.mil/article/148465/army\\_researchers\\_develop\\_cold\\_spray\\_system\\_transition\\_to\\_industry](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



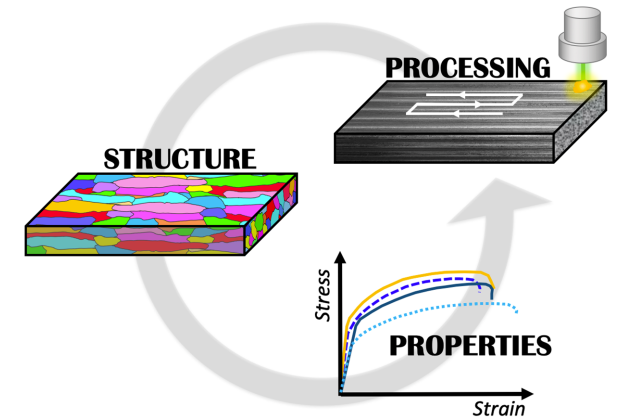
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# Subtask 1C: Modeling and Simulation of Microstructure and Properties

- 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



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# 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

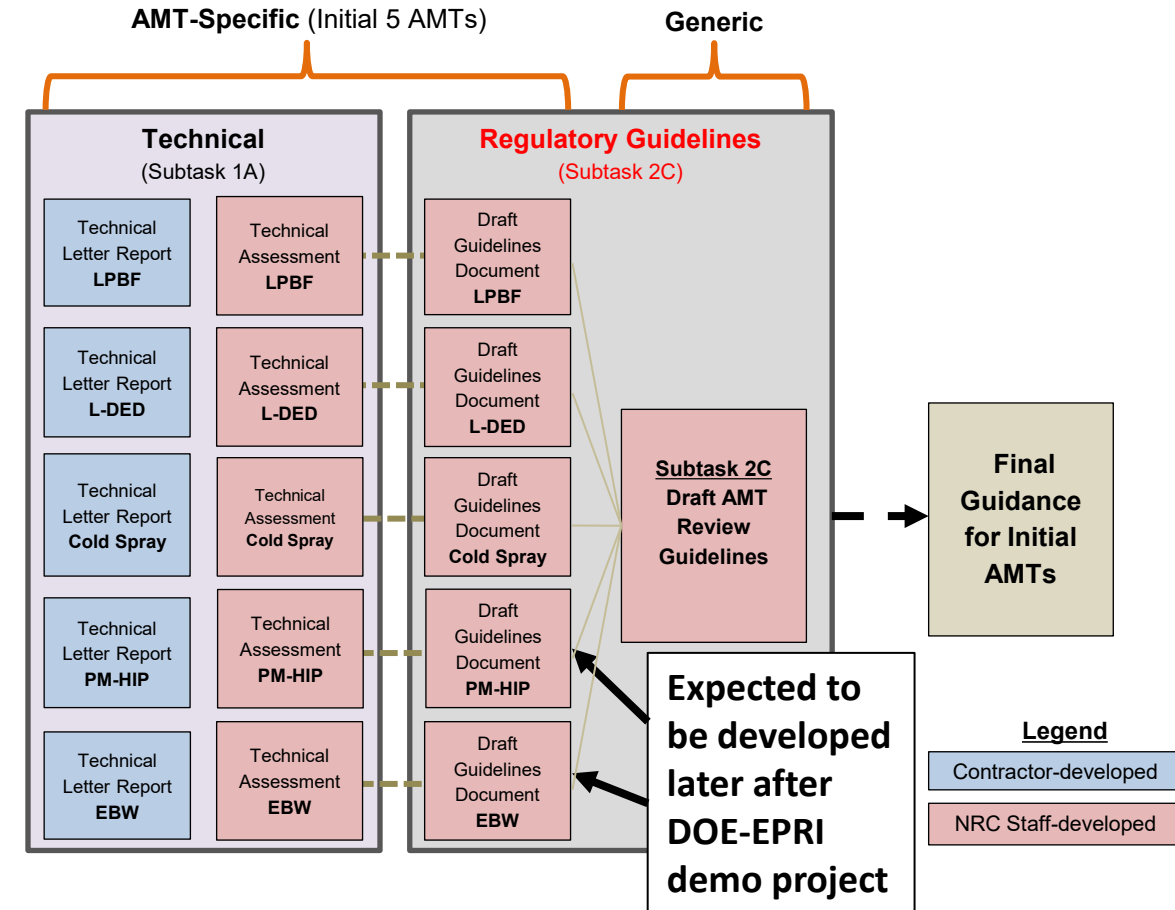
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# Subtask 2C: AMT Guidelines Document

- 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>

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# 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

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# 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>

# Status of Deliverables – Task 1

| Subtask                                      | Actions/Deliverables                                  | Status                                 |
|----------------------------------------------|-------------------------------------------------------|----------------------------------------|
| 1A AMT processes under consideration         | Additive Manufacturing (AM) – Laser Powder Bed Fusion | Complete - <a href="#">ML20351A292</a> |
|                                              | AM – Directed Energy Deposition (DED)                 | Complete - <a href="#">ML21301A077</a> |
|                                              | Cold Spray                                            | Complete - <a href="#">ML21263A105</a> |
|                                              | Powder Metallurgy (PM) – Hot Isostatic Pressing (HIP) | Complete - <a href="#">ML22134A437</a> |
|                                              | Electron Beam (EB) welding                            | Complete - <a href="#">ML22143A927</a> |
| 1B Inspection and NDE                        | NDE gap analysis                                      | Complete - <a href="#">ML20349A012</a> |
| 1C Modeling and Simulation of Microstructure | M&S gap analysis to predict microstructures           | Complete - <a href="#">ML20269A301</a> |
|                                              | ANL M&S gap analysis to predict material performance  | Complete - <a href="#">ML20350B550</a> |

# 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 - <a href="#">ML21200A222</a>                                                                                                                                    |
| 2B Assessment of regulatory guidance   | Path forward on guidance development or modification                                            | Complete - <a href="#">ML20233A693</a>                                                                                                                                    |
| 2C AMT Guidance Document               | Draft AMT Review Guidelines                                                                     | Complete - <a href="#">ML21074A037</a>                                                                                                                                    |
|                                        | Draft Guidelines Documents for specific AMTs                                                    | AM-Laser Powder Bed Fusion - <a href="#">ML21074A040</a><br>AM-Laser-Directed Energy Deposition - <a href="#">ML22143A950</a><br>Cold Spray - <a href="#">ML22143A950</a> |
| 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: <a href="#">ML20357B071</a><br>RIL: <a href="#">Part 1</a> <a href="#">Part 2</a>                                                      |
| 3E Material Information course         | Training course and course materials                                                            | First 6 seminars complete - internal                                                                                                                                      |

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# 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

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# Current and Future Activities

- Continue to support AMT guidance development
  - Includes additional AMT-specific DGDs
- Knowledge management and external interactions
  - Workshops
  - Staff training seminars



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# 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

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# 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



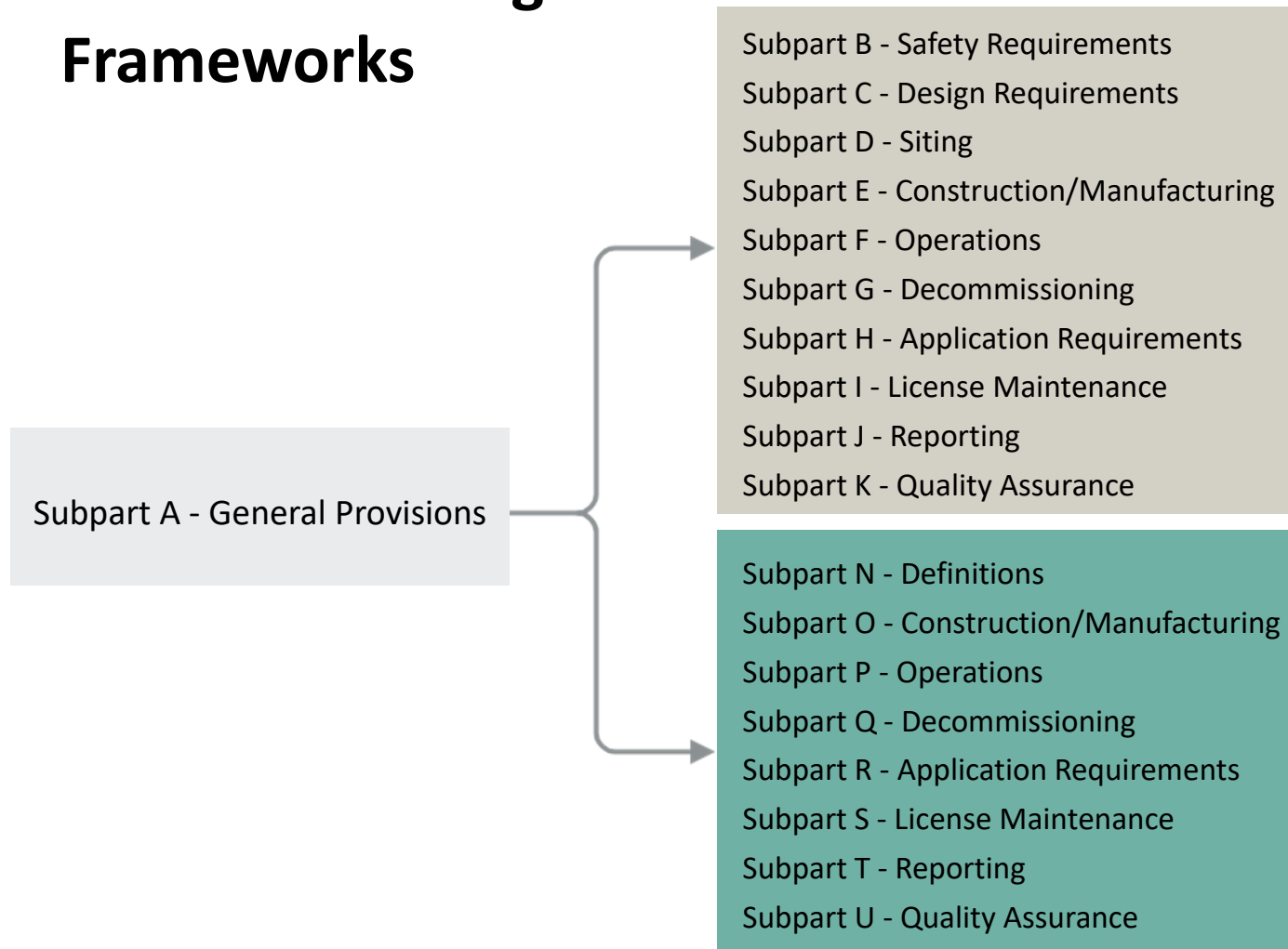
ACRS Full Committee Meeting  
July 6, 2022



## Agenda

- Overview of Part 53 Structure
- Comparison of Part 53 Frameworks
- Discussion of Key Subparts
- Guidance Development
- Framework Integration

# Part 53 Licensing Frameworks



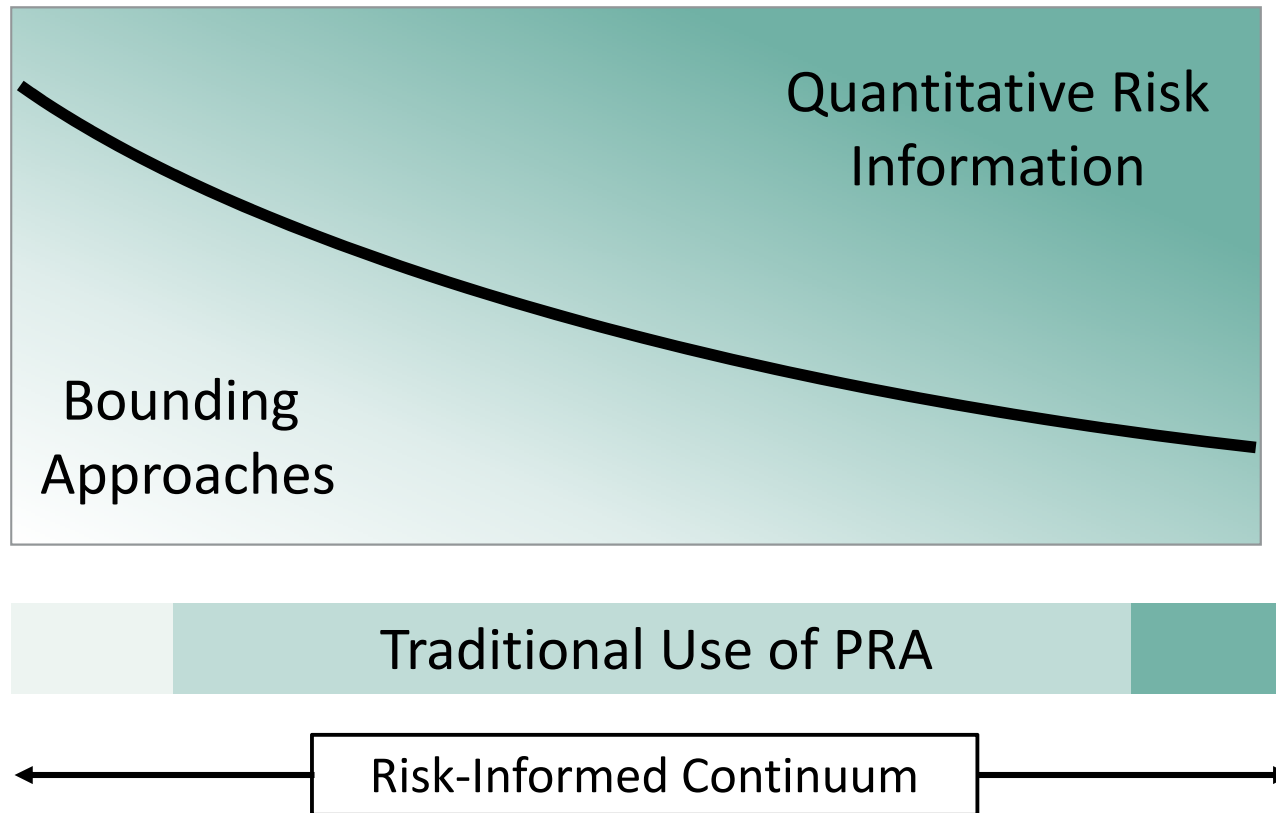
## Framework A

- Probabilistic risk assessment (PRA)-led approach
- Functional design criteria
- Top-down approach for meeting high-level safety criteria and defining key safety functions

## 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”

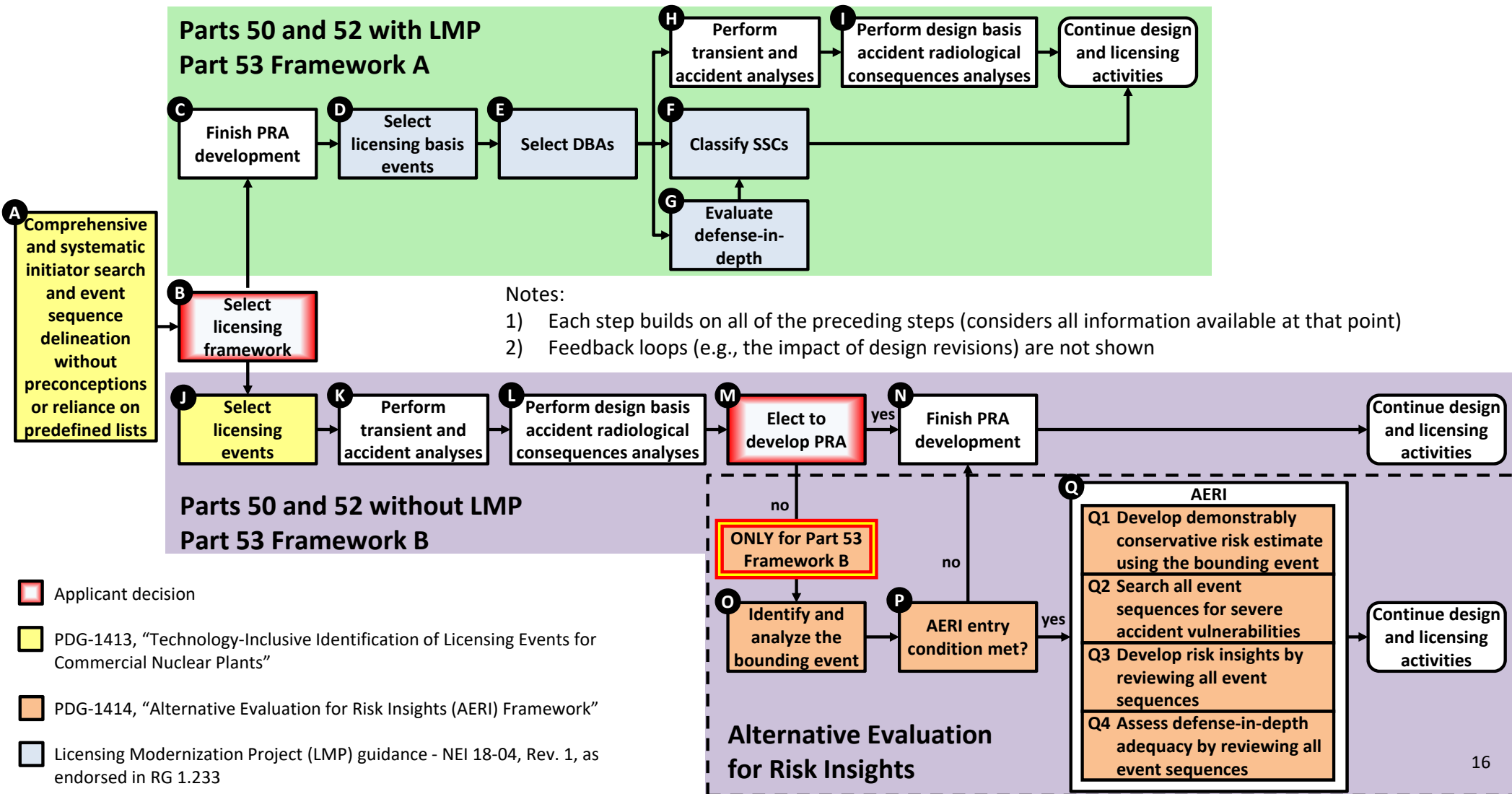


# Evolution of the AERI Alternative Approach

- 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
- 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)

**Uses risk insights to enhance regulatory efficiency.**

# Licensing Frameworks – Risk Evaluation Perspective



# Proposed AERI Entry Condition

## **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:

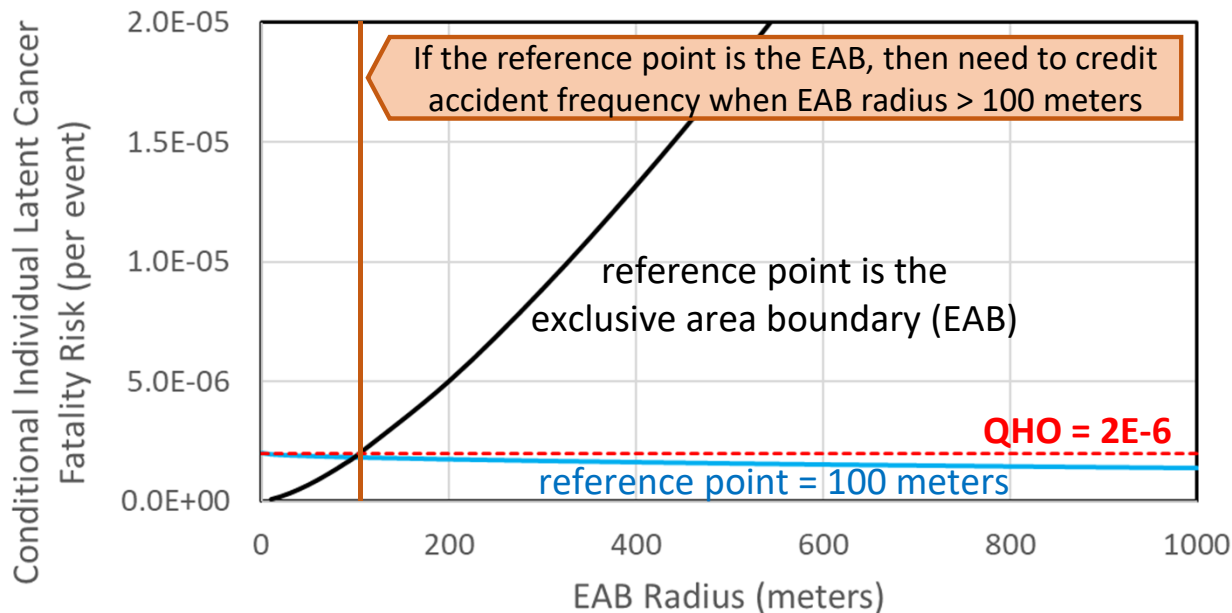
- (i) A PRA, or
- (ii) An AERI, provided that the dose from a postulated bounding event to an individual located 100 meters (328 feet) away from the commercial nuclear plant does not exceed 1 rem total effective dose equivalent (TEDE) over the first four days following a release, an additional 2 rem TEDE in the first year, and 0.5 rem TEDE per year in the second and subsequent years.

**The AERI entry condition is not a safety or siting criterion!!!**

- 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

Comparison of Reference Point Locations



- **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):
  - Identifies licensing events for each licensing framework
  - Provides historical perspectives (early licensing, development of the standard review plan)
  - 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:
  - Conducting a systematic and comprehensive search for initiating events
  - Delineating a systematic and comprehensive sets of event sequences
  - Grouping the lists of initiating events and event sequences into licensing events
- Appendix A (Comprehensive Search for Initiating Events):
  - Reviews techniques for searching for initiating events and points the user to helpful references
  - 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

| Licensing Framework         | Initiating Event Search and Event Sequence Delineation |                                                        | Licensing Event Identification             |                               | AERI     |                                                                                                                                 |
|-----------------------------|--------------------------------------------------------|--------------------------------------------------------|--------------------------------------------|-------------------------------|----------|---------------------------------------------------------------------------------------------------------------------------------|
|                             | Approach                                               | Acceptability                                          | Approach                                   | Acceptability                 | Approach | Acceptability                                                                                                                   |
| Parts 50 and 52 with LMP    | PDG-1413                                               | PRA Standards<br>• LWR – RG 1.200<br>• NLWR – RG 1.247 | NEI 18-04, Rev. 1, as endorsed in RG 1.233 | QA Program Part 50, App. B    | n/a      | n/a                                                                                                                             |
| Part 53, Framework A        |                                                        |                                                        |                                            | QA Program Part 53, Subpart K |          |                                                                                                                                 |
| Parts 50 and 52 without LMP |                                                        |                                                        | QA Program Part 50, App. B                 |                               |          |                                                                                                                                 |
| Part 53, Framework B (PRA)  |                                                        | Quality Assurance (QA) Program Part 53, Subpart U      | PDG-1413                                   | QA Program Part 53, Subpart U | PDG-1414 | QA Program, Part 53, Subpart U                                                                                                  |
| Part 53, Framework B (AERI) |                                                        |                                                        |                                            |                               |          | For dose/consequence and demonstrably conservative risk assessments, use PRA Standards<br>• LWR – RG 1.200<br>• NLWR – RG 1.247 |



# 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   | <i>Federal Register</i>                  |
| 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       |