Official Transcript of Proceedings

NUCLEAR REGULATORY COMMISSION

Title: Advisory Committee on Reactor Safeguards Safety Research Program Subcommittee

Docket Number: (n/a)

Location: teleconference

Date: Monday, September 20, 2021

Work Order No.: NRC-1680 Pages 1-135

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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SAFETY RESEARCH PROGRAM SUBCOMMITTEE

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MONDAY

SEPTEMBER 20, 2021

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The Subcommittee met via Videoconference, at 2:00 p.m. EDT, Vesna Dimitrijevic, Subcommittee Chair, presiding.

COMMITTEE MEMBERS:

VESNA B. DIMITRIJEVIC, Subcommittee Chair

MATTHEW W. SUNSERI, ACRS Chairman

JOY L. REMPE, ACRS Vice Chairman

RONALD G. BALLINGER, Member

VICKI M. BIER, Member

DENNIS BLEY, Member

CHARLES H. BROWN, JR., Member

GREGORY H. HALNON, Member

JOSE MARCH-LEUBA, Member

DAVID A. PETTI, Member

DESIGNATED FEDERAL OFFICIAL:

Hossein Nourbakhsh

ALSO PRESENT:

Christian Araguas, RES

Holly Cruz, RES

Michelle Gonzalez, RES

Alan Kuritzky, RES

John Nakoski, NRR

Sean Peters, RES

Mehdi Reisi-Fard, RES

Mark Salley, RES

Mark Thaggard, RES

Jason Thompson, RES

AGENDA

I. Opening Remarks and Objectives 4

II. Overview of the Division of Risk Analysis 6

III. Discussion of Technical Research Activities and Focus Areas

- Performance and Reliability Branch 39
- Probabilistic Risk Assessment Branch . . . 55
- Fire and External Hazards Analysis Branch . 69
- Human Factors and Reliability Branch . . 101

Adjourn 135

P R O C E E D I N G S

2:00 p.m.

CHAIR DIMITRIJEVIC: Okay, I have 2:00 p.m. here, so I think we can start our meeting, so the meeting will now come to order. So, this is a Safety Research Program Subcommittee meeting in preparation of Advisory Committee on Reactor Safeguards biennial review of the NRC Safety Research Program.

I am Vesna Dimitrijevic, Chairman of today's Subcommittee meeting and the ACRS lead for the review of the activities in the Division of Risk Analysis of the Office of Nuclear Regulatory Research.

Members in attendance as I saw last is Dave Petti, Greg Halnon, Jose March-Leuba, Joy Rempe, and Matt Sunseri. I have not seen Ron Ballinger or Vicki Bier, and Charlie Brown will a little late, and I think Dennis had some obligation and Walt Kirchner is traveling, so.

We hold these open meetings to gather information to support our biennial review of the NRC's Safety Research Program. The ACRS sections of the U.S. NRC public website provide our charter, bylaws, agendas, monthly reports, and full transcripts of all full and subcommittee meetings, including slides presented there.

The meeting notices and agendas for these meetings are also posted there. We have received no written statement or request to make an oral statement from the public.

The Subcommittee will get the information, analyze relevant issues and fact, and formulate a proposed position and action as appropriate for deliberation by the full Committee.

A transcript of the meeting is being kept and will be made available. Due to the COVID pandemic, today's meeting is being held over Microsoft Teams for ACRS and NRC staff. There is also an audio line allowing participation of the public over the phone.

When addressing the Subcommittee, the participants should first identify themselves and speak with sufficient clarity and volume so that they may be readily heard. When not speaking, we request the participants mute their computer microphone or phone.

Okay, we will now proceed with the meeting and I will call up Mark Thaggard, Director of the Division of Risk Analysis for the NRC Office of Nuclear Regulatory Research, to begin today's presentation. We can see presentations on the screen,

so Mark, please proceed.

MR. THAGGARD: Okay, good afternoon. As was mentioned, I'm Mark Thaggard. I'm the Director of the Division of Risk Analysis. I assumed this role at the beginning of 2021 with the retirement of Mike Cheok, which I think many of you may remember.

For those of you that don't know me, I've been with the agency for more than 30 years. I've worked in various offices at the agency, including NMSS, NRO, NSIR, and Research, as well as I spent some time working for former Chairman Meserve. Prior to becoming the Division Director, I served as the deputy in the division since 2016.

I do appreciate the opportunity to come before the Committee this afternoon to go over the activities within the division. We always value the feedback and insights that the Committee provide through these biennial assessments.

Our plan this afternoon is for me and my deputy, Christian Araguas, who you'll hear from shortly, to provide a general overview of the division activities, and then you'll get a briefing from each of the branch chiefs on the specific activities within each of their branches. Can I have the next slide?

So, I want to begin by going over five

primary objectives for the division. The first is to be ready for future technologies.

One of the initiatives that we have been following with respect to advanced reactors is a joint effort by EPRI and Vanderbilt University to look into conducting a safety assessment for advanced reactors.

We had started a similar initiative, but decided to forego our effort to see what insights we could gain through following the EPRI effort.

The EPRI/Vanderbilt assessment included looking at existing tools, methods, and best practices that could be applied to analyzing the safety of advanced reactor designs. This project showed how hazards could be identified early on in the design stage.

This work has been completed. We're still looking at their reports to see what possible insights that we can gain from it.

MEMBER REMPE: Mark, this is Joy. You sounded like you were getting ready to change to another slide or topic and I wanted to ask questions on this, but if you had more on this topic --

MR. THAGGARD: No, no, I was getting ready to change to the next topic, so go ahead.

MEMBER REMPE: I'm good with my ESP over

virtual reality software. Okay, elaborate more because I know I just recently became aware that your division had done this, and did this Vanguard/EPRI effort cover all different types like a gas reactor, a molten salt reactor, and a sodium reactor?

Did it consider all the hazards, the spent fuel, for the ones, the microreactors as they're being placed on site when they're loaded with a core? I mean, how much depth did you cover?

MR. THAGGARD: So, I don't have a lot of the depth personally. Maybe one of my staff members can jump in if one of them -- but the reactor that they focused on, and it was EPRI and Vanderbilt University that did the work, the design that they focused on was primarily the molten salt reactor design, although they conducted it with the mindset of it being technology neutral.

So, they wanted to try to see if, you know, whatever they came up with, it could be applied to any type of design. So, you know, they focused on the molten salt reactor. Supposedly, from the insights that have been provided, it could be applied to any type of design.

I don't recall specifically whether or not they looked at all of the different type of hazards.

That's a level of detail I don't specifically have. I don't know if one of my staff members who followed that work, if they're on, maybe they could chime in on it. If not, we'll have to get back to you on that.

MEMBER REMPE: So, I'm not hearing anyone chime in, so I would like more details about this because, again, I keep seeing the public workshops where the DSA staff has gotten a source term for each type of reactor, and there's different types of initiating events and different challenges.

And so, again, I don't mean to be overly skeptical, but it just doesn't have the same -- it doesn't appear on the surface to have the same amount of depth that we're getting for these other reactors, but maybe I'm wrong because I don't have all of the details.

MR. THAGGARD: Okay, yeah, we'll have to follow up with you on that, Joy, to get you more information. I thought one of my staff members were going to be on, but they may have gotten tied up.

MEMBER REMPE: Thank you, because again, that was one of our conclusions from prior times was that we actually would like to have seen the same plant analyzed with the same -- with different tools from DRA, and DSA, and now we hear only one is being

done by DRA, and so you understand where I'm coming from.

MR. THAGGARD: Yeah, and so when we were going to undertake this effort, our initial thought, we were going to focus on the high-temperature gas reactor, that design, because we thought, in terms of trying to develop a PRA model, we thought there might be the most amount of information available on that.

I'm not exactly sure why they particularly, they selected the molten salt reactor design, but as I said, their focus was trying to be technology neutral. I think presumably they could have selected any specific design.

And I see somebody's got their hand up, so maybe they --

PARTICIPANT: Michelle Gonzalez has her hand up.

MR. THAGGARD: Oh, okay.

PARTICIPANT: Go ahead, Michelle.

MS. GONZALEZ: Hi, Mark, this is Michelle Gonzalez from the Nuclear Regulatory Research Division of Risk Analysis. I was involved in this work. I came in later on when we were pretty much just completing the work and finalizing the document.

But at least what I remember from this,

pretty much the objective of the work was to achieve meaningful integration of safety throughout the full design process since the start of the design process, so this would help to fill a void in early stages of safety for non-LWRs.

So, in terms of if it covers all the hazards or all the -- I'm not sure, and I'll follow up with Mark and I'll provide additional information on that.

MEMBER REMPE: Yeah, when you say the molten salt, is it something with the pebble fuel or is it something where it's got the fuel floating around in the coolant? What type of molten salt reactor are you looking at?

MS. GONZALEZ: So, it started off, it was divided into phases. The first phase was a focus on the molten salt reactor and it was pretty much from utilization with the technology and all of that for molten salt.

The second phase used the MSRE Project, and then they refined the methodology pretty much with what they call learn by doing, and then for the pilot study, they used a Kairos Power fluoride-salt-cooled high-temperature reactor.

MEMBER REMPE: Okay, yeah, please do

follow up, and if you can, clarify to me why you think this will help you with evaluating PRAs from microreactors and gas reactors, and why it's believed that this is a justified exercise that's technology neutral, okay?

MS. GONZALEZ: Will do.

MEMBER REMPE: Thank you.

MR. THAGGARD: Okay, so our current support for the advanced reactor program has picked up recently and is expected to increase over the next couple of years.

One of the primary areas of support that we're providing right now is in the PRA standards development area. This is an important area because the standard is needed in order to provide the basis for determining the acceptability of PRAs that will be used in support of any license submittals.

Our staff, along with the staff at NRR, were heavily involved in reviewing and providing comments on the recently piloted non-light water reactor PRA standard, and we're currently working on the regulatory guide that will endorse the use of that standard. The Future Plant Design Subcommittee of the ACRS was briefed on that this morning and I think that just completed.

And as you heard during that briefing, a significant challenge is that the non-light water reactor PRA standard is going to cover areas not yet endorsed by the light water, covered for light water reactors.

Also, in support of the advanced reactor program, we are conducting research on a graded approach to scale and target human factor engineering reviews for small and microreactors.

This includes developing human factor engineering review criteria. We're also working with the NRR staff in developing technology inclusive operator training and examination requirements.

Through our involvement under a recently signed agreement to participate in a newly formed holding project, we're looking at operator performance in digital control rooms, human performance in operation of small modular reactors, operator performance in highly automated plants, and the effects of adaptive automation on operator performance.

We also have a future-focused research project on the use of dynamic PRAs which may have application for analyzing passive systems. You'll hear more about this project in one of the branch

presentations.

We also recently signed off on the user need with NRR to develop PRA guidance that will be needed to support licensing non-light water reactors. This will include developing guidance to address PRA uncertainty, which would be an important issue for non-light water reactors where we don't have OpE information.

In addition to work supporting advanced reactors, we are finishing up development of SPAR models for Vogtle Units 3 and 4 which will be needed to support oversight of these units when they become operational. We're also continuing to maintain and make enhancements to SPAR models for operating reactors.

Like the other two research divisions, we are doing some limited work on artificial intelligence. This includes a scope and assessment of AI use within the industry. As part of this effort, we recently issued a Federal Register Notice to get specific feedback on anticipated AI use.

We also recently signed a MOU with DOE to work with them on sharing information and insights on the use of AI techniques for analyzing OpE data. Again, we will come back to this in one of the branch

presentations. Another --

CHAIR DIMITRIJEVIC: So, Mark, I ask you, so you are giving us just a general high-level picture and all of those things will come again in the slides for the branch work things?

MR. THAGGARD: That's correct. I mean, if you got questions now, we can handle them, but our intent was to cover them in a little bit more detail in the branch presentation.

CHAIR DIMITRIJEVIC: Okay.

MR. THAGGARD: Another objective of the division is to complete several launch research projects. This includes work on the aluminum heat issue, the Level 3 PRA Project, and the probabilistic Flood Hazard Assessment Project.

We have faced some challenges in completing these projects, but our aim with each of these activities is completion of high-quality products that are useful to the program office.

Again, you'll hear about each of these projects during the branch presentations. However, I would like to point out one thing regarding the Level 3 PRA Project as it relates to advanced reactors.

We are looking for ways to leverage insights from the Level 3 PRA work to support our

readiness for licensing advanced reactors. For example, the Level 3 PRA Project is expected to provide insights on accessing the -- excuse me, is somebody trying to ask a question? If you're not asking a question, can you put it on mute? Thank you.

So, as I said, we are looking to leverage insights from the Level 3 PRA work to support our readiness for licensing advanced reactors. For example, the Level 3 PRA Project is expected to provide insights on assessing the risks from multi-unit sights and integrated site risks which could prove useful for licensing small modular reactors.

We are also attaining insights on the use of the License Modernization Project and use of alternative risk metrics. Our plan is to document insights we gain from the project so that they can be readily used for licensing advanced reactors.

A third objective of the division is to facilitate transformation. DRA has an important role in the Agency's transformation effort through overseeing the innovation activities.

Innovate NRC 2.0, if you've heard of that, or the IDHEAS scale software, both of those are managed by staff within the division.

A fourth objective of the division is to

grow the Agency's risk-informed decision making capabilities. In line with the emphasis that the Agency in recent years on using risk insights in decision making, we are looking for ways to provide risk tools for non-risk practitioners.

This includes developing SPAR, ASP, and human factor dashboards to help inspectors and license reviewers in understanding the risk importance of reactor systems and initiating events.

We are also looking for opportunities to expand our support beyond NRR. We are currently working with NMSS in developing risk tools for dry cask storage licensing reviews and providing environmental support for their decommissioning program.

We see a potential need for support by NSIR and their efforts to use risk insights and fiscal security. We also see a possible need for more research on the effects of extreme weather events.

The fifth objective of the division is to build and enhance staff capacity. One challenge to the division is staffing. Based on our recent strategic workforce planning assessment, we anticipate having a shortage in one of our core positions over the next five years. This anticipated shortage is

expected with our reliability and risk engineers due to retirements.

Key competency is the greatest focus for us or risk analysis and quantification methods and risk integration. Our strategy to address this need includes hiring and training staff, rotational assignments, and staff developmental assignments.

We recently hired entry level staff and have converted a couple of summer hires into co-op students, which we hope will give us some opportunity to develop the competencies of greatest need.

We also recently started an effort to cross train staff across branches to give us greater flexibility in handling staff losses and to broaden staff skills.

This overview of the division's key focus areas shows that we have efforts underway to be ready for future technologies while also supporting key Agency priorities such as risk-informed decision making and transformation. We're also aggressively working to address anticipated staffing issues.

To ensure that we manage these activities in a smart way, we recently started an effort to revise our strategic plan to ensure that we are working on the right activities and to anticipate

future changes in line with the Agency's environmental scan. Can I have the next slide?

So, we're always looking for opportunities to leverage resources and skills through collaborating with others. This slide reflects our current collaboration efforts, both internationally and domestically. I would like to highlight a few specific examples to show some of the benefits that we get out of these interactions.

We are active participants in the risk, external events, and human and organizational factors CSNI working groups with NEA. In particular, the working group on risk is currently working on an effort to look at PRA uncertainty, which as I've previously stated, could be useful in our support for advanced reactors.

We have a bilateral arrangement with France's IRSN to collaborate on flood risk modeling where they are sharing some of their modeling capabilities on riverine floods and storm surges.

We are exchanging human performance data with the Czech Republic and South Korea to expand our human performance database.

And lastly, I would like to mention that both EPRI and NIST have provided a lot of technical

expertise and modeling support for our work on the aluminum HEAF issue.

So, with that, I will turn the briefing over to Christian unless you have some specific questions on the items I've gone over so far.

CHAIR DIMITRIJEVIC: Well, I have one specific question. I assume though the technical staff will come to the presentation of the branches, but this high-level stuff which you brought, like facilitate transformation, grow risk-informed decision making capability, building capacity, in this area, I have a question which I think will be best addressed by you.

When you say facilitate transformation, how do you guys visualize the goal of transformation? What are you trying to facilitate?

MR. THAGGARD: With transformation?

CHAIR DIMITRIJEVIC: Yeah.

MR. THAGGARD: Okay, so one of the Agency's efforts, part of this transformation is innovation, and so we, right now, we have the lead for that whole effort. So, right now, we're facilitating staff's ability to submit ideas when they -- new ways of doing things, and we also facilitate crowdsourcing.

I believe Sean Peters, his branch runs

that effort. I believe he's going to cover this in a little bit more detail when it gets to his briefing, but the bottom line --

(Simultaneous speaking.)

CHAIR DIMITRIJEVIC: Yes, please.

MR. THAGGARD: Yeah, the bottom line is that so we have staff in our division that, you know, that basically runs that whole effort. They help staff in terms of when they come up with ideas, help them either get that in the right place or, you know, or if staff have suggestions, they help facilitate getting that suggestion in the right place.

So, as I said, you know, all of that is run through our IDHEAS scale software platform, and our staff, they run that platform.

CHAIR DIMITRIJEVIC: I have a specific actually -- is something I struggle with because in the general, I thought that this transformation should result in better focused regulation, right, something which is streamlined and not overly complex and unpractical. So, you know --

MR. THAGGARD: Well --

CHAIR DIMITRIJEVIC: -- is that how you visualize this transformation? Because it's not the more we learn, the more innovation which we have. It

seems like the process is becoming more complex, and complex, and complex, and wants more and more details. So, my question was sort of how do you guys visualize what this transformation is leading to?

MR. THAGGARD: Well, the whole idea of the transformation of the Agency is to become a modern risk-informed regulator, and it's got more than just the innovation piece of it.

There are pieces related to, as I said, you know, using risk insights. You've probably heard of like Be RiskSMART, that whole initiative. That's part of the Agency's transformation effort.

And I'm kind of failing openly, but there are like five components to the Agency's whole transformation effort. The innovation piece of it is just one part of it, but the overall transformation, part of it is the change in culture, which we also have a piece of that too.

But the overall effort is to become a modern risk-informed regulator, and so your ideal about, you know, streamlining regulations and, you know, doing things in a more streamlined fashion, that's all part of the overall transformation effort. The innovation piece of it is just one part of that. I don't know if that --

CHAIR DIMITRIJEVIC: No, no, that's all right. Yeah, okay, I was basically trying to define what does it mean, modern? I mean, you know, you have so many loose ends, you know, which can be tied to make these things more efficient, but we also have a lot of unanswered question. All right, all right, I will address that --

MEMBER REMPE: Well, Vesna, I'd like to chime in with the first part of your question because when I heard about this a while back, maybe a couple of years ago, it sounded like John and his branch were basically helping to develop a spreadsheet-based software for taking the input, you know, sending out a call to the staff for good ideas to put in to some sort of software, and then tabulating them and ranking them, and is that what you're meaning, Mark, when you say they facilitate? Do they develop the software? Do they help rank --

MR. THAGGARD: No, the --

MEMBER REMPE: -- the ideas, or what is it that they do?

MR. THAGGARD: So, I think one of my staff members probably want to weigh in on that, so I should probably let -- and maybe Nev. She's running that. So, if you want to go ahead, Nev?

MR. PETERS: Mark, this is Sean Peters.

MR. THAGGARD: Oh, Sean, okay, yeah, go ahead, Sean.

MR. PETERS: Yeah, so innovation is a couple of things. Our human organizational factor specialists signed in with the EDO's office. We distributed three people to the EDO's office to help them design and modify the innovation program so it could be sustainable.

So, we actually develop the pieces of, you know, how you solicit ideas, how you process those ideas, and then how you, I want to say staff and fund the ideas, and how you get those ideas forward.

And so, the actual software that we utilize is an organizing aspect of it, but it's not the entirety of the program, right? You actually have to build an infrastructure and teams that implement the innovation.

The other thing that we're doing, and this kind of may answer some of Vesna's questions, you'll see later in some of our presentations that our groups are developing risk tools and evaluation criteria that are scaled based upon the risk of the facilities, and so when I get into our human factors presentation later, I'll be talking about our scalable human

factors engineering guidance.

The old human factors engineering guidance we had was developed for large light water reactors, big Part 50 applications, and applying a major cross-sectional look at entire human factors engineering programs is kind of ominous for, like, say microreactors.

So, what we do is we develop that scalable criteria, and that's one of those kind of transformative concepts that we have for applying the right level of review to risk of the facilities.

MEMBER REMPE: So, this is Joy, and thank you, and it's coming back to me. This was actually an EDO user need request, right, that --

(Simultaneous speaking.)

MEMBER REMPE: -- to address this transformation.

MR. PETERS: Absolutely right. So, our team worked in the EDO's office, but we just couldn't indefinitely loan them to the EDO's office, so what we did working with them, we transitioned the entire program over to the Office of Research to run that innovation piece.

So, Innovate NRC 2.0 is run out of Research with those same organizational factor

specialists, and what that does is allows us to continue operations efficiently whenever we have changes in the organization.

MEMBER REMPE: Thank you.

MR. THAGGARD: Okay, if there are no other questions for me, I guess we'll go ahead and turn it over to Christian.

MR. ARAGUAS: All right, so I'm looking at the time. I know we're over our allotted for this, so I'm going to try to move us through the continuing theme of the high level. I've got about three slides to get through and then we'll get to the branch presentations.

So, with that, again, good afternoon, everybody, and my thanks as well for the opportunity to come and speak with you today. So, as Mark alluded to, I'm the newest member of the DRA leadership team having joined in February of this year, and I am the Deputy for the Division of Risk Analysis.

And I'll take a minute here as well just to share a little bit about my background. I came into the Agency with a degree in electrical engineering, and over my 20-year career here at the NRC, I've had the opportunity to work on operating reactors, new reactors, advanced reactors, and as well

on our materials programs serving in a variety of different roles.

And I also spent three years in the EDO's office as an executive technical assistant servicing a number of offices, but more notably, the Office of Nuclear Regulatory Research, so I was able to see firsthand the critical role that we play in supporting the Agency's mission. So, next slide?

So, just like you saw with the Division of Systems Analysis and the Division of Engineering, you know, we too play an important role in supporting the Agency's mission.

We do so through establishing and executing timely research programs that support our partners in the reactors and materials business lines.

And I'm really proud of the work this division performs and I wanted to take a moment just to acknowledge some of our achievements depicted on this graphic since we last briefed you.

We completed a major effort to update all 68 of our Standard Plant Analysis Risk or SPAR models for all sites to allow for the use of diverse and flexible mitigation capability or flex equipment for licensing and oversight applications.

We issued over 30 technical reports or

guidance documents in the form of NUREGs, research information letters of RILs, white papers, and regulatory guides, and we also held over two dozen public meetings and workshops and seminars on technical topics.

Most notably, this spring we held the sixth annual Probabilistic Flood Hazard Assessment Workshop which had over 300 attendees, and then most recently this summer, we had the Subsurface Soil Surveys Public Workshop which had just under 200 attendees.

We also became the permanent home, as we just talked about here, for the Agency's innovation program, successfully transitioning the program into the division, putting in place the infrastructure and processes to maintain long-term program sustainability.

And I'll just add before we move off this slide, I wanted to revisit -- I know one of the primary focus areas of the ACRS during the last biennial and as highlighted during this year's kickoff in April, which was better understanding whether the office has sunset any research activities.

I'll say that so we interpreted that as to cover both work completed, or work that was

terminated, or work that was no longer -- I'm sorry, work that we terminated because there was no longer a need or work that we sunset because we felt that sufficient research had been completed.

I think, as I shared, you know, we've completed several research activities. I think one that I didn't even capture on the list is user need driven for NRR and this was the work on human factors for non-destructive examination.

A fair amount of reports were developed, and we're in the process of developing a summary NUREG and plan to close out that user need.

But I will say that in terms of looking at research activities where we would have been terminated or sunset, we haven't terminated or sunset anything, I think, in that time period.

But I wanted to highlight, you know, I believe the question is absolutely valid. As Ray mentioned previously in April, you know, we should strive to understand when enough research has been done to support our role as a regulator, or additionally, when our priorities have shifted such that a specific activity is no longer needed.

And I'll just say I'm confident that between the monthly counterpart meetings we have with

our partners, leveraging our work request processes to align on specific work, our quarterly work request status meetings with division management, our annual program review meetings with our partners, our annual review of prioritization for the budget cycle, and certainly our engagement with you, that we have a sufficient framework in place to align on needed research or when, in fact, there needs to be a course correction.

And I'll just highlight I think a good example of this is our recent course correction on the research that we've been doing on high energy arc vaults, and I don't want to steal Mark Salley's thunder as he plans to cover this a great deal during his presentation. So, next slide?

Let me just turn to how we are organizing the division. Our division is responsible for the establishment and execution of research programs relating to probabilistic risk assessments, human factors, and human reliability analysis, performance and reliability analysis, and movement of radionuclides through environmental systems, operating experience, and generic issues and fire safety.

Our mission is to provide, as stated here on the slide, is to provide world class technical

support for the implementation of risk-informed regulatory activities and decision making in nuclear safety and security.

We are comprised of four branches being led by a technically strong group of branch chiefs that in most cases have been in their respective positions for a number of years.

The first branch you'll be hearing from will be our Performance and Reliability Branch or PRB. Mehdi Reisi-Fard, who you heard from this morning, is the branch chief, and he is the newest branch chief in the group joining in 2020, but he brings a wealth of experience having joined the NRC in 2007 as a risk and reliability analyst, and serving in this capacity in both research and NRR before assuming his current role.

His team is responsible for managing the operating experience data collection analysis program which serves as the foundation for keeping our risk tools current, and is in charge of the Accident Sequence Precursor Program.

PRB is also the lead for developing and maintaining risk-informed decision making guidance documents, as well as development and endorsement of PRA standards.

Next, you're going to hear from our Probabilistic Risk Assessment Branch, PRAB. John Nakoski is the branch chief and he has been the branch chief in the division for the last eight years, and serving in this current role for the last four years.

John is currently on rotation, so Holly Cruz, who is acting branch chief, will be presenting on his behalf. She is no stranger to research as she's a technical assistant for the Division of Engineering and has been doing a great job backfilling for John.

PRAB is primarily responsible for maintaining and enhancing computer codes and methods used by the Agency for conducting risk analysis, so, for example, our SPAR models or SAPHIRE code.

And then next, we'll hear from the Fire and External Hazards Analysis Branch. Mark Salley is the branch chief there and he's served in this role for the last 17 years. His branch is responsible for fire risk, external hazards, and environmental hazards research.

And then we'll wrap up with a presentation from Sean Peters who also is no stranger to the ACRS. He is the branch chief for the Human Factors and Reliability Branch and has served in this role for the

last 13 years.

His branch is responsible for the planning, developing, and managing research programs related to human performance and human reliability analysis, and as previously mentioned, he's also responsible for managing the Agency's innovation program. Next slide?

So, I'll just spend a few minutes here providing a high-level overview. I know you've seen this similar view graph before for some of the other presentations, but a high-level overview of our program's resources.

At a glance, our overall budget for the Risk Analysis Research Program in fiscal year 2022 is about $16.5 million, which equates to about 36 expert staff overseeing nearly $10 million.

While this represents a six percent increase from our fiscal year 2021 budget, the majority of that increase was driven out of the decision to have DRA serve as the new home for the Agency's innovation program.

So, our program resource levels have remained largely flat over the last few years and will likely continue to remain so into the future. Having said that, we would expect there to be variability in

the resource levels across the business lines to align with Agency priorities.

For example, we know that advanced reactors is a high priority for the Agency, and we are working on a few work requests, user needs that could support increases in our advanced reactor budget over the next five years.

Conversely, we would see, with the wrapping up of HEAF activities, such that resource needs for fire research could significantly decrease in the out years.

And just to help make this slide and budget discussion more meaningful, we use the same categories that we typically use when we develop our budget input to the program offices.

But for additional context and similar to what you saw or heard from the Division of Engineering, about 84 percent of our work is in the operating reactors business line, seven percent is associated with new reactors, five percent with advanced reactors, and four percent for the materials business lines.

And now I'll just kind of roll through very quickly the line items on the slide. So, starting with the first line item, about 20 percent of

our budget is planned to support the development and enhancement of risk analysis tools. Most of that goes towards maintaining our SPAR models and the SAPHIRE code used to run those models.

About 19 percent of our budget goes towards operational events analysis programs. This includes implementation of the accident sequence precursor program, as well as assessing operating experience, maintaining operating experience data systems, and leveraging insights from this data to enhance our risk tools.

Our guidance and development budget sits at about 15 percent of our overall budget and includes support for risk-informed decision making activities, development of PRA standards, updates to PRA guidance, and technical support for human factors guidance.

About 14 percent of our budget supports work on human reliability analysis methods and data collection, and this also includes our involvement in the Halden human technology organization project.

Our fire research program makes up about 11 percent of our resources in FY 22, and includes work on improving fire PRA realism and our efforts to complete research on high energy arc vaults.

Our external hazards budget makes up eight

percent of our budget, and includes work on our probabilistic flood hazards analysis, and that's basically the primary driver.

We have another eight percent that is a mix of smaller projects or areas where we provide some nominal level of support. That includes support for the materials business lines, our work on the Level 3 PRA, and future focus research items which you'll hear about in the branch presentations, and our ownership of the Agency innovation program.

For NMSS, we support, you know, both the spent fuel storage, and transportation, and decommissioning of low-level waste business lines, and this is an area that we are also looking to expand our support.

An example I can give is related to the spent fuel storage and transportation business line, and that is they have expressed interest in leveraging DRA to develop a risk took to help scope future reviews of transportation packages.

And lastly, about five percent of our budget is focused on research to support the Agency's readiness to review advanced reactor applications. As I mentioned earlier, this is certainly an area that we expect to increase over the next several years, and a

lot of the focus up to now has been on our code work, but as you're aware, there's a fair amount of attention shifting towards guidance needed in the human factors area and in PRA acceptability.

And with that, that wraps up the budget discussion, so I'll open it up for questions. Otherwise, we'll turn it over to the branch presentations, starting off with Mehdi Reisi-Fard to kick us off.

CHAIR DIMITRIJEVIC: I have a general question because obviously there is a lot of cross, you know, cross interaction within this area, and when you said they're developing advanced standard, the reg guide for advanced reactors belongs to guidance developed.

I noticed when I compared your 2018 presentation and distribution, the guidance have increased significantly by advanced reactor bodily change in two years, which is strange for me, but now I understand there is a lot of cross things because you are developing guidance for advanced reactors, but that's classified under guidance development. Am I right there?

MR. ARAGUAS: That's correct.

CHAIR DIMITRIJEVIC: So, therefore, we

cannot really -- when you are in charge of innovation as you say, innovations can be anywhere in any area, even probably most of innovations will be, you know, connected to advanced reactor business, right?

MR. ARAGUAS: So, yeah, I would look at innovations as really sort of us serving as the support for the Agency and trying to embrace being more risk informed through the various tools, whether that's guidance for advanced reactors, whether that's updating our SPAR models to support NRR, or even, as I mentioned, in the materials business line.

I think for the spent fuel storage and transportation business line that doesn't lend itself to traditional PRA, you know, how can we support them to be more risk informed, more focused for their licensing reviews?

And so, that's where I see, you know, as Mark alluded to in his response, us supporting the Agency's goals of being more risk informed, so I think it spans the full gamut of the items on this list.

CHAIR DIMITRIJEVIC: Well, another thing I noticed, I mean, after our discussion this morning, that since the PRA requirements for the non-light water advanced reactors will require a lot of PRA, you know, this bullet with the Level 3 PRA also applies to

advanced reactors. So, basically, there is a lot of, even I will say this is just such a --

I mean, five percent on advanced reactors now, it doesn't sound at all, I mean, you know, should meet the Agency needs, but actually since you have this cross interference, you can define all of the efforts which are applicable for advanced reactors.

MR. ARAGUAS: That's correct. Okay, I will turn it over to Mehdi.

MR. REISI-FARD: Good afternoon. My name is Mehdi Reisi-Fard. I'm the Branch Chief for the Performance and Reliability Branch in the Office of Nuclear Regulatory Research.

I joined the Agency in 2007 and I've worked in research and NRR as a reliability and risk analyst, and later as a team leader before starting as the branch chief in PRB in May of 2020. Can we go to the next slide, please? I'm on slide number nine.

PRB supports, my branch, PRB, supports the mission of the division and the Agency's risk-informed activities by planning and managing research programs to systematically collect operating experience and assess reliability information, perform event assessments, and support development of guidance for risk-informed decision making.

As shown here, PRB activities cover three major areas. The first area is coordinating activities to develop and maintain guidance related to risk-informed decision making and PRAs.

Under this area, we develop approaches to determine the acceptability of PRAs used to support regulatory applications, and we also address the development of guidance for licensing and oversight using risk information.

Under this area, we support developing processes, develop process tools to risk inform dry cask storage licensing and oversight of regulatory activities.

Another example of activities under this functional area is the future-focused research on using the Licensing Modernization Project known as LMP for operating reactors, and I'll get into a more detailed discussion about all of these in future slides.

The second functional areas is the Accident Sequence Precursor or ASP program. The ASP program involves the systematic review and evaluation of operating events that have occurred at U.S. plants.

The ASP program identifies and categorizes events which have the potential to lead to core damage

under a set of hypothetical circumstances. This evaluation is performed with the goal of gaining operational experience insights.

The third area is collection, review, and evaluation of OpE information under Management Directive 8.7. Through our processes under this functional area, we generate reliability data that are used by NRC and industry in risk models and risk-informed decision making.

I will provide more details on ongoing projects, accomplishments, and future direction for each functional area in the next slides. Can you please move to the next slide? I'm on slide number ten now.

This slide provides a list of ongoing projects. In the area of risk-informed decision making and PRA guidance, we have the major task of endorsing the non-light water reactor standard that was published early in 2021, as well as the industry peer review guidance in NEI 20-09.

Endorsement of this standard, as you heard this morning, was a significant effort as the PRA standard covers most hazards and radiological sources, and the endorsement may affect potential endorsement of future standards such as low power shutdown, level

two, level three, and other standards.

The staff values guide is developed under a very aggressive schedule to support the regulatory needs. Staff determined that issuing a trial use is most appropriate, similar to the first endorsement of level one standard. That gives us the ability to review the trial implementation and make necessary adjustments in the final guide.

With respect to light water reactor standards, we support issuance of a number of PRA standards. Level one is expected to be published by the end of the calendar year.

Other standards such as level two and advanced light water reactor will follow the publication of level one, and the staff is participating in various working groups for developing and finalizing those standards.

Besides these items, we have several other activities that are driven by a work request that we expect to be formalized very soon. Some examples include two databases that we plan on developing, one for PRA standards and one for PRA methods. We anticipate working on enhancing guidance on treatment of uncertainties and developing guidance or reg guides on PRA acceptability.

One area to highlight in the area of risk-informed decision making guidance is development of risk tools for spent fuel dry storage. This work is nearly complete.

A report was published last year. Research will provide additional support to NMSS during the implementation phase, and we support making any additional changes as needed to the guidance.

The last item --

CHAIR DIMITRIJEVIC: I just want to say that I think this was my favorite slide when I went through this because, you know, it was a typo which says treatment of certainty, because we always talk about treatment about uncertainty, but here we get to develop treatment of certainty and I thought that was a pretty nice typo.

How do we treat certainty actually, you know, what we know versus what we don't know? I don't know did you notice this typo, but it was sort of interesting.

MR. REISI-FARD: Yes, definitely thought-provoking and it was not intentional. It's a typo, but interesting concept though.

MEMBER REMPE: So, this is Joy, and since we've already broken your flow, you said a database to

support the guidance and standards. What's going to be contained in that database?

MR. REISI-FARD: I get to that a little bit more later on --

MEMBER REMPE: Oh, okay.

MR. REISI-FARD: -- but at a high level, it's going to be repository of all standards, published standards, as well as some trial use standards and relative standards, and it's going to create a workflow process so that the staff can see the interconnections between different requirements in the standards.

And the staff will be able to use the database to document their positions and endorsements, and that documentation, that workflow process will end result in having kind of the database basically publish the endorsement of the staff, basically a workflow process from entering all of the requirements in the standard to staff developing their position on different requirements.

MEMBER REMPE: Thank you.

MR. REISI-FARD: Sure, the last item in the area of risk-informed decision making is the future focused research that utilizes the NRC's Level 3 PRA model and the LMP methodology to gain risk

insights on operating reactor technology.

Phase one of the FFR used selected initiating events, SSCs, from the existing Level 3 PRA results for internal events. Phase two will expand the scope of the project to include the results from the expanded Level 3 PRA model that includes external events and credit for flex.

Phase one is complete. We completed several other things and the final report. Phase two was started early in the summer and we expect to complete it by early 2023.

For the ASP program, in addition to our normal activities regarding screening and analyzing events, we are collaborating with NRR, especially after the Duane Arnold derecho event, to explore how we can better use ASP insights in regulatory activities.

In the area of operating experience, last year, the PWR Owners Group raised a number of technical issues in one of the reports primarily related to the analysis and derivation of basic event parameters used in the NRC and industry risk models.

In the last year or so, the staff evaluated those issues, developed and published a response to the PWR Owners Group. In that process,

the NRC response identified a number of enhancements to the NRC data and analytics activities.

We continue to issue our periodic reports on initiating event rates, LOOP, system studies, and component reliability.

The last item on this slide is the development of AI machine learning and data analytics tools to analyze OpE and risk information. This is a somewhat limited scope activity and is mostly focused on activities under the newly established MOU with DOE at this time, and I will discuss that in the next slides in more detail. Can you go please to the next slide? I'm on slide number 11.

In the next few slides, I highlight some recent accomplishments and future direction for each functional area. Starting from RIDM and PRA guidance, staff published Reg Guide 1.200 and the revision to Reg Guide 1.200 in December of last year.

Their revision endorses the PRA review process and criteria for reviewing the newly developed methods, as well as it endorses the seismic code case.

In addition to Reg Guide 1.200, we revised three other reg guides which include Reg Guide 1.177 for risk-informed decision making for tech specs, Reg Guide 1.178 for in-service inspection of piping, and

Reg Guide 1.175 for in-service testing. Revisions for these guides provide updated guidance for consideration of defense-in-depth among other changes.

We supported issuance of the non-light water reactor PRA standards. As I said, it was published earlier in 2021. The last accomplishment that I'd like to highlight in this area is completing the framework for the database for PRA standards.

The database includes, as mentioned earlier, a repository of published, and in some cases, trial use, and balloted PRA standards. It provides tools for staff in their review of standards to identify connections among numerous requirements in the standard, and provides the workflow to develop and publish the endorsement.

Right now, a framework is complete. We have some more work to do to complete it, to populate the database and, you know, have all of the functions in place before we can fully utilize it.

MEMBER HALNON: Mehdi, this is Greg Halnon. Is that going to be available to the industry or public, or portions of it to help them navigate the same?

MR. REISI-FARD: Some aspects of it, yes. So as you all know, the standard itself is copyrighted

material, so we can't make the entire database publicly available, as we planned on making the staff endorsements publicly available. And it's going to be through the database, and it's going to have, you know, the flexibilities that a database would provide, such as search functions, sorting, and publishing functions that typical databases provide. So the short answer is yes --

MEMBER HALNON: Okay. Thanks.

MR. REISI-FARD: So for future direction, all the items under the future direction are from the work request that we expect to be formalized soon. We are closing the existing user need in this area. It's NRR-NRO 2011-009, which we are planning on closing.

The new user need will have an expanded scope. The expanded scope addresses the necessary activities to support the integrated framework for risk-informed decision-making, such as issues related to work on PRA acceptability for non-light water reactors, enhancements to the risk-informed decision-making framework for light water, as well as advanced reactors. The user need also addresses the increased use and development of PRA consensus standards, as a number of new standards are expected to be published. And, finally, it addresses the need to enhance and

somewhat modernize the tools to enable us to maintain review and endorse the newly-published industry documents consistently and efficiently.

Can you go to the next slide, please? I'm on slide number 12.

I start talking about the area of data collection and analysis. We're talking about some of the accomplishments in this area. We responded to a work request to identify gaps in implementing the causal alpha factors in modeling CCF and to determine whether the existing alpha factors accurately reflect current industry performance. A report on this task was that included our technical analysis was published in early 2021.

We have issued on-site electrical system reliability study. That study represents a comprehensive evaluation of the performance of key electrical components. We supported audits and interactions with PWR Owners Group on FLEX reliability data, and we issued a number of components reliability reports, system studies, and reports on LOOP evaluations and initiating events rates.

On the future direction, I have already covered some of these items. A couple of items to highlight. The first is that we are renewing our

contract with INPO. This will be another five-year contract to gain access, to be able to gain access to input data. The other item is on efforts to explore the use of advanced computational tools to analyze OpE.

In June, we formalized an MOU with DOE to collaborate in the areas of operating experience and applications of data analytics. The MOU supports us, you know, both the NRC and DOE, in the development of tools and techniques to analyze OpE data and by sharing data; technical information; lessons learned; tools; and, in some cases, the cost related to the development of approaches and tools.

We have had period information exchange meetings with DOE for several months now with broad participation from all interested organizations in the agency.

On a related note, we plan on issuing a report on potential uses and applications of advanced computational tools and techniques for nuclear power plants. This report included an analysis of responses to an FRN that was issued earlier in the year. We issued and Mark Thaggard talked about it earlier in his presentation, the issue of an FRN requesting public comments on the emerging role of AI immersion

learning in the U.S. commercial industry, nuclear industry. Comments were requested in response to a series of questions focusing on the potential application and perceived efficiencies from adoption of these new tools. As I said, the report that we plan on finalizing in the next month or so will have an evaluation of the responses received from the industry.

Can you go to the next slide, please?

Last area is the ASP program. Some accomplishments include revising the office instruction for the ASP program. The revision includes some new information on including the risk of all hazards for which the SPAR models are available, treatment of missing hazards as a source of uncertainty, and more explicit consideration of uncertainties in general. The revision also includes guidelines to include the timeliness of the analysis.

We developed and released the ASP dashboard. This dashboard is an attractive source of precursor information that provides various filters and slicing tools. All final precursor reports are hyperlinked within this tool. This is the first Microsoft Power BI dashboard that is available on the NRC's public page.

For future direction, we participate in efforts to identify methods for improving the application of ASP information in the ROP. The Duane Arnold derecho event, as I mentioned earlier, it has some important risk insights, and we are trying to find a way to better incorporate lessons learned from the ASP program in the oversight activities.

Again, under the MOU with DOE, we are exploring the use of AI immersion learning and data analytics to identify risk insights and trends from past ASP analysis. In the long run, we are exploring whether we need to modify the ASP program framework or risk criteria to make them more suitable for risk evaluation of operational events for a broader set of reactor designs, including advanced reactors. And we continue providing our knowledge management sessions to staff at the headquarters, as well as regional offices.

Next slide, please. This is my last slide, and this is just a snapshot of the dashboard that I mentioned earlier. Without getting into any detail, I just wanted to show how we can communicate and categorize various information using this dashboard related to hundreds of ASP analyses that were done in the past 30 - 40 years.

MEMBER REMPE: So before you leave us, I have another question about this database. From the guides and standards, was that motivated by a user need or self, I don't know, initiated? What caused you guys to decide to do this?

MR. REISI-FARD: It is part of the user need that we are formalizing now, but when we started working on the PRA acceptability for non-light water reactor, we kind of, you know, it kind of became obvious that we had to look at a number of other standards in order to develop our positions for the non-light water reactor. And, you know, currently, we have the 2009 version of Level 1 LERF standard. We have a number of balloted standards for Level 1 LERF in the past few years or so.

So we were dealing with a number of standards, and it became clear that we need to better understand the connections between different requirements and different standards, and it was born out of that. And, you know, once we tried to put it together, we saw this is kind of something that can help us in the long term as more standards will be published. In fact, not speaking for JCNRM but, you know, kind of having heard some of their discussions, I think at the industry level they are also moving to

develop, I don't want to call it similar but a database, as well, for their own, so that they can track different standards that they're developing.

MEMBER REMPE: Sounds like a good idea. I'm a little puzzled when you said you're starting to do this before the user need is written, but I don't quite understand how that works, but maybe it would be better, it might be something you might want to clarify.

And then, last, it seems like there might be a way you guys could coordinate somehow or other with this effort or perhaps not. Maybe you want to have an independent NRC database. Any thoughts on that?

MR. REISI-FARD: We did think about that. There are advantages to have some level of independence. We are maintaining and updating this database for, you know, for specific regulatory reasons and uses. The industry database may serve different purposes. So I think we thought that it's better to have some level of independence.

And, you know, when I mentioned the -- just one clarification on the database. When we started working on this, it wasn't really -- again, it started as an idea to compare different standards. In

fact, at the beginning, we used to call that, even now in some cases we call that the comparison database, basically comparing different standards. And we needed to do that to support the non-light water reactor PRA acceptability project.

Later on, when we started on engaging with NRR to formalize this new user need that I mentioned in my presentation, we kind of worked with them more in this area and developed a kind of more specific framework to develop that database.

MEMBER REMPE: Thank you. That helps.

MR. REISI-FARD: Sure. So with that, I turn it over to Holly Cruz, the acting Branch Chief for Probabilistic Risk Assessment Branch.

MS. CRUZ: Thanks, Mehdi. For those following along separately, I'm on slide 15.

As Medhi mentioned, I'm Holly Cruz. I'm acting for John Nakoski as the Branch Chief of the Probabilistic Risk Assessment Branch, PRAB. My background is in mechanical engineering, and I've been with the agency for 15 years, primarily in NRR. As Christian mentioned, I've been in research for the last year and a half as the technical assistant for the Division of Engineering.

Next slide. This is slide 16. PRAB

plans, develops, integrates, and manages research and development programs relating to probabilistic risk assessment models and methods and supports agency efforts to use risk information in all aspects of regulatory decision-making. PRAB activities fall under two functional areas: risk-informed decision-making activities where we support the agency by developing probabilistic risk assessment guidance and methods for new and emerging areas and the development of risk models and tools, including software, to support agency-wide risk-informed regulatory programs.

Next slide. This is slide 17. The work captured under risk-informed decision-making activities includes the full-scope comprehensive Level 3 Probabilistic Risk Assessment, which we'll talk about more on a follow-on slide; external hazards and FLEX modeling, recovery and restoring functions credit, international standards participation where we have John Nakoski as a member of the committee on the Safety of Nuclear Installations Working Group on External Events. Additionally, PRAB staff are involved with the International Common-Cause Failure Data Exchange Project led by the Organization for Economic Cooperation and Development through the Nuclear Energy Agency. We also plan to have a

Japanese foreign assignee join us in early calendar year 2022.

Continuing on, this work includes PRA research on accident-tolerant fuel, dynamic PRA as a part of future focused research -- we have an independent slide on that, as well -- and advanced reactor and regulatory guide support.

The work captured under the development of risk models and tools includes: SPAR model updates with current plant information; all-hazards SPAR modeling including seismic, high winds, and internal flooding. One or two models include fire, as well. The SPAR-DASH risk data dashboard, IDHEAS-ECA application, SAPHIRE software updates and enhancements, and cloud-based SAPHIRE. We'll talk about these risk models and tools more on the next slide.

This is slide 18. A large part of the work PRAB does supports the SAPHIRE code and SPAR models. These risk tools have been developed for event assessment, reactor oversight, and reactor licensing, and to maintain staff PRA skills and knowledge management. Under accomplishments, the staff have incorporated FLEX modeling into 68 SPAR models and completed 12 significant model updates

since the last ACRS manual. We complete approximately six updates per year. Idaho National Laboratory completed six models in 2020, and they're in the process of completing the last two models for 2021.

We developed a pilot version of the SPAR-DASH data visualization dashboard using Microsoft Power BI. The SPAR-DASH project is aimed at providing a user-friendly format of risk-informed information regarding the operating fleet of nuclear reactors. This project supports the use of risk-important data and regulatory decisions associated with the Be RiskSMART framework and has three stages: data extraction, cleaning, and visualization.

Looking forward for SAPHIRE and SPAR improvements, we plan to expand and enhance the SPAR model scope and implement a cloud-based SAPHIRE code. We talked a little about SPAR-DASH. We've developed a communications plan that includes sharing the pilot with partner offices to obtain feedback and developing staff guidance and workshops. We also have some SPAR model reassessments under development, such as the human failure event reassessment using IDHEAS-ECA, a software tool capable of modeling both internal events and the use of FLEX equipment.

Next slide, please. Could you advance to

the next slide, please?

MR. THOMPSON: Past Level 3 --

MS. CRUZ: Pardon me?

MR. THOMPSON: I think it showed the Level 3 PRA.

MS. CRUZ: Okay. Sorry. It's not showing on my screen. Is that still showing SAPHIRE and SPAR? But I'll go ahead.

So I'm on slide 19. The next project I'd like to talk about is the Level 3 Probabilistic Risk Assessment. In a staff requirements memorandum from 2011, the Commission directed the staff to develop a full-scope site Level -- sorry -- site Level 3 PRA to support risk-informed decision-making, reflect State-of-the-Art Reactor Consequence Analysis, SOARCA, insights in the proper risk context, and further enhance staff PRA skills.

In March 2012, the staff provided the Commission with the initial Level 3 PRA project plan, and, in September 2012, the staff provided the Commission with its plans to apply the Level 3 PRA project results to the NRC's regulatory framework. Since that time, the staff has provided annual project briefings to commissioners' assistants.

The staff have completed substantial work

on the Level 3 PRA projects, including incorporation of the SOARCA technical and project management insights. To provide some context, the staff completed 19 base case models, which translates to 90-percent completed for phase 1. Phase 1 covers the development of the initial model and internal report. Phase 2 covers development of the final model and internal report, incorporating review comments from the Level 3 PRA Project Technical Advisory Group, feedback from the ACRS, and any other reviews. The technical advisory group consists of NRC technical advisors in PRA and related fields, as well as two senior PRA experts from industry, one from Westinghouse and one from EPRI.

The staff have also completed three 2020 FLEX models which translates to 18 percent completed for phase 1 and completed five public reports which translates to 23 percent of the draft reports under review. We plan to complete the technical work in early 2023 and to submit a final NUREG summary volume publications by mid-2024.

As we move forward towards these milestones, we plan to release project reports to the public in batches. Research will work with the program offices, the Office of Public Affairs, and a

voluntary licensee on releasing the reports. In addition, we plan to present the public reports to the ACRS for review and comment.

We previously briefed the ACRS Reliability and PRA Subcommittee on many of the phase 1 models and results. Due to the pre-decisional status of the information, most of these subcommittee briefings were conducted in closed sessions. We plan to brief the ACRS on the phase 2 models and results in open sessions and will work with the ACRS staff to schedule the briefings likely in calendar year 2022.

The staff envisions this model will be used as a tool to gain risk perspectives on some of the NRC's current or emergent activities, such as accident-tolerant fuel or the licensing modernization project.

Next slide.

MEMBER PETTI: I have a question.

MS. CRUZ: Oh, okay.

MEMBER PETTI: This is Dave. In terms of the number of plants that are going to be looked at at Level 3 PRA, are they bound or, you know, we've got a couple of the old BWIs and a couple of the newest ones and PWRs from the different vendors. How was the subset picked?

MEMBER PETTI: So I believe we have Alan Kuritzky, who is our lead for the Level 3 PRA project on the line, and I will defer to Alan on that question if that's okay.

MEMBER PETTI: Okay.

MR. KURITZKY: This is Alan Kuritzky with the Division of Risk Analysis in the Office of Research and the lead to the Level 3 project. So we're actually looking at a single plant. It's a Westinghouse four-loop plant, large dry containment. We always intend only to look at a single site, a single plant, just due to the vast scope of the project. And the determination of what plant to use, we had actually come up with some criteria at the beginning of the project, at the outset, and actually held some public meetings to go over and describe what we were looking for and to get feedback from industry and their support. The Commission actually told us to in the SRM to work with industry to come up with a volunteer licensee, and there were actually several volunteers that we were going to choose from. But, unfortunately, because it was timed right around the Fukushima accident and, once all the post-Fukushima PRA responsibilities were starting to fall down on the industry, they quickly backed off supporting the Level

3 project, so we ended up with a single volunteer, fortunately, that was able to support a very significant effort in supporting us and we're very appreciative of that. So there's only one plant, again, a four-loop Westinghouse, unlike the --

MEMBER PETTI: Okay. That answers --

MR. KURITZKY: -- where, of course, we looked at all different types.

MEMBER PETTI: Right, right. Thanks.

MS. CRUZ: Thanks, Alan. So I think we're ready for the last slide, which is slide number 20.

The last project I'd like to cover for PRAB is dynamic PRA. Dynamic PRA refers to PRA approaches that simulate system behavior and accident scenario development over time. As a supplement to commonly used event tree or fault tree methods, the use of dynamic PRA has the potential to provide additional useful risk insights for operating plant designs and operations.

PRA-based applications can also be anticipated for future advanced reactor designs. Dynamic PRA also plays a major role in university PRA and research and development programs, and the Department of Energy is supporting significant national laboratory work, including large-scale tool

development at Idaho National Laboratory.

The objective of this future-focused research is to prepare NRC staff on the efficient use of dynamic PRA tools for anticipated submittals developed using dynamic PRA methods. This study will primarily focus on staff development for the efficient use of dynamic PRA tools and methods and consists of three main tasks. The staff will initially complete a literature review to leverage ongoing dynamic PRA activities identifying methods, approaches, and available dynamic PRA tools. The staff will also participate in training exercises to develop capabilities for using the existing dynamic PRA tools, and the staff will develop hands-on experience by using dynamic PRA tools to develop a simple dynamic PRA model.

The results of the study consists of three main deliverables noted under accomplishments and future direction. First is an interim report documenting literature review and dynamic PRA activities. We have a draft in progress expected to be complete by the end of October. Next are training sessions on the use of dynamic PRA tools. Three of them completed to date, including an introduction to dynamic PRA virtual workshop in November 2020,

training on the Event Modeling Risk Assessment using Linked Diagrams, EMERALD, software tool in January 2021, and the Reactor Analysis and Virtual Control Environment, RAVEN, tool training in May 2021. The final report documenting dynamic PRA model results is expected in July 2022.

We hope to leverage this work to maintain awareness of a still-developing cutting-edge PRA technology and monitor industry interest to ensure readiness for future licensing activities.

That's all I have for PRAB.

MEMBER BROWN: Can I ask a question?

MS. CRUZ: Sure.

MEMBER BROWN: I was a non-PRA person, so bear with me. What's the difference between a dynamic PRA and the standard PRA I've been listening to for the last 13 years?

MS. CRUZ: So, again, I'm going to phone a friend, and I think we have Michelle Gonzalez on the line who is the lead for this effort. So if she's on the line, I'm hoping she can address that question.

MS. GONZALEZ: I'm here, Holly. So in very short words, basically, for dynamic PRA, we use simulation tools. We have incorporation of the programs to obtain the results or what we want to look

at instead of just using the regular event tree, fault tree approach.

MEMBER BROWN: Excuse me. So you're using transient analyses type approaches? When you say simulation, that's what that means to me.

MS. GONZALEZ: Well, no. We can incorporate, it's an incorporation of different tools actually. We can use tools for thermal hydraulics and see how the things react over time.

MEMBER BROWN: That's a transient then, right? I mean, you're talking about time transients for certain events or certain types of parameters that you monitor in the PRA and see how the transient performance affects your various parameters that you're looking for in determining whether everything is okay or not? I'm just trying to understand what the difference is; that's all.

MS. GONZALEZ: Yes. John has his hand raised. John, if you want to add something to this.

MR. NAKOSKI: Yes. This is John Nakoski. I'm the Branch Chief. Holly is acting for me. I'm listening in. The simple way I think about this is a dynamic PRA, and it was mentioned, uses, like you said, a transient analysis, thermal hydraulic codes, to see what the effect of an action is over time.

Simply thinking, I think, of our current models as more static. There are some time dependencies in there, of course, but they're more a static snapshot, a moment in time on what the risk is based on that. And I think that's the biggest difference, simply speaking, in my mind.

MEMBER BROWN: Okay. I look at the event tree approach and how you come up with your final answers as being, like you say, a static specific type of an analysis. So you're just trying to make other time-based tools in order to make some of these assessments, as well.

MR. NAKOSKI: That's correct. And, you know, you're looking for one of the things that we have in our mind is looking at recovery actions: are there some things, you know, time dependencies in there that perhaps we could leverage some of the dynamic tools that are, dynamic PRA tools that are out there to give us insights on the timing of recovery actions so that is there a credit that we can give and what impact would that have on the final risk assessment. That's kind of looking over the horizon a little bit. That's not something we're going to be doing tomorrow, but, you know, looking three, five years down the road, what can we do.

MEMBER BROWN: Okay. It's an interesting thought. I hadn't thought about it in that way before, so thanks.

MR. NAKOSKI: Yes.

MS. CRUZ: Thank you, John and Michelle. So I'd like to now --

CHAIR DIMITRIJEVIC: I have one short question on Level 3, and then I think this is a good time for us to take a break. We are right in the middle of the presentation.

So I have a question on Level 3. Would Level 3 include the risk integration for the multiple plants on the site? I think somebody mentioned that today, and I was wondering, I was wondering, since you only have one unit as an example, would risk integration be part of some of Level 3 consideration?

MR. THAGGARD: So I can answer that, if you want, Holly. The answer is yes. The site that we're using actually has more than one unit, and it's not only the multiple units but we're also looking at spent fuel pool and dry cask storage. So the integration, so integration is a big piece of that.

CHAIR DIMITRIJEVIC: Excellent, excellent. Thank you. So I propose, now is like around 3:30, I propose that we make 15-minute break and then we get

back at 3:45 and then continue with our, I think the fire and external hazards is next, right?

MS. CRUZ: Yes.

CHAIR DIMITRIJEVIC: Okay. Excellent. So we will reconvene at 3:45. Thank you.

(Whereupon, the above-entitled matter went off the record at 3:31 p.m. and resumed at 3:45 p.m.)

CHAIR DIMITRIJEVIC: We can resume the meeting. I guess that Mark Henry Salley will be our next presenter on the Fire and External Hazard Analysis Branch. So, Mark, please take it over.

MR. SALLEY: Thank you very much. I'm Mark Henry Salley. I'm the Branch Chief for Fire and External Hazards Analysis.

Background on me, I started the fire research team actually back in 2004. It grew into a branch.

Back around the 2016 time frame we combined the fire research with the environmental transport branch. And that's the fire hazards and external, excuse me, the fire and external hazards analysis branch as we know it today.

Prior to that I was eight years in NRR in plant systems branch. And ten years before that I was the corporate fire protection engineer for TVA

Nuclear.

Go to the next slide please. A little bit about FXHAB. We have three distinct areas, three diverse areas, that we have that make up this branch. The first one if the fire research branch. Or excuse me, the old fire research branch.

The fire research area looks at two areas. There's two tracks basically. As you're well aware, half the industry stayed with the 10 CFR 50 Appendix R licensing basis. The prescriptive licensing basis.

The other half evolved to the 10 CFR 5048 C, which is the risk informed performance basis, licensing basis commonly called NFPA 805. And that's the work that's done in this area to support those two different tracks.

A second functionally area is the external hazards. Of course the big one that we talk a lot about there is the probabilistic flood hazards assessment. It worked PFHA.

We're also looking at other things that we don't want to miss. For example, high winds, we're going to talk a little bit about, we well as some other weather affects that we should deal with.

The one thing we do not do in external hazards is seismic. So the earthquake and the

seismic, that belongs to DE, the civil engineering folks.

The third area, it's kind of a new area but it's not really new. And I've got it here as environmental hazards. I really should have titled this as environmental impacts. And it's some work we do, typically with our partners in NMSS.

Next slide please. We'll just touch on the major projects and then we'll take a little deeper dive into each of them.

If we look at fire PRA, the term you'll hear today that's thrown a lot is fire PRA realism. But if we go back to 2004 there was a report, it was the first time we worked together really closely with the Electric Power and Research Institute, EPRI.

And we jointly published a report commonly referred to as NUREG-CR-6850. It's actually that or EPRI-109-1989. Like I said, it was the first time we ever jointly published.

And this is basically the method of how do you do a fire PRA. This report was important for a couple of reasons.

It affects some of the how we do risk informing with fire for STP, but it also formed the basis for the plants that wanted to go forward with

NFPA 805. As this gave them methods on how to do the fire PRA.

We can't forget post-fire safe shutdown. That, of course, goes back to March 22nd, 1975, the Browns Ferry fire in Appendix R. And there still was an amount of work that we've done in there. And occasionally things come up that we still support that.

An area that's probably the biggest thing we're working on today in fire research is high energy arcing fault, or HEAFs. You can think of those as a, first steps would be an arc flash, which is something that's fairly commonly, but when the fault stays locked in it develops into a HEAF.

And I'll just point out that this is kind of a newer area. This was not in our lexicon until really the 2004 time frame. The first place that you'll really see this mentioned is in NUREG-CR-6850.

This is kind of a newer phenomena. Based on a lot of what we've seen in operating experience has lead us to this. And also, be aware that it's not unique to nuclear power plants.

Anywhere there is a lot of electricity, specifically medium voltage, HEAFs can occur. So that's the area.

And the final area that I want to touch on, that I think is important, is training. You can do a lot of really good research things but if you don't get it out in people hands in training them how to use the models and tools sometimes it's all for not.

Other major projects we got, the external hazards of course if the PFHA work. PFHA we're completing the first part of raising a seven year project getting Phase 1 completed where we're working into Phase 2. I'll talk about that in a little bit. There is three phases to that project.

High winds is a newer area that we're looking at. There has been some research done. We've supported part of it with other partners. We will discuss that with high winds.

And another area that we're starting to explore is weather extremes. This past year, anyone who's just watched the news saw that with the cold weather in Texas, as well the hot weather, some of the things that their nuclear plants have gone through. So weather extremes/intensity is something we want to take a look at.

The other area, like I said, is the environmental impact. I shouldn't have used hazards

there it should have been impact, I think is a better description.

But here we're looking at things like subsurface characterizations, radon and ET covers, as well as the MARSSIM's agreement, which we'll talk about in a little bit. So those are the ten thousand foot major projects that you'll see within this branch.

Next slide please. As I said, the thing you'll hear a lot in industry is improving fire PRA realism. That seems to be the goal. That's what we strive for.

If I take you back in time to, I think August 24th, 2018 we were in front of the ACRS, and if you remember it, we showed you a graph that EPRI had put together and presented in a RIC session, and we called it the skyscraper chart, if you remember it.

And it listed the first 16 or so plants that had come in for NFPA 805. And where they were finding their high fire risks.

And if you remember the first one, it was electrical enclosures, cabinet fires. The second was transients. And the third was high energy arcing faults.

Since that time we've been doing a lot or

work. Most of it, many times, in partnership with EPRI under an MOU. And we've reduced some of the conservatism, brought a little more realism to how we model things like electrical enclosure fires.

The picture off to your left there is an experiment we ran at NIST. And where we were modeling how group cable trays burn and the flames spread and the heat released produced from these cable tray fires.

So we've done a lot of work in that area. And we're brought a lot more realism to those types of fires.

Transient was another one. We just completed a big project. EPRI did half the testing at Jensen Hughes, we did the other half in NIST. We combined our data and we developed some methods on how better to model transient fires.

That's an area that we're going to continue to do a little more research on and come up with simpler methods for our inspectors to model transient fires and what risk they play when they find them in the plants.

The third area that we're going to talk about, of course, is the high energy arcing faults. That we'll have a separate slide on, and we'll get

into that in a little bit.

We've produced a number of work. The joint work with EPRI was NUREGs. Some scientific research we were also able to do with NIST.

For example, where the fire is located in a compartment actually makes a difference when you model it or when you see it in real life. So we've done some testing with NIST and published those as research information letters.

Next slide please.

CHAIR DIMITRIJEVIC: I have a question.

MR. SALLEY: Sure.

CHAIR DIMITRIJEVIC: I have a question of this slide because I think some of those failures are very, very, you know, very crucial areas for that area, I mean, the fires, as much as I remember when I was doing fire PRAs.

When it comes to the cabinet fires, there is another topic which is slightly different than which you define here. This is, you know, you can analyze inside fire and propagation as an (audio interference). But also you can analyze cabinet inside the area which is being heated up by fire.

Was any research done on what temperatures in the elemental temperature the cabinets are, should

be considered to start failing their functions and what type of failure modes are these associated with it.

MR. SALLEY: That's a very interesting question. And yes, cabinets tend to make up one of the major risk factors.

Simple things we looked at was, early on, was the cabinet opened or closed with the ventilation makes a very big difference. But your question, it deals with fragility.

And if there is another cabinet on fire or a ground based transient fire, whatever the source may be, it could be an oil fire, et cetera, when does it take the cabinet out. We are actually looking at that right now with the high energy arcing faults because one of the things we look at with the high energy arcing faults is we developed, which we call a ZOI, a zone of influence, we do the same with a thermal fire.

And the question becomes, what temperature do I get when I see the fragility of the cabinets of fail. Now, the big thing is cables. Cables tend to be the big target that we see in cable trays and conduits.

But that project right now is actually looking at that. And we're doing some modeling with

the HEAF at the source term, if you will, to see when we get that failure in cabinets and other targets. So that's --

CHAIR DIMITRIJEVIC: Okay. All the breakers and switches too, you know, in addition to the cables. So then you can start, you know, can consider spurious operations and things like that.

MR. SALLEY: Most definitely. Most definitely. And the cabinets by you a bit. I mean, we see with things like conduits, if a cable was at least an air drop versus one that's in a medium or a rigid conduit, of course the material adds some thermal heat sink for you and it actually buys you some time.

So we have an ongoing effort right now doing that as part of the HEAF program.

CHAIR DIMITRIJEVIC: Okay, thanks. Thank you.

MR. SALLEY: Sure. Sure. And again, to follow up on your point, one of the research projects we got going, that we'll deal with NIST, and again, it gets to the ventilation control with the fire obviously, heat, fuel and oxygen, but again, the ventilation can control about how much oxygen you're getting in for combustion.

And that's something that we saw early on. Just to touch on the conservatism that came up with the early cabinet fires. And the Europeans still do a lot of this, is that if you open the cabinet door and burn what's inside, obviously there is ample oxygen. So it becomes a fuel limited fire. And you tend to see the larger fires that way.

However, what we see in OpE is a lot of times the cabinets are closed so all you have is a ventilation louvers to lobby oxygen in. So you can think of it like your fireplace. If you're limiting the oxygen then you're controlling the combustion.

And that's an area that we still want to do a little bit of work with NIST. And scientifically we can nail that down for our models. So that's the last item on there.

Next slide please. HEAF. HEAF is the big one we've been working. We've been working on this one for quite a while.

I guess the most recent news is that this used to be known we pre-GI 018 for the aluminum high energy arc faults. In the past month we have exited the GI program.

Right now there is nothing. This was the last item that was in the generic issue program. So

that program is currently vacant or empty.

We brought this back to research. We need to do a little additional work. It's work that's ongoing, along with EPRI.

We formed a working group a couple of years ago to really, on this side. This is kind of a new area for us to go into.

It's not an area that's very well explored, which you'll find a lot in the literature. I mentioned earlier was arc flashes and NFPA, the IEEE. They've done a lot of work in this area. But again, their primary mission there was electrician safety for personnel safety.

So their durations of the event were limited, roughly, to two seconds. When we see the HEAFs, it's basically an arc flash that has stayed locked in for some reason and it grows quite a bit from what we see in the arc flash.

So that's an area that we're still doing an amount of work on. Again, with that, NRR is going to do a LIC-504 project to try to get a handle on some of the risk insights for this so they can get some decision making. And that is ongoing.

Final piece, with HEAF, is this all started out as international research. Research we've

done with the OECD, NEA. And that's kind of where we were trying to get a handle on it.

And actually what we were trying to do was to do the research to validate Appendix M in NUREG-CR-6850. Which is how we model the HEAF events. Of course, things were going fairly well until we ran into some aluminum components and we saw a different failure mechanism. A much more energetic fault.

And from there we kind of entered the generic issue program, which we've since exited. But that's where we're at with that. We've done an information notice, 2017-04 I believe it is. And we put that out.

As a final thing with the HEAF project, like I said, it's still ongoing. There is a lot of deliverables that are going to be coming due in FY22.

We've created a website. And all the latest information on this project can be found on the website.

MEMBER HALNON: Hey, Mark, this Greg Halnon.

MR. SALLEY: Go ahead.

MEMBER HALNON: Yes. When this issue first came out it caused a lot of consternation throughout both regulatory and the industry. How do

you guys stay in sync with the inspection folks and what's going on at the sites when you have an issue like this?

Did it get into the generic energy program late or did it, what happened there and why now are we kind of deciding that it's not as serious an issue as it was?

MR. SALLEY: I don't think seriousness is the key. I think what brought us out of the generic issue program is that you're not supposed to stay in a generic issue program forever.

And this program, this research, was there for five or six years and we weren't making enough progress. There still needed to be some additional research done.

So following the process is pretty much why we had to remove this from the program and bring it back to research until we complete those pieces and then reevaluate it as to where it needs to be. We still follow all of the regions quite a bit.

December 16th last year the Harris plant, they experienced a HEAF due to some insulation problems on the aluminum bus stop. So we try to stay well informed and work with our original partners on that to get the last information.

MEMBER HALNON: Okay.

MR. SALLEY: The thing with HEAFs is they're not super rare, but they're super common. So every few years we tend to see one. And that was kind the crux of the information notice that we needed to stop, go back and look at the OpE over time and connect the dots, if you will.

MEMBER HALNON: Okay.

MR. SALLEY: So that's where we're at with that. Mark Thaggard, do you want anything else on existing the generic issue process?

MR. THAGGARD: No, I think you characterized it correctly. So it's not a, we didn't make any determination on the significance of the issue, as Mark Henry said.

If you look at the criteria for getting something into the GI program, there is certain criteria. One of them is whether or not you can make a, come to a resolution in a timely manner. And we just haven't been able to do that yet. We need to get some more work done.

MR. SALLEY: Okay.

MEMBER REMPE: So this is Joy. And I really appreciate this discussion because I've read the industry notices or the popular press notices and

they clearly say it was pulled out because you couldn't, you can't do research for a long period of time for a GI issue, or generic issue.

But I haven't heard anything in the popular press saying, with an additional research it can go back in. And that's what I'm hearing from you guys today, which we just don't have enough information to evaluate it and maybe it got in prematurely?

MR. SALLEY: Yes. When we originally went in, I think we thought we had a little better handle on what we needed to do from the research side. There was a lot of confusion back then.

Part of the thing, if you go back in time and look at it was just how much aluminum was out there. And from the informal surveys that NEI did it's like, well, there's little to none. So it was kind of framing itself as a different kind of problem.

As we look further, EPRI just finished a survey this past year and found that aluminum is basically in every plant in the country. So we're still learning a lot about it.

Yes, I believe it can reenter the program, but for the decision makers in the regulatory office I think they need to move ahead faster and further

than us. And that's what the LIC-504 process should help them to inform their decision.

MR. THAGGARD: Well, the other thing is, I wouldn't say it was entered prematurely, I think we've learned a lot. I mean, that's part of the working.

One of the thing that we've learned is that there are some issues here that are a lot more complicated than I think we originally understood when we first got into it.

MEMBER REMPE: Okay, this really helps. And I get, that's why I'm kind of repeating my take on it so I can make sure my take on it is correct, so I appreciate you pointing that out to me. Again, this has been a very helpful discussion.

MEMBER BROWN: Can I speak up? This is Charlie.

MR. SALLEY: Sure, Charlie.

MEMBER BROWN: Can you hear me?

MR. SALLEY: Yes, sir.

MEMBER BROWN: My mind is blowing. Five, six, seven years ago, this issue of the energy arc, how the energy arc faults came up.

And back in the early to mid-'80s we had, I was in the naval nuclear program, submarines and

aircraft carrier parts of it. And arc faults are not, it's not a matter of aluminum or copper it's a matter of loose connections, and aluminum just contributes to loose connections better than copper does, for the most part.

And it was a big problem in submarines and aircraft carriers. And we almost killer people with a couple of high energy arc faults. It blew out of the panel.

Fortunately the petty officer happened to be leaning over tying his shoe strings at the time and he didn't get a fireball through his back. And we embarked on a huge program which we then developed arc fault detectors. They were installed in all the submarines, as well as in aircraft carriers.

And I brought this up to the research group, and I forgot who else, pointed them to the documents and their hardware. I mean, you can really search the hell out of this, but it's fixable.

It doesn't seem like anybody wants to fix it, they just want to research it. I'm being a little bit sarcastic when I say that because I was surprised that this pops back up again like this and all we're doing is worrying about all the aspects of analysis and research and can you predict it and all this other

kind of stuff when it's fixable. Why research it if you can fix it.

MR. SALLEY: Yes, Charlie, Commissioner Ostendorff used to also beat me up with this too with his navy background. He'd hit me in a few commission meetings with the same thing.

But again, it takes us into the world of backfit. And I don't know that we're there to even consider that yet.

MEMBER BROWN: Well why research it if they're going to fix it? I mean, researching something that's a fire, put out the fire then if they're not going to fix it.

I know you can't mandate anything. But it seems resources spent time studying it when you're not going to do anything about it seems like the money would be better spent in some other areas.

MR. SALLEY: You know, one of the things with the HEAF, and when we entered the generic safety issue program, the mantra, or the thing that we heard a lot of was, oh, here we go again, another GSI-191. And it's going to develop into that.

Part of the reason to how we work through the GI program, and the reason it stayed a pre-GI it never went to a generic issue, was that we didn't want

to repeat the same mistakes. We wanted to have the full understanding of it, we wanted to have the analytical tools.

When we do an analysis, or a plant would use our methods to go out there and analyze if they have a potential risk, we wanted them to be the best we could possibly be, not some overly conservative method. And if that's --

MEMBER BROWN: Why bother? You can analyze the heck out this stuff. And if industry is not worried about it on the small occurrences that they have, that they wouldn't backfit stuff to prevent them, then I have a hard time seeing why we're spending research money on it.

MR. THAGGARD: Well, we need to spend --

(Simultaneously speaking.)

MEMBER BROWN: -- a little bit critical here because you cannot mandate backfit, I agree with you, but I don't see that. We had a reason to do it.

When you're enclosed in a submarine hole or you're enclosed in a machinery space in an aircraft carrier, you've got some real severe problems when you have one of these things blowout. So we had a real incentive.

I don't know how that applies to the

commercial world, but you say it doesn't happen that often, and obviously the industry is not interested in backfitting any equipment in there to prevent them so, or respond and de-energize stuff when they occur.

MR. THAGGARD: Well --

MEMBER BROWN: There are ways to do it, so, I'm sorry for my, I'm not trying to be mean or nasty, it just seems to me that if we're looking for resources we ought to be using them in the places where they might be more, have some results when something gets done.

MR. THAGGARD: Well, the reason that we were doing the research is to determine whether or not that something needed to be done. We haven't made that decision.

And then if we make that decision that something needs to be done, then we need to have information to be able to support that. But also to determine what is the fix that we would recommend. So we have to do the research to understand whether or not this is an issue or not.

MEMBER BROWN: You've got the data of how often it occurs. You don't have to figure out all the nuances and micro details about why they may or may not occur.

MR. THAGGARD: Well, we need to know, I mean, Mark mentioned earlier this thing, the zone of influence. So you take that for an example.

We need to know how big this zone of influence to know what equipment is impacted. If it turns out that nothing is impacted, then you know you don't have an issue.

MEMBER BROWN: Well --

(Simultaneously speaking.)

MR. THAGGARD: Well, there hasn't been enough of these things to be able to make that conclusive statement because it hasn't happened. Something isn't going to happen in the future.

MEMBER BROWN: That's the point. There are not enough of them. And industry is very particular about stuff that damages plants and takes things out of commission.

So apparently it's not a big enough of an issue that the industries and the utilities have not gone after that to install or prevent them. So I just, hey, I'll quit. I'm just bringing it back up again. It just seemed like resources that would be better spent other places. Just an observation.

MR. SALLEY: No, Charlie, I respect your comment. And there's a lot of frustration on this,

with this project.

As we get into it, there is still things we learned. And Mark was talking about the ZOIs. And one of the things we're looking at is the different voltages, the different ways that you can get it.

Whether it's feed from the generator, if a plant has a main turbine, excuse me, a main generator breaker. A lot of different scenarios. So when we're trying to work through that.

A couple of things. One thing, by looking at it and studying it, EPRI has put out a couple of documents, a couple three documents, on not just the survey of what's out there and where they see the potential risk, but also on some good preventative maintenance in that. So it brought it to the forefront there.

And as you well know, in a defense-in-depth environment, prevention is always the best thing. If you can do prevention.

So hopefully we've done some good there with industry doing some good PMs. And hey, if we got to go thank the bolts and the buses and that's for this outage, but we're going to put that off until the next outage. Maybe that's not a good idea. Maybe we need to go and look at that because we are seeing

these types of events.

So hopefully we've done some good there. But again, I think we need to shake the research out the whole way to see just how bad it is.

And it's going to be very plant specific. Some plants may have no issue at all. Other plants, again, it's just like an Appendix R circuit analysis where you get a pinch point.

Where you have the wrong two pieces of equipment, the wrong two trains of equipment coming together. And that's kind of what we're trying to get the methodology and the tools out there for someone who wants to look for that to be able to find that.

MEMBER BROWN: Well this stuff happens in 450 volt circuits just like it does in medium voltage circuits.

MR. SALLEY: Yes. Yes, it does. It happens in D/C as well as A/C.

MEMBER BROWN: Yes. So zone of influence, obviously it just has not been a problem for 40 years, 50 years and nobody has done anything about it. So I will reiterate my comment that it seems to me that, and I'm not worried about it being a generic issue or not a generic issue, that's not the point, the point is, this is fixable.

And trying to fiddle around with figuring out what zone of influence this is, you're going to try to convince the industry to go off and do something. Their experience doesn't prove necessary.

And I'm not arguing for or against, I'm just saying there are ways to do it. The navy has equipment already developed with technics for more open switchboards as opposed to watertight switchboards.

So I just, it's like spinning your wheels, as far as I'm concerned. It's just an observation.

MEMBER REMPE: So, to just cut it bluntly, the only way the Commission usually does something like what Charlie wants, is that they perceive it's an adequate protection issue or they need to issue an order or something like that.

And I don't think you have enough evidence to motivate the Commission to do something, so you have to make it into a fact that you have to do the research. Is that a true statement, Mark?

MR. SALLEY: That's spot on. You're exactly right. And that's the due diligence that we're going for.

And, again, Charlie, I sympathize with what you're saying. If we look at Japan, we're doing

a lot of research with Japan. If we go back to 2011, the great earthquake, the plant that was closest to the epicenter was a plant called Onagawa.

Of course, Fukushima overshadowed everything, but if we look at the operating experience at Onagawa and they had multiple HEAFs there that lasted up to eight hours. Japan has a very big research programing, bigger than ours, that's going on to explore this.

And their regulatory stance, as we seem to understand it, is they're going for that being able to limit it to less than two seconds with things like you use the sensors and the detectors. And that's what they're doing in Japan.

I don't know that we would ever get to that. But again, we're trying to do what Dr. Rempe said and get to that due diligence in research.

So this is the problem, we understand it and this is the risk it poses. And those are the hard questions that we're trying to answer right now.

MEMBER BROWN: I give up.

MEMBER REMPE: I think we can't change the way the rules are about the whole Commission, Charlie.

MEMBER BROWN: No, I think --

MEMBER REMPE: So we should move on.

(Laughter.)

MEMBER BROWN: No, I understand. I mean, I'm not arguing for backfits or not, I'm arguing that I don't see where there is a huge problem that we need to spend research money on, that's all.

MR. SALLEY: If I can bring that around to what I said earlier, and I which I had some backup slides here, but if we go back to the EPRI skyscraper chart, this was the number three risk driver they saw when they did the 805.

We've been very successful in bring down the first two, but when you get into this game, as you suppress risk in one area often times it pops up in another area. So this was their third big risk driver for the plants that we're doing the transition to NFPA 805.

We've lowered the first two, cabinet fires and transients. But I think with HEAF, again, in the vein of looking for realism, we're going to see that there is a potential increase here. So, that's what I would say, would be some of the justification to continue on forward with it.

CHAIR DIMITRIJEVIC: Okay, thank you. We have interesting discussion on this topic obviously.

MEMBER BROWN: I quit.

(Laughter.)

CHAIR DIMITRIJEVIC: Not much we can do about it. So, okay, so we can continue then please.

MR. SALLEY: Okay. So that pretty much takes care of HEAF. Good flip on the slides there, Jason.

The second area that we'll talk about is our work in PFHA. Very busy year for us. We're winding down roughly the first seven years of the program.

This is where we develop a lot of the technical basis. We looked at things like climate, precipitation, riverine flooding, paleoflooding, some hydrology, coastal flooding and some combined mechanisms.

The reasons for this was to establish the technical basis. And that's basically what the first phase of the program has done.

Again, right now we're doing a lot of knowledge transfer from our contractors who had done work for us to the research and the NRR staffs and sharing that information. And we're moving into the phase two, which is at the bottom there. The three pilot studies.

That's going to be the big effort for

2022. We're roughly three-quarters of the way complete.

And we're looking at three pilot studies. A site scale flooding study, including LIP, which is local intense precipitation. A riverine flooding model, which includes a dam failure. And also some coastal flooding.

After we've completed those pilots, then in 2023 we will start to start thinking about, do we need to do some regulatory guidance. And that would be the third phase of the PFHA program.

Another very important piece of this program, and I'm very so proud of my people that have worked on this, we'll talk about, I have a separate slide, is on the workshop that we do. We've done six of them, and we're going to be doing our seventh one this year. We've already got our dates. The seventh one will be held February 15th through the 18th of this year.

And we're learning, and also expanding this, to pick up other external hazards. High wind being one thing that we definitely want to look at.

Next slide please. So, you can see some of the topics. We've already covered these. Our last workshop and agenda are listed there. These are all

the presentations.

The last years was done completely virtual. It was very well received. Over 300 attendees.

I think we can go to the next slide, Jason. And I love this slide that the guys made up and worked on it.

And this is kind of drilled down a little bit to who is looking at this workshop and where is the interests. You can see that it's pretty broad and it's international.

We've got academia, we've got other federal agencies in here. A lot of participation. A lot of conversation, a lot of good exchange of information.

And as you well know, one of the big things with the NRC is communication. And being good communicators and sharing technology, being transparent.

This workshops is a model of that. And it's brining all the right people together to discuss all the right information. And like I said, I really enjoy this slide because it kind of brings it all together.

The seventh one is scheduled. It will

probably be virtual, although we do have the auditorium scheduled for this year. We'll have to see what COVID does. But we're looking for bigger and better.

And like I said, expanding into some other areas of, we've expanded a little bit into OpE. With some of the stuff like the Fort Calhoun flood.

We've had presentations, as well as the events that have happened in France. And this year we're looking to bring in a little bit more of the external hazards.

Next slide please. The next area that I just want to touch base on, I said this is an area we've done a little bit in the past.

If you remember around 2017 time frame we had a NUREG, I believe it was 7231. I know it's one of Mark Thaggard's favorites, but this is when we modeled the radioactive, excuse me, we modeled the radionuclide transport in fresh water. Which was lakes and rivers.

It shared a lot of good information that we had put together. We expanded some of the work that we're doing with our partners in NMSS.

Looking at things like radon covers and how they've held up over time, ET covers,

geomembranes, guidance for how to look at this. And we're also looking at the MARSSIMs.

There is a revision coming up. Of course that's NUREG-1575. That program is one that we're with a number of partners. DOE, the DPA is a lead on it and the DOD. And it's for the, a lot of the cleanup work. It's kind of the go to document that's out there.

Another area that we're working with here is we had a workshop, I believe the next slide if we could Jason, on subsurface monitoring and how this went. Using PFHA as a model we tried to do something similar with our partners at NMSS to look at subsurface.

And this is kind of, again, the drill down for the first time we've done it. Some feedback on this that we received has been very well. You can see we've had a couple hundred people, just under 200 people, I believe, attended. If my numbers are correct.

The agreement states. I had so much positive feedback from the agreement states it seems that we don't maybe cater to them or involve them enough. But this workshop really brought them together.

And a lot of the feedback that I got from a few of the states was, hey, this really wasn't a workshop we viewed this as a training because we just learned so much listening to what's going on in so many different areas that they were very pleased with this.

This is something that we hope to grow in the future. We're going to have a RIL, we're going to put out a research information letter, a RIL, and document everything that we have. And you can see the workshop materials right now if you care to take a look at it, it is there.

So this is an area, again, with our partners in NMSS that we're hoping to expand. And again, the idea of communication throughout the industry and with all the best practices and the best information is what we're striving for here.

So I believe that brings me to the end of my presentation. If there is no further questions, I will turn this over to Sean Peters.

MR. PETERS: Thank you, Mark. I'm Sean Peters, I'm from the Human Factors Liability Branch.

From a background for myself, I'm a space mechanical engineer in my background. I worked in the Air Force 1 and Air Force 2 projects in technical

support. I worked in the space programs as a design engineer for space shuttles, space station and Delta IV rocket programs.

I've done research in seismic engineering and alternative energy. I've worked in the oil industry.

And then after that long, I guess resume right there, I've also spent 22 years with the Nuclear Regulatory Commission. Came in as a inspector in Region I, safety system design inspector.

I was a reactor systems engineer doing accident analysis in NRR and worked as a project manager in technical system throughout NRR before I came over to research. And research I did a brief stint as a branch chief over our nondestructive examination groups.

And now I work in the human factors and reliability branch and I've been here for 13 years. So thanks for having me. And I know you guys have heard a lot from me over the years so I'll try to be brief on the areas you've heard a lot from me on.

Next slide. So, HFRB, we developed and maintain state of the art human organizational factors and human reliability analysis guidance and methods.

You guys know a lot about my HRA work, but

from a human factors perspective it's about half of the branch work and human organization factors. And what we do in the human factors world is we provide expertise to support human factors technical issues across all business lines.

Historically we've worked with the Office of Administration, we've worked with ENSR, we've worked with the regions, we've worked with NMSS, NRR. If you name an organization that involves a human, we've worked with it.

We typically develop human factors rule language and review guidance for, well, I'm sorry, not typically, typically we do human factors review guidance development. We developed that rule language.

Right now one of the more high profile items we're working on in the human factors world is developing review criteria for new and advance reactors. Including looking at things like advance operations, automations and control concepts. I'm going to talk a little bit more about this on a further slide.

For organizational factors we provide technical support for implementation of our safety culture programs. We support the NRC's desired

culture initiative. And we develop and implement the integration programs. I will also talk about that on a further slide.

HRA methods and human reliability data will also have its own slide. And the ACRS is pretty familiar with what we're doing, at least on the HRA methods.

HRA, data we collect data from utilities, from our own, given from its test facility where we have our own pressurized water reactor simulator and we collect human data for that to support our programs.

And we also work with our international partners. Mark Thaggard alluded to it that we work with the Korean Atomic Energy Research Institute, KAERI, out of Korea.

And we also work with UJD Res out of Czechia, also known as the Czech Republic. We work with the groups there to collect human reliability data.

And we also try to coordinate internationally with the Holland Reactor project to establish new data programs to improve that data.

So next slide. So human factors. I'm going to tell you a little bit about the projects that

aren't as well known.

So fitness for duty is one of our longest standing projects that we've had in HFRB. And fitness for duty, it encompasses both drugs and alcohol use and abuse and detection and fatigue.

And what we've learned with fatigue is that fatigued is a very subtle science. There's not a lot of work going on in there anymore now that we have rule language in place and implemented across the industry.

But drugs and alcohol, at least on then drug side of it, are constantly evolving. It almost seems to be an exponential rate increase in the number and types of drugs and evasion technologies.

So we're trying to stay on top of that by having a program that looks at international best practices. What are they doing overseas to detect these and how can we affect our own regulations to catch up to the different technologies that are out there.

Nondestructive examination is another item that we were looking into. It stemmed back in the mid-2010s from items where our NEA folks were finding, or at least NEAs were finding flaws in some of the vessel piping welds.

And what they were saying is that these flaws should have been detected on numerous, previous attempts but weren't and they were trying to understand why were they found in this final attempt and not in the early attempts.

And so, one of the things that came up was that there are significant human factors challenges when you look for welds. When you train operators and they get their, I'm sorry, when you train inspectors and they get their licenses for doing them, to start the examination of facilities, they train in a classroom type environment where they have easy access, controlled temperatures, controlled lighting. But when you're out in the field it's just a completely different beast.

And so we did an evaluation of that. We looked at the training practices. And we have reports that have been completed on this activity that tell about these best practices and best ways to train. And look at the human factors challenges out there in the industry and what can be done about it.

So, human factors training program development, so the NRC has hired several new staff to do human factors technical review for NRR. And when we know that this is kind of a pipeline to other jobs

throughout the agency, we know there is going to be a consistent turnover in that field.

And so, what they're looking at is trying to find ways to train non-human factors experts with a base set of knowledge so that they can apply that in their field and become experts in licensing reviews of human factors issues.

So we developed this training program and we expect to have it completed in the October time frame of this year. And the materials we have for that training we plan to share internationally. Not just with the U.S. but with our counterparts through the Nuclear Energy Agency, through our working group of human organizational factors.

And then OpE reviews. We constantly scan the operating experience out there in the industry to understand what are the human factors challenges out in the world and what can we do about it in our regulatory programs.

So, new advance reactors. I'm going to talk about that on a later slide. Organization factors also.

But from an organization practice perspective, one thing that we won't talk much about is our reactor oversight process tech support. This

kind of builds off the human factors operating experience review.

We look at the, as implement inspection programs, and well look at ways that we can enhance those programs and improve how they examine, not just human factors issues but also the safety culture issues at facilities.

So, I'm going to go to the next slide. This is going to be Slide 34. So, advance human factors licensing review guidance updates.

This is, again, a very high profile project. And what we do in human factors, we have a strange regulation that says, licensees must design controls with state of the art human factors principles.

And because it dictates that they have to state of the art not just adequate, it means us, as a research entity, we have to stay on top of what that state of the art is and what those new principles are.

So what we've done, since I've come here, I came here in 2008 and we were at the advance stages of the, well, the early stages of the nuclear renaissance, there was a lot of look into seeing what were the new reactor technologies that were coming out and what kind of human challenges were going to be

associated with that.

So remember that time that we developed six technical reports on the advance technologies, we've developed enhance guidance for small modular reactor reviews based upon our experience supporting the NuScale reviews. And this is, we've updated that through our NUREG-0711. Which is our human factors engineering program review model.

And NUREG-0700, which is our human system interface design review guidelines. And so, we've updated those guidance, both for small modular reactor and advance technology control and reviews.

But one thing we're finding with advance control room reviews is that they are definitely different than what we used under Part 50. So Part 50 reviews are for large light-water reactors.

Our full program review, while we'll going right down to the details and the nut and bolts of the entire program, and doing cross-sectional looks at how they implement that in the facilities looking at the control room technologies and doing integrated system. Integrated system validation of those technologies and how they operate at the control room side. And that's been very useful for even our part 52 applicants looking out at the Vogtle Plant.

But when you're looking at advance technologies or advanced reactors, there is a wide scale. There are large ones that are not too dissimilar for the scope and feel of a Part 50 type review, all the way down to almost plug and play type reactors. Little tiny batteries that you kind of push a button and leave and leave it alone.

So the challenges are review guidances built for that large review, but not for these tiny reactors. And so, we've been developing right with NRR scalable human factors engineering review guidance. So we're looking at, how do we scale that based upon the details of reactors that come in.

And we're also looking at how we scale the operator licensing requirements based upon the reactors that are coming in the door. Like a reactor knowledge set in training needs to be a certain level for large light-water reactors, but probably not so much for some of these smaller plug and play type reactors. So we'll looking at how to scale that.

MEMBER HALNON: Hey, Sean, this is Greg.

MR. PETERS: Yes.

MEMBER HALNON: I'm going to ask a question and give you some clarifying comments. I assume that when you say state of the art control room

designs you're saying that state of the art is better.

And I ask that because the touchscreen aspect of the new control rooms and digital control rooms takes what an old operator, like myself, takes the human machine interaction piece, the feel of it, the listening of it, out of the picture. And I think that's not better.

Now, it may just be that I'm an old guy, but I've operated a digital plant, I've operated a normal plant. When I say normal I mean the 1970, '80s vintage.

And now I have a car that I can't figure out how to turn the air conditioner on and off because I had to go through three pages of touch screens.

(Laughter.)

MEMBER HALNON: Are you guys looking at that aspect of it from the perspective of, is state of the art better all the time?

MR. PETERS: Yes. So, the state of the art, we have to look at our state of the art human factors engineering design principles. And so, we have to make sure that how we evaluate that is state of the art.

So those new technologies, you're absolutely right, some can have detrimental effects.

There not always for the positive. Right?

What you're alluding to are things like key-holding where you have to go through menu after menu to find the item you want. That's not necessarily a good thing.

And you're looking at this kind of tactile response you have from analog control rooms are really great. You know when you flip the switch.

But I've also got to work on the generic PWR up in Idaho and I got to try to close valves and operate pumps. And I had to touch that thing like two or three times just to get it to work. And then you got to play real close attention if it actually flipped because you weren't getting that tactile response.

So you're right, there are challenges. And that's what we do with our scalable guidance. We get to tackle those particular challenges. And we do research that. And we have reports out there on that.

And one of the things we found, at least for the touchscreen, is that they tend to be more difficult for people to navigate then, what do you say, like a mouse click type interface for some of the newer designs.

So what we see out in France is that they

don't really do touch screens, they go to the mouse click type interface.

MEMBER BALLINGER: Hi, this is Ron Ballinger. And I'll beat a dead horse.

(Laughter.)

MEMBER BALLINGER: Have you read the book called the Glass Cage?

MR. PETERS: I have not. No.

MEMBER BALLINGER: Highly recommended. Highly recommended.

MR. PETERS: I'll look it up.

MEMBER BALLINGER: By me. By me anyway.

MR. PETERS: Okay.

MEMBER BALLINGER: It's about what happens when you, basically when you become fixed and captured by the screens. And you lose track of things in two ways.

One, you lose track of things because you're like doing a video game. And you also lose track of things because the computer software that's behind all that stuff becomes a surrogate for your brain if you're not very careful.

And so it allows you to, you make mistakes, but in addition to that, that software compensates for the competency of the operator, to

some extent. And you have to be very careful because it allows you to, in affect that I don't think the NRC does this, but in some cases it allows you to hire somebody that would not otherwise be hired because of competence thresholds.

MR. PETERS: Yes. And I think you're describing what we have a concerns about, which are these kind of, we call it just the black box, that the machine is doing something and you don't comprehend how it's working and then it spits out a direction for you to go. And that loss of connectivity and understanding a plant physical processes, that's a very important factor that we look at with our advance principles.

Next slide. Okay.

CHAIR DIMITRIJEVIC: Yes, I would like, I just would like to add one small comment about this enhanced guidance for small modular reactor.

The NuScale was specific in this area that this was a small modular reactor, the significant passive features. Which actually allowed plenty of time for the human actions.

If this is not the case that having multiple modules on small location should make an operator actions much more complex and it will

introduce, like if you have a 12 unit, there is a likelihood that each of them could be a different PRA. One would be under schedule. Or the other thing is you can have initiated events, which affect all 12 units in the same time.

So basically, small modular reactor have a, there's a small modular reactor, just small modular means the operator actions can be much more complex. And they're both introducing a NuScale case that different relaxation is it has a significant passive features.

So this thing, you have two different. One is bringing the more complications and one is simplifying the human actions that NuScale was having about characteristics.

MR. PETERS: Yes. That's why the review is absolutely needed because you have to do the combined effect, right. If it was just one module, oh, advance reactors would be easy.

CHAIR DIMITRIJEVIC: Right.

MR. PETERS: Much easier than operating reactors. But when you're throwing 12 open simultaneously, yes, absolutely, you have to prove and validate that you can actually maintain these if there are these large accidents.

CHAIR DIMITRIJEVIC: Right. And because they're the regular, you know, performance shaping factors have changed, you know. Stress level like is completely different if you have things happening in multiple units versus that single. And so, all performance shaping factors will be affected with a number of the units.

So, I just wanted to make these comments because I know we just adjusted the views, the number of operators in the, but that's because of the passive features not because they're small modular reactors. Okay.

MR. PETERS: Yes. Passive features and longtime frames for performing the actions. Absolutely. Thanks, Vesna.

Next slide. So, one of the things that consuming, oh, we got a hand by Vicki Bier.

MEMBER BIER: I don't know if this is the right time for the question or not. Feel free to defer it if you prefer.

But this morning there was a very brief discussion about errors of commission and whether we are or not yet ready to handle them more broadly in PRA. So at some point, can you give a bit of where we are in that process and whether there is any ongoing

research, et cetera?

MR. PETERS: Yes, I can talk about it on my next slide.

MEMBER BIER: Super.

MR. PETERS: I can talk about HRA methods on the next slide.

MEMBER BIER: Great. Thanks.

MR. PETERS: Awesome. Thanks, Vicki. Make myself a note here.

So, organizational factors. The things that are consuming a lot of staff energy in HFRB right now are agency innovation and agency culture change.

So, we are one of two places in the agency that has organizational factor specialists. There are some in the Office of Chief Human Capitol Officer. And the rest are in the Office of Nuclear Regulator Research.

And back when innovation started, this big push in innovation started, I think OCHCO was just hiring specialists into OCHCO.

So we had multiple staff members in HFRB move into the EDOs office in a technical support role. And they helped build the innovation program from its Innovation 1.0 over to what we call InnovateNRC 2.0 program.

And what that helped was we built that infrastructure and we drove the procedures and processes for maintaining and sustaining innovation. Using that organizational factor of science of how do you actually keep these things in a perpetual state.

So, we built that program. We brought it over it to HFRB and we're actively running it. And the goal of it is to help us improve in all aspects of our operation of the NRC.

Before all of our organizational factors specialists supported our safety culture commonly language programs and the inspections and technical support out there at the, at licensee's facilities.

So we were out there on a regular basis looking at issues and problems that we could see in licensee operations. But we weren't applying that to our NRC operations.

And so, this was a great opportunity to not just have this outward look on how organizations performed but take our expertise and help the agency itself improve its performance and become this modern risk informed regulator that we're looking for.

So, our staff is still doing that. They're still doing the safety culture common language, we're still doing support for 95002 and

95003 inspections where we're looking at multiple degraded cornerstones.

And we are supplying the technical bases behind these determinations of operators, or operational capabilities at plants. And so, on top of NRC, again, we're trying to help both NRC and the industry and prove their organizational capabilities.

And finally, safety agency culture improvements. Our Staff are major supporters of our desired culture initiative. And you've seen presentations from our staff members and they help target improvements, not just in research, but in individual offices around the agency.

So the future for this program, we would like to take a look at, we'd like to continue to foster the culture of continuous innovation at the NRC. And we also, we've worked really hard and have major successes in our internal crowd sourcing capabilities.

And that helps us a lot in internal processes. And sometimes in technical challenges that people want to get outside of that, of their existing mind set and framework and get other people from the NRC to weigh in on.

But we've gotten to see presentations from

external organizations where external crowd sourcing is a major component to their programs that helps them solve longstanding technical issues that you've had in their technologies.

And so, what we're doing right now is we're working on developing MOUs and getting the contracting processes ready so that we can start harnessing the power of external technical experts in different fields to help weigh it and maybe provide new ideas to solve some of our longstanding challenges in the NRC.

And I have a couple in mind in HRA that I'm trying to hash out the additional stages of it right now. But they're out there.

And one that Vicki may have alluded to is errors of commission. So I'll get to that on the next slide. Any questions on Slide 35 here.

CHAIR DIMITRIJEVIC: Are you going to extend looking on that human actions to shut down?

MR. PETERS: From a human factors standpoint we are not doing anything in human factors and shutdown, but on HRA, the IDHEAS method was specifically built to help the human factors and shutdown.

But let's move over to Slide 36. And we

can get into some of the HRA discussion.

So, shutdown involves a lot of manual actions and some reduction in defense-in-depth simultaneously and kind of weird configurations of the facility.

So what we have developed with IDHEAS-ECA was this human-centered technical approach where you can apply it to areas that just aren't highly proceduralized control rooms, like our old HRA methods were. And these are actually field operations you can apply in those areas.

So what we're doing in our HRA methods and data, at least for the, maybe the few ACRS Members who haven't been in all the IDHEAS presentations, but we're trying to improve HRS realism. And we're trying to do that through enhancing our methods, reducing uncertainty, and utilizing data.

So, enhancing the methods, we're trying to make strong scientific links between the HRA methods and the existing scientific literature from human factors. And when we do that, we're trying to reduce uncertainty because uncertainty is a major driver of HRA.

Large orders of magnitude in uncertainty, what we found in some of our background research. And

so we had targeted work in improving what we considered a couple of high aspects of uncertainty in the methodology. And of course, we're trying to collect as much data as we can to try to data inform those methods.

So, over the time I've been here on this program, we've developed 14 technical reports, we've developed two improve HRA methods, we've developed a comprehensive database of human error data.

This is our IDHEAS data, which the ACRS got to look at late last year. No, I'm sorry, early this year. I'm getting my (audio interference) as I meet with the ACRS, or at least the Subcommittee and PRA regularly, so.

We also have a software tool for HRA implementation, which is our IDHEAS-ECA software method. And we have a software tool for HRA data collection, which is our SACADA method. SACADA is the scenario authoring characterization and debriefing application.

And that took is implemented out our partnering utility. And we collect all the training data from every scenario that they run on their simulator at that facility. And that provides us a plethora of data.

We also collect data from our own testing platform that we have. Our pressurized water reactor that we test with our partners at University of Central Florida. And we collect human factors and human reliability data out of that.

Feature directions for the program. Right now we are testing our IDHEAS-ECA and CN3 (phonetic) applications in NMSS. We plan to get that report out here in the late fall, early winter time frame. Depending upon how many technical revisions we need to make to it.

And once that is in play, NMSS has plans to try to promote the use of our IDHEAS-ECA software tool for the fuel cycle industry. And once we get into fuel cycle we're also going to be looking at other, because the method is human-centered, it's very technology neutral.

We're looking at also expanding that into other applications in NMSS. Of course, we've already IDHEAS-ECA in all of our reactor operations. It's already built for applications in all of our operating reactor applications.

The other thing we're working on right now is, I just got a dependency model, a new dependency model, based upon the ACRS recommendations back in the

summer of early to mid-timeframe in our IDHEAS program. And so that's on my desk.

I hope to be able to review it this week or get it out for concurrence for everybody, but it's a much stronger method. It gets into more details as to what are the causes and implications of dependency, which allows a better focus on targeting safety related improvements to those interdependent actions.

Once we get that dependency method out the door we would like to take a look at what can we do for crediting recovery in our HRA methods. Is there something that we can build off the dependency or is there something new that we need to create.

Other things we're looking into, we're developing a draft report on new and joint human error probabilities. Trying to understand what's the current state of the art, the technology behind it and what can we do to enhance that.

And finally, uncertainty. Just starting now, now that we go to this dependency model in place, we're trying to understand other major sources of uncertainty in HRA and looking at, basically prioritizing ranking of which ones can we tackle now and where can we get our best bangs for the buck.

And finally data. We, again, we have

utility partners and we're looking for more utility partners. We have several international partners. And we're working with our, through the Halden Reactor project.

We created a new task for international HRA data exchange. And so, what we're trying to do is get that data out there so that our analyst can collaboratively work on it from the data that we capture from all over the world and see how we can inform our human error probabilities with it to provide a more granularity, more realism to HRA methods.

And that is my last slide. So I know there may be some questions out there. Vesna has already unmuted so --

CHAIR DIMITRIJEVIC: Yes. I have a very short question because it just reminded me when you mentioned the criticality. Did you use this when you were completing the FLEX models?

MR. PETERS: So no, we did not credit recovery when we did the FLEX models. So that's a great, it's a great insight there.

So once we get this understanding of how we can, you know, credit recovery then we can start applying it back to some of our old models.

CHAIR DIMITRIJEVIC: So wait, wait, wait. But you couldn't do the FLEX without human actions even if you didn't call them recovery, right? I mean, that's all human actions.

MR. PETERS: Yes. I mean, human action is the primary driver for risk and FLEX scenarios. Once you get to that world it's all, what does the human do and how can they get the equipment running properly.

There are, there tend to be long lead times in that, so you tend to have multiple opportunities for recovery over that. Those time frames for human actions and FLEX scenarios.

CHAIR DIMITRIJEVIC: Okay. All right. Well, the other thing which I just want to mention, because I, one of the reason I ask about shutdown because earlier we were talking about errors of commission, errors of commission, and you said that you're outsourcing that program, if I understood you well. Right?

MR. PETERS: Um --

CHAIR DIMITRIJEVIC: That you have external experts looking in these errors of commission. I just want to mention, I don't know, significance of error of commissions, it could be much higher in shutdown because that's where, you know, and

we may have a backup knowledge in data but not that of commission and shutdown. I just want to make this comment for you all.

MR. PETERS: No, thank you very much. Yes, to get to Vicki's question about errors of commission. So thanks for the reminder. Definitely a high error probability on my side for remembering that.

But errors of commission, there was a project that the NRC did, and I think Dennis Bley was one of the team members on that project, when we developed the ATHEANA methodology. They developed that method specifically to try to create a way to help identify what we consider logical error of commission.

It's a very good methodology. There's a very high quality qualitative analysis piece to it. It's not very much -- it's not implemented in a lot of places in the industry right now. It's one of the two methodologies that they can use, can do the quantitative analysis -- I'm sorry, qualitative analysis for fire HRA. So there is an approach. But the challenge was that errors commission that it's very, very resource-intensive to try to understand how to capture the data definition into a PRA model.

So that's probably the main reason it's not implemented. And I guess with that, I think it's a very tough question, how do we deal with that in the future. I mean, I don't know that we got a comprehension or understanding of how we can totally capture errors of commission.

So I think getting our experts together, understanding that we do have this ATHEANA method, are there things that we can do to enhance that? Or other different, like, computing tasks that can complement that qualitative analysis.

MEMBER BIER: Thank you. And I wasn't particular pushing that it should be done, I just wanted to kind of come up to speed on what the current status was, so.

MR. PETERS: Yes, not a problem. So yes, as far as status, we haven't touched it for a while. It is one of those longstanding issues in HRA. But I always call certain projects like our holy grails. And that's one of our holy grails. To try to really capture the Commission to try to tackle uncertainty.

I mean, these are these kind of things that are really nebulous problems for the HRA community. Thank you.

So that concludes my presentation. So the

next presenter will be Mark Thaggard. Thank you.

CHAIR DIMITRIJEVIC: Thank you.

MR. THAGGARD: Okay. So before we conclude the presentation this afternoon I would like to take a couple of minutes and go over a couple of years for anticipated future engagements with the Committee.

I just listed three here, there may be others. We anticipate coming back to the Committee as we've prepared published reports for the Level 3 PRA. I think that was highlighted.

We also anticipate coming back to the Committee to brief the Committee on the HEAF project as that projects draws to closure. As well as, excuse me, someone have a question? Okay.

As well as we anticipate possibly having additional engagement on Reg Guide 1.247, as was mentioned at this morning's meeting.

And we're certainly open, interesting in hearing from the Committee if there are other specific areas that they would like for additional engagement.

So, can I have the next slide, Jason. Well, the, one more. Okay. So let me conclude by saying that the division of risk analysis activities align with the Agency's efforts to accommodate modern

risk-informed regulator.

Our effort in leading the agency's innovation activities is an important part of the agency's transformation efforts, as we've mentioned. And we are fully engaged in efforts to be ready for future technologies. We also have activities to support the use of risk and decision making.

Hopefully what we --

CHAIR DIMITRIJEVIC: Sorry to interrupting you, but I would also like if you touch on that because I thought that his miss, this is something we're missing in presentation.

What do you see as your biggest challenges?

And, you know, basically on the status of those efforts. Do you see that anything has shortcoming stops or any other big challenges?

MR. THAGGARD: So, I think, you know, I mentioned that one challenge we have is a staff area. We are a small division.

We anticipate losing some of our core positions. Maintaining risk and reliability engineers is a real challenge for us.

In terms of the technical areas, some of the big projects that we've been working on that we

face a number of challenges. And some of those also relate to staffing.

And so, one of the big challenge is trying to get those projects concluded. Come to a conclusion on them.

The Level 3 PRA project is a prime example. That project has gone on for a number of years. And the biggest challenge we've had there is staffing. You know, we keep losing, keep people on project. And that's kind of pushed the schedule out.

So, clearly, one of our challenges is getting those projects, also the aluminum HEAF, we've had some discussions on that, getting those projects to a conclusion is a challenge. Some of it's related, as I said, to staffing.

The other thing is, I alluded to this at the beginning of my, at the beginning of the presentation, there are some areas where I think that we would like to move into, and has some additional research in the area, for example, in the security area, I think we could maybe have more, provide more support in the physical security area. So we are trying to do some work in that area.

And I think there is a need for more research in terms of looking at some of these extreme

weather events. As I think Mark Henry pointed that out.

So I don't know if that gets to your question, Vesna, but I tried to highlight some of the things that I think I see as challenges or areas that we need to look at in the future.

MEMBER HALNON: Mark, this Greg.

MR. THAGGARD: Yes.

MEMBER HALNON: So extreme weather events and how that, I was going to ask you about that, and how the --

MR. THAGGARD: Yes.

MEMBER HALNON: -- weather transpositions may effect guidance going out to the large light-water reactors would be a really good, maybe a single slide on that next time you do an update.

MR. THAGGARD: Okay.

MEMBER HALNON: Because we've seen a lot of heavy, heavy storms that have drawn precipitation down. And when I look at how we used to transposition some of those storms to other areas, it could really affect the guidance coming out just based on maximum probability, probable floods and those types of ravine levels and whatnot. So a single slide on that would be excellent.

MR. THAGGARD: Okay.

CHAIR DIMITRIJEVIC: This answered my question. My concern was, is there something we can do to help you in the overcoming challenges and things like that? I was curious how do you see them.

MR. THAGGARD: Okay.

CHAIR DIMITRIJEVIC: Okay. Anybody, any Board Members have questions or comments they would like to make?

All right. If not, we thank you for a wonderful presentation, which was finished right on right time. That was very nice. Slides were beautiful and we stayed within the time frame.

MEMBER REMPE: Vesna?

CHAIR DIMITRIJEVIC: Yes. Yes. Yes.

MEMBER REMPE: Can you hear me? This is Joy.

CHAIR DIMITRIJEVIC: Yes.

MEMBER REMPE: I'm a phone line.

CHAIR DIMITRIJEVIC: Oh, okay.

MEMBER REMPE: So I tried to cut in early and it takes a while to unmute mute. But anyhow, Mark, I'm wondering if we could request, after we hear a bit more about what's going on with non-LWR technology neutral report, PRA, is that something that

we should asked to be briefed on?

MR. THAGGARD: Yes, we can provide a briefing on it. You know, it may be a short briefing but we can provide a briefing on it.

(Laughter.)

MEMBER REMPE: Yes. Let me learn a bit more about it.

MR. THAGGARD: Yes. Yes.

MEMBER REMPE: I just am kind of wondering about why there has been such a change. And so, it might be something where we might have some suggestions on what else might be needed to make that exercise fruitful. But anyway, let's kind of exchange information, if we can see the reports. I think it might be helpful.

MR. THAGGARD: Yes.

MEMBER REMPE: Okay.

MR. THAGGARD: Yes. We can certainly provide the reports. So that might be a good starting point.

MEMBER REMPE: Okay, that sounds good. Thank you.

MR. THAGGARD: Okay.

MEMBER REMPE: Sorry to interrupt.

CHAIR DIMITRIJEVIC: Thanks, Joy, to

remind us that that stays as an open --

MR. THAGGARD: Yes.

CHAIR DIMITRIJEVIC: Okay. If no any other Members have comments we can ask the public, if anybody from the public would like to make a comment?

Okay, hearing none, this means we are finished for today. Thank you very much for the presentation. Thank you for everybody's participation and have a nice evening.

(Whereupon, the above-entitled matter went off the record at 5:03 p.m.)

Advisory Committee on Reactor Safeguards Biennial Review

September 20, 2021

Mark Thaggard, Director
Division of Risk Analysis
Office of Nuclear Regulatory Research

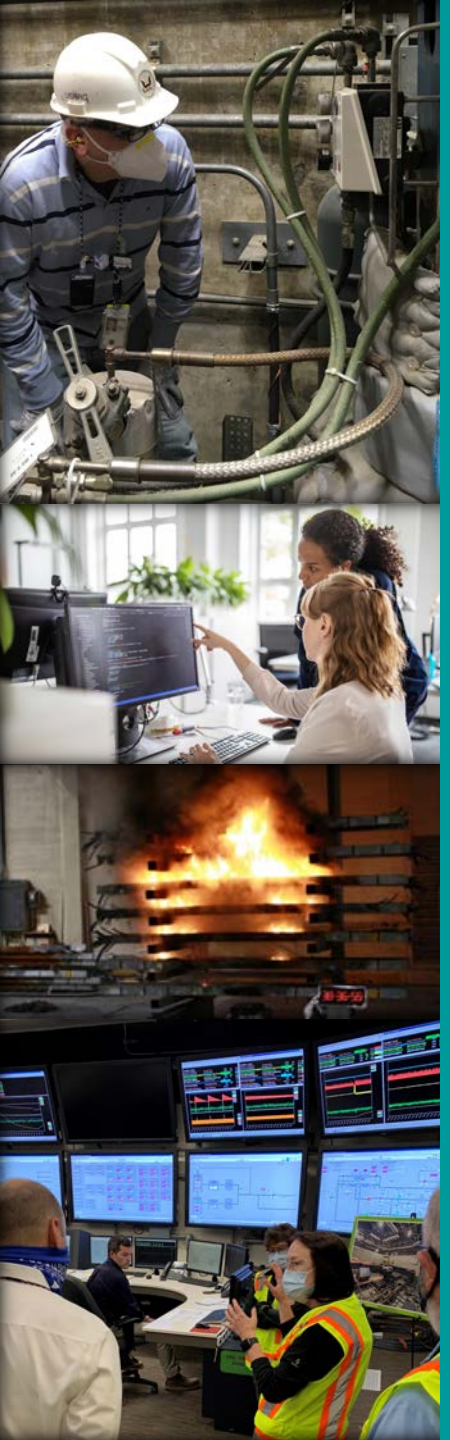
Key Messages

Our Vision

Be a prominent agency resource on risk-related matters developing and pursuing solutions to current and anticipated regulatory challenges.

Our Objectives

- **Be ready** for future technologies
- **Completion** of high-quality research products
- **Facilitate** Transformation
- **Grow** the agency's RIDM capabilities
- **Build and enhance** staff capacity



Collaborations

U.S. DEPARTMENT OF ENERGY

NASA

NIST

USGS
science for a changing world

EPRI ELECTRIC POWER RESEARCH INSTITUTE

NEA
NUCLEAR ENERGY AGENCY

NOAA

STP
Nuclear Operating Company

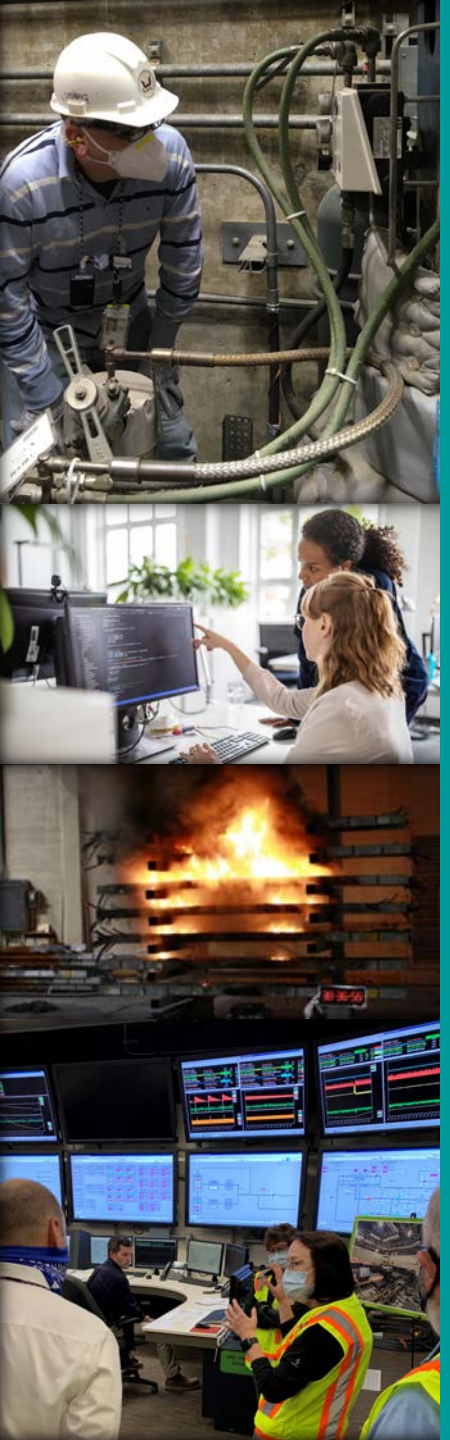
ÚJV

KAERI

IRSN
INSTITUT DE RADIOPROTECTION ET DE SÛRETÉ NUCLÉAIRE

Advisory Committee on Reactor Safeguards Biennial Review

Christian Araguas, Deputy Director
Division of Risk Analysis
Office of Nuclear Regulatory Research



Accomplishments

"DRA remains current on relevant risk-informed and other related regulatory issues and anticipates and meets the future needs of our stakeholders."

68 SPAR Models Enhanced

12 Preliminary L3PRA Models

7 licensee flood hazard submittals reviewed

2 HRA methodologies Improved

27 Public Meetings Workshops, and Seminars

303 Licensee Event Reports Reviewed

6 Research Information Letters Issued

9 NUREGs Issued

4 RGs Revised

9 Reports on Component Reliability and Systems Studies

40 Events Identified as potential precursors

7 Events Identified as precursors

19 New staff, Co-Ops, and summer interns

innovateNRC2.0

Division of Risk Analysis

Mission: To provide world class technical support for the implementation of risk-informed regulatory activities and decision making in nuclear safety and security.

Performance and Reliability Branch
Mehdi Reisi-Fard

Probabilistic Risk Assessment Branch
John Nakoski (Holly Cruz, Acting)

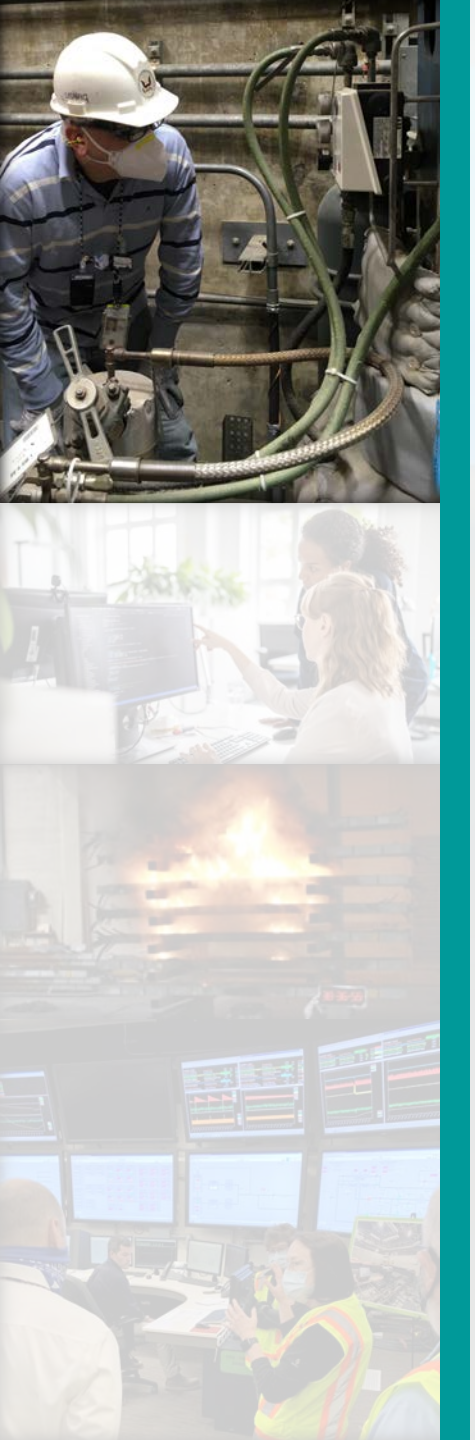
Fire and External Hazards Analysis Branch
Mark Henry Salley

Human Factors and Reliability Branch
Sean Peters

Program Overview

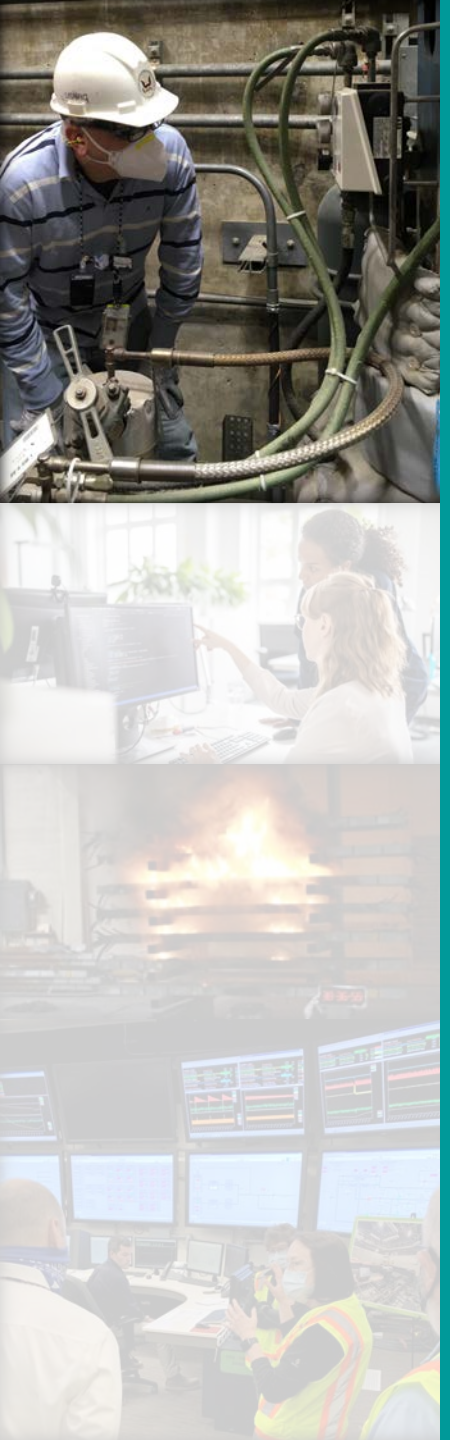
16.5 million

FY22 Resources



Performance and Reliability Branch

Mehdi Reisi-Fard



Performance and Reliability Branch

About PRB

PRB plans, develops and manages research programs to systematically assess reliability information, perform event assessments, and support the RIDM framework

Functional Areas

RIDM AND PRA GUIDANCE AND STANDARDS

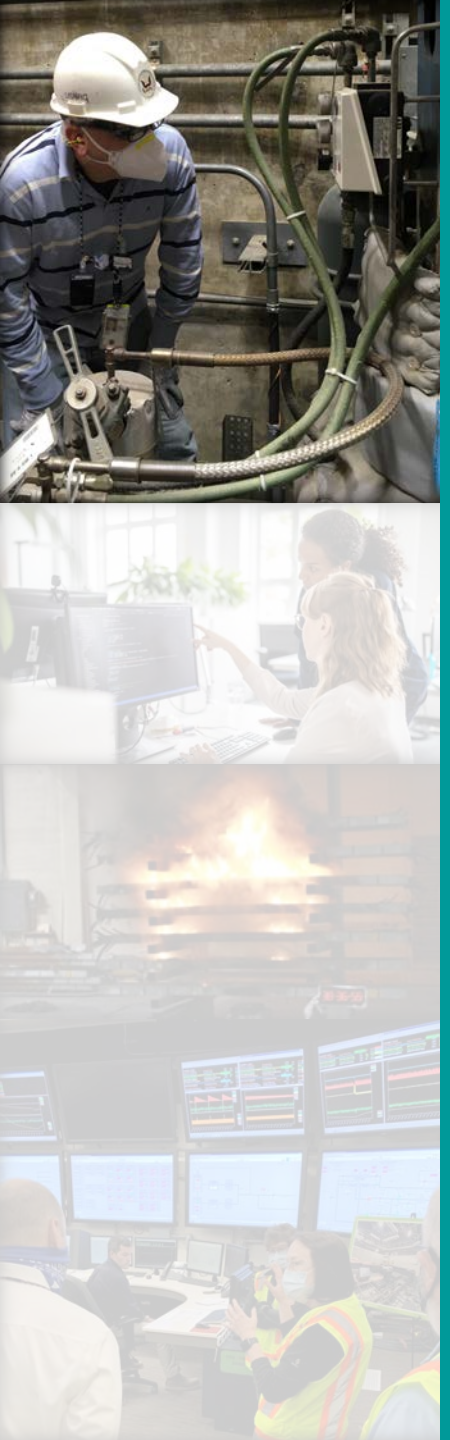
- Develop and maintain guidance and tools for risk-informed decisionmaking and use of PRAs

ACCIDENT SEQUENCE PRECURSOR (ASP) PROGRAM

- Evaluate operating experience to identify, document, and rank operational events by calculating the risk associated with events or conditions.

OPERATIONAL EXPERIENCE, DATA COLLECTION, AND ANALYTICS

- Direct the collection, review and evaluation of OpE Information for maintaining risk models used in risk-informed decisionmaking.



Performance and Reliability Branch

Major Projects

RIDM AND PRA GUIDANCE AND STANDARDS

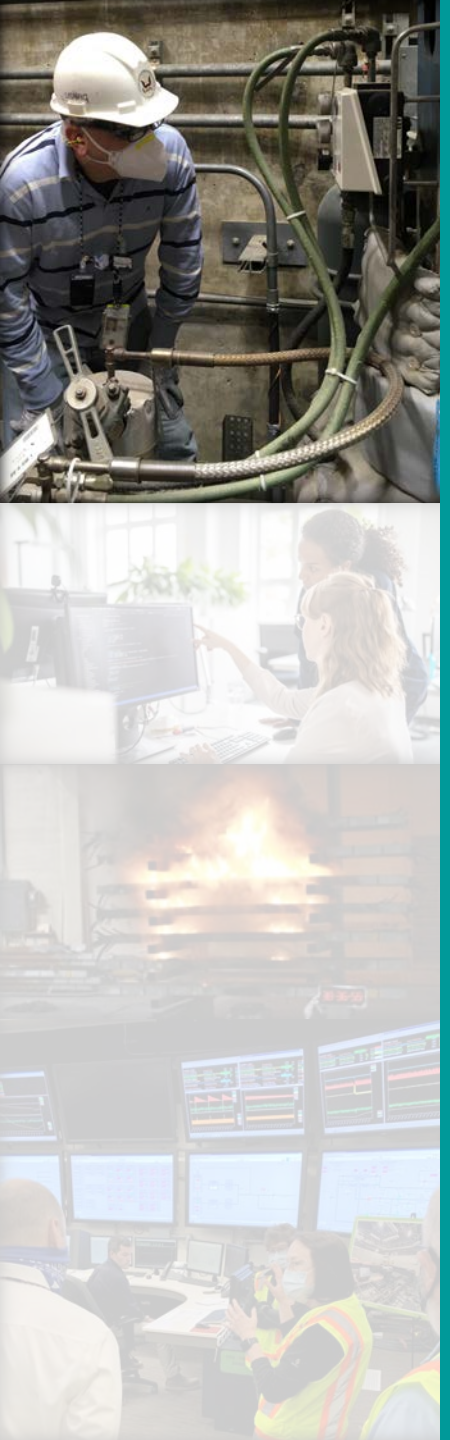
- Issue Trial Use Guide 1.247
- Support issuance of PRA Standards
- Tasks under the newly established UNR related to
  - Regulatory guidance on PRA Acceptability and Integrated Risk-Informed Decision Making, treatment of certainty, the PRA database, Glossary of risk-related terms, Database of Methods Used in PRAs
- Development of risk tools for spent fuel dry storage
- Future Focused Research on LMP for Operating Reactors

ASP PROGRAM

- Routine screening and analyses of events
- Support activities to enhance the application of ASP information in the ROP

OPERATIONAL EXPERIENCE, DATA COLLECTION, AND ANALYTICS

- Address the issues identified in PWROG-18029
- Issue the IE, LOOP and CCF summary reports
- Develop AI, ML, and data analytics tools to analyze OpE and risk information



Performance and Reliability Branch

RIDM and PRA Guidance and Standards

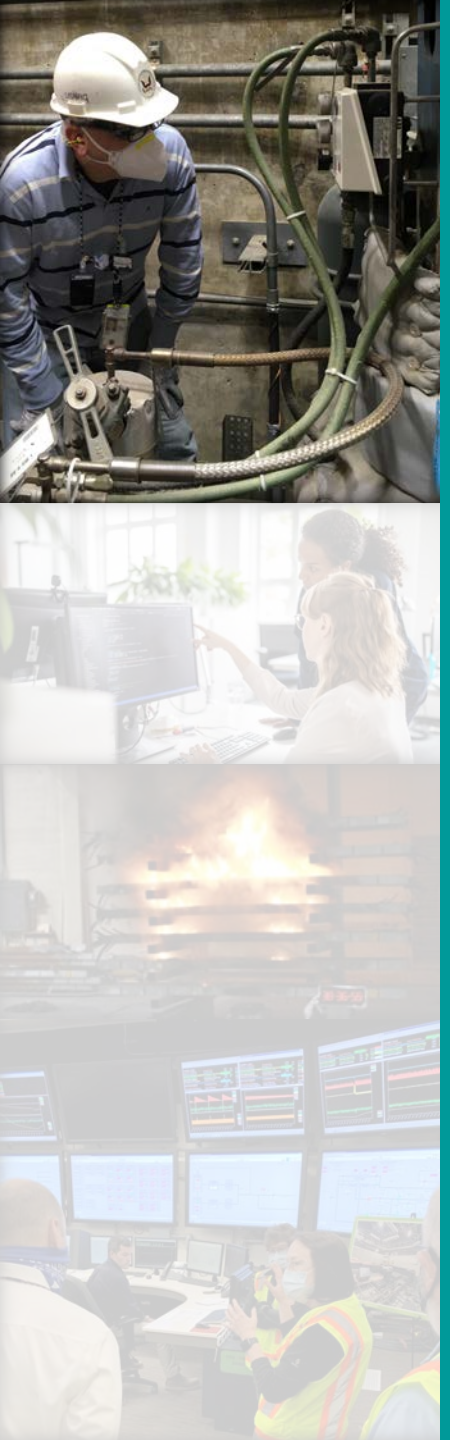
Develop approaches determining the acceptability of PRAs to provide confidence in the results of the PRA for risk-informed decision making; Address development of guidance for licensing and oversight of risk-significant technical areas

Accomplishments

- Issued RG 1.200, Rev. 3; RG 1.177, Rev. 2; RG 1.178, Rev. 2; RG 1.175, Rev. 1
- Supported issuance of the NLWR PRA Standard (Jan. 2021)
- Developed the PRA Standards Database

Future Direction

- Issue RG 1.247
- Support issuance of L1/LERF, ALWR, Level 2, Level 3, LPSD PRA Standards
- Regulatory Guidance on PRA Acceptability
- Enhance guidance on the treatment of uncertainty
- Update of glossary of risk-related terms
- Develop a database of methods used in PRAs
- Develop guidance on RIDM
- Develop guidance on uses of non-PRA techniques



Performance and Reliability Branch

Data Collection and Analytics

Directs the reviews and evaluations of OpE Information for the purpose of maintaining and updating models used in risk-informed decision-making

Accomplishments

- Implemented causal alpha factors in modeling CCF
- Issued On-Site Electrical System Reliability Study
- Supported audits and interactions with PWROG on FLEX reliability data
- **12** Reports Issued

Future Direction

- Finalize resolution of issues identified in PWROG-18029
- Renew the contract to access INPO data
- Explore the use of advanced computational tools to analyze OpE
- Use data visualization tools to present LERs, other OpE information
- Issue the IE, LOOP and CCF summary reports

Performance and Reliability Branch

ASP Program

Evaluates U.S. NPP operating experience to identify, document, and rank operational events by calculating a CCDP or a ΔCDP

Accomplishments

- Revised Office Instruction
- Developed and released the public ASP dashboard
- Completed Duane Arnold derecho event risk analysis

Future Direction

- Improve the application of ASP information in ROP
- Use of AI/ML and data analytics
- Event risk assessments for a broader set of reactor designs
- Continue providing KM sessions

Performance and Reliability Branch

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923

# of Precursors

1969 2020

Plant Type
- BWR
- PWR

Region: All

Analysis Type
- Degraded Condition
- Initiating Event

Initiating Event Type: All

LOOP Duration: All

Natural Phenomena: All

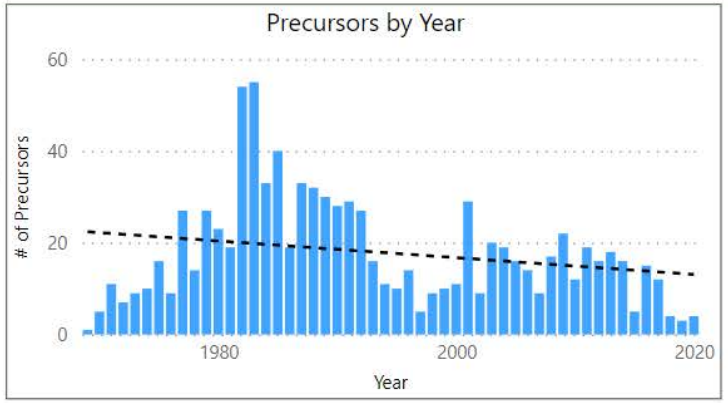
Hazard Group: All

Performance Deficiency: All

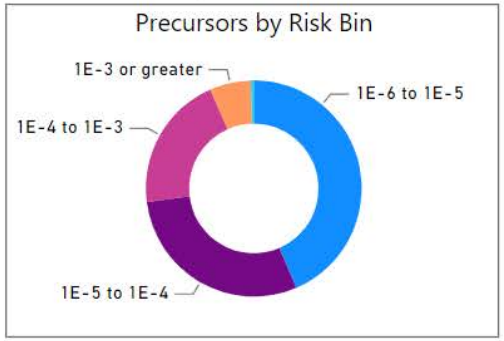
Condition Duration: All

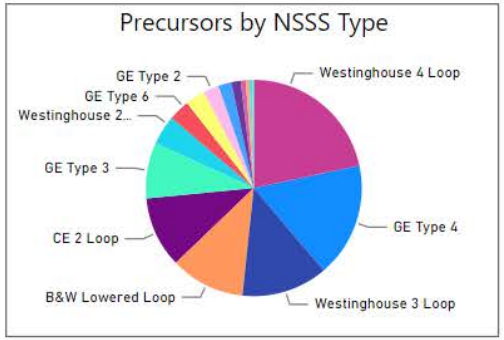
SDP
- SDP

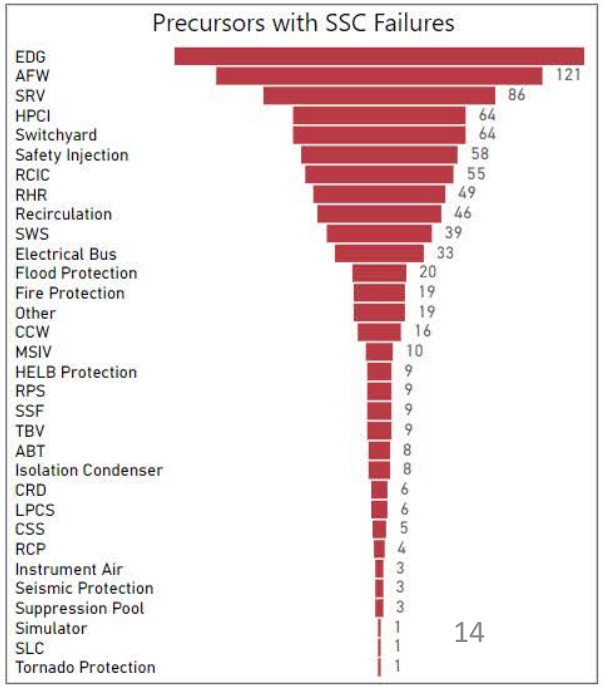
Shutdown
- Shutdown



Plant	Event Date	Description	Result	ASP Report
Duane Arnold	8/10/2020	LOOP caused by high winds		Analysis is ongoing
Brunswick 1	8/3/2020	LOOP during Hurricane Isaias		
Quad Cities 2	3/30/2020	Electromatic relief valve 3D did not actuate due to out of specfication plunger		Analysis is ongoing
North Anna 1	2/18/2020	Degraded upper cylinder piston pin bushing discovered during maintenance activities on EDG		Analysis is ongoing
Surry 2	11/20/2019	AFW system flow diversion due to failed pump disharge check valve	5E-006	
Browns Ferry 3	3/9/2019	LOOP caused by operator error	3E-006	
Pilgrim	1/8/2019	RCIC system fails during surveillance testing	3E-006	







Probabilistic Risk Assessment Branch

John Nakoski
(Holly Cruz, Acting)

Probabilistic Risk Assessment Branch

About PRAB

PRAB plans, develops, integrates and manages research and development programs relating to probabilistic risk assessment (PRA) models and methods, and supports agency efforts to use risk information in all aspects of regulatory decision making

Functional Areas

RISK-INFORMED DECISION-MAKING ACTIVITIES

- Support agency RIDM activities by developing PRA guidance and methods for new and emerging areas

DEVELOPMENT OF RISK MODELS AND TOOLS

- Develop and maintain PRA models and software to support agencywide risk-informed regulatory programs

Probabilistic Risk Assessment Branch

Major Projects

RISK-INFORMED DECISION-MAKING ACTIVITIES

- Full scope, comprehensive Level 3 PRA
- External Hazards & FLEX Modeling
- Recovery/Restoring Functions Credit
- International Standards Participation
  - WGEV, ICDE, Japanese Foreign Assignee
- ATF PRA Research
- Dynamic PRA (FFR)
- Advanced Reactor Support
- Regulatory Guide Support

DEVELOPMENT OF RISK MODELS AND TOOLS

- SPAR model updates with current plant information
- All Hazards SPAR Modeling
- SPAR-DASH risk data dashboard
- IDHEAS-ECA application
- SAPHIRE software updates and enhancements
- Cloud-based SAPHIRE

Probabilistic Risk Assessment Branch

SAPHIRE and SPAR Models

Develop risk tools for event assessment, reactor oversight, and reactor licensing, and to maintain staff PRA skills and knowledge management.

Accomplishments

Incorporated Flex Modeling into 68 SPAR Models

12 Significant Model Updates

Pilot-version of SPAR-DASH data visualization

Future Direction

- SAPHIRE & SPAR Improvements:
  - Expand and Enhance SPAR Model Scope
  - Cloud-based SAPHIRE
- SPAR-DASH:
  - Share/Obtain Feedback (partner offices)
  - Staff Guidance/Workshops
- Application of IDHEAS-ECA

Probabilistic Risk Assessment Branch

Level 3 PRA

Develop full-scope, site Level 3 PRA to support risk-informed decision making, reflect State-of-the-Art Reactor Consequence Analysis (SOARCA) insights in the proper risk context, and further enhance staff PRA skills.

Accomplishments

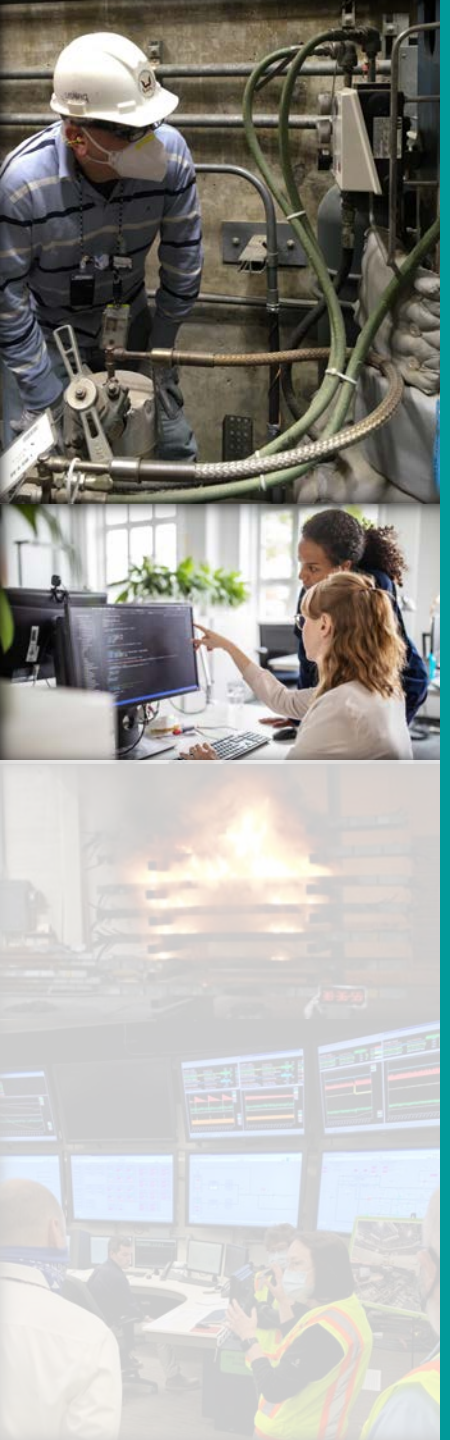
19 Base Case Models (90% completed Phase 1)

3 2020-FLEX Models (18% completed Phase 1)

5 Public Reports (23% of draft reports under review)

Future Direction

- ACRS Interaction
- Meetings/Public Release of Reports
- Knowledge Management and Risk Tool to Support Regulatory Decision-making



Probabilistic Risk Assessment Branch

Dynamic PRA

Future Focused Research to prepare NRC staff on the efficient use of Dynamic PRA (DPRA) tools for anticipated submittals developed using DPRA methods.

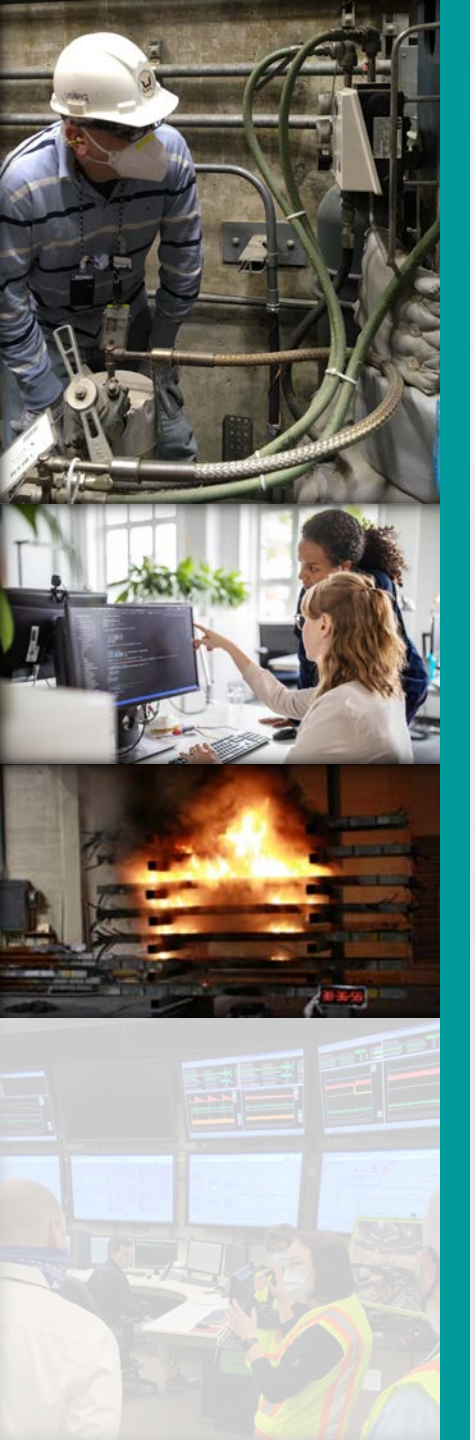
Accomplishments

1 Interim Report (literature review, activity summary)

3 Staff Training on the use of DPRA Tools

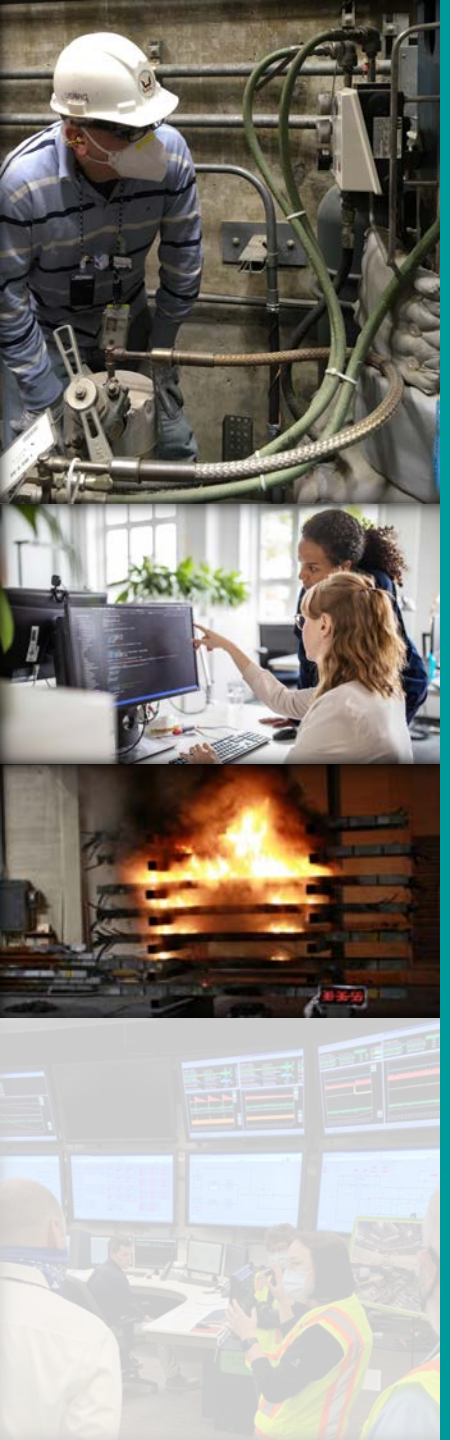
Future Direction

- Final Report (document model result)
- Follow-on Workshops/Training
- Support Changing Environment



Fire and External Hazards Analysis Branch

Mark Henry Salley



Fire and External Hazards Analysis Branch

About FXHAB

FXHAB is responsible for Fire Research and External Hazards Research (except earthquakes)

Functional Areas

FIRE RISK RESEARCH

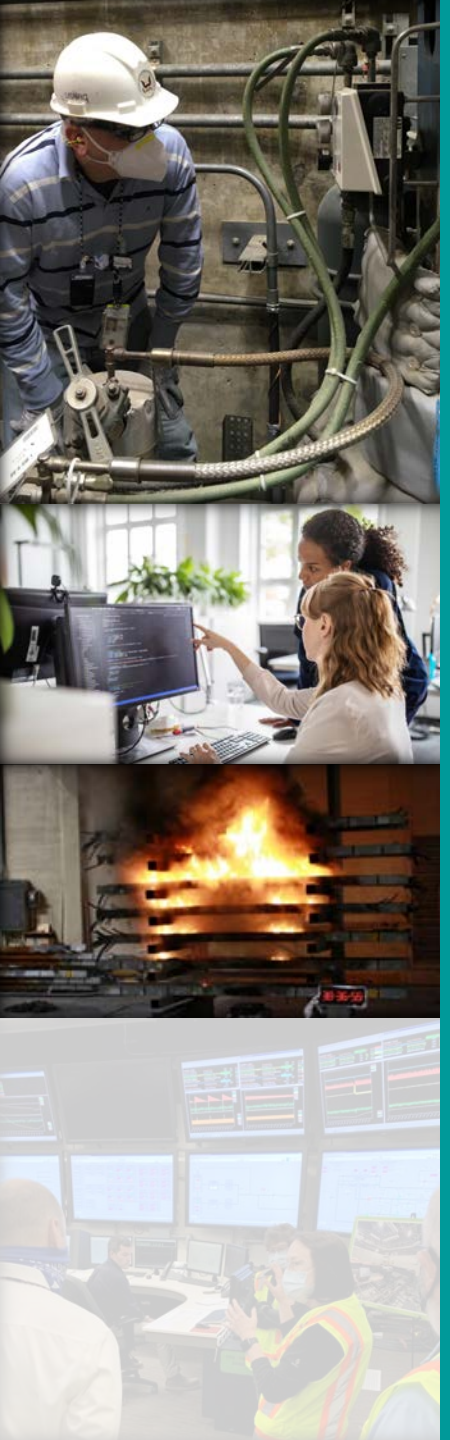
- Provide expertise in the area of fire hazard analysis and fire PRA

EXTERNAL HAZARDS RESEARCH

- Provide expertise in the area of external hazard analysis except for seismic

ENVIRONMENTAL HAZARDS RESEARCH

- Provide expertise in the area of environmental hazard analysis



Fire and External Hazards Analysis Branch

Major Projects

FIRE RISK RESEARCH

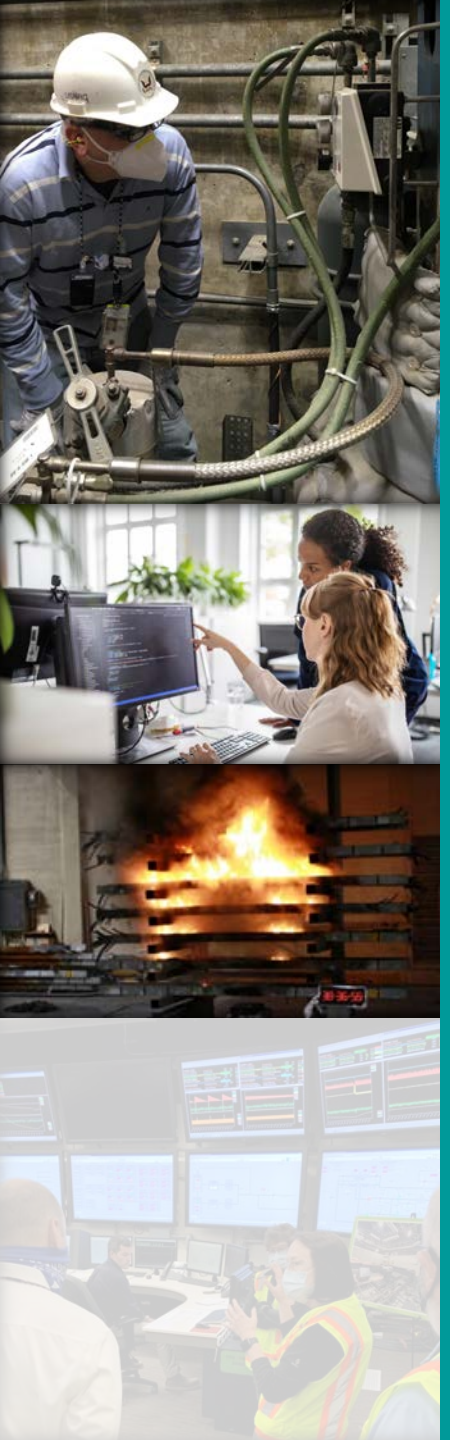
- Improve Fire PRA Realism
- Post-Fire Safe-Shutdown
- High Energy Arcing Faults (HEAF)
- Training

EXTERNAL HAZARDS RESEARCH

- Probabilistic Flood Hazard Assessment
- High Winds
- Weather Extremes

ENVIRONMENTAL HAZARDS RESEARCH

- Subsurface characterization
- Radon and ET covers
- Multi Agency Radiation Survey and Site Investigation Manual (MARSSIM)



Fire and External Hazards Analysis Branch

Improving Fire PRA Realism

Working with EPRI to advance and improve the realism when performing Fire PRAs

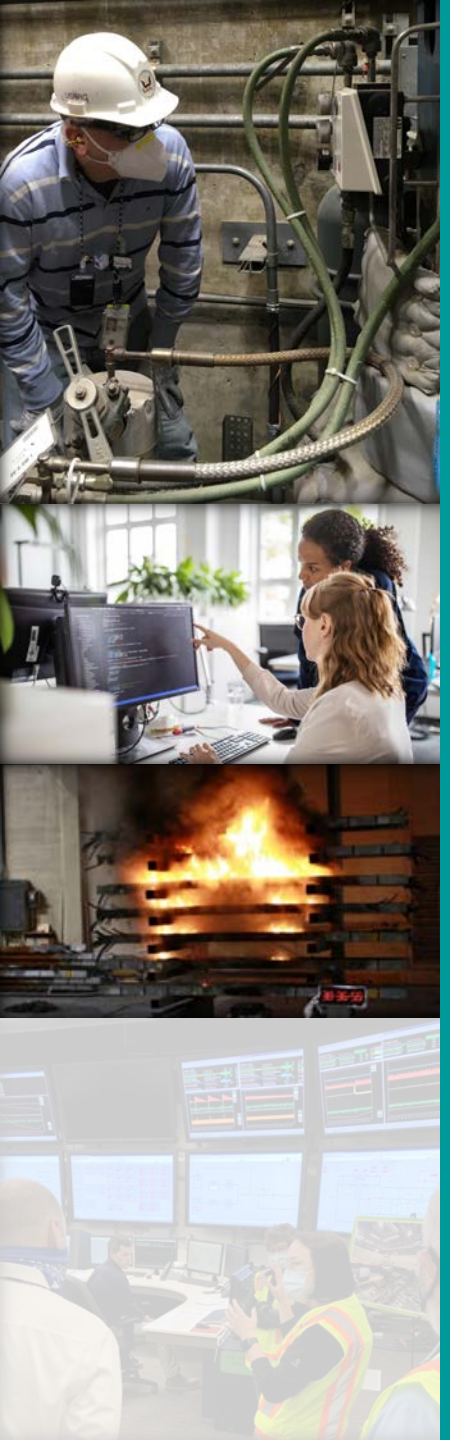
Accomplishments

4 NUREG Reports

2 Research Information Letters

Future Direction

- Prepare NUREG-1805 Supplement 2 to implement new tools, methods, and data developed for NRC Inspectors from recently completed research projects
- Work with EPRI to support additional improvements in fire PRA realism
- Provided comments on draft EPRI report 3002020747, Modeling of Oil Fires in Fire Probabilistic Risk Assessment
- Provided comments on draft EPRI report 3002020746, Small Electrical Enclosure Testing – Fire Test Report
- Ventilated Controlled Cabinet Fires with NIST



Fire and External Hazards Analysis Branch

High Energy Arcing Faults (HEAF)

- Working with EPRI,OECD/NEA to advance and understanding of the risk posed by HEAFs
- Exiting the Pre-GI 018 Aluminum HEAF and transferring back to research
- NRR performing LIC-504 evaluation

Accomplishments

2 Public Meetings

Completed draft RIL characterizing zones of influence

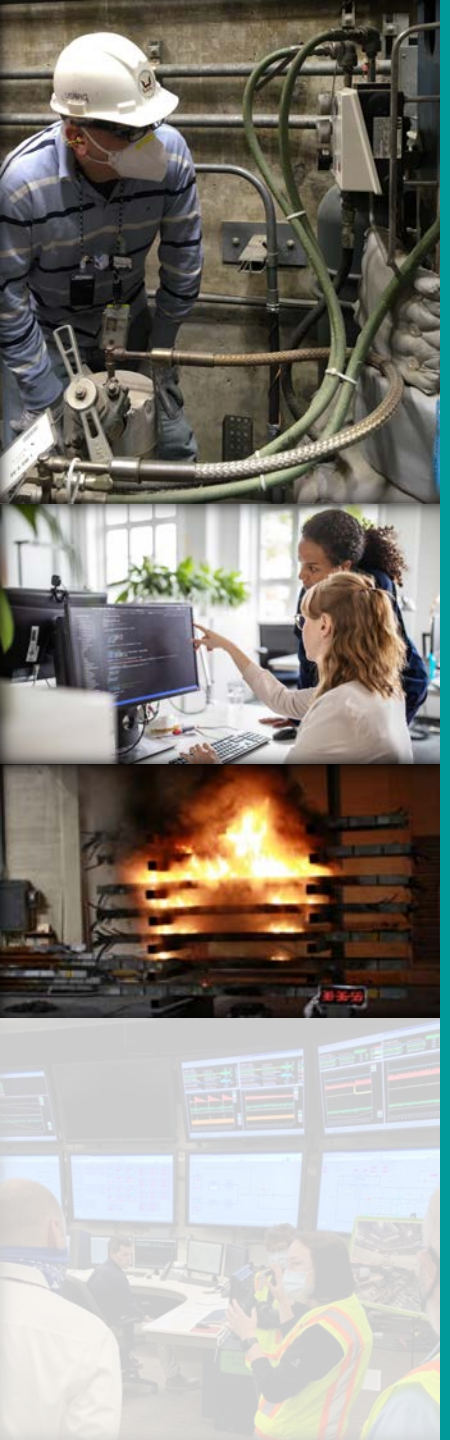
Developed web site and published detailed project plan

Future Direction

- Complete and publish WG tools and methods
- Support NRR with LIC-504 evaluation
- Resume Phase 2 of OECD/NEA Program

NRC HEAF Public Website

https://www.nrc.gov/about-nrc/regulatory/research/fire-research/heaf-research.html



Fire and External Hazards Analysis Branch

Probabilistic Flood Hazard Assessment (PFHA)

The PFHA Research Program is developing the technical bases, tools and guidance needed by NRC staff to reviewing regulatory submittals that apply a risk-informed approach to determine a site's flood hazards and potential consequences. The PFHA research comprises three phases: (1) Technical Basis Research; (2) Pilot Studies; and (3) Guidance Development.

Accomplishments

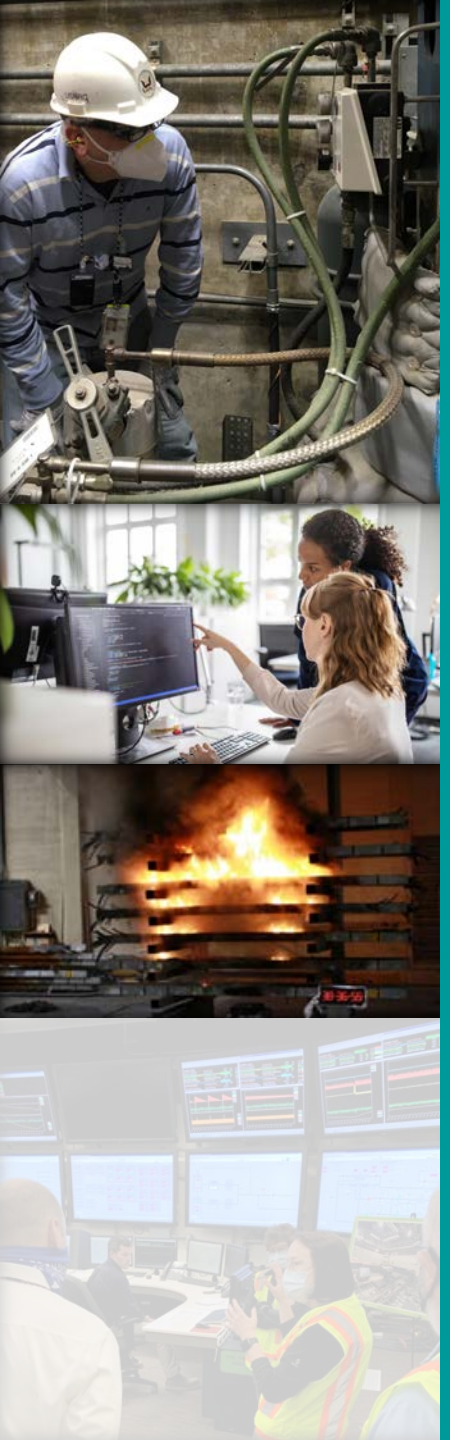
20 Technical Reports Published

Technical support, workshops, and staff training

3 pilot studies on flooding initiated

Future Direction

- Pilot studies will be completed in 2022
- Regulatory guidance will be completed in 2023
- Expand Workshop into other External Hazards



Fire and External Hazards Analysis Branch

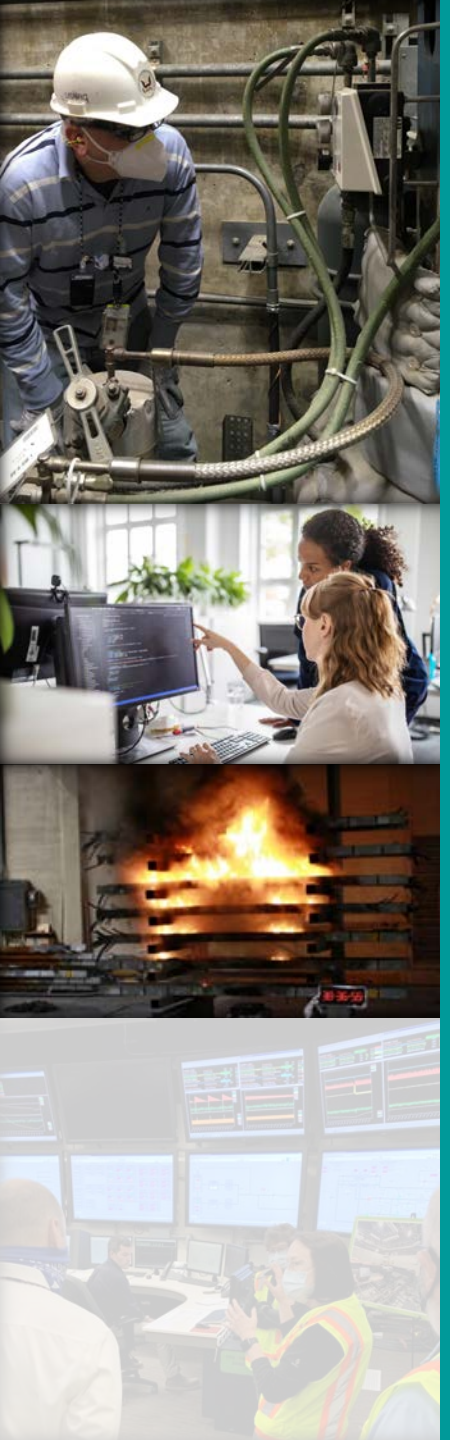
Probabilistic Flood Hazard Assessment Research Workshop

On February 22-25, FXHAB held the 6th Annual PFHA Research Workshop. Participants provided information on recent results, current activities, and perspectives on future research directions.

Workshop Topics:

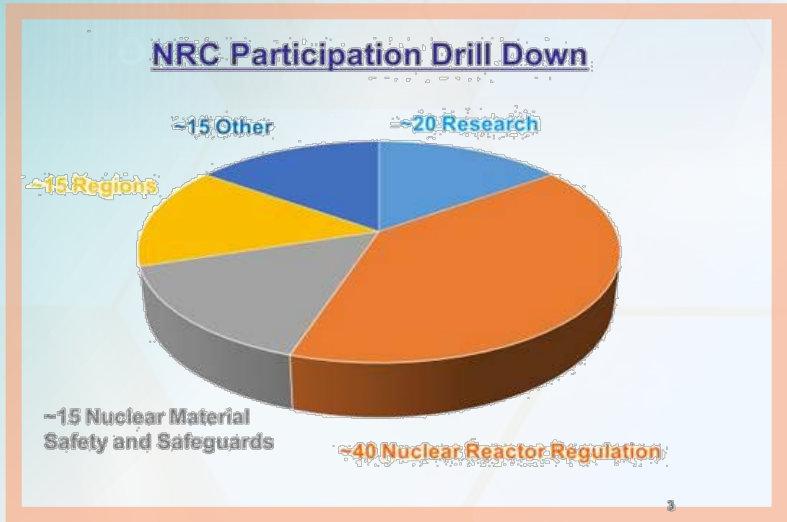
- Climate
- Precipitation
- Site-scale, riverine, and coastal flooding
- Modeling frameworks
- Flooding Events and Operational Experience
- External Flooding Probabilistic Risk Assessment
- 7th Annual PFHA Scheduled for February 15 –18, 2022
    - Phase in other External Hazards

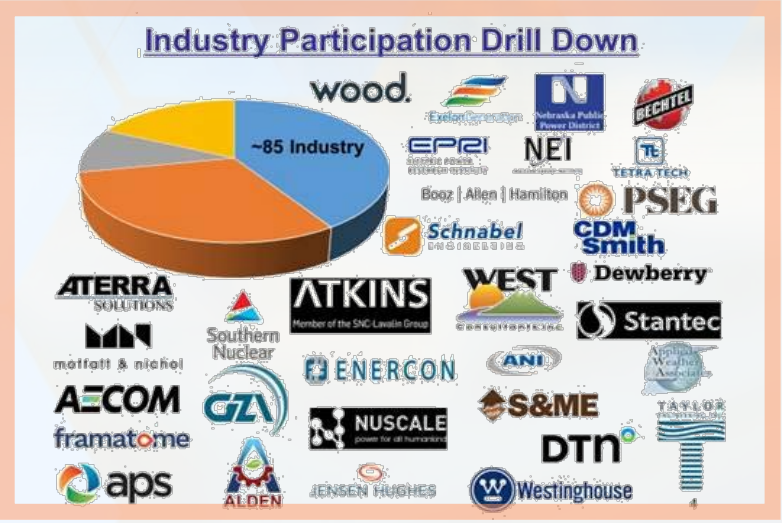
Workshop Agenda and Presentations: ML21064A395

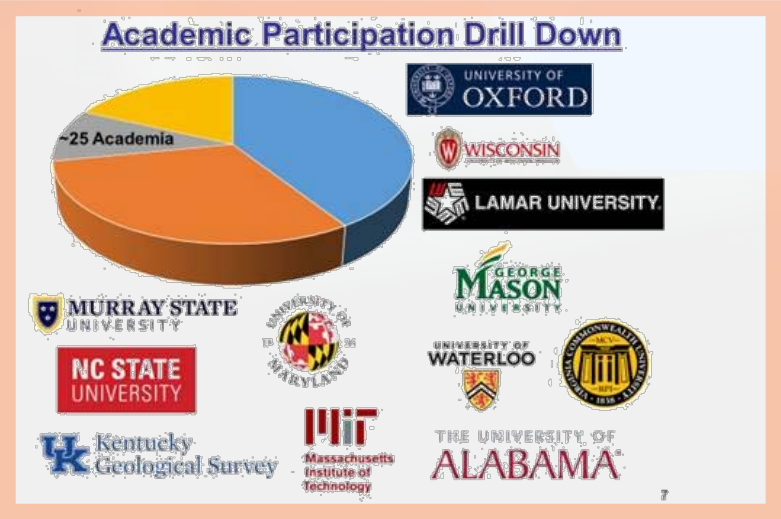


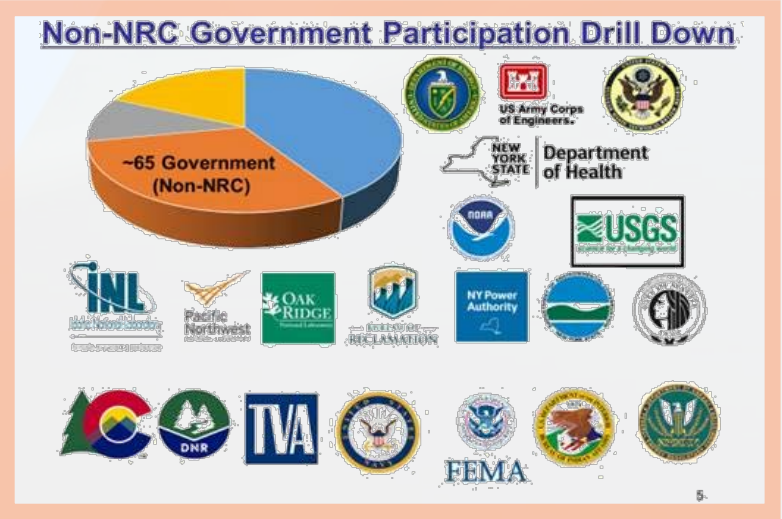
Fire and External Hazards Analysis Branch

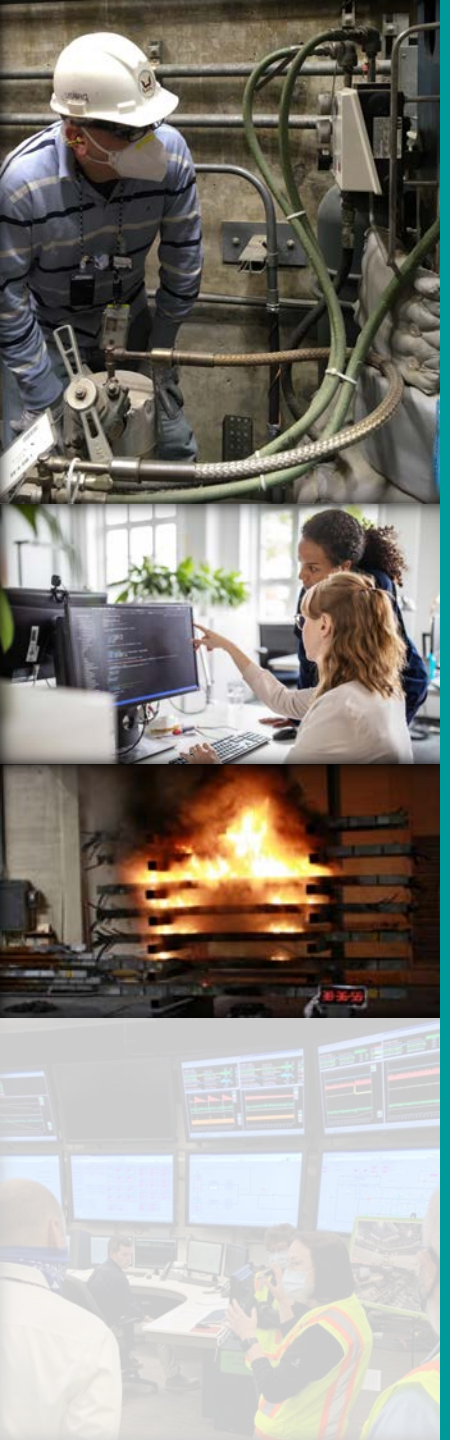
Probabilistic Flood Hazard Assessment Research Workshop











Fire and External Hazards Analysis Branch

Subsurface characterization and waste covers

Provide expertise in the area of environmental hazard analysis including subsurface monitoring, radon barriers and ET covers. This is a new area in the branch we are developing to primarily support NMSS related environmental projects

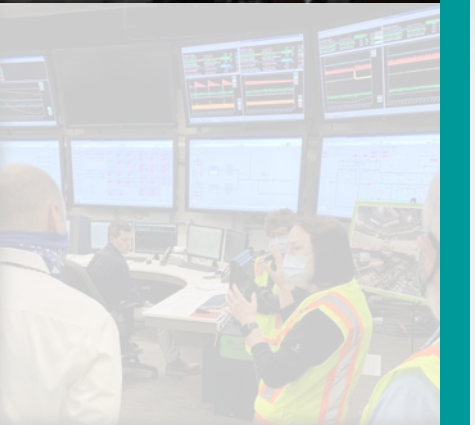
Accomplishments

Radon Barriers Project
- NUREG/CR-7288 in publication process
- 2 peer-reviewed publications

Subsurface Soil Survey Public Workshop

Future Direction

- Develop Guidance on Subsurface Contamination Survey
- Develop Guidance for Evapotranspiration (ET) Covers
- Develop Guidance for Evaluation of Geomembranes
- Research Assistance Request (RAR) NMSS-2021-005 (ML2119A221)
  - Assistance with the finalization of MARSSIM Revision 2 based on public and peer review comments to be published as NUREG-1575 Rev. 2

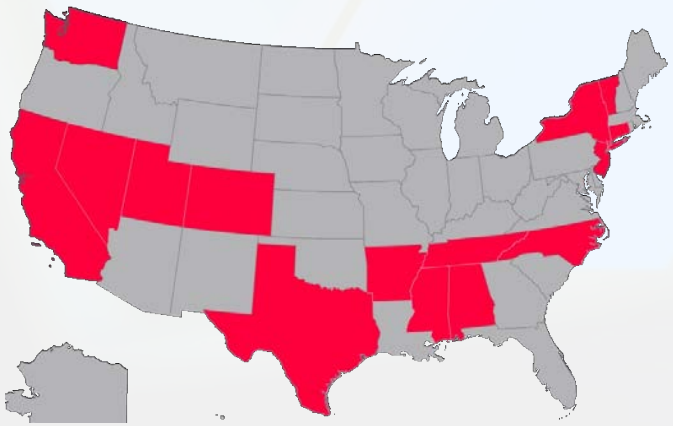


Fire and External Hazards Analysis Branch

Subsurface Soil Surveys Public Workshop

On July 14-15, RES/NMSS held a public workshop on the technical basis for guidance on conducting and evaluating surveys of residual radioactivity in the subsurface soils of licensee sites. The NRC began to address this problem in NUREG/CR 7021, “A Subsurface Decision Model for Supporting Environmental Compliance,” issued January 2012.

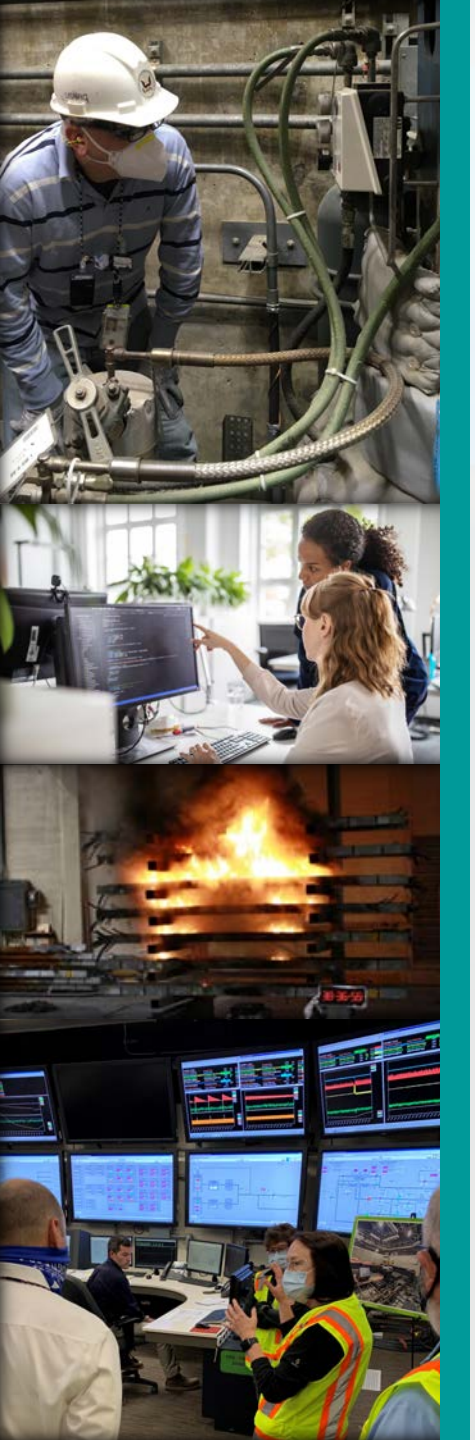
State Agencies:



Federal Registrants

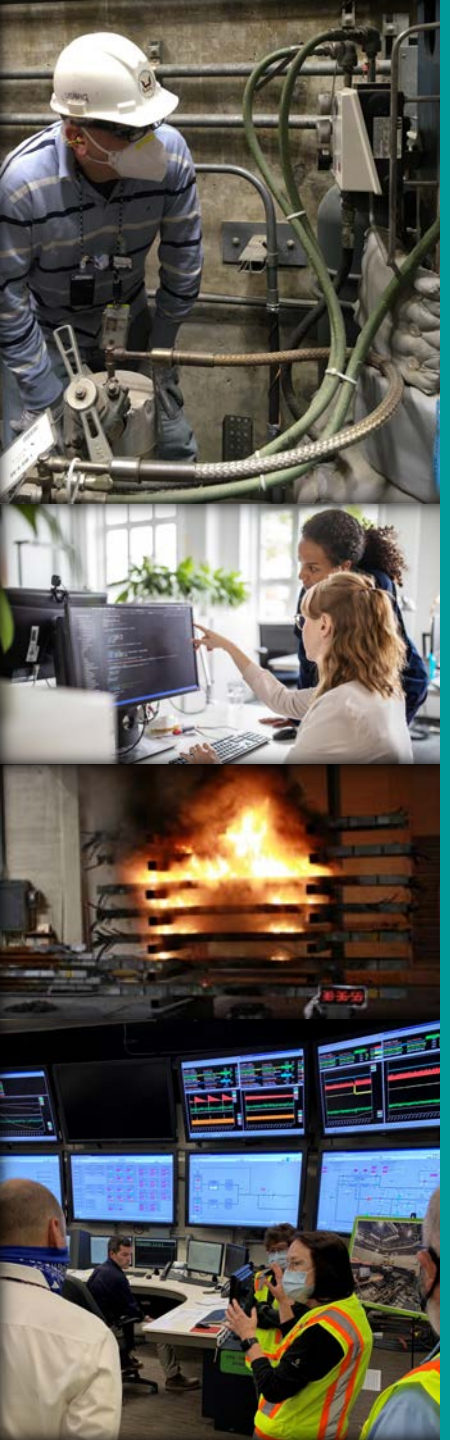
Industry

Workshop materials: [ML21208A206]



Human Factors and Reliability Branch

Sean E. Peters



Human Factors and Reliability Branch

About HFRB

HFRB Develops and maintains state-of-the-art human and organizational factors and human reliability analysis guidance and methods

Functional Areas

HUMAN FACTORS

- Provide expertise and support for human factors technical issues across all BLs
- Develop human factors rule language and review guidance for new and adv reactors, including for adv operations, automation, and control concepts

ORGANIZATIONAL FACTORS

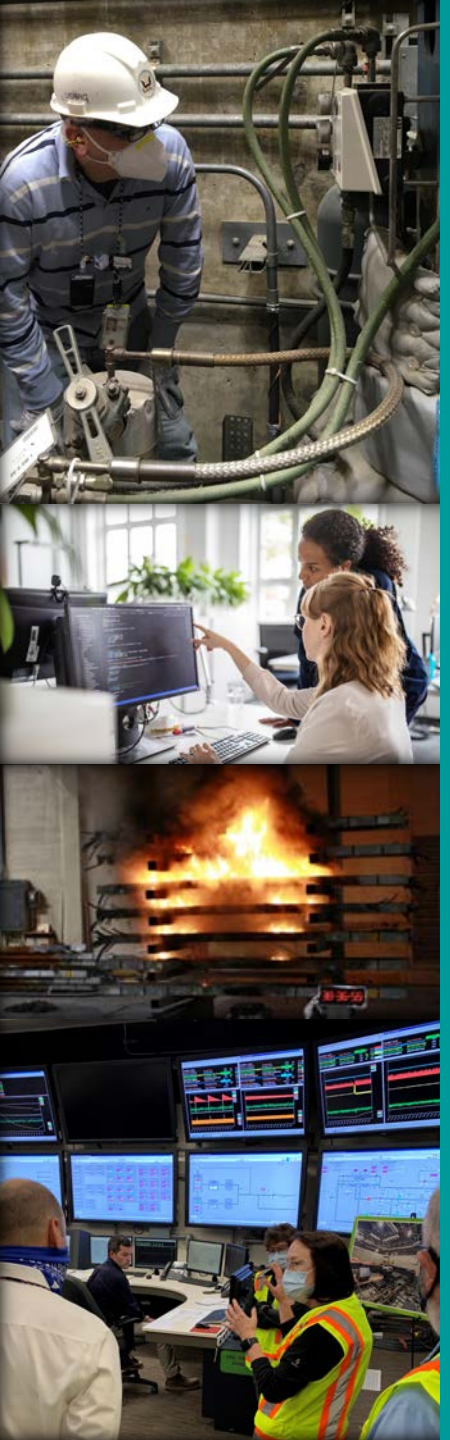
- Provide technical support for implementation of the NRC's Safety Culture programs
- Support the NRC's Desired Culture Initiative
- Develop, implement, and improve the NRC's Innovation programs

HUMAN RELIABILITY ANALYSIS METHODS

- Develop and improve HRA methods for agency risk applications

HUMAN RELIABILITY ANALYSIS DATA

- Collect and analyze data to improve the NRC's human factors guidance and HRA methods



Human Factors and Reliability Branch

Major Projects

HUMAN FACTORS

Operating Reactors:

- International Fitness for Duty Practices
- HF of Non-Destructive Evaluation Techniques
- HF Training Program Development
- HF Operating Experience Review

New and Advanced Reactors:

- NUREG-0711 and NUREG-0700
- Part 53 scalable HF licensing guidance
- Part 53 scalable operator licensing guidance

ORGANIZATIONAL FACTORS

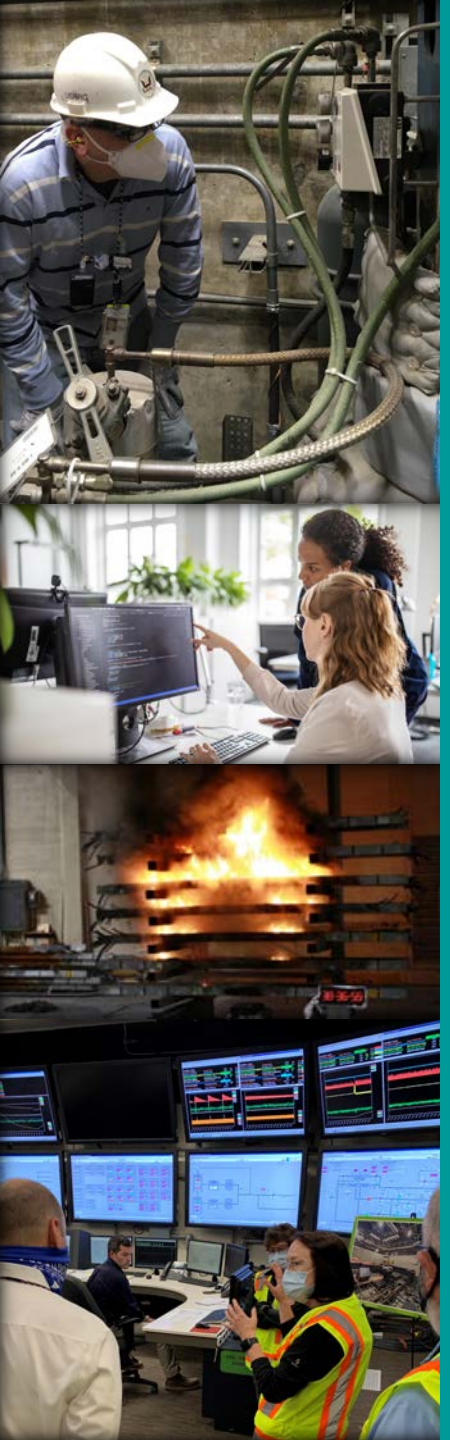
- Safety Culture Program Tech Support
- Reactor Oversight Process Tech Support
- Agency Desired Culture Initiative
- InnovateNRC2.0

HUMAN RELIABILITY ANALYSIS METHODS

- IDHEAS-G, IDHEAS-ECA

HUMAN RELIABILITY ANALYSIS DATA

- SACADA
- Human Performance Test Facility
- IDHEAS-Data



Human Factors and Reliability Branch

Advanced Human Factors

Human Factors Licensing Review Guidance Updates

Develop state-of-the art human and organizational factors guidance for advanced technologies and concepts of operation

Accomplishments

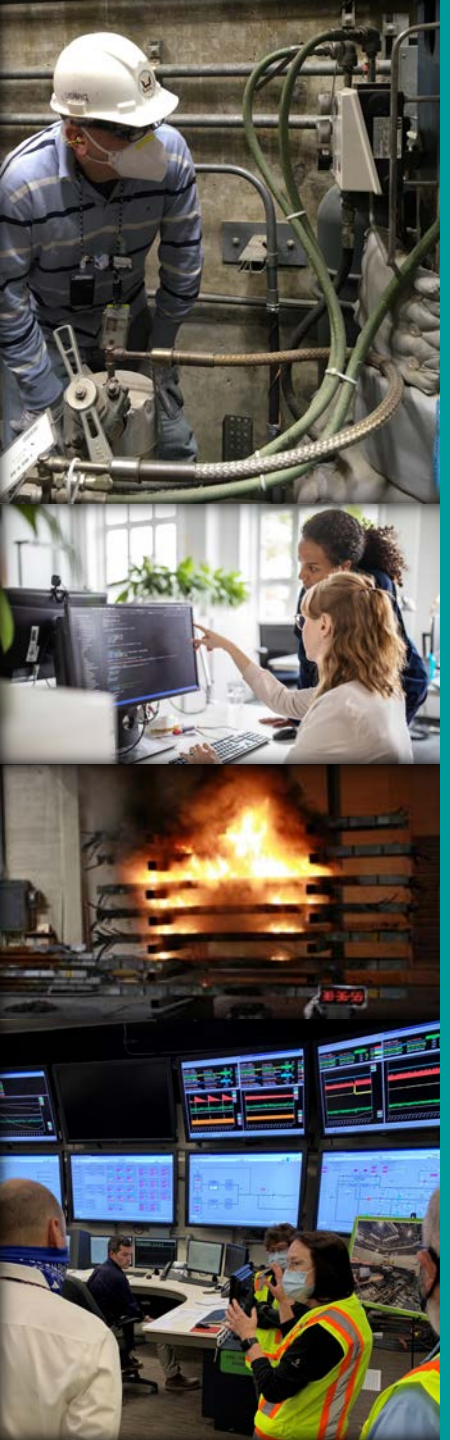
6 Technical Reports

Enhanced guidance for small-modular reactor reviews

Updated guidance for advanced technology control rooms

Future Direction

- Part 53 Scalable HFE Review Guidance
- Part 53 Scalable Operator Reactor Licensing Requirements



Human Factors and Reliability Branch

Organizational Factors

Agency Innovation and Culture Change

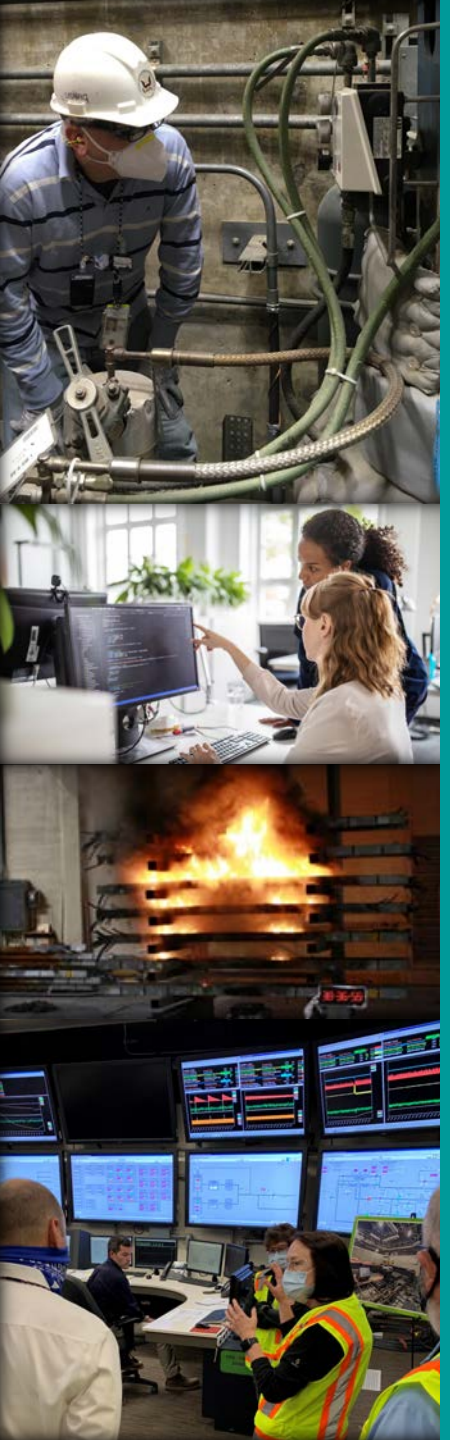
Utilize organizational factors expertise to drive innovation and culture change at the NRC to ensure that the NRC is a modern, risk-informed regulator

Accomplishments

- Developed InnovateNRC2.0 Program
- Safety Culture Common Language and Tech Support
- Support Agency Culture Improvements

Future Direction

- Foster a culture of continuous innovation at the NRC
- Enhance capabilities to perform external crowd sourcing for significant tech challenges



Human Factors and Reliability Branch

Human Reliability Analysis

Human Reliability Analysis Methods and Data

Improve realism in HRA through enhancing methods, reducing uncertainty, and utilizing human performance data

Accomplishments

- **14** Technical Reports
- **2** Improved HRA methods
- Comprehensive database of human error data
- Software tool for HRA implementation
- Software tool for HRA data collection

Future Direction

- Methods:
  - IDHEAS testing in NMSS Applications
  - Dependency/Recovery
  - Minimum Joint Human Error Probabilities
  - Uncertainty
- Data:
  - More plant participants
  - International HRA Data Exchange

Areas for Future Engagements

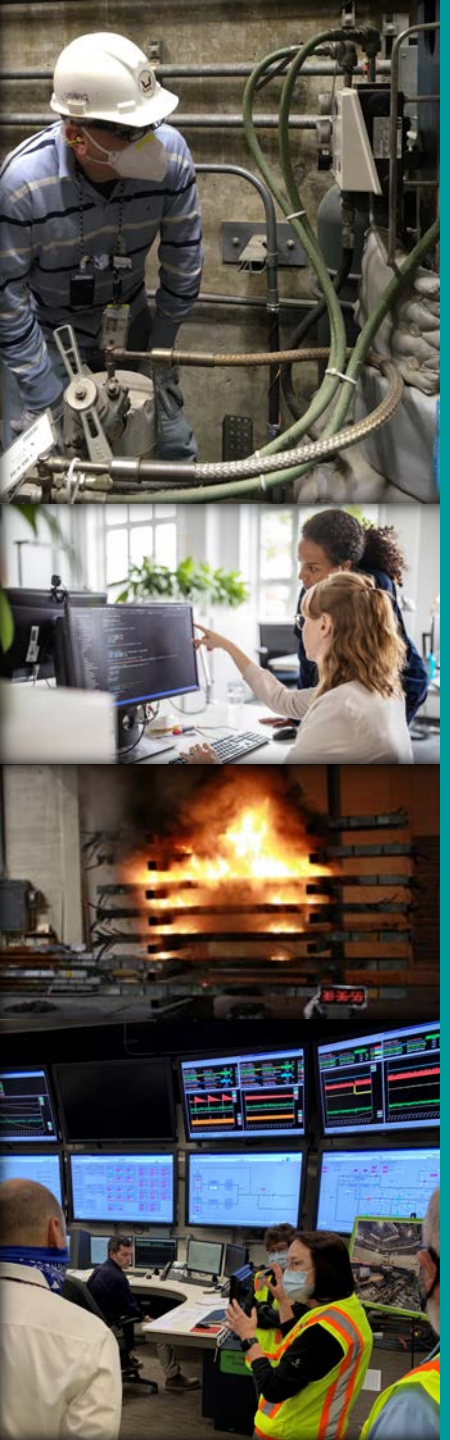
Level 3 PRA

HEAF

R.G. 1.247

Acronyms

ΔCDP	Increase in Core Damage Probability
ACRS	Advisory Committee for Reactor Safeguards
AI	Artificial Intelligence
ALWR	Advanced Light Water Reactors
ASP	Accident Sequence Precursor
ATF	Accident Tolerant Fuel
BL	Business Line
CCDP	Conditional Core Damage Probability
CCF	Common Cause Failure
DPRA	Dynamic PRA
DRA	Division of Risk Analysis
EPRI	Electric Power Research Institute
ET	Evapotranspiration
FFR	Future Focused Research
FLEX	Diverse and Flexible Coping Strategies
FXHAB	Fire and External Hazards Analysis Branch
GI	Generic Issue
HEAF	High Energy Arcing Faults
HFRB	Human Factors and Reliability Branch
HFRB	Human Factors
HRA	Human Reliability Analysis
ICDE	International Common-Cause Data Exchange
IDHEAS	Integrated Human Event Analysis System
IDHEAS-ECA	IDHEAS-Event and Condition Assessment
IDHEAS-G	IDHEAS-General Methodology
IE	Internal Event
INPO	Institute of Nuclear Power Operations
IRSN	Institut de radioprotection et de sûreté nucléaire
KAERI	Korea Atomic Energy Research Institute
KM	Knowledge Management
L1	Level 1
L3PRA	Level 3 PRA
LER	Licensee Event Report
LERF	Large Early Release Frequency
LMP	Licensing Modernization Project
LOOP	Loss Of Offsite Power
LPSD	Low Power Shutdown
MARSSIM	Multi Agency Radiation Survey and Site Investigation Manual
ML	Machine Learning
NASA	National Aeronautics and Space Administration
NEA	Nuclear Energy Agency
NIST	National Institute of Standards and Technology
NLWR	non-Light Water Reactor
NMSS	Office of Nuclear Material Safety and Safeguards
NOAA	National Oceanic and Atmospheric Administration
NRR	Office of Nuclear Reactor Regulation
OECD	Organisation for Economic Co-Operation and Development
OpE	Operational Experience
PFHA	Probabilistic Flood Hazard Assessment
PRA	Probabilistic Risk Assessment
PRAB	Probabilistic Risk Assessment Branch
PRB	Performance and Reliability Branch
PWROG	Pressurized Water Reactor Owners Group
RAR	Research Assistance Request
RG	Regulatory Guide
RIDM	Risk-Informed Decision Making
RIL	Research Information Letter
ROP	Reactor Oversight Process
SACADA	Scenario Authoring, Characterization, and Debriefing Application
SAPHIRE	Systems Analysis Programs for Hands-on Integrated Reliability Evaluations
SOARCA	State-of-the-Art Reactor Consequence Analyses
SPAR	Standardized Plant Analysis Risk
SPAR-DASH	SPAR Dashboard
SSC	Structures, Systems, and Components
STP	South Texas Project
UNR	User Need Request
USGS	United States Geological Survey
WG	Working Group
WGEV	Working Group on External Events



Thank You