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(202) 234-4433

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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683RD MEETING

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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WEDNESDAY

MARCH 3, 2021

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The Advisory Committee met via Teleconference, at 9:30 a.m. EST, Matthew W. Sunseri, Chairman, presiding.

COMMITTEE MEMBERS:

MATTHEW W. SUNSERI, Chairman

JOY L. REMPE, Vice Chairman

WALTER L. KIRCHNER, Member-at-Large

RONALD G. BALLINGER, Member

DENNIS BLEY, Member

CHARLES H. BROWN, JR., Member

VESNA B. DIMITRIJEVIC, Member

JOSE MARCH-LEUBA, Member

DAVID PETTI, Member

PETER RICCARDELLA, Member

ACRS CONSULTANTS:

MICHAEL L. CORRADINI

STEPHEN SCHULTZ

DESIGNATED FEDERAL OFFICIAL:

DEREK WIDMAYER

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P R O C E E D I N G S

9:30 a.m.

CHAIRMAN SUNSERI: Good morning, everyone, it's 9:30 a.m., we will convene the meeting. The meeting will now come to order. This is the first day of the 683rd meeting of the Advisory Committee on Reactor Safeguards.

I am Matthew Sunseri, Chair of the ACRS. I'll now call the roll and verify communications.

Ron Ballinger?

MEMBER BALLINGER: Here.

CHAIRMAN SUNSERI: Dennis Bley?

CHAIRMAN BLEY: I'm here.

CHAIRMAN SUNSERI: Charles Brown? Charles let me know he might be disposed for a few minutes at the beginning of this so he expects to join soon. Vesna Dimitrijevic?

MEMBER DIMITRIJEVIC: Here.

CHAIRMAN SUNSERI: Walt Kirchner?

MEMBER KIRCHNER: Here.

CHAIRMAN SUNSERI: Jose March-Leuba?

MEMBER MARCH-LEUBA: Yes.

CHAIRMAN SUNSERI: David Petti?

MEMBER PETTI: Here.

CHAIRMAN SUNSERI: Joy Rempe?

VICE CHAIRMAN REMPE: Here.

CHAIRMAN SUNSERI: Pete Riccardella?

MEMBER RICCARDELLA: Here.

CHAIRMAN SUNSERI: All right, very good, we have a quorum. The ACRS was established by the Atomic Energy Act and is governed by the Federal Advisory Committee Act.

The ACRS Section of the U.S. NRC public website provides information about the history of the ACRS and provides documents, such as our charter bylaws, Federal Register notices for meetings, letter reports, and transcripts of all full and Subcommittee meeting, including the slides presented at the meeting.

The Committee provides its advice on safety matters to the Commission through its publicly available letter reports.

The Federal Register notice announcing this meeting was published on February 12, 2021 and provided an agenda and instructions for interested parties to provide written documents or request opportunities to address the Committee.

The designated federal officer for this meeting is Mr. Derek Widmayer.

At today's meeting, the Committee will

consider the following. We will be preparing a letter report on the integrated human event analysis system general methodology.

Following that, we will have two briefings, one on the Regulatory Guide 1.24, fresh and spent fuel criticality analysis. And the second, the gateway for accelerated innovation in nuclear and advanced reactor demonstration program. We will finish the day with continuation of the report writing if necessary.

A bridge line has been opened to allow members of the public to listen in on presentations and Committee discussions. We have received no written comments or requests to make oral statements from members of the public regarding today's session.

I just want to remind everyone that members of the ACRS Staff monitor the remote aspects of the meeting so there is no need for participants to intervene if there's problems with open mics, feedback, or other communication problems.

There will be an opportunity for public comment. We will set aside time for comments in the agenda from members of the public attending or listening to our meeting.

Written comments may be forwarded to Derek

Widmayer, the designated federal officer. A transcript of the open portion of the meeting is being kept and it is requested that the speakers identify themselves and speak with sufficient clarity and volume so that they may be readily heard.

And lastly, participants should mute themselves when not speaking. I have a couple of comments to make before we get started with the agenda.

First, I want to acknowledge we are approaching the ten-year mark since the great East Japan earthquake. The earthquake and associated tsunamis were triggers for the accidents at Fukushima Daiichi Nuclear Station and emergency responses at several other nuclear facilities.

The global nuclear industry response was broad indeed. Corrective actions are enduring and we see examples in our work ten years after the event.

There was an additional toll on society as a result of the earthquake. In Japan, it was reported that over 120,000 buildings were totally collapsed, 280,000 half collapsed, and nearly 700,000 others damaged.

There were over 16,000 reported deaths, 6000 injuries, and 2500 people reported missing. So,

here we are ten years later and I can't tell how broad or deep the global response was to this part of the tragedy. I do see the actions we can take though.

Today, we are facing another issue associated with natural forces, and that's climate change. The nuclear industry is promoting the advancement of nuclear energy as part of the solution to the threat of carbon emissions to our atmosphere.

I anticipate that we will see a wide variety of designs and concepts seeking approval to operate, and I look forward to our role in ensuring the safety of these reactors.

Next, on a sad note, I want to pay respects to a former ACRS member that recently passed away. Don Barton was appointed in 1996. He was a retired executive at General Public Utilities Corporation, and a graduate of the U.S. Merchant Maritime Academy.

John began his career in the nuclear industry in 1960 working in a nuclear program before joining GPU in 1971. Regarding Barton's work on ACRS, former ACRS Chair John Stetkar said, and I quote, John read everything, much more than I could ever hope to digest.

We all know Stetkar so I can't think of a

better testament to John Barton's commitment and hard work in support of ACRS than those words. Thank you.

Now, I'd like to open the floor to Members for input, comments, or questions regarding today's agenda. No comments, all right. So, we will now transition into the first item of the agenda and that is report-writing for human event analysis system general methodology report.

Dennis Bley will be leading us through this part of the session and I will turn it over to Dennis.

CHAIRMAN BLEY: Thank you very much, Mr. Chairman. Matt, I've been having my sound get intermittent. If I should get cut off, if you'd continue reading I'd appreciate it. I'll come back in on the phone line if I need to.

PARTICIPANT: Dennis, I just want to say I thought Matt was cutting in and out as well so it's not as crisp as in the past.

CHAIRMAN BLEY: We'll do the best we can. Before I read through the letter, you're going to notice it's a little different in format than we usually use.

I adopted the same format we used on two previous letters on this issue and I think it works

better this way because it puts the focus right on the 2006 SRM. So, that's why it's a little different.

I'm hearing people talking or noise.

CHAIRMAN SUNSERI: There is some feedback going on so if you're not speaking, close your mic, please. Mute yourself. Go ahead, yes. Dennis, did we lose you?

Are you there?

CHAIRMAN BLEY: Somebody muted me.

CHAIRMAN SUNSERI: Yes, I think the Staff did. When we get those problems back, once the staff do so when they do that, they can't unmute you, you have to unmute yourself.

CHAIRMAN BLEY: Thanks for telling me because I had no idea. This letter is to the Chairman and the subject is NRC Human Reliability Methods for Chairman Hansen.

In November 8, 2006 Staff requirements memorandum resulting from the October 20, 2006 meeting with the Advisory Committee of Reactor Safeguards, the Commission directed us to work with the Staff and external stakeholders to evaluate the different human reliability models in an effort to propose either a single model for the Agency to use or guidance on which models should be used in specific circumstances.

(Whereupon, the above-entitled matter went off the record at 9:36 a.m. and resumed at 9:39 a.m.)

CHAIRMAN SUNSERI: All right, there was a bunch of shuffling and it was quite loud on my end. Yes, okay, so we will call the roll now starting with Ron Ballinger?

MEMBER BALLINGER: Here.

CHAIRMAN SUNSERI: Dennis Bley? You can unmute now. Charles Brown?

MEMBER BROWN: Here.

CHAIRMAN SUNSERI: Vesna Dimitrijevic?

MEMBER DIMITRIJEVIC: I am here.

CHAIRMAN SUNSERI: Walt Kirchner?

MEMBER KIRCHNER: Here.

CHAIRMAN SUNSERI: Jose March-Leuba?

MEMBER MARCH-LEUBA: Yes.

CHAIRMAN SUNSERI: David Petti?

MEMBER PETTI: Here.

CHAIRMAN SUNSERI: Joy Rempe?

VICE CHAIRMAN REMPE: Here.

CHAIRMAN SUNSERI: Pete Riccardella?

MEMBER RICCARDELLA: Here.

CHAIRMAN SUNSERI: And I'll go back to Dennis, I know you're there, Dennis.

CHAIRMAN BLEY: You're right.

CHAIRMAN SUNSERI: So, we're going to reconvene the sessions here for today. Our afternoon topic is regulatory guide 1.24, Fresh and Spent Fuel Criticality Analyses.

Ron Ballinger will be facilitating this part of the discussion.

I just want to let those that are listening in that we do have a -- I'll call it for lack of a better term a carryover item from our last full Committee meeting planning and procedures session, where we are going to propose writing a letter on control of access, digital INC control of access.

So, we will use the time in agenda slide for report preparations, like for example, 3.3, 4.3, et cetera, and we'll use that time management to make sense today. So, I just wanted to give everyone a heads-up on that.

Any questions before we move on? All right, I will yield the floor to Dr. Ballinger.

MEMBER BALLINGER: Thank you, Mr. Chairman. This presentation relates to actually a new Reg Guide, which is a summation and recommendations related to performing criticality analysis for spent or fuel storage.

And the Reg Guide endorses, with a few exceptions, NEI 12-16. It turns out that the spent fuel pool criticality analysis has evolved, if you want to use that word, over time, actually, from the earlier note that I could find.

It's the so-called Kopp memo in 1998, which described the Staff's thoughts related to performing this analysis.

But spent fuel pools have evolved with time, storage density has gone up and everything. And so the analysis that's required has evolved, if you will, with that.

And it's resulted in a number of analysis go back and forth between the Staff every time analysis is done to go back and forth and make sure it's in agreement with the Staff's idea of what goes on.

So, this Reg Guide basically incorporates all of this guidance into one place for this type of analysis. So, I would turn it over to -- if he's on, I hope -- Mr. Lukes to give us some opening remarks as well.

And he can correct something I may have said incorrectly.

VICE CHAIRMAN REMPE: Ron, before we

start, I thought you were going to make the announcement, but I do have to recuse myself from this discussion because of conflict of interests concern.

MEMBER BALLINGER: I didn't know.

VICE CHAIRMAN REMPE: I did copy you on the emails, but anyway, I've made the announcement. If there's a better way to say it, Chris, please speak up and say it.

MR. BROWN: You're correct, Joy, and we did note it on the conflict of interests memo.

MEMBER BALLINGER: It's my cognitive impairment. Okay, so Bob Lukes, are you there?

MR. LUKES: Yes, can you hear me?

MEMBER BALLINGER: Yes.

MR. LUKES: First of all, you said everything correctly. So, my name is Bob Lukes, I am the Branch Chief for the Nuclear Methods and Fuels Branch in NRR.

We appreciate the opportunity to present to the ACRS our new Reg Guide. As you stated, it's GG1373 Fresh and Spent Fuel Criticality Analyses.

As was said, this Reg Guide endorses with clarification any guidance document, 1216, guidance for performing criticality analysis of spent fuel storage and lightwater reactor power-plants.

The NRC is issuing this Reg Guide to describe and approach that is acceptable for Applicants and licensees under 10 CFR Part 50 and 52 to demonstrate that the NRC regulatory requirements are met for subcriticality, appeal assemblies, stored in new fuel vaults and spent fuel pools.

This Reg Guide is the culmination of several years of work by both the NRC and NEI. This new Reg Guide will provide clarity and certainty to the life expectancy regarding spent fuel criticality analysis.

As always, we look forward to your questions and comments on the Reg Guide. Thank you, that's it.

MEMBER BALLINGER: This is Ron again. I might add that I reviewed this document back, I think, in June or July and recommended against the letter but that we should wait until we get the public comments back to make a decision.

So, one of the decisions we need to make today amongst the Committee is do we want a letter or not? So, I think that's all I needed to say additionally.

So, I guess Ben Holtzman is here, hopefully.

MR. HOLTZMAN: Yes, I'm here, can you guys hear me?

MEMBER BALLINGER: Yes, the floor is yours.

MR. HOLTZMAN: Wonderful, thank you, good afternoon. My name is Ben Holtzman from the Nuclear Energy Institute. I'm joined today by Hatice Akkurt and Bob Hall from EPRI.

On behalf of the industry presentation team and the industry in general, I'd like to thank the ACRS for their interest in this important topic.

Additionally, I'd like to thank both ACRS and the NRC in their efforts in putting together this meeting and giving us the opportunity to share our perspective for NEI 1216 and the associated guidance development process in general.

The issues addressed in NEI 1216 and the related documents have a long history of strong NRC engagement and we look forward to reaching a conclusion that provides regulatory certainty and predictability for both industries and NRC.

Looks like that's working. So, the origin of this work dates back to 2006 when NRC Staff brought additional oversight to criticality issues associated with spent fuel pools.

This created uncertainty in the regulatory framework and resulted in utility LARs submissions being held to a shifting regulatory standard as NRC questioned existing regulatory practice that was not formally documented, such as the Kopp memo.

NRC then issued interim Staff guidance in 2010 that applied to additional conservatisms, compared to the Kopp memo, but did not give industry regulatory certainty and predictability for spent fuel criticality LARs.

In response, EPRI sponsored work to qualify the depletion and uncertainty and determine whether the uncertainty used in the Kopp memo was in fact conservative.

Simultaneously, NEI began the effort to develop guidance on acceptable methods for performing spent fuel pool criticality safety analyses, NEI 12-16.

The goal of this effort was and remains to provide durable guidance that enables consistent criticality analyses for Applicants and reviewers.

Historically, spent fuel pool criticality analyses were straightforward but over time they became more complicated because of the implementation of new fuel types and multiple burnable absorbable

materials.

Furthermore, utilities began to use more complex arrangements within the spent fuel pool, such as having pools that consisted of multiple regions. I want to stress that while these previous analyses were simple, they were very safe, just less complex.

It was the implementation of these more complex spent fuel pool management strategies that led to more complex criticality analyses and that, in turn, led to the need for more guidance.

So, as I mentioned, this issue has a long history of engagement between NRC, industry, and EPRI. These interactions have taken the form of numerous public meetings, RAIs, even a full week audit by NRC back in October of 2016.

This has resulted in very detailed guidance backed by technical justification. The work from the beginning was two parallel efforts that were being done in tandem, the NEI 1216 guidance and that work which was informed by the EPRI benchmark reports.

So, a little bit of the timeline or history of this was first we had NEI 1216 Rev 0 and the EPRI benchmarks that were initially being developed and then submitted to NRC back in March of 2013.

This led to extensive public dialog with NRC through a series of four-day public meetings NRC Staff and management that took place between September of 2013 and February of 2014, resulting in alignment on acceptable methodologies for criticality analyses, which were documented in meeting summaries and then reflected in a revised NEI 1216, which was submitted as Rev 1 to NRC in April of 2014.

We also had then Revision 2, which was submitted in January of 2017. So, part of the reason for this revision was that the neutron-absorbing monitoring section had been removed and moved to NEI 1603 based on agreement with NRC.

NEI 1603 was submitted as the topical report in August of 2016 and a final safety evaluation or SER was received in March of 2017.

I want to highlight that this is a great success story for both industry and NRC as it took less than a year from submission to approval of NEI 1603.

We also then subsequently had NEI 1216 Revision 3, which was submitted in March of 2018, and then Revision 4 which was submitted in September of 2019.

The EPRI benchmarks received final

approval in January of 2020. Next, I'd like to highlight a few important topics that are noted in the documents that will be further elaborated on in the EPRI portion of the presentation that's coming up.

Specifically, the calculation of the maximum K effectives, the depletion code validation, and the criticality analysis checklist.

So, with that, I will transition to the EPRI portion. Hatice? Hatice, you're on mute if you can hear me.

MEMBER BALLINGER: Well, we've already achieved something that I've learned and I've now learned how to pronounce her name. Is she on?

PARTICIPANT: If you're on the phone, you can star 6 to umute yourself.

MEMBER BALLINGER: She's logged in.

MS. AKKURT: Can you hear me now?

MEMBER BALLINGER: Yes, you're a little soft.

MS. AKKURT: Okay, I will try to speak louder.

MEMBER BALLINGER: Thank you.

MS. AKKURT: Very much. I didn't realize I had to star 6 and unmute myself. Thank you, Ben, I'm Hatice Akkurt from EPRI. I will get started with

my notes from EPRI and then Bob from EPRI will take over from that.

Next slide, please, Ben. So, one of the most challenging problems in this review for us was how to handle the decision of uncertainty and bias.

And if you know spent fuel is mostly the trap of spent fuel and if you are going to apply burn-out credit, then it can cause detonation and depletion of uncertainty, it needs to be addressed.

So, going back one step, fresh fuel normally can call the experiment from intonation of the focus for experiment used for code validations. There are hundreds of applicable experiments that can be looked at.

When it comes to spent fuel, there are many experiments moving spent fuel, and performing critical experiments using spent fuel is very expensive and there are not many supposed to be there.

MEMBER BALLINGER: Pardon me, but there's somebody that has their microphone on and we're getting a fair amount of background noise. Can you mute your microphone, please?

Thank you.

MS. AKKURT: We are hearing a lot of background. Can you mute yourself?

MEMBER KIRCHNER: Ron? This is Walt. We're getting a lot of cross --

(Simultaneous speaking.)

MEMBER KIRCHNER: Somebody has as number 410-768-1803 needs to mute their phone. We had that --

(Simultaneous speaking.)

MR. BROWN: That's the bridge line. There's another 980 number that's showing a lot of static on it too.

MS. AKKURT: 980 is myself. I am talking.

MEMBER BALLINGER: The static has disappeared so somebody's done something, thank you.

MS. AKKURT: Sorry about that. I hope the audio quality is improved now.

So, as I mentioned, for bridge fuel you have options. You can use the critical experiments in the handbook but when it comes to spent fuel, there are no critical experiments and performing critical experiments is very expensive.

And using the bridge fuel assumption is overanalyzing, obviously. Then the question of uncertain bias and bias for spent fuel criticality analysis is a big one.

So, in 1990, Ron, earlier you mentioned in

your opening remarks, NRC Staff Kopp issued a memo and basically, it stated that in the absence of any other data or methodology, an uncertainty that equals five percent of the reactivity cb4 used.

And this uncertainty, five percent, is accounting for I just saw the data and everything else for all those uncertainties.

Given that this was easy to justified, it has been used by utilities in many of the applications. So, around 2009, this company was challenged for the technical justification behind the Kopp memo.

So, at that time, NRC sponsored the Oakridge Lab, which is based on chemical and same measurements.

Chemical and same measurements is the fact that it contains a lot of measurement uncertainty, therefore, it is propagated into the methodology and at least preliminary industry that Kopp memo means not necessarily conservative or close to burnup range.

EPRI also sponsored the development and methodology. EPRI methodology is based on actual practical data from four operating reactors using the 44 cycle flux map data.

The good thing is that flux map data

contains much smaller measurements of uncertainties. So, EPRI was developed in the two reports that are listed at the bottom of the flight.

And these two reports have been submitted for NRC review and topic report until the NEI umbrella, as Bob mentioned earlier.

Next slide. So, EPRI then goes through the review cycle and we had multiple rounds of REI and public meetings, and eventually, we got the final test evolution report in July of 2019 and published the report in September.

The report influenced all the rounds of REIs, the REI responses, the draft and final SVA. Now, the important thing to note here is EPRI benchmarks as a result of uncertainty and bias values that are determined as a function of burnout.

The first thing that has ever been on the table that is on this slide is uncertainties are much less than five percent so the technical basis for Kopp memo is now demonstrated.

And also for those who would like to get additional margins, there is additional margins as a function of burnup.

MEMBER MARCH-LEUBA: Can I ask you a question? This is Jose March-Leuba. It's interesting

that the uncertainty seems to grow with the lower gigawatt burnout.

Granted, there are very few bundles with 10 gigawatts in the spent fuel pool but you never found the peak. You would expect there to be a peak. It could have grown greater than 5 at 5 gigawatts.

Do you understand why it goes up? I suspect that it's because of the aluminum modeling. Do you know the uncertainty is larger on the lower burnout?

MS. AKKURT: So, this is in percentage so in percentage it's larger but if you look at the absolute values, the uncertainty is higher for higher burnout.

MEMBER MARCH-LEUBA: So, this is percent of delta K, not percent of delta K over K?

MS. AKKURT: Yes, this is percent of reactivity. It's in percentage but if you have the absolute values in the report too, but for delta K, percentage is found to be easier to implement.

So, the first thing is in terms of absolute value, it is lower. And the second reason you exactly answered the question, part of the issue is that obviously you don't have many values at ten so the data is relative there.

And also, at zero it is delta zero so we are starting at zero.

MEMBER MARCH-LEUBA: That was my point, there will be a peak that doesn't feel like it's going to hit five percent but maybe at 5 gigawatts, could it have been 5 percent?

MS. AKKURT: I don't think so. Then you look at the thread of the data and the report itself, it is no linear but it is doesn't change in direction in causing a peak.

Do you get it?

MEMBER MARCH-LEUBA: Yes, could you explain to me for my location what are the units of the percentage? What's the percent in? What is it?

Typically, we talk percent delta K over K.

MS. AKKURT: Yes, delta K over K.

MEMBER MARCH-LEUBA: Is that the percent that you're talking about?

MS. AKKURT: Yes.

MEMBER MARCH-LEUBA: So, the K of a low burnup fuel would be higher, wouldn't it? Never mind.

You have confidence that if you had done a finer mesh and gone down all the way to 5 gigawatts, it doesn't feel like if I set it up linearly, it would hit 5 percent. And you have confidence that will

happen.

MS. AKKURT: We have confidence in that because if you look at the spread of the data and the shifts of the data, you will not have sudden changes in shape.

MR. HALL: Could I weigh in on that?

MS. AKKURT: Yes, please.

MR. HALL: So, the five percent or the three percent or all those numbers are the percentage of the worth of the burnout, not the K itself.

So, it's the reactivity change from fresh fuel to burn fuel.

So, the less burnout, the less change in K from fresh fuel to burn fuel so these percentages become less meaningful as you go to lower burnouts because the reactivity detriment, relative to fresh fuel, keeps getting smaller the closer you get to zero burnout.

MEMBER MARCH-LEUBA: Thanks, now I understand what the units are.

MS. AKKURT: Okay, thank you very much, Bob, for the clarification.

So, for the EPRI benchmarks, the final approval was received in January of last year and they are now approved for use in future licensing actions.

So, as that mentioned earlier, we had multiple things going in parallel.

1602 was resolved a while ago and the benchmark portion, we have final approval and now it is -35.

Next. For the depletion uncertainty, the 1216 basically offers multiple options. EPRI benchmarks show that for PWR and PWR 5 percent is conservative so it continues without doing any additional work.

And if Applicant choose to take benefits of the additional ones listed in the previous slides, then they will model the 11 benchmarks that has been described in the reports and take the additional margin. But some additional work is needed.

And 1216 also, there is the method like reactivity. One thing that is obviously clear is this being guidance, you can't choose to pursue an alternative approach then they can do it.

They are not limited to these options but they need to provide the technical data because then they come in exceptions, as we will discuss later.

Next slide. The other topic that we spent some time in collaboration with the NRC Staff and the industry members were part of the Work Group is what

are the parameters to consider of uncertainty and what are the parameters that should be considered biased?

So, we did go through the potential parameters and put them in corresponding buckets. Why is this important?

Because for the uncertainty, for final calculation, biases are added, whereas the uncertainties are supposed to be combined, and the list is given here.

The other important thing is what are the important factors? And the importance is based on the overall effect on the total uncertainty.

So, if an Applicant shows that individual parameters of uncertainty are below the ten percent of the total uncertainty, then they can consider it insignificant.

That means that if it is shown, then they don't have to repeat this analysis for all scenarios in their application so they can focus on a more safety-significant parameter evaluation.

Next slide.

MEMBER KIRCHNER: Hatice, this is Walt Kirchner. Before you go on, could you go back one slide? When I look at that list of uncertainties, which ones are dominant?

It would seem to me that fuel manufacturing and such wouldn't be -- I mean the fuel is produced, manufactured to a pretty good QA standard.

It would seem to me that burnup uncertainty, you mentioned earlier flux maps and so on, again, I don't think the uncertainties are in the code.

It would it seem to me the burnup uncertainty would be dominant but I may be completely wrong. Which of those factors do you see for a typical spent fuel pool analysis is dominant?

MS. AKKURT: I would agree with you.

First of all, some of the manufacturing tolerances are small and that's why we said safety-significant versus a word for showing that they are much less than ten percent and showing one and saying these are significant.

The most significant ones, if I were to list, are going to be your burnup uncertainty and depletion codes uncertainty and bias and motivation uncertainty.

Obviously, for lightwater reactors there are a good number of principal experiments and areas of applicability, quite good candidates for

uncertainty and biases, which is something already in the approval.

But if you are using Monte Carlo confirmation for your calculations, for example, you can use that uncertainty provided that you have the computations.

The codes are now so good and computational and even the SFARs are so in terms of reaching good precision in terms of the uncertainty reduction, the biggest one is going to be they're not uncertainty and education for uncertainty.

MEMBER KIRCHNER: I would agree. I wouldn't think that criticality code uncertainty, if you're using MCMP, for example, at this point in its deployment over many decades, there's not a large uncertainty.

That's been benchmarked many, many times. Yes, I would think depletion code and burnup uncertainty would be dominant in this analysis that you're showing in the equation.

MR. HALL: Can I jump in, real quick?

MS. AKKURT: Sure.

MR. HALL: So, part of the criticality analysis occurs for fresh fuel which also gets stored in the spent fuel pool. So, in those cases, the

dominant factors would be things like rack manufacturing tolerances and eccentric positioning within the rack cells and those sorts of things.

If you have, for example, a flux trap rack, the K effective can be fairly sensitive to the dimensions of the flux trap. It's between two sheets of poison material.

As you deplete now, the depletion code uncertainty and the burnup uncertainty are of the same order of magnitude and add up pretty quickly to overwhelm the rest of the uncertainties.

The validation uncertainty is not insignificant.

MEMBER BALLINGER: This is Ron.

Some of the earlier absorber materials that are used, which are now being phased out, I guess, their degradation might also introduce something which I guess would fall under the facility, structural, and materials uncertainties.

MR. HALL: We would probably take that as a bias if it's a known degradation.

MEMBER BALLINGER: Got it, okay.

MEMBER KIRCHNER: Bob, this is Walt Kirchner again. Nominally, for the fresh fuel storage, don't you pretty much have -- I'm searching

for the right word? -- overly conservative poison for that particular aspect of the fuel staging?

MR. HALL: One of the references earlier was to multi-region pools.

When fuel storage got more dense, for example, if you're going to put fresh fuel next to fresh fuel in a set of racks, those are the highest reactivity fuel assemblies you have in the pool for a PWR.

And so they would need the most poison or the most spacing or what have you, whichever way you're going to control K. So, as you put depleted assemblies in the pool, they're lower reactivity but they're higher uncertainty.

So, it's an interplay between what's the K and what's the uncertainty in the K, and what is the orientations in which I'm storing them? Am I storing burned fuel all by itself, am I storing mixtures of fresh and burned?

Am I storing all fresh fuel together?

So, there's Region 1 and Region 2 is the normal terminology for those sorts of REC differences, where highest reactivity fuel would go into Region 1 and lower reactivity fuel would go into Region 2.

MEMBER KIRCHNER: Thank you.

MS. AKKURT: Thank you, Bob. Next slide.

MR. HALL: Next slide. There we go. So, one of the things that we added as an appendix to NEI 1216 was a criticality analysis checklist. And the intent here was to capture the guidance in short form.

The checklist is six pages long and it's organized in a sequence of what you might expect for a typical new fuel or spent fuel pool criticality analysis report.

It's effectively a laundry list of all the things that you would expect to see described and calculated or otherwise presented in a complete analysis.

And that would be from the perspective of demonstrating completeness but it's also from the perspective of the reviewer being able to replicate some or all of your results.

So, I said it was a laundry list of possible content items. That's true, not every item would apply to every analysis. Some people would have certain types of poisons or certain types of racks or certain types of fuel.

Others would not so there's a yes-no there that is a quick reference, okay, when you look at the checklist, you can get a quick idea of what the scope

is of the submittal.

There's a lot of uses for this. The first time would be in pre-application meetings, the Applicant and NRC has a discussion of we're going to bring this application, this is what our scope's going to be, this is how we intend to do it.

If you bring the checklist to the pre-application meeting, now it can be very directed as to specific items that jump off the page. How come you checked no for this?

Or okay, explain to me more about this multiple legions within the pool, for example.

It's useful for the Applicant to know that based on all the collective RAIs and discussions between industry and NRC, what we'll process for NEI 1216 development, if you've satisfied all the items on this checklist, you're pretty sure that you have a complete robust application.

For the reviewer, the reviewer can quickly turn the scope of the application and the key items are addressed without having to hunt and search for them.

And then along those lines as well, some applications have come in where the notes and explanation column can be used to actually point to

where in the document the license limit request, the reviewer can find that information.

So, it's a nice roadmap for the reviewer as well as another possibility. So, it's six pages, it was finalized with the Staff over a week-long audit to ensure it was complete.

It intended to head off necessary RAIs and bring consistency towards the content for Applicant and reviewer.

MEMBER BALLINGER: This is Ron. So, you're satisfied this checklist -- whenever I see a checklist I wonder whether or not it becomes something that gets assumed to be almost biblical.

Are you satisfied that the unknown unknowns are taken care of here, are there aren't any?

MR. HALL: There can always be unique situations.

Part of what NEI 1216 says is if you want to deviate from this methodology or you have something unique and different than what's described here, submit it and it will be reviewed but it's not necessarily covered in this guidance.

So, that's always a possibility, that it's not complete. So, the checklist was intended to be for the majority of submittals, this would be

complete.

And of course, for new things that are coming down the road, there can always be revisions when those things begin to come into use, to add things to the checklist and to the guidance that need to be added to continue to make it complete.

MEMBER BALLINGER: Thank you.

MS. AKKURT: I will just add that, as Bob mentioned, the checklist is six pages long and it was developed in coordination with NRC Staff during the one-week long audit.

And part of it was gather the experiences from technicians and so on. That's partially why it's six pages long. We tried to cover possible scenarios.

Obviously, they may not all be there but then that will be the exception deviation.

MR. HALL: Next slide. I think this is going to go back to Ben?

MR. HOLTZMAN: Thank you. So, again, I'd like to highlight all the positive efforts between all the parties that have led us to this point.

As was alluded to before, we're nearing the finish line regarding this ten-year-long effort, which would be the endorsement of NEI 1216 through Reg Guide 1.240.

Although I do want to mention that we were surprised by the number of exemptions and clarifications in the Reg Guide, considering to overall level of engagement with NRC regarding each word of the documents.

As we noted in our October 23rd comment letter, absent additional clarification, we see one particular exemption, Exemption A, being problematic.

Specifically, our concern is that exemption A does not provide the regulatory certainty or predictability desired when we began the ten-year-long effort.

First, we don't understand the principal by adding the neutron absorber example as part of the double contingency principal.

Second, we would like clarity on what is meant by controls or documents. Specifically, using the neutron absorber example, we would like details on how the licensee would demonstrate correct installation.

Industry has controls and procedures. Is the intent that is long as a utility can show that they followed their existing controls or procedures, that that alone is sufficient to demonstrate the neutron absorber panels were correctly installed?

Third, if utilities cannot demonstrate through controls or documentation, it's not clear what analysis an assumptions must be made. Moreover, it's not clear what it refers to in the last sentence of the exemption where it says treat it as part of the normal condition.

Industry would like to get clarity on this exemption, either during this meeting or in subsequent public meetings before the Reg Guide is formally issued.

Industry currently feels the proposed guidance lacks direction for resolving this proposed situation and we want the Reg Guide to be finalized to endorse NEI 1216 to conclude this multi-year effort.

But we want durable, robust guidance that enables consistent criticality analyses for Applicants and reviewers. We don't want to finish the process only to have a result that does not meet the goal that we spent all this time to achieve.

MEMBER MARCH-LEUBA: This is Jose, go back there, go back on your slide. Can you give us a summary of what Exception A says? I know I read them all but I don't remember them.

Could you explain what Exception A says?

MR. HOLTZMAN: Yes, but I'm going to have

to refer to Hatice because I can't pull it up while sharing my screen.

(Simultaneous speaking.)

MR. EUDY: I think that's all we need to do, is just pull up the draft guide. I don't have an option to share.

MS. AKKURT: So, Exception A says a licensee or other company considers certain conditions to be unlike the conditions, such as possible closing and the turn absorber panel may not have been correctly installed.

However, if no controls or documents exist, preclude such a condition, then the licensee or Applicant should treat it as part of the normal condition.

MEMBER MARCH-LEUBA: Okay, I remember it now. Maybe we'll have the discussion when the Staff is on the microphone. Because it sounds pretty recent to me.

If you have controls and documents that show that you installed everything correctly, you can take care of it. If you don't have them, you cannot. That makes quite a lot of sense to me.

But let's have the discussion when the Staff is in the microphone.

MR. HOLTZMAN: Okay, I'll continue then. So, we wanted to highlight some lessons learned, both because as part of the nuclear industry continues improvement is very important.

And also because we believe that additional work is going to be needed in this area to address accident-tolerant fuels with increased enrichment to realize higher burnout. And as such, we anticipate a subsequent Revision 5 to NEI 1216 and continued engagement with NRC.

All parties have spent significant resources to reach this point. These interactions have taken the form of numerous public meetings, RAIs, and even a full week-long audit, as we had discussed before.

This has yielded very robust, detailed guidance backed by technical justification where every word has been discussed and reviewed.

Separating the SUs into standalone documents was a successful strategy that improved regulatory stability and predictability but extended the overall duration because it reduced the urgency to reach a final conclusion.

The long delays in finalization of NEI 1216 and the Reg Guide does not demonstrate a

transformation or risk-informed regulatory process, in our opinion.

Additionally, we'd like to put on the record that industry feels a double standard was applied to NRC contractor work compared to industry work.

The NRC contractor work was not performed under a QA program but was accepted and implemented. Conversely, the industry's non-QA report on the same subject was not implemented.

In summary, industry was surprised by the number of clarifications and exceptions in Reg Guide 1.240 due to the detailed hands-on development between industry, NRC, and EPRI on the guidance and technical documents.

Industry currently feels the proposed guidance lacks the direction for resolving the proposed situation in exemption A and we want to ensure the endorsement of NEI guidance through the approval of the Reg Guide achieves the desired objectives of having clear and direct guidance that can be used by both the Applicant and the reviewer to bring regulatory stability and predictability to this important subject area.

And with that, thank you for your

attention. We will take any additional questions at this time.

MEMBER BALLINGER: This is Ron, I don't hear any questions and we'll have a time at the end for additional questions as well from the public. But if there aren't any additional questions, can we transition to the Staff presentation?

Are you guys ready to go?

MR. EUDY: Kent Wood will be presenting for the Staff. This is Mike Eudy from Research.

MEMBER BALLINGER: I'm assuming that he'll be talking about the last slide that the industry presented?

MR. EUDY: Yes, he's prepared to talk about the exemptions.

MEMBER BALLINGER: Okay, so I see the slide, I guess we're okay? Kent, the floor is yours.

MR. WOOD: Let me make sure I've got everything ready to go and am off mute. My name is Kent Wood, I've been the lead reviewer for spent fuel pool criticality analysis at NRR DSS now for over a decade.

I was instrumental, along with Bob Hall and Akiche with developing and working together with developing NEI 1216. So, I'm going to go through some

comments on here.

So, the first thing I've got, I'm going to talk a few minutes about background and history, then I'm going to talk about our clarifications. There were 17 of them, I don't want to go into each one.

If you have a question about specific ones, I'll go into that but I'll talk about the three exceptions that we took and the three clarifications that we got comments on.

And then just a few comments that Ben alluded to was going forward, what we might expect in the future.

So, the background is the initial design construction of spent fuel pools were low density, a lot of room and spacing between each fuel assembly for a flux trap analysis were done at the fresh fuel.

It seemed like they were low on regiments for initial startup back in the '60s, late '60s, early '70s. There was no 10 CFR 5068, the guiding regulations were 10 CFR 7024, which everybody got an exemption to because they did the criticality analysis.

And there was GDC 62 predecessors.

The 98, the pool was going to be low density, relatively few number of fuel assemblies in

them because they were going to be shipped off for reprocessing after a year or two.

And then the first re-rack wave came along because re-processing didn't happen. So, they started putting more racks in, higher density racks in, and to get that higher density, they had to go to using neutron-absorbing materials it would be the fuel assemblies to maintain the subcritical requirement.

And that's when they started putting in -- the PWR was put in what we referred to as a two-region setup, where Region 1 would have a smaller flux trap with two poison panels on each fuel assembly with the idea of that's where you put in your fresh fuel before it went into the reactor.

Or if you have lightly burned fuel coming out of the reactor, that's where it went. And then there was Region 2, which only had a much tighter density, racks, with only one neutron-absorbing material panel in between each fuel assembly. But this fuel was considered to be either a second burn or end-of-its-life burn.

And there was a generic letter that came out in 78, Reg Letter 7811. It talked about this re-racking process and it talked about the estimate of information on criticality but it talked about

everything, including disposal, sizing calculations for the racks. It covered a lot of information.

And then the second re-rack analysis wave came along primarily due to a boraflex degradation, which was a material that was put in when the high-density racks were put in.

It's a silicone rubber-based material impregnated, basically, with B4C and it's sort of dissolving or cracking or shrinking and causing problems. So, there was some guidance that came out in the mid '90s, a generic letter about it.

A lot of licensees stopped taking credit for the boraflex that was in it because to take credit for it required a monitoring program which started introducing a lot of biases and uncertainties in the monitoring, a lot of isotope tribes continued to take credit for it.

And also about this timeframe, that's when they started allowing soluble boron credits in the pools for the PWRs for normal operations. Before that, it was just they gave credit for the soluble boron that was in the PWR pools or like an accident condition.

Of course, BWRs don't have soluble boron so they can't take any credit there. And then towards

the end of this phase in late 1998, the NRC issued 10 CFR 5068, which basically says stop regulating by exemption to the 7024 because here, by '98, from '68 to '98, you're talking 30 years worth of exemptions on spent fuel criticality analysis requirements.

The third rack analysis wave has been ongoing probably since -- I would consider it to be about the mid 2006, 2007 timeframe where people were realizing the people who still had boraflex were realizing that they couldn't continue to live with that, that they're degradation was getting too high.

And so they were coming for reanalysis and re-racks and then we came up with the guidance, the ISG and 2010. We issued that.

That was some lessons learned. It didn't cover necessarily everything but I thought we improved on what we needed there with that ISG.

But then we also wanted to, since it's an interim Staff guidance, we wanted to get permanent guidance and that's when we started with the idea of working on a more permanent guidance out.

And unfortunately, it's taken longer than anybody would like.

The Reg Guide, we worked with EPRI, NEI, and other industry representatives to develop all 16.

There was Ben and Hatice and Bob all led the meetings we had, the numerous meetings, week-long audits. And the intent was to improve regulatory certainty.

Regulatory certainty has always been, in my view, a two-way street. In order to achieve regulatory certainty, we need to know at the NRC what we're going to get from the licensees.

And so that enables the licensee to know what to expect to get back from us. So, the idea is that 1216 in the Reg Guide is to establish that common understanding of what's going to be in the package so that we can get regulatory certainty.

If we endorse 1216 with 17 clarifications, a lot of those clarifications are forewarnings or warnings to not do certain things or like, hey, a couple of them we've talked to you about.

We talked about the ATF, higher enrichment, higher burnup. There's a couple in there that talked about, hey, future changes aren't covered here and things like that.

There was three exceptions that I'll talk about next and then we got serious public comments on three of the clarifications and I'll talk about those in a little bit of detail, and then I'll revisit.

And one of them is the one that has got

the industry's main comment from NEI. The three exceptions that we took, one was to an EPRI position statement in there.

We agree with the EPRI position is treated as a bias and needs to be calculated. There are some words in there that once we thought needed some clarification because they talk about doing a six-by-six array of fuel assemblies.

And each fuel assemblies can have hundreds, if not thousands, of potential locations within each cell.

If you just talk about five main points that the fuel assembly could be in the center, and then the four corners, and you do a six-by-six array of those assemblies, you're talking about billions of possible combinations.

And there's words in there that allude to the idea that the worst possible combination is so unlikely that my concern was that somebody down the road would come in and say, well, it's so unlikely that we don't have to analyze it.

The flip side of that coin is the idea that you found the limiting or 9595 configuration is also very improbable. So, you need to look at this and so that's the reason why we got Exception 1 in

there.

We didn't get any comments on these exceptions actually so I don't think they're controversial and I don't think they changed the way we're doing business.

The next one is the idea of using boiling water, what's called four critical measurements, as benchmarks. We take an exception to this because we don't think there's enough detail in the guidance to actually implement something like this.

It doesn't stop somebody from trying to do it, it's just we don't think there's enough information in the guidance to actually do it.

This is something that we've actually agreed upon at that week-long audit. The industry and NEI wanted to keep that section in there. We told them we would take exception to it. It was like we'll agree to disagree and move on.

The second thing, the second exemption, was the code-to-code comparison as validation for criticality codes. This is something that's not accepted in criticality safety analysis.

And again, there's not enough information in there and I've never seen it done in my 12, 15 years of doing this. I've never seen it done so we

didn't know exactly what it would look like so we took exception to it.

If somebody wanted to try it, it would be a first of a kind event. And this is another one that was agreed upon to be an Exception A that week-long audit.

Now, those are the exceptions part of the 17 total comments in that clarification exemption section. The next three things I want to talk about are where we got the significant comments on from the industry.

And the first one is the one that is this double contingency principal. It's actually based on -- sorry, got to keep up with the slides -- an actual license amendment we got.

A licensee came in and told us that -- with reanalysis of an existing rack and that they had indications that they maybe have missing panels of their absorber.

So, this is based on reality of something that happened and that's why it's in there. Now, the comment takes exception to using a misinstalled neutron-absorbing panel as the example.

Because licensees have controls to ensure that a misinstalled panel does not go undetected. But

the clarification also says that if you have controls to prevent it, you don't have to consider it as part of the normal condition.

So, we thought, when we got the comments back from the industry, that the example is correct and in its entirety, considering both the example and then the clarification that if you have controls and documents to say that it's precluded, you wouldn't have to calculate or consider it during the design phase.

MEMBER MARCH-LEUBA: This is Jose, let's talk about this. Is this the exception that the industry was complaining about?

MR. WOOD: Yes, sir.

MEMBER MARCH-LEUBA: Okay, so I've been reading it, Samuel 1 Alpha, and I'm with you. It clearly says what you say it says. I don't understand what the concern from the industry is.

It says as long as you have controls, you can take credit for this absorber, for example. But if your controls are missing or you do an audit and you find your controls were incorrectly applied, then you have to analyze it.

I don't understand what the problem is.

MR. WOOD: I would have to agree with you

to a large extent there. In an analyses, I would say it's kind of like if you remember back to the piping stubber issues that we had, they were supposed to be originally installed, say, every six feet but they were cut to fit during actual installation.

And some of them had a spacing greater than six feet. And so basically, this contingency is telling us that you have to deal with the -- when you're doing analysis, especially when you're doing a reanalysis, you have to consider the as-is condition, not just the design.

Now, during the design phase, the presumption is that everything will be installed in accordance with the safety-related quality assurance and maintenance procedures that every licensee has for doing these types of modifications.

And a part of those would be the licensee had to assure themselves whether the modification is on the spent fuel pool, the reactor coolant pumps, the steam generators. They have to assure themselves that it was done and installed correctly.

And if they can assure themselves that it's not done and installed correctly, then they have to take corrective action.

And if it's not installed correctly, there

could be some fallout from if they have a missing panel, we wouldn't say this during the licensing phase when they submit this that they would have to consider it, but if they find they have missed one, depending on what is, depending on how they disposition that, then that's going to -- it depends on what their next course of action is going to be.

Now, we talk about some of these panels, they're neutron-absorbing inserts that go into the storage cell with the fuel assemblies. If you're missing one of those or it's installed incorrectly and you find that, you just take it out and put it in right.

Some of the other designs, where the neutron-absorbing panels are encased, that's a lot more problematic. But it's up to the licensee, if they find they have this condition, that they would have to deal with it.

But during the design phase, the presumption is, like any license amendment that comes in for anything that they do at the plant, they have to ensure that it's installed correctly.

And if it's not installed correctly, they have to disposition it. So, we didn't think we were saying anything different that applied in this regard

to anything else they do at the plant.

What we're trying to say is you really need to consider things that you rely upon that might affect your double contingency analysis, might affect your analysis, besides just what was in the tech specs.

MEMBER BALLINGER: This is Ron. I think I'm in agreement with Jose.

There's such a difference between what you're saying and what we just heard from the industry folks that it's almost an logical inconsistency here, that I must be missing something, that some discussion which has not been had, which connects the two.

MR. WOOD: You'd have to ask the industry. To me, we thought it was clear.

We got this comment, we talked amongst ourselves and several people at the NRC and we thought that it was clear that you have to consider -- if you don't have something that precludes -- a double contingency is you don't have to take something -- consider two independent items as mutually occurring.

But what we're saying is, well, if you don't have something that prevents something from occurring that you would take credit for, then how do you know it hasn't already happened and it's become

the as-is condition?

And so when the accident happens, it's not two independent things, the as-is condition has already happened and been sitting there because you don't know that it hasn't happened.

MEMBER MARCH-LEUBA: This is Jose again. This is the equivalent of the unanalyzed condition, the operating domain.

If you assume your panels are six feet apart and they happen to be six feet and one-eighth of an inch, you're one-eighth of an inch off. You overanalyzed.

You have to come up with a quick calculation in that case that would show one-eighth of an inch doesn't make any difference or do another analysis or fix it. But clearly, you're in an analyzed condition.

I'm with you guys.

MEMBER BALLINGER: This is Ron again. The only thing I can think of is could there be an issue with very old pools where there might not have been the same quality controls or there may be some unanalyzed degradation that's going on. I still can't figure it out.

MR. WOOD: This came out of an actual

license amendment request. So, getting the final words that are actually in NEI 1216 were agreed upon years ago, several years ago.

And perhaps this license amendment came through after we redefined the words in 1216 because we were still waiting on the EPRI topical report to be finished before we could start work on the Reg Guide.

So, it was lessons learned. It was actually somebody was re-analyzing an old rack, they weren't installing a new rack, and they went through and they believe they had potentially missing panels.

And if you have a missing panel, that needs to be considered. Where is it? What is it? How many are there missing? So, that was a large part of the analysis and the questioning with the licensee.

Now, I would expect somebody's putting in new, fresh racks or putting in these inserts into the design phase. They would take credit for, hey, we have a modification, we're putting new equipment in, we're going to install it with our procedures.

We expect our procedures will ensure it's done correctly. And if they find an issue, the licensee has to disposition that. If they decide to accept it as is, missing panel, well, that's going to lead them down one path of resolution.

Another path, like I said, for an insert, those can be pulled out and put back in. We consider those, essentially, maintenance items for the inserts because they can be accessed and removed and new ones installed, as opposed to a neutron-absorbing panel that's encapsulated.

But it's inherent on the licensee, we didn't really with this aspect as far as that goes because we put the controls and documents in place to preclude it. But we were saying anything different than would apply to any other modification at the plant.

MEMBER BALLINGER: I think we'll probably come around on this on the discussion part but can we keep going?

MR. WOOD: Yes, sir. So, that leads me to the next one, which is the graded approach margins and control. A graded approach is an older term that tries to incorporate the idea of before risk was -- where it is now.

And once the analysis of what the guidance says is that, hey, if you have a lot of margin, you might be able to streamline your analysis.

And what we're saying with this exception or clarification -- it's not really an exemption, it's

a clarification. It's a reminder to the licensee that if you streamlined your analysis because you've got 1000 parts per centimeter mil, PCM, percent milrow, to the regulation, you've got 1000 PCM margin to the regulatory requirements.

And with that margin you used to streamline analysis, if you go back and decided, well, I made some changes so I have to do something not as streamlined as what I did before, that large margin is part of that and they need to be cognizant that using all of that margin may not be appropriate.

And that's what that clarification is. We still expect the licensee to control the margin in their analysis, again, like we pretty much do for other plants but we want it to be clarified that if you use the large margin to get a graded approach, that margin provides some of the basis for that graded approach.

And using all of that of a large part of that could cause a problem. We got a comment on that and we think we're good there.

The next comment -- do I have a question? Okay, the next comment we got was about the soluble boron modeling during the reactor completion phase. Criticality analysis for spent fuel in the pools are

really two separate analyses.

The first one that was talked about was the depletion analysis and that generates the post-radiated isotopics that are in the fuel assembly.

That's modeled on the reactor and you have to model the depletion of that fuel and the operation of that fuel assembly in the reactor. And then you come up with a set of isotopics that then get modeled in that fuel assembly, when that fuel assembly is in the spent fuel pool.

Typically, the depletion analysis are done with standard reload codes, and then typically, the spent fuel pool criticality analysis is done using a Monte Carlo code. In the U.S. people use either MCMP or scale.

Next screen? I keep on forgetting to advance my slides. So, we relied on NMSS as doing criticality analysis for the casks for a long time, and they had a lot of work done by Oak Ridge National Laboratory and they publish a lot of NUREG Crs.

And the idea to simplify the analysis by using a constant soluble boron in the depletion analysis phase to simplify the analysis rather than trying to model an actual boron letdown curve.

And there was a paper that was published

by individuals at Oak Ridge National Laboratory that said that using a cycle-average soluble boron would result in a conservative post-life reactivity of the fuel assemblies.

And as far as I know, that's the only published work on that. It's been accepted by the industry, it's been accepted by NMSS as using for this concept. And the concept makes sense, I could explain it if somebody wants me to in more detail.

But this is again based on an actual license amendment request, a couple actually. Somebody came in and tried to use an average other than the cycle average.

They wanted to use the lifetime soluble boron average of the spent fuel assembly based on its burnout. And we had accepted this a couple times, but we consider this to be a deviation from the guidance. We've accepted it more than two times.

There are some other times where we accepted it and somebody would go back and say, hey, look, we have an old cycle that we shutdown early, maybe they transferred it from 18-month to 24-month cycles or vice versa.

And so they have a cycle that was unusually high with soluble boron and we would

disposition that on a case-by-case basis.

But going forward, you don't know -- for the lifetime average going forward, you don't know if that average is climbing or declining to the fuel assembly going forward. And you'll get radically different answers.

So, we put a clarification in there to make sure the licensee is clear that we're only talking about cycle average in the guidance document and what we've endorsed.

They can do other things and we'll review it and like I said, on case-by-case we'll approve them.

MEMBER MARCH-LEUBA: Can I ask a question? What they call the EPRI uncertainty benchmark, didn't they use the two boron concentrations cycle dependent? I would have used the two depletion as doing the core follow, right?

MR. WOOD: I'm sorry, could you restate the question?

MEMBER MARCH-LEUBA: Yes, so when EPRI calculated the uncertainties, the percent value that we were talking about an hour ago, I'm 90 percent sure they did a core follow and they actually used the actual boron concentration at every time step.

That's the easy calculation to perform because you already have the data in the plan computer. You've already done it.

MR. WOOD: What they've done for the EPRI depletion is they're calculating -- what they've calculated there is they have taken a flux map measurements throughout the core's life.

And certainly, those measurements were taken at the actual soluble boron concentration that were done. Now, in order to do that, they were deriving a method to calculate a bias and an uncertainty on essentially, the isotopic predictions of the depletion code.

When it comes down to soluble boron concentration, what we're talking about is licensees, depending on their cycle operating, one cycle could be 800 PPM as the cycle average and in the next cycle it could be 900.

So, what we're using as cycle average, if every cycle is below the cycle average in the analysis, then you know you're conservative. If you cannot find that, then you have to spend extra time looking.

MEMBER MARCH-LEUBA: The actual boron concentration ranges from 1200 to 100 but it's

linearly in the whole cycle.

MR. WOOD: Actually, I can range from 2200 down to 0 but what was shown is that in this paper I mentioned -- I guess I could pull it up and show you the graph.

MEMBER MARCH-LEUBA: No need to go into detail. You have some basis to calculate that by using a cycle average of boron concentration, you produce a bias on the reactivity of the discharged fuel that is conservative. I just don't see the need.

(Simultaneous speaking.)

MR. WOOD: -- completes its full cycle, then it is conservative to use a cycle average soluble boron. Actually, if a fuel assembly shuts down mid-cycle, it's actually non conservative.

MEMBER KIRCHNER: Yes, I was going to make that point. How do you --

MR. WOOD: There's a clarification in the beginning of NEI 1216 about potential mid-cycle shutdowns.

MEMBER KIRCHNER: How do you define the average? It seems to me that may not be in all cases conservative.

MR. WOOD: Well, the cycle average is a line on a graph. You plot your slot in your reactor

soluble boron concentration as a function of burnup and then you just calculate the average. It's just a simple calculus problem.

(Simultaneous speaking.)

MEMBER KIRCHNER: I'm just trying to think through whether that is always a conservative result.

MR. WOOD: The idea is that it's conservative if you complete the cycle. If the fuel assembly completes the cycle and goes from the 2200 all the way down to 0.

But the physics of what's happening is for this modeling is that during the first portion of the cycle that you're modeling for that type of depletion, you don't have as much soluble boron in the model as in practical.

So, that's actually non-conservative.

MEMBER KIRCHNER: Right.

MR. WOOD: So, therefore, what the paper shows is the cause of the poisons and everything that are in a fuel assembly, it kind of balances out and you don't see much of an effect until you get to the end of the cycle.

And at the end of the cycle, the first cycle, you have more soluble boron that what is actually present. So, in that case, that's

conservative.

And so you're building up conservatism towards the end of that cycle, and then that fuel assembly would be discharged in the model.

And then in the model it starts out at the beginning of the second cycle having this conservatism built into it. And as the first starts off, that conservatism is slowly taken up by the lower soluble boron concentration.

And then it goes down to at some point it's a wash, you get back to where it would be if you had modeled it explicitly.

But then it becomes non-conservative, I can echo out to at some point where now you've turned up, you've turned the tables on it, and you've started back up the other side where now you have more soluble boron in the model than what's in the life and you start building conservatism back in.

And so by the time you get to the end of the cycle for that fuel assembly, you've built the conservatism back up, it's above zero so now you're in positive conservatism space, if that's a way to think about it.

And so at the end of the second cycle, and then you start the third cycle and you repeat that

kind of a process, where it starts high.

It starts conservative, gets down where it will be non-conservative and then it comes back up to being conservative at the end.

But that stipulation is that you have to finish the cycle and go from the full 2200 at the start, cold zero power down to power cold down at the end of a cycle.

So, you have to complete that and that's part of what's showed in the paper or the graph. If you shutdown halfway through, you may have some amount of non-conservatisms in there.

And there's a caveat in NEI 1216 that says, hey, if you have to shutdown mid-cycle you have to consider that.

But once again, this is what's part of what's been expected as industry guidance and what we've been doing for years, using some other average. We haven't established those, the limit may or may not be appropriate, what else might need to be done?

So, we took clarification that we're only talking about this one average way of calculating the cycle average.

MEMBER KIRCHNER: It just seems to me, Kent, that an average like that makes sense if the

fuel has gone thoroughly through three cycles and burned up to a high burnup.

Anything less than a high burnup then perhaps -- I'm doing this mental construct in real time -- we would perhaps be less conservative.

MR. WOOD: Excuse me while I pull this paper up. Where's it at?

MEMBER MARCH-LEUBA: It's okay, we don't need to know the details. If you could send the ACRS via the proper channels of that paper so we can review it, that would be fantastic.

MR. WOOD: I've asked Chris to get us the paper.

MEMBER MARCH-LEUBA: For God's sake, we live in the 21st century. Why are we using -- in 1970 when you had to use the site rules, it makes sense to make these approximations.

But now? Just do the two core follow for the operations. You already have it. At the end of the operations cycle, you have the isotropics of every in a bundle, adjusted by the measurements that you've done three times a year in BWRs.

Why do you need to do a new calculation? You've already done it.

MR. WOOD: To do what you're saying could

be done but that means that K effective would have to be calculated for each fuel assembly as it's discharged each time.

And the point of the current industry method of controlling this is to calculate relatively bounding analysis that would consider, well, what if I had this cycle soluble boron concentration is higher -- it will vary from cycle to cycle.

You try to pick one that will be bounding going forward and do the analysis, assuming that's the cycle average soluble boron you have, and then when it comes around, you don't have to calculate each fuel assembly each time.

What you're suggesting would be possible but would be a change to the way it's done in the industry is what you're guessing would require actually in the K effective of each fuel assembly each time it's discharged.

MEMBER MARCH-LEUBA: We are scraping the bottom of the barrel to get margin for the spent fuel pools when they were throwing away a lot of margin by not doing the analysis properly.

Okay, that's my personal opinion. I would do it right.

MR. WOOD: Somehow I've got to the screen

I wanted to. Going forward here, I'll echo what Ben Holtzman and NEI and EPRI have said.

The NEI 1216 Reg Guide, 1.240 will increase regulatory certainty with regards to fraction spent fuel criticality analysis for the operating reactors. To a certain extent, it already has.

We have several licensees that have already used NEI 1216 in their applications that we have reviewed and approved. That's without the endorsement from the Reg Guides.

Now, this was alluded to earlier and I mentioned it before.

When we get into accident-tolerant fuel, increased enrichment, higher burnup levels, we'll need to be evaluating whether we need to any changes to the 12 -- well, we're not going to evaluate 1216 but the Reg Guides are necessary.

The next one of the clarifications I put down there is we say a lot of what we have in here is based on our experience based on looking at hundreds of analyses at the NRC.

And we've seen dozens and dozens of different applications coming in that we've reviewed. So, we would track what's important, what's not. Sometimes an uncertainty for one licensee may be

insignificant and for the next person it would be significant.

And we can get into the here's or why's but we had a database that we track a lot of these things on to see when they're outliers, are they always the same, are there always high, are there always low?

And usually and quite often we find for whatever reason we didn't take the time to go into it and determine why those people were higher than others, mostly because we don't have the resources and we also don't have the detailed information and the analysis to make that determination.

But we would see an outlier in some of these uncertainties. One licensee is like, oh, never mind, and another licensee was like 500 PCM. And we're like, oh, well, you can't ignore that.

So, there's a lot of statements like that that are in NEI 1216. Every time there's a list of things to consider, the licensee always has to make sure that list is their list and they don't have anything to add or they can take anything off.

But they have to make that decision on their own when they're making that. We got a clarification in there, I think we missed one that

talked about the lattices for the BWRs so we put that clarification in and that's another one.

But going forward, I would expect there will be some changes we'll need to make, depending on what forms of accident-tolerant fuel actually make it into the reactors, when and how high the increased enrichment is and the burnouts.

And we keep on mentioning this every time we go to an ATF increased enrichment higher burnup level meeting that these things will need to be addressed and so far as we'll get to that.

The answer we get is we know and we'll get to it.

MEMBER MARCH-LEUBA: This is Jose again. How does the guy handle lead test assemblies? So, you had three or four fuel bundles that need to go into the pool under ATF maybe coming in and cutting, for example.

MR. WOOD: That would be any lead test assembly they would use. There's the caveat, I shouldn't say caveat, but there's statements in there that say the licensee has to make this analysis.

The licensees, they're doing a lead test assembly whether it's an ATM or something else. You have to say does this meet all my criteria?

The guidance for an ATF, for one of the lead test assemblies that's in ATF, that's one of the things. We're not going to revise the guidance for a lead test assembly but those might have to be addressed on a case-by-case basis if we figure it out.

MEMBER BALLINGER: This is Ron. With respect to Bullet 2, I think the industry is in agreement with that. I think they said the same thing in their conclusions.

But with regards to Bullet 1, are you saying this has already been used? Does that include the exceptions?

MR. WOOD: Yes, to a certain extent, it does include the exceptions. Like I said, the one exception, 1A, that was based on an actual license amendment.

And we reviewed that with somebody that had a missing panel and they had to address it. So, that was something that we have that actually happened.

MEMBER BALLINGER: I understand that was the precipitating event but what about since then?

MR. WOOD: We haven't had anybody come in with that situation since then. That was a one off.

That was just used as an example more to

say when they're thinking about double contingency, they need to think beyond the tech specs and not just the tech specs, what the point of that clarification is really.

MEMBER BALLINGER: I just need it to be clear. Thank you. Is this your last slide? Yes, it looks like it.

MR. WOOD: Yes, sir, it's my last slide if anybody has questions.

MEMBER BALLINGER: Okay, I don't hear any questions. We've got a half of an hour, which is very good because what we need to now have -- we need to make some time for public comments.

But it would be nice to have enough time to have a discussion about this because we're trying to make a determination of whether or not we should as a Committee do a letter or not.

So, I would like very much to hear Members' thoughts related to this so that we can get a little bit of an idea of the direction that we might go in.

So, for Members, would you please provide any discussion you think is relevant?

MEMBER MARCH-LEUBA: Ron, this is Jose, I would like to ask the Staff and the industry the value

of ACRS providing a letter to them? What does the staff want to do?

Do you care whether we write a letter or not?

MEMBER BALLINGER: That was actually part of the discussion we had some time ago when we were actually thinking about whether or not we should even have a meeting.

So, that is a good discussion to have and we didn't get, at least in my mind, a definitive answer, which is why we're having this meeting. So, maybe the Staff can give us a better answer?

MEMBER MARCH-LEUBA: So, the question to Staff is if ACRS writes a letter, let's assume it's a positive letter, does that have value for you? Or is that going to delay you too much?

MR. EUDY: This is Mike Eudy from Research, I'm the Project Manager for the Reg Guide.

Based on my recent experience with the set points Reg Guide, if we don't hear there are any significant issues with issuing a final guide, no serious issues are presented by ACRS or concerns, then our prerogative is to move forward with issuing the Reg Guide as quickly as possible.

So, I guess I haven't heard. And the

value of a letter, if the letter is going to be go ahead and issue, then the sooner we know that the better.

But unless we hear something today, we won't really wait around to hear from ACRS unless you tell us that something serious needs to be addressed.

So, the value of a letter to us would be if it points out there's issues that we need to come back and work on with respect to content of this Reg Guide.

MEMBER MARCH-LEUBA: Unless our letter is negative in one of two points, all we would do is delay your publication by a couple of months. And therefore, we will be hurting you.

Let me ask you a different question, there are some areas of contention with industry, like that Exception A. Would a position from ACRS on that exemption help or delay you for nobody?

MR. EUDY: I think we have to figure out, and anyone else from the NRC Staff can chime in, what a remedy to that situation would be if we think we shouldn't issue this Reg Guide because we haven't resolved that issue.

We feel we've resolved it through the public comment but NEI doesn't agree. So, I'm not

sure what the remedy for that is other than we can issue the Reg Guide and pursue a revision or they can pursue a revision to the NEI document and we can incorporate it in a future rev.

But I don't know what decision would need to be made if that's going to be a sticky issue for us. At this point, to halt issuing this Reg Guide, is there anything from management if you could chime in?

MR. RAHIMI: This is Meraj Rahimi, Branch Chief for the Regulatory Guide in the Research. I have this Reg Guide and Mike is the Project Manager.

So, I think really the intent is that you've seen the final Reg Guide, you've seen the clarifications and those exceptions.

And in my opinion, if the ACRS can weigh in, either at this meeting or actually in a letter saying that it is sort of the way it's written. It is you recommend the issuance.

I think that sort of carries weight in terms of we know an independent body, technical people, ACRS, has looked at it and they agree with the Staff. And then we can go ahead and issue the final Reg Guide.

MEMBER BALLINGER: This is Ron again. It probably is my ignorance, but I still don't understand

the nub of the argument between the industry and the Staff with regards to that exception.

Can somebody explain that to me a little bit better? Probably the industry, I guess, because they're the ones that are upset with this.

MR. RAHIMI: Yes, I would say at this point, that's right, maybe Bob Hall or Ben Holtzman can really articulate what is specifically -- maybe elaborate on what they already talked about.

And again, these experts would be more than happy to respond.

MR. HOLTZMAN: This is Ben Holtzman from NEI. Thank you guys for the opportunity to elaborate a little bit more on what our point was.

So, the NRC's presentation has a couple of points I'd like to comment on, the first of which I would like to correct a statement that was made. The previous LARs and Hughes referencing's precedent was not that the utilities believed that they failed to follow their procedures or controls.

Rather, the utility had a legacy analysis that assumed missing panels as part of the off-nominal condition in their analysis, which again, is not part of the normal condition, as you guys know.

We're not trying to dispute if there was

an actual incorrect installation we would have to ensure the analysis and reality are made consistent with each other.

If the utility realized the spent pool racks' as-built conditions is different from the analyzed analyses, then the analysis and actual physical racks need to be brought into alignment.

On this point we agree. There's a challenge, of course, for new installations because this analysis needs to be done before the installation.

And then as such, we interpret the statements of NRC to be that we would not need to assume any incorrect installation because the utility has controls in place to ensure correct installation.

And secondly, we want to explicitly confirm what I think I heard Kent starting to talk about, which is if a utility has no indication that there was a deviation from the existing controls or procedures.

Or in other words, that we assumed that the controls and documents that are in place, and we have controls and procedures in place of course, then that is sufficient to demonstrate that we are meeting this assumption in the guidance.

I just want to re-highlight that there is no case where there was any indication that a panel was either missing or was only done as part of an accident assumption in that legacy analysis.

MEMBER BALLINGER: So, what I'm hearing is that for a new pool the design is presented before the pool is built in accordance with QA procedures and everything.

But once it's built, it's the same QA procedures that have to be used to verify that it was constructed as intended. So, is this just a paperwork problem?

MR. HOLTZMAN: So, the question you're essentially asking, if I understood it correctly, is what is the paperwork to demonstrate that we installed everything correctly?

MEMBER BALLINGER: I guess that's one way to put it but somebody else might be able to say it more clearly.

But it sounds to me like all the Applicant needs to do is to verify the pool was constructed in accordance with the design and QA.

MS. AKKURT: It's not necessarily for pool construction. For a negative spent pool, for example, if you are going for reracking you submit your

application prior to the reracking.

If you are getting insurance on units of observed materials. So, at that point, you have no way of showing, you are saying I'm going to to do this and I'm going to do this under my QA.

Suppose after the installation you become aware of this, there are control mechanisms in place to remedy that.

MEMBER KIRCHNER: This is Walt Kirchner.

Since this Reg Guide seems to hang around primarily the analysis of the pool and the storage, is this tantamount to assuming a single failure that would require industry to assume that one of these boron absorber panels is missing?

I see an analogy with using a very conservative Appendix K approach to analyzing locus but, Ron, I'm at something of a loss to discern here what the disagreement is.

Both sides present a reasonable position but I haven't discerned yet what the problem is.

MEMBER BALLINGER: I'm with you there too. I just can't figure out why it wouldn't be a very simple thing to verify. Even for older spent fuel pools, anything that's done with these pools is done under a QA program. So, unless there's a mistake

that's been made, I don't know.

MR. HOLTZMAN: This is Ben. If I may, maybe if we reframe the question as explicitly simple as I can, maybe that would help.

MEMBER BALLINGER: That would be good for me.

MR. HOLTZMAN: So, if we installed under procedures, which we agree we have, if we install under procedures, is that enough to demonstrate that we meet this?

MR. WOOD: This is Kent Wood. The answer would be yes.

MEMBER BALLINGER: Case closed?

MR. WOOD: I thought that's what the example said. If you have controls to preclude it, you wouldn't have to consider it as the normal condition.

And to me, you were taking exception because we mentioned this because you have controls to prevent it. So, I was having trouble understanding the disagreement as well.

MR. HALL: This is Bob Hall. I'll take a shot here as a former spent fuel pool criticality analyst. Part of the concern was how the words could be read by a future reviewer who didn't write them.

What does it mean, controls and documents? How many controls, which controls, what documents, how many, what would be sufficient to satisfy that requirement?

And then the second part of it is, if, and we're not aware of any situation where this is true, but if someone couldn't satisfy that requirement, then the last sentence, it needs to be considered part of the base analysis.

Does that mean that the analysis has to be redone assuming no panels at all in the fuel pool? One missing panel? 100 missing panels? How many? There's no guidance.

So, part of our concern was that it created a hypothetical situation from which there was no clear way out.

MEMBER BALLINGER: Again, I keep coming back to the plant being designed and built in accordance with the design and checked with the QA.

Are we running the risk of basically contriving an issue that is I'll never say impossible but precluded by the existing procedures and designs?

MEMBER KIRCHNER: It would seem to me, Ron, that something like this, which I'll use the term at risk, safety-related, would come under Appendix B.

So, that would suffice to define the controls, design controls, recordskeeping, other checks and balances, if it's a maintenance, if it's a repair kind of issue.

Since double contingency was mentioned somewhere along the line, I had the feeling almost like it was requiring the Applicant to just go ahead and assume that one of these absorber panels is missing and then demonstrate that you still had that sufficient margin.

So, the words seem ambiguous to me as to what is expected versus what would actually be done in the plant, notwithstanding the fact that a mistake could be made and so on and so forth, but then you hope that your corrective action program promptly addresses that.

MR. LUKES: This is Bob Lukes on the Staff. Again, this is an interesting question and something we thought was, as some of the other Members said, was pretty clear.

And anywhere in the plant, if you don't know the condition of a piece of equipment and you're doing an accident analysis, you have to assume the worst case for that condition.

So, in the idea of the spent fuel pool,

for example, if you didn't know how your panels stalled, you don't know the condition of your panel, it would not be appropriate to just assume that panel is just functioning normal.

So, I think that's what this part gets to the heart of and I was trying to understand the NEI's concern.

And we thought maybe it had to do with old plants where panels were installed, where they lost the records, where they've never done any surveillance but they still want to take credit for these panels.

And they're doing things to evaluate these panels, whether it be these badger inspections or visual inspections, to make sure the panels are laying on the bottom of the pool in dust like the boreflex panels.

So, I think that we're coming at it from the reasonable assurance that it's reasonable to assume that you know the status of your panel. It's reasonable to assume that you know it was installed and is functioning.

If not, it would be reasonable to assume also that you already either have a procedure in place to verify it correctly or you have some type of documentation for your EXP program because it's

safety-related and shows it was installed correctly.

I'm a little confused on the concern also.

MR. HALL: This is Bob Hall, I think based on Kent's clarification to Ben's very direct question we're back to agreement.

MR. HOLTZMAN: So, Bob, I just want to follow up with what you just said because I want to make sure that I didn't mishear you on that.

So, if we install the panels under procedures, we meet the requirements for this exception, is that correct?

MR. LUKES: I'm trying to read your question for something cryptic that I may be missing but I would assume that if you followed your Appendix B quality procedures in installing the panels, it would be acceptable to assume the panel is installed correctly, right?

I agree with that.

MEMBER BALLINGER: I'm not sure what else you could do.

MR. LUKES: Right, I don't either. You could do everything, you could install a reactor coolant pump. They have a procedure, Appendix B, double sign-offs to make sure it was done correctly and the case is closed.

We don't go back later and assume the pump was installed incorrectly.

MR. WOOD: If we're talking about during the design phase was the problem that they would have to consider this during the initial design phase before implementing and installing the modification.

And when you're in the design phase, I agree that you're following the plan to establish maintenance and quality assurance procedures for making safe modifications for the plant would be sufficient to say this does not need to be considered during the design phase initial licensing.

Like I said in my presentation, if during those installation and during that verification of installation you discover that for whatever reason a mistake has happened or something's happened, that would need to be dispositioned under your quality assurance program.

And which path you chose, it would have different potential outcomes but those are so varied that we can't be prescriptive in the guidance document about what you could or might do.

You could reinstall, you could fix, you could accept as is, you could make a repair. I think the specificity on how you would disposition something

you might find during your post-installation verification or confirmation, then...But during the design phase, we expect licensees to be following their procedures.

And we wouldn't be expecting to see this on an initial design for new pools or reracks or inserts. But we might expect to see something like this on a reanalysis some place.

MR. LUKES: But to follow Kev's logic there, maybe this is what NEI is kind of getting at?

If you followed your procedures and you installed these panels and everything is good and then you go to install the panels and for some reason you notice that one of the panels was installed correctly, of course you couldn't assume that every panel was installed correctly because you just found a flaw in your QA program.

So, that would have to be addressed. How do you address that?

Normally, as I've seen this done in the industry, when they find a flaw that their QA program said something was done correctly and in actuality it wasn't, you would have to go sample or do some type of corrective action to analyze what went wrong in your quality assurance program.

And you would have to have whatever was part of that QA as treated as not correct and you have to go look at it. But that's standard nuclear QA, right?

MEMBER BALLINGER: We have to allow for some time for public comments. So, for the record, what I'm hearing is that based on this discussion, we now believe there's no difference between the industry concern and the Staff's exception, if you will.

In other words, if the racks are installed in accordance with procedures and in accordance with design and there's QA that's the end of the problem. It would be nice if I had a yes or no answer on that.

MR. LUKES: Yes from the NRC. That's correct.

MEMBER BALLINGER: Thank you very much.

MR. HOLTZMAN: This is Ben Holtzman from NEI. We still are a little confused about the wording but we received the clarity we need.

Thank you for the discussion and for the clarification. We vote for this to be moved forward and issued as quickly as possible. Thank you.

MEMBER BALLINGER: Hallelujah. Okay, thank you very much. So, unless there's other discussion --

MEMBER PETTI: I just think in light of this I'm not convinced we need a letter.

MEMBER BALLINGER: Well, that was my next question. We don't normally have extensive public comments but we may. But I'd like to get feedback from the Members with regards to whether we think there needs to be a letter.

So, I take it that we have one.

CHAIRMAN SUNSERI: Ron, make that two. I don't see we'd add anything.

MEMBER BALLINGER: Jose?

MEMBER MARCH-LEUBA: Yes, I'm for not writing a letter. I think this transcript has more value to the industry and the Staff than a letter would.

MEMBER BALLINGER: Okay, we're rapidly approaching a majority. Anybody else? Let me ask the question, are there any Members that would say we need a letter?

MEMBER KIRCHNER: I'll give you another not needing a letter. I think the discussion amongst the Committee with the Applicant and the Staff was a worthwhile contribution.

MEMBER BALLINGER: For sure, and so it's clear enough so that we don't need anything enshrined

in a letter, that would be my vote. Okay, any other Members?

Okay, thank you very much, this has been a very valuable discussion. I think we need to now look and see if we could get the public line open. It's hard for me to tell.

PARTICIPANT: The public line is now open for comments.

MEMBER BALLINGER: Thank you. Are there any members of the public that would like to make a comment? If you would, please state your name and make your comment.

PARTICIPANT: You're okay, Ron, go ahead.

MEMBER BALLINGER: I think we're okay. So, not having any public comments and getting a clear direction from the Members, I'll turn it back over.

Thank you very much for the presentations and the discussion and I'll turn it back over to Chairman Sunseri.

CHAIRMAN SUNSERI: Thanks, Ron, and thanks for the Members and the presenters on that, a very good, lively discussion. I think we reached some mutual common grounds on that thing.

All right, so it's 2:55 p.m. What I would like to do is inform the next presenters that we need

to take a break so let's take a 20-minute break. We'll reconvene at 3:15 p.m. and we'll start with the gateway for accelerated innovation.

And we will give them back 15 minutes at the end if they need the additional time past 5:00 p.m. Members, any other comments? All right, we're recessed until 3:15 p.m. when we will resume the presentations. Thanks.

(Whereupon, the above-entitled matter went off the record at 2:56 p.m. and resumed at 3:15 p.m.)

CHAIRMAN SUNSERI: Okay, it's 3:15. We will reconvene the ACRS meeting. We'll start with the roll call. Ronald Ballinger?

MEMBER BALLINGER: Here.

CHAIRMAN SUNSERI: Dennis Bley?

CHAIRMAN BLEY: Here.

CHAIRMAN SUNSERI: Charles Brown?

(No audible response.)

CHAIRMAN SUNSERI: Vesna Dimitrijevic?

MEMBER DIMITRIJEVIC: Here.

CHAIRMAN SUNSERI: Walt Kirchner?

MEMBER KIRCHNER: Here.

CHAIRMAN SUNSERI: Jose March-Leuba?

MEMBER MARCH-LEUBA: Here.

CHAIRMAN SUNSERI: Dave Petti?

MEMBER PETTI: Here.

CHAIRMAN SUNSERI: Joy Rempe?

VICE CHAIRMAN REMPE: Here.

CHAIRMAN SUNSERI: Peter Riccardella?

MEMBER RICCARDELLA: Here.

(Simultaneous speaking.)

CHAIRMAN SUNSERI: Wow, that was weird. I'm sorry, Pete Riccardella?

MEMBER RICCARDELLA: Yes -- yes, I'm here.

CHAIRMAN SUNSERI: Yes, when I said that, my cell phone actually thought -- woke up Siri and she started talking to me. But anyway -- sorry about that. And let's go back to Charles Brown?

(No audible response.)

CHAIRMAN SUNSERI: All right, well we have a quorum, so we will get started. This is the gateway for accelerated innovation in nuclear --

(Simultaneous speaking.)

MEMBER BROWN: I'm here. I'm here, Matt.

CHAIRMAN SUNSERI: Okay, thank you --

(Simultaneous speaking.)

CHAIRMAN SUNSERI: And advanced reactor demonstrations program. At this point I'll turn it over to Dennis Bley.

CHAIRMAN BLEY: Thank you very much, Mr.

Chairman. Before we begin, two things. One, this is an information briefing. It's not something in lieu of a subcommittee or full committee meeting. I'd like to thank Derek Widmayer our Senior Scientist who helps our future reactor subcommittee. He had gone to a talk by these folks and thought the committee would be very interested in hearing how these programs are moving forward.

We are going to be hear about the DoE Office of Nuclear Energy-funded Gateway for Accelerated Innovation in Nuclear -- GAIN -- and the National Reactor Innovation Center, NRIC, programs. GAIN and NRIC are complimentary and coordinated efforts to support the nuclear industry towards commercialization of nuclear innovations. Our speakers today are Lori Braase, who is Program Manager for GAIN; and Dr. Ashley Finan, who is the program -- who is the Director of the NRIC. Lori will go first. Lori, please go ahead.

MS. BRAASE: Well thank you very much for this opportunity to present to you. Christine King, the Director, she was looking forward to doing this today but she's had a family medical emergency this week and is still out. She does want to tell everybody hello, though, and certainly would love to

have been here and -- and I will not do her justice. She has a very good way of presenting GAIN. So forgive me for that.

But I've been with GAIN since the beginning. Kemal Pasamehmetoglu hired me to start GAIN on January 2, 2016. It was announced at the White House in November of 2015. And it's an initiative that was envisioned to help the U.S. nuclear industry connect with the national lab systems to further and accelerate their commercialization activities. It was born out of some university workshops where industry said, hey -- you know -- there are things that we can't do without a national lab, but you're so hard to work with. We're -- we have a really hard time getting in the door. And when we do, we're not really treated maybe like we're important work. So the program work often took precedence over the industry work. So out of that, GAIN was born. So next slide, please.

Our mission and vision really focuses on industry. So the vision is that the U.S. nuclear industry is equipped to lead the world in deployment of innovative nuclear technologies to supply urgently needed, abundant clean energy, both domestically and globally. Our mission then is to provide the industry

with access to cutting-edge R&D along with the technical, regulatory and financial support necessary to move innovative nuclear energy technologies toward commercialization in an accelerated and cost-effective fashion.

So with this vision and mission in mind -- next slide, please. So what does it really mean, then, for the United States? If we -- if we can retain and regain our U.S. leadership, then industry and DoE will lead global technology commercialization. The supply chain will be able to enable global industrial leadership. And our end users and utilities will be able to optimize their domestic energy portfolio using various sizes and types of nuclear power and other clean energy sources. Next slide, please.

So we're often asked, what's the difference between NRIC and GAIN? And we're very complimentary, as was stated earlier. GAIN was established in 2015 as a resource for accelerated development of nuclear innovations with lab partners. We -- it -- we enable comprehensive nuclear innovation ecosystems at all development stages. We provide streamlined access to testing, experimental facilities, lab expertise, and legacy data. And we

also provide a connection to the regulatory expertise, whether it's at the labs or through NRC. And we actually manage the NE voucher program.

Ashley is going to tell you more about NRIC. This slide shows you what -- that NRIC is a little different. They are focused on demonstrating reactor concepts, getting the lab facilities up to speed, providing those sites -- demonstration sites. But she will -- she will go into much more detail. So I won't take that away from her. Next slide, please.

So this is our GAIN wheel. And we developed this wheel and we have associated goals for the wheel. But we wanted to show everyone that we are not just NE vouchers. We're not just a funding opportunity. GAIN has five main focus areas. And at the top is that we are a private-public partnership. And we take that very seriously with our national labs, with NRIC, with other federal agencies, with our nuclear industry, and EPRI, NEI, USNIC, et cetera.

We also have a big outreach, communication, education arm to GAIN. Conferences, workshops -- through social media. We have GAIN directories. We have a very large, information-rich website. But we take that piece seriously -- workshops for GAIN are a means to connect with our

industry and to listen to them. We've connected 2,000 or more needs or requirements from industry over the last five and a half years. So we use these methods to stay connected and to listen.

We have an information part of this wheel. And that is -- is a little harder to do, in a way. But we have a -- we have documents with links to OSTI on the GAIN website. We have a data preservation effort going on to collect legacy information and get it into industry's hands. We have been working on this for five years. And we -- we are scanning documents. We are getting them reviewed and trying to get them into industry in a way that's useful to them.

It's a rather large effort and we are moving somewhat at a snail's pace, but we're certainly trying. I can tell you a little more about that later. We have a modernization part of this wheel, which is focused on modernizing contracts for industry -- helping them get into the labs easier. We have made some progress in that area which is -- it's pretty good.

We have a standard CRADA for our vouchers as well. And that's been very useful to get them out -- get them signed, to get industry the information they need from the labs. So our contract

modernization effort has -- has done quite well. And that includes our policy and regulation.

So then, finally, our collaboration and funding opportunity part of the wheel. And this includes our voucher, and the industry FOA, and -- and other types of funding opportunities that we can talk about later, too. So our goals, then, are really focused on that wheel. And goal one we've talked about all ready, is to give the nuclear industry access to financial support, lab capabilities and facilities. Goal two is, we work with industry to identify their gaps and their needs and to develop the path forward to inform DoE research programs and remove barriers for industry.

The needs that we identify during those workshops are typically as a result of a program request. So many of our workshops are program related so that they can talk to industry, build those relationships with industry, and adjust their programs going forward to focus on those industry needs -- and build the capability and the expertise that's needed.

Goal three is our regulatory goal. And we work with our stakeholders at NRC to communicate and resolve common issues through regulatory interactions. Jim Kinsey is our regulatory interface and Jim -- Jim

and GAIN have been working together on a regulatory webinar series. So we just -- we did the first one with -- it was really quite enjoyable, it's Phil Hildebrandt and Roger Mattson and they were talking about the history of regulation and -- it was -- it was very good. The video is on the GAIN website, if you're interested.

Goal four is access to -- industry access to their technology commercialization efforts which contract modernization, and that type of thing. And goal five is really focused on our legacy information. And we have added an aspect to that, which is the clean energy area. We are -- are out now developing a new webinar series that's tailored to carbon-free discussions. And so we've -- we just finished our first webinar yesterday. It will also be on the GAIN website, if you're interested.

We actually had a New York State representative and Energy Northwest talking about their energy goals. And it was very interesting how different they were. And they had a -- a little banter going back and forth that was very -- very good about being technology-neutral, for New York, and technology-specific for Northwest -- for the Washington area. So it was very interesting webinar.

Next slide, please.

VICE CHAIRMAN REMPE: Lori?

MS. BRAASE: Yes?

VICE CHAIRMAN REMPE: This is Joy. Could I interrupt you with a question about this slide and the prior slide?

MS. BRAASE: Sure.

VICE CHAIRMAN REMPE: I'm just trying -- historically, a lot of times we think of GAIN associated with deployment, or accelerating technology for future plans. But when I look at what's on this slide and the prior slide, it seems like there's nothing to preclude an innovative methodology for the operating fleet. So let me give you a couple of examples and tell me, yes, if -- if things -- if the conditions were right, maybe that could have been -- GAIN might have assisted with it. For example, if some BWR owners wanted to try an innovative way to improve their training process for -- looking at severe accidents. Or if -- if both PWRs and BWRs as well as, like, an advanced small module LWR wanted to do some SRV relief valve testing because, for example, recently some Fukushima investigations that indicate that there might be fatigue that would allow those valves to be opening up below their set point

pressure.

So it's something that would be useful to both advanced as well as operating reactors. Could folks bring a proposal to the GAIN platform and ask for funding?

MS. BRAASE: We have had two or three -- I can't remember exactly how many -- vouchers that were focused on light water reactors, yes. The best thing to do is get a hold of us and talk through the idea. We -- we really are focused on innovative new ideas. You know, so if there was an innovative pump, or something that would make a big difference for the light water industry. But I can certainly find those examples and let you know what vouchers they were.

We're going to come up to the vouchers here in a minute. I can't remember exactly which vouchers. But we have provided funding to light water efforts, yes.

VICE CHAIRMAN REMPE: Okay. Again, I'm interested in safety and research for safety -- and I am not trying to propose anything. I just --

MS. BRAASE: No, no -- no.

VICE CHAIRMAN REMPE: -- trying to understand what's in and what's out with this program.

MS. BRAASE: It's -- it's really all about

innovative technology. And so if it's something -- a new heat exchanger or, you know that type of thing -- that's really more what the vouchers are for. Yes.

So next slide. This is a document that John Jackson and I put together that has the contract mechanisms on one side and funding opportunities on the other. It is a general document that's applicable across the National Lab System. So it talks about the different funding mechanisms and how you can access those. It's been -- it's been a good guide for us, and for industry. So it's on the GAIN website. If you're interested, I can also email it to you. We just wanted to show you this slide so that you knew some of the available information we have for industry.

John Jackson is our -- currently our technical interface. And he's very good at putting pieces and parts together for industry when they have certain needs from the National Lab System. And so these funding opportunities can be used in a way to help industry get to -- get further down the road to commercialization. Next slide.

So vouchers -- vouchers are very unique. And for our GAIN Nuclear Energy Voucher -- I'll just tell you a little bit about what they are. They're a

competitively awarded access to facilities and staff in the DoE National Laboratory complex. They are not a financial award to a company. The funds go directly to the National Lab to do the work, and there is a 20-percent cost share involved.

The awardee then becomes the customer, so to speak, for the National Lab. And they're -- they're about 500k. So they're not large amounts and they have a year time period from when the CRADA is signed to -- to completion. They've turned out to be a very good way for a National Lab to get to know a certain industry company. And they make relationships that then help that company in other areas of their progression -- of their research, or their engineering efforts. So it's been -- it's been really good for the National Labs to connect with industry in this way as well.

There aren't any size restrictions on companies. We have large companies and small companies. But we do have an extra consideration if the companies are smaller. So around one voucher awards -- our round-one voucher rewards just ended, we just announced. And these are the winners for round one. Right now we are reviewing the vouchers with round two, which closed February 1st. And all of the

voucher information is on the GAIN website and you can click on the links there and read the little summary for the vouchers.

TerraPower -- this year TerraPower is the first voucher awarded for work at LANL. And it involves characterization of plutonium chloride salt properties, using their neutron beam imaging facility at LANSCE. So Oak Ridge, Argonne and INL get the bulk of the vouchers, it seems, because we have the connections with industry. But our other national labs can do this as well.

So we have interactions with Lawrence Berkeley, with Lawrence Livermore, with Sandia, Savannah River, Brookhaven -- they're just not as tied-in with the industry as we would like. So we continue to work with them as much as we can. Next slide, please.

So this is a listing of our vouchers from last year. And it gives you an idea of some of the proposals that we had. We've been talking more and more lately with industry about graphite. And that seems to be coming up quite a bit. So we're taking a look and seeing if we need to do a little more communication with industry on their graphite needs. So that was one of the vouchers for Ultra Safe Nuclear

Corp.

Oklo had a voucher to address gaps in legacy data on fuel-steel interactions. And we had a new company, Natura Resources, they're in Abilene Texas. And so they're looking at Abilene Christian University building a molten salt reactor. So there's quite a range of companies and needs that the vouchers help with. And every -- every cycle -- every three months, we have five to ten companies apply for vouchers. And that's been pretty steady through the last five years. Next slide, please.

So we do some statistics the best we can. And for -- including our round one, 2021 vouchers, we've had a total of 57 awarded. Twenty-eight vouchers have been completed. And then that results in $20 million to the National Labs with a total project cost of $25.3 million because there is that 20-percent cost share. The graph just kind of gives you a bit of an idea of the National Lab involvement in the vouchers. Next slide.

So on the contract modernization piece of the GAIN wheel, we have -- we have approved -- we went to DoE and worked with the legal entities at DoE and others to -- to develop a nuclear energy advanced class patent waiver. And in this waiver, DoE foregoes

taking the title to the patent-able inventions. They are available when the contract negotiations begin. They're applicable to the large domestic businesses interested in DoE-NE funding. Small businesses have other paths. And the waiver really was geared to accelerate negotiations for the industry funding opportunity award and the events reactor demonstration awards -- and to reduce uncertainty in negotiations.

We are currently working on a GAIN Access CRADA. And this is kind of unique where an industry partner works with the National Lab to sign a CRADA. But that CRADA grants them access to other labs in the -- in that agreement. So we're working with Argonne and INL on a voucher where both labs can use that one CRADA. This is something we're working on in 2021. We are -- we are close to having at least one signed. So we -- we should be reporting success on that by the end of 2021. But it will be really good for industry because they don't have to contract with only one lab to get the work done.

So conceptually, industry partner has the work scope that crosses multiple labs. The lead lab puts the CRADA together. The partner labs sign the CRADA. So this is -- this is very good and it crosses the offices of NE science, and NNSA.

MEMBER PETTI: Hey, Lori?

MS. BRAASE: Yes?

MEMBER PETTI: This is Dave.

MS. BRAASE: Hello Dave.

MEMBER PETTI: So in terms of a patent waiver, this is for any assistance -- a CRADA or a voucher -- anything under the GAIN umbrella?

MS. BRAASE: I believe so, yes.

MEMBER PETTI: Okay, yes. Okay.

MS. BRAASE: And I can get you more information if you're -- if you're interested. Okay, next slide.

This is more in my area here. Legacy documents. One -- when we met with industry in July of 2016 we had three different meetings. We had meetings with the fast reactor technology companies, molten salt reactor technology companies, and high-temperature reactor companies. And so we had these three industry-focused meetings, and in those meetings they identified their initial set of needs. And those -- that report is on the GAIN website if you're interested. And I can send it to you as well.

And so the -- they were -- they were the initiating contact that we had with all of these companies. From that meeting they identified their

top cross-cutting needs. So one was access to regulatory connection. One was access to modeling and simulation tools from the National Lab system. The third one was access to HALU, high-assay low-enriched uranium. And the fourth one was access to legacy documents. Those were their top four items. And -- and in five years we've made progress on all four.

Legacy documents have turned out to be much harder to do -- especially in this -- this day in age with working with some other countries. So finding these documents -- the applied technology designation was an issue back in, I think, November of 2016 John Kotek issued a statement -- issued a directive saying there will be no more applied technology designation. So that went away, which is good. The problem is, though, we still have to have all of those documents reviewed. And OSTI provided us a list of almost 12,000 applied technology documents that they have.

So it -- we've been working with industry to identify the documents they want. They have to go through the export and classification reviews. And right now we have request for new production reactor documents that we found in -- in storage in Idaho Falls, and they're being scanned and reviewed. And

there's several other classes of documents that industry is interested in. It's getting them in their hands, and getting them released when their export control as been a little more difficult.

MEMBER PETTI: Hey, Lori?

MS. BRAASE: Yes?

MEMBER PETTI: The CBF documents, I was the manager involved when those programs closed. So many boxes crossed my desk. You know, the piece of paper you get after 25 years -- what do you want to do with it? I thought most of the critical data was in the database at NEA. Isn't that -- is that still true?

(No audible response.)

MEMBER PETTI: Does industry know that? I mean -- the actual raw data was sent to NEA and sits in big validation databases for -- for many of the experiments.

MS. BRAASE: Well I don't think I knew that, David.

MEMBER PETTI: Okay.

MS. BRAASE: I -- I think I have a couple of great big binders with information on Loft. So --

MEMBER PETTI: Well we should talk offline here.

(Simultaneous speaking.)

MS. BRAASE: Okay.

VICE CHAIRMAN REMPE: Actually, I had a question about those documents too. Was this motivated -- there was a couple years ago when some folks like Corradini and Fauske -- and I am trying to remember who else reached out and had an ANS session concerned about the loss of thermal hydraulics data. And I was going to ask before this was brought up -- is this related -- is that -- wait, I don't know if you've looked at the proposal, Lori, but did it tie back to this ANS -- Neil Todreas is involved too, as I recall. But anyway, they were asking for support in identifying where data -- be of most interest to the industry. And was this tied to that -- or an outgrowth of this ANS session?

MS. BRAASE: You know, that I don't know. They actually -- Fauske and company actually contacted us and put a proposal together. We've funded them for a couple of years to do a couple different things. They -- they identified sort of an outline of documents the first time of -- of what might be of interest. And then they just finished a report -- I think, just -- boy, it's just been within the last month of the next effort.

So yes, we've -- we've -- they're very good about identifying data out there. It's not necessarily data that we think the advanced nuclear industry might be interested in at this time. And the -- and the -- some of the data is at, I think it said IAEA. So it's not always that easy to get. But there is some information on the GAIN website about the Loft data from -- that Fauske did. So --

(Simultaneous speaking.)

VICE CHAIRMAN REMPE: I'm guessing there's a coordinated effort and I'm just -- again, thinking about NRC research folks that -- I'm hoping that everybody -- I hope this is part of that bigger effort. And so it would be good to find out a little bit more about the motivation for it.

MS. BRAASE: I'm happy to send you some information, Joy.

VICE CHAIRMAN REMPE: Thank you.

MS. BRAASE: You bet --

(Simultaneous speaking.)

VICE CHAIRMAN REMPE: Just go through -- because of ACRS -- I know we know each other, but anyway, go through ACRS to make this all official.

MS. BRAASE: Okay.

VICE CHAIRMAN REMPE: Thank you.

MS. BRAASE: Whatever I need to do, just let me know and I can get you some information.

MEMBER PETTI: So Lori, Mike is on the line. Maybe he -- he knows something of this history, too, having spent his career in thermal hydraulics.

DR. CORRADINI: Yes, this is Corradini. I guess I wanted just to give some information. So there was a group of five of us -- Bob Henry from Fauske and Associates, Neil Todreas, Bob Budnitz, myself, and Frank Ron from -- formerly of EPRI -- retired. And we put in a -- I'll call it a thought piece on how this should be done. The -- the small grant was awarded to Fauske and Associates because it had to be to an industry. And we focused on three example experimental series, Loft, the containment experiments at Battelle in Germany and now the third one escapes me. But we used Loft as the example. And I think to Dave's original question, we found that NEA had a great deal of most of this data already in its books.

(Simultaneous speaking.)

MS. BRAASE: Yes.

DR. CORRADINI: We had changed -- we had also checked with NRC, in particular Richard Lee's branch as well as -- now I -- escapes me. But Steve

Bajorek, the branch that he is in. And we identified all of those in the final report that went into GAIN from the Fauske and Associates team.

VICE CHAIRMAN REMPE: So Mike, as a follow-up, since NRC is involved, does that report get back to Steve and folks at NRC Research? Because Chris Richards retired.

DR. CORRADINI: Right. And I think the answer to your question is yes, but it has to flow through the GAIN office since they're the one that had provided the original voucher money for the effort. It was all -- originally thought of as an example -- that is, the Loft data, as an example of what one would do. And we listed -- as you're well aware, I think, Joy, you answered some of the questionnaires that we had put out -- both the industry as well as the universities and labs -- as to a whole range of experiments that ought to be considered in this regard.

VICE CHAIRMAN REMPE: And so are you making progress as it's continuing? Because -- I'm sorry, this is a side thing. But I just am curious --

(Simultaneous speaking.)

DR. CORRADINI: No -- no, I just wanted to -- I just wanted to give you more background. That is

being led, again, by Bob Henry at Fauske and Associates. And they made a second proposal and that -- after that point, I guess I've lost track of it.

VICE CHAIRMAN REMPE: Okay, thank you.

MS. BRAASE: We did fund a second effort, and they just finished. And I can give you that information. I'm not sure we'll have a third effort, but we do have -- we do have the second effort. And we do have the report.

Okay, next slide. The other thing that we've been working on -- Argonne, Sandia, a little bit INL and ORNL -- the database's experimental information are out there and we started an effort -- really back in early with -- with Argonne on the TREAT experimental relationship -- relational database, excuse me. They were working on this database and then they ran out of funding. And they only needed a little bit more to finish. And so GAIN provided them enough money to finish the TREXR database -- is what it's called.

And with that effort, Argonne has a really great database and a really great way of providing data through the system. And so it's progressed. Each one of these databases have had a story behind them. And Argonne's been very good about getting the

data in a place that industry can access. You have to -- you have to put information in and apply for access. So it is controlled. They're working on -- right now, they're working on some QA efforts with some of the data. The interesting thing about the Sodium System and Component Reliability database is that that was an effort industry pushed for. About three or four years ago when the vouchers -- Shane Johnson announced that he was going to do something different with the vouchers. And one of the ideas he announced was that there was going to be a comprehensive voucher available to industry where more than one company could sign up and collaborate on a voucher.

In the end, we couldn't do that. But what happened was, industry decided to test Shane and so they submitted a voucher -- a collaborative voucher into GAIN to finish this database. And of course, we couldn't give them a voucher. But what we did do is we said, hey, this benefits all of industry. It shouldn't be a voucher anyway. And because it benefits all of industry we were able to get funding through our -- our own coffers, so to say -- so to speak -- to help finish that database -- to provide it to industry. And -- and it was a great success. And

as a result we've provided them some additional funding to do phase 2 on this database.

So we call it walk-in work, but it's -- it's some funding we set aside to respond to needs from industry when it benefits a bigger, broad set of industry companies. So that -- that was really -- that was really a cool start to some -- some industry-needed information. And we did it in a different way.

The molten salt folks out of Oak Ridge are working on a component reliability database. And it -- it's somewhat driven by industry requests. And as industry requests information and they build up this database. So we're working at making that available the end of this year. Next slide, please.

So as part of our outreach, and during COVID, we had to be creative. And so early on we had a couple of workshops scheduled. And we couldn't do it last year, so we turned them into webinars. And we have webinar workshops, and then we have just webinars for information. So again, I talked about this earlier -- Jim Kinsey -- we've developed the regulatory route to commercial nuclear deployment. And he's -- he's -- he's finished two webinars. He's got two more to go. All that information is on the website under workshops.

Christine's Shaping our Carbon-Free Future -- the first one was yesterday and we have four to six in the series on that one. And then we have three workshops scheduled in the next few months. And when I say workshop, that means it's industry-focused, it's gathering needs to inform programs. The first one in April will be related to the Advanced Reactor Safeguards and Security program. And then in May we'll do another microreactor workshop so that we can let industry know what's going on in the microreactor program and what their comments and needs are, and how they would reshape what's being done, if they have ideas and needs and feedback.

And then we have a face-to-face -- fingers crossed -- a face-to-face workshop scheduled at the end of August. And that's with the Advanced Methods for Manufacturing workshop. And this one is a little different because we're going to look at trying to push the envelope on qualification processes -- materials qualification and different methods and processes. And have a -- a look at how we can do this differently to -- to -- so to speak, speed up the process in qualification. So we'll see. We are hoping we get to do it face to face so that we can be creative and, you know, have a -- have a really great

relationship-building workshop. Next slide, please.

GAIN outreach -- it is -- is a big deal for us. We work very hard at it. And I know that many people maybe don't think it's very important. But we do stay in touch with our industry. So we have an outreach effort that involves NGOs and industry companies and states. We have an effort with Envoy Public Labs where they do state engagement. Christine and Ashley just presented to the Minnesota State Legislature -- and Ashley can give you more information on that, but Minnesota's got a vote in front of their Senate -- there -- to repeal the moratorium on nuclear power.

We have a -- a focused effort to reach clean energy companies and the public and to talk about nuclear as part of the renewable conversation. We have a big social media effort NRIC and GAIN share communication support, so we have some great communication folks that are creative and -- and really build off of both of our programs. So this just gives you a little idea of our social media and our web analytic. Next slide.

One of the other things that we did last year -- we had a podcast with titans of nuclear. And we had three podcasts. So Christine did the first one

-- John Jackson, the second, and Nick Smith, the third. So those podcasts are available on GAIN website as well. So that -- that was quite an experience. Christine -- Christine -- we have a quote there from her. Connect with what excites you about nuclear today, and imagine nuclear tomorrow. So if you're interested in hearing what they had to say, the podcast have some personal aspects to it, and professional -- and they were very well done. Next slide.

Right now, this is our GAIN organization. This is not an typical org chart. People -- we are a full-functioning team that really works together to get anything done. But just to kind of tell you -- for how we've broken them out. We have Christine. Our deputy is Andy Worrall. We have a new formation of an executive leadership community which hasn't started yet. Senior advisor is Hussein Khalil at Argonne. So I run a lot of the aspects of GAIN on the program management side. And the technical interface is John Jackson. So -- but we do very much all work together. And it -- and actually, many of these folks are part-time and matrixed in. So we have a small team. Next slide.

So this is the end of the presentation.

But I did want to say that today, after, you know, six years -- five years of doing the GAIN initiative, our technology working groups for fast reactor, molten salt reactor, and high-temperature reactor continue to meet. Two of them meet, I think, monthly. And they invite GAIN to participate. NEI is kind of a covering for them -- gives them a platform to meet. But they're fully functioning, independent groups. And they provide input to us. They have a collective voice when they need to resolve issues that apply to all of them. It's -- it's really quite a statement that these competitive companies continue to meet together to work through these -- these issues and to work with the National Labs. So it's a success story for us.

EPRI and NEI are also part of this team and together we have a means industry counsel that focuses on both the light water aspect and the advanced reactor aspect of modeling and simulation. And HALU -- there's a report that's being finalized to go to Congress on -- on HALU and how to start providing quantities of -- of that to industry and what the plan is. And so -- I think at the end of the day, there's been a lot of progress made with GAIN and with the industry. And we certainly look forward to

the next five years and hope that we can reach some of those goals that enable our industry to be world leading.

So thank you very much for letting me present and I hope I did Christine proud in some way. But one she'll be back to present to you and answer all your questions. But if you have any questions for me, I'm happy to -- to help.

CHAIRMAN BLEY: Lori, thank you. This is Dennis Bley. I really appreciated your talk. I -- I heard something on GAIN some years back that had no substance. And I didn't follow it. You've given us a lot of substance and I'm -- I'm impressed. I just really appreciate you coming. Members, if you have any questions this would be a good time. If you haven't already asked them.

(No audible response.)

CHAIRMAN BLEY: I guess not. So thank you -- thank you very much. I guess it's time now to turn the floor over to Dr. Ashley Finan. And as you heard Matt say earlier, we got started a little late. So if you go over a little bit, that's fine. But it looks like we've mostly caught up. So I hope it works -- works out directly. So at this point, Dr. Finan, I'm going to turn it over to you.

DR. FINAN: Great, thank you very much turning it over to me. All right, now hopefully just one -- can you hear me okay?

CHAIRMAN BLEY: Yes, that's much better.

(Simultaneous speaking.)

DR. FINAN: Okay, good. Nobody ever wants two of me. So I -- I really appreciate the opportunity to speak with you today. It's -- it's kind of pretty exciting. I was looking at the meeting details here, and it's the 683rd meeting of the ACRS full committee. So it's quite a history that you have -- and an illustrious and important one. So I appreciate the opportunity. I am going to take a few minutes to talk about the Advanced Reactor Demonstration program and about the organization that I have the privilege of running -- the National Reactor Innovation Center. So I will go ahead onto the -- the next slide, please.

The National Reactor Innovation Center is a national program run from DOE-NE. It's run by Idaho National Laboratory. But again, it's a national program. And our vision in the near term is to support the demonstration of at least two advanced reactors by the end of 2025, thereby really reestablishing U.S. nuclear energy leadership --

showing that we are the best in the world at advanced nuclear technology.

And then continuing to develop and demonstrate, and then deploy, commercial advanced nuclear by 2030 so that is providing abundant clean energy by that time. And then the next slide, please, if you would.

A little bit more detail -- our five-year program objective includes that -- that first vision. Enabling demonstration of at least two advanced reactors. We want to do that by making available infrastructure, sites, materials, and expertise -- particularly across the lab complex. So we want to provide regulatory support and coordination to companies pursuing demonstrations, as well as develop best practices in public engagement. And then it doesn't end in 2025. We wanted to be working to also prepare DoE an the labs for continued innovation and demonstration -- not a one-time event, but ongoing innovation. So we want to do that by developing best practices and a competency within the DoE labs and the U.S. nuclear industry for planning and construction and demonstration at nuclear projects.

We also want to develop enduring infrastructure and expertise that can enable industry

to continue to innovate, as well as enable labs and universities to continue to innovate and establish methods for efficient coordination among the laboratories. And we work very closely with GAIN on that. I kind of skipped over the relationship between GAIN and NRIC because Lori presented that. But I will emphasize that we -- we work to be complimentary and coordinated. So -- so Lori mentioned the access CRADA. That's one of those methods for efficient coordination. NRIC has developed a resource team so another method. So we're -- we're working to open up channels of communication so that we can all really work together. This is going to take a village, the way I see it, to get these reactors done in the -- the time frame that DoE is pushing us to move. So we want to be working together and all pulling in the same direction. So next slide, please.

So we are committed to achieving our vision through our mission to inspire stakeholders and the public to empower innovators to test and demonstrate their technologies, and to deliver successful outcomes through efficient coordination of partners and resources. And these are shown in -- in sort of a circle here because I see them as -- as being intricately related. I am convinced that as we

empower the private sector to demonstrate their technologies, we'll be able to deliver successful outcomes. And I am confident that that will captivate and inspire stakeholders and the public as they can see what advanced nuclear technology can really do for what we need as a -- as a society and as a world. Next slide, please.

NRIC's key stakeholders include the public and in particular the local public around the areas where demonstrations might occur. INL is one of those locations, but there are also locations around the country that -- that we are focused on for a potential advanced reactor demonstration. We have industry stakeholders, which include the advanced reactor developers, the supply chain for those developers and then, on the other end, the potential users of those reactors or the products of those reactors -- whether that's electricity or heat or hydrogen.

And then on the government's side, we of course have DoE as well as NRC, Congress and others -- and you see DoE -- DoD and NASA because there are significant demonstration efforts being developed within -- and actually pursued within the Department of Defense and within NASA. And while we're not directly supporting them, we are trying to prepare

infrastructure that could be of use to them -- and prepare those same competencies that could be of use to them when they're ready, if that's -- if that's helpful.

And then of course researchers at the laboratories and at the universities. One of our key functions is to try to -- you know, especially at the laboratories -- connect the developers who are demonstrating reactors with the subject matter expertise and the people who can help them make those projects successful throughout the lab systems. And then, in the universities, we see some of that. We also see the universities as a place where we can find R and D in complimentary technologies that could enable us to ensure that these technologies turn out to be scalable. They need to be affordable. They need to be constructed on schedule and on budget, and they need to be relevant to the grid of the future and the integrated energy systems that we envision in the future. So that's another area where we see the universities coming in. And of course the universities are part of the talent pipeline.

Next slide, please. So the historical context for this -- there -- there were historical reactor demonstration programs that really proved that

we can do this. And I know there are a lot of folks who think that this is ambitious and -- and not going to happen. But history counsels us to be more hopeful because the Atomic Energy Commission demonstrated over a dozen reactors in as many years with private industry cost-share. At the National Reactor Testing Station in Idaho, the nation built 52 reactors over a period of about 25 years. And of course, we have a lot of other history in the U.S. and internationally of advanced reactor demonstration programs.

So we are really encouraged by our history. And what we see recently is bipartisan policy enthusiasm for moving forward with this in recognition of our climate challenges and our global energy needs. And we see the Nuclear Energy Innovation Capabilities Act, which actually authorized and called for the National Reactor Innovation Center. And then the Nuclear Energy Innovation Modernization Act, which of course you're very familiar with as it's deeply concerned with modernization of nuclear regulation.

And then the Advanced Reactor Demonstration Program which showed up in appropriations last year, but then has been authorized further in the Energy Act of 2020. And sets up this

really big demonstration program for advanced reactors, which I will cover in detail in just a moment. So a lot of, you know, strong, historical context. We know that when we're faced with an urgent need we can innovate and we can demonstrate in advanced reactors. Maybe it's been a half century since we really did that quickly. But we now have this policy support to do it again. And we have -- if you go to the next slide -- we have a U.S. advanced reactor industry that is comprised of dozens of companies and really is -- is developing a wide range of technologies with different strengths. Sizes ranging from around a megawatt to a gigawatt. And coolants that span most of the -- most of the coolants we've ever looked at, including gas, sodium, salt, lead and water. And a significant private investment interest in this space.

So it's an exciting time relative to the current industry in the United States. The motivation this time is really about clean, reliable energy with increased efficiency and the potential for improved resource utilization and reduced waste. And this group of companies is looking at very diverse markets -- and in fact, diverse products. So that differentiates them from the current operating fleet

right now. So of course, the operating fleet is also looking to diversify into hydrogen and other opportunities. So, I guess everybody is -- is moving that way. Next slide, please.

VICE CHAIRMAN REMPE: Ashley, this is Joy. Could you go back a slide? I just was curious about some of the bullets under your demonstration programs.

I'm well aware of the Atomic Energy Commission's advanced reactor deployment program and I remember the production reactors and what of course has gone on out here in Idaho, but when you get down toward the end, I'm not sure why you included international development. Are you talking about their deployment programs?

And then, of course, the NGNP, I can remember when they put a sign up out at the site saying future site of the NGNP, and nothing else went up along with that sign, so why is that one included in your list of bullets?

DR. FINAN: Yeah, that's a good question. I mean, it is part of our history here, and it's true that it was not ultimately successful and I think there are important reasons for that, and reasons that we need to learn from really and I think we're working to do that, but it's one of our more recent -- it was

a demonstration program. It was not successful. You are quite right.

In the international space -- oh, go ahead, Joy.

VICE CHAIRMAN REMPE: Oh, go ahead and finish and then I had a -- well, I'll follow up.

DR. FINAN: Okay.

VICE CHAIRMAN REMPE: I interrupted. Well, Clinch River was another example, and Bill Madia has a very good presentation that I saw that I'm sure the slides are somewhere available online, but of the history of DOE in recent years, deployment of programs and some of the pitfalls, and there was a lot of good lessons he cites on why some of them are way over budget and were ultimately not successful.

DR. FINAN: Yeah, Clinch River was a really interesting case study in continuing with a project that had support from a variety of different districts even in the face of decreasing policy need for the project, right?

The initial reasons for pursuing the project essentially became lower priorities, and yet they continued because of political momentum. It was really not a very good picture and I think that's another one that we need to learn from, so, and I've

studied that one, so I appreciate your bringing that up. I agree with you. It's a good case study.

On the international development, we have seen, for example, if you look back at the development of BWRs and PWRs in the UK --

Well, so let's see, if you look at the UK and Canada and the reactors that they developed, they went from their very first reactor, very small reactor to their commercial plants in a period of, if I'm remembering correctly off the top of my head, 12 to 14 years, and that's going through several iterations of demonstration projects of increasing size over, again, you know, roughly a decade, decade and a half.

And that, to me, is kind of a staggering pace of development that we don't always even aspire to over the last half century in nuclear, but I think the point is we're aspiring again to be innovative at the kind of speeds that were achieved at the beginning of the atomic energy movement.

So, that's what I would -- you know, I guess I take your point on the slide and I can probably make some edits there, but that's what I take out of it.

VICE CHAIRMAN REMPE: I'm not really concerned about the slide, but along the same theme,

John Deutch led a task force, the SEAB Task Force, jeepers, I guess it must have been about four years, five years ago now, that talked about the fact that it's not just getting a reactor, a new design up, the first of a kind.

Because there will be problems just as we've seen what's going on with the Vogtle plants and any new technology, especially when you're trying to recreate the industry where some of the folks who supply nuclear grade components were no longer available, so that one really needs to think about the nth of a kind, that the government needs to take a major role and perhaps even get past the first hump before they have a viable technology. What are your thoughts about that?

DR. FINAN: Yeah, absolutely, I am -- so one of my -- my biggest fear, and I'm not really afraid of this because I think we're working to make sure this doesn't happen, but coming into this job, right, my concern was, well, we don't want to just build a reactor and have that be it, first of a kind and last of a kind, right? That's not the idea here.

We want something that's going to be scalable and relevant to climate change, and so you'll see when I get to two slides from here that DOE is

focusing on the supply chain, so they are thinking about that supply chain issue, some things for the advance.

Another thing that I'm really working on in the NRIC program is how do we develop the advanced construction technologies, the digital engineering, and the project management approaches that will enable these projects to be scalable, to come in on schedule and on budget, and not have those problems that you're pointing to.

And I mean, granted, Vogtle is first of a kind, so you expect to see some issues, but we've seen a bunch of good literature over the last five years that has identified what are the key cost drivers of nuclear construction costs or, yeah, well, cost, drivers of cost, sorry about that.

But anyway, what are the key cost drivers? What do we need to address? And we've found that many of them are in civil construction or are in the way that we do design engineering and transition to construction and operation, and so I think there are opportunities there.

And I have another area where I'm trying to grow an opportunity to address some of the project management issues that we see in nuclear construction,

and then there's one more which is integrated energy systems where you're really making sure that you're planning for the future market, not the past market.

So, I think that I'm very focused on that issue and I'll get to it at a high level in this presentation, but it's deeply important to me and it's a top priority, so I welcome further conversation on it, and maybe when we get to that slide, if you have reactions, I'll welcome them then also.

VICE CHAIRMAN REMPE: Okay, thank you.

DR. FINAN: Sure, so I'm going to just spend a couple of minutes here on the advanced reactor demonstration program. This is not run out of my organization. Rather, NRIC is really part of the advanced reactor demonstration program.

So, DOE-NE has put together the ARDP and there are a number of awards within it. NRIC is here to help support those companies in their process and help make them successful. NRIC is also here to help other companies, even the ones who didn't win ARDP awards.

So, we're working with companies who have no government money or have government money from other sources, but we're also supporting the advanced reactor demonstration program whose objectives are to

develop, construct, and demonstrate several advanced reactors with beneficial capabilities, including inherent safety features, superior reliability, greater fuel utilization, and an ability to integrate electric and non-electric applications, as well as support a diversity of advanced designs that offer significant improvements over the current generation of operational reactors, and stimulate private sector companies and those supply chains that will be crucial to having nth of a kind development.

There are three funding pathways in the advanced reactor demonstration program that are aligned with a variety of maturity levels.

So, the first is the advanced reactor demonstrations awards which DOE calls the demos, and those are cost-shared demonstrations for two reactor designs and they're a 50/50 cost share, and those designs have the potential to be operational in five to seven years.

And then the second category is risk reduction for future demonstration awards and DOE calls those risk reduction, and those support five other advanced reactor designs that have the potential to be operational in ten to 12 years.

And then finally, the advanced reactor

concepts awards, there are several of these partnerships focused on advancing reactor designs that are moving towards the demonstration phase, but aren't necessarily in a countdown phase with that kind of firm timeline at this point. Next slide, please?

MEMBER PETTI: Hey, Ashley?

DR. FINAN: So, these are the -- yeah, go ahead.

MEMBER PETTI: Ashley, this is Dave, just a question on -- if we can go back. Are these like one-time awards right now or like -- I see ARC-20. I remember ARC-15. What's the frequency of these? Do you know what DOE's thinking in this?

DR. FINAN: That's a good question, Dave. Thank you. They made their initial awards in 2020. Just at the end of 2020, they made these, and the expectation is that they will continue to receive incremental funding through their project.

And so when they made those awards in 2020, they awarded certain amounts, but it was not all 2020 dollars. So, for example, the demonstration awards are up to $4 billion at a 50/50 cost share.

So, DOE, hypothetically, if they committed to $2 billion, they only gave a portion of that, so $80 million in 2020, but their intent is to continue

to fund those pending appropriations until those five to seven years or ten to 12 years are complete.

MEMBER PETTI: Thanks.

DR. FINAN: Sure, so the next slide? This just shows the awardees for the three categories, and I'm going to go through each category in its own slide so you can advance to the next slide, please.

So, the two technologies selected for the advanced reactor demonstration demo pathway were the TerraPower Natrium reactor and the X-energy Xe-100 reactor. The TerraPower Natrium reactor is a sodium fast reactor and then the X-energy reactor is a high temperature gas reactor.

These projects are both looking at the Energy Northwest site in Washington State as one of their possible sites, and X-energy has made clear that that's their preferred site. TerraPower is also very serious about that site, but they are doing a site selection process during this first year, so they haven't made a final selection.

So, again, the demonstration projects are to actually build and operate these technologies. These would be NRC licensed, and so they are working with the NRC to move toward a license application.

VICE CHAIRMAN REMPE: So, in both cases,

there's an organization that's willing to actually own and operate the plant too. It's not just the vendor that you're giving this award to?

DR. FINAN: That's my understanding, yes, and Energy Northwest is a partner in both of these projects --

VICE CHAIRMAN REMPE: Okay.

DR. FINAN: -- the utility there. Next slide, please? The risk reduction pathway selected five different technologies.

They include Kairos Power, and there, the award is for the design, and construction, and operation of their Hermes test reactor, which is a precursor to their commercial reactor, and this is a fluoride salt cooled TRISO pebble fueled small modular reactor.

The next is the Westinghouse eVinci which is a heat pipe cooled microreactor with TRISO fuel, and there, their risk reduction award is for technical risk reduction for moderator design, wick manufacturing, refueling, and licensing. It doesn't actually include the construction of the reactor at this point.

And then BWXT has also a high temperature gas reactor, microreactor, and they have an award to

mature some of their technology focusing on their uranium nitride TRISO fuel.

Holtec has their SMR-160 which is a light water cooled natural circulation PWR, and they have an award here for early stage design, engineering, and licensing activities.

And then Southern Company, in partnership with TerraPower but Southern Company is the lead here, has a risk reduction award to design, construct, and operate the molten chloride reactor experiment which is a small demonstration reactor as a precursor to their molten chloride fast reactor, and you can go to the next slide, please.

MEMBER PETTI: So, Ashley, 180 megawatts thermal is the definition of small?

DR. FINAN: That is their molten chloride fast reactor, so I should have been more clear. The first column, that's their commercial target reactor.

MEMBER PETTI: Oh, I see.

DR. FINAN: The actual risk reduction project is about 100 kilowatt thermal --

MEMBER PETTI: Okay.

(Simultaneous speaking.)

MEMBER PETTI: Okay, that makes sense, thanks.

DR. FINAN: So, good point, yeah. Okay, next slide, please? And then here under the ARC-20, there were three awards. One is the advanced reactor concepts for conceptual and preliminary design of their sodium core reactor, and then one for General Atomics for conceptual design of their gas cooled fast modular reactor, and then for MIT for conceptual design for the MIGHTR gas cooled high temperature reactor.

So, those are the awards, and at this point, you know, our goal is to help support them. So, I will move on to talking a little bit more about NRIC unless there are any more questions on those awards. Okay, the next slide then, please?

So, part of our mission is to empower these companies, right, and we want to support those companies who DOE has entered into a public/private partnership with, so I'm going to talk a little bit about how we're empowering those companies. Next slide, please?

So, first, we're working really closely with GAIN, and with GAIN and NRIC together, I believe that DOE-NE has worked, you know, in partnership with Congress, of course, to set up the support that will help companies move from their concepts to their

commercial product. So, together, we're really trying to help them cross this bridge. Next slide, please?

So, some details on what NRIC is doing to support them, we're developing a demonstration resource network which includes test beds and demonstration sites first, and so those include a couple of existing facilities.

And I'm not going into detail today, but there are two facilities at INL that we've identified as potential test beds for demonstration reactors, so they are buildings.

One is the EBR-2 dome which you can see in the slide and it's a dome shape, and the other is the ZPPR cell which was the zero power physics reactor cell, and that's kind of the cone shape in the picture here.

Those two facilities both previously hosted reactors. The EBR-2 dome hosted a 62.5 megawatt thermal reactor and then the ZPPR cell hosted zero power critical reactor experiments, and those both are still here and they're potentially places where we could host reactors again.

So, we've done preconceptual design on both of those facilities, for the EBR-2 dome in order to host reactors up to 20 megawatts thermal or so, and

then on the ZPPR cell, to host much smaller reactors up to 500 kilowatts thermal.

And we are -- we've done some trade studies on that design and we've run an RSP for the conceptual design, and we're working to move that forward over the next couple of months and initiate the conceptual design on those facilities so that we could begin construction within a year or so, or a year or two.

So, that's one element of the resource network. We want to have these facilities because they represent existing infrastructure that we can leverage to enable multiple innovators, and the model is that you would have a demonstration reactor that could come in.

Maybe it would take them about three months to set up, six months to operate, and three months to take down, and so nominally every year, you could have a new experiment and we can have that continuing innovation over time without each of these short demonstrations requiring the investment of the containment facility or the confinement and all of the accouterments that come along with that.

We're also developing some characterized demonstration sites at INL, as well as potentially

some NEPA evaluated sites.

So, we've developed with Pacific Northwest National Lab a plant perimeter envelop approach to doing environmental evaluations in the absence of a specific design, but instead enveloping all of the different advanced reactors that we think could want to demonstrate there so that we can get a little further down the road on the site, do a NEPA evaluation and be ready for a reactor, and then move at the speed of business when we have a company that's ready to demonstrate.

MEMBER BALLINGER: This is Ron Ballinger.

DR. FINAN: Yes, Ron?

MEMBER BALLINGER: I'll expose my ignorance. What's the status of FFTF?

DR. FINAN: I don't know.

MEMBER BALLINGER: Anybody know?

DR. FINAN: That's a good question.

MEMBER BALLINGER: I mean, as far as I know, they were, you know, they were there. It's a facility. It's got a containment. It's got hot cells that may or may not have been disassembled. I don't know the status, but it --

VICE CHAIRMAN REMPE: So, Ron, years ago -- I'm not the expert on FFTF, but I'll qualify this,

but just to get to the question, years ago when I visited, they had stripped the hot cells of the windows and shipped them to other labs.

For many, many years, as you probably know, they pumped around the sodium, but at one point, they drilled some holes and they've quit pumping it down.

Now, it depends on -- the last time this question was asked, it depended on who you talked to on whether you could restart it or not, and so I wouldn't want to say you could or couldn't at this point because I'm not an expert on it, but there were a lot of questions and if it had been too long.

MEMBER BALLINGER: I think I recall that to use this, you would have to assume the legacy cost which was a couple hundred million dollars, but I don't know.

MEMBER PETTI: I remember what Joy remembers, a lot of DOE activity looking at advanced reactor tests and demonstration, and that issue came up, and I agree with Joy. It depends on who you talk to as to whether or not you could come back after they've drilled a hole in the vessel, so.

DR. FINAN: Yeah, and that's helpful. That's also what I had heard, you know, from one

source. Oh, they drilled holes. You can't do anything, and then from another, well, actually, you could, so it's a good question.

One of the -- we are actually looking at that hot cell facility that Joy mentioned. So, one of the gaps that we found -- we did a survey of advanced reactor demonstrators to understand what their needs were.

One of the major gaps is in fuel fabrication for initial fuel for some of these initial reactors, and we are working with PNNL to do a deeper dive into understanding that gap and also --

And they've already drafted that deeper dive, but then they're looking at how could we fill that gap and is there a facility within the complex existing that could fill that gap?

And one of the potential facilities includes that hot cell facility whose acronym I can't remember right now, but it's the one Joy was referencing with the windows taken out.

You know, we do know there are significant costs to refurbishing some of these facilities, and in some cases, you know, we ought to be looking at new facilities instead.

What we found with the EBR-2 dome is that

that facility was fully decommissioned and, you know, cleaned up as needed, and it's now really -- actually, they've started to destroy it and started to cut through the wall. That has since been repaired in order to reuse it, and it's really, I think, a great facility for this.

Our cost estimates right now for putting in the minimum viable test bed as we see it are coming in in the, at the high end is around $31 million and the point estimate is right around $20 million.

So, that's actually a really, really fantastic number for trying to be able to provide a significant confinement function and everything that we can have right there, but as far as fuel fabrication, we are looking at the FFTF area there to see if there's an opportunity.

We're also doing -- we've done a study with Nevada national security site, which is still in draft but will be finished up this spring, looking at whether there are potential demonstration sites within NMSS, perhaps in some of their tunnels or elsewhere there.

So, we are looking at other options. These are the ones that were, you know, clearly good ones, and we've moved out on those, but there are

others in the queue that we're considering.

So, in the experimental, I mentioned the fuel facility issue already, that we're trying to figure out how we make sure we can provide fuel fabrication facilities for these advanced reactor demonstrations.

On the experimental side, we're finding a lot of demand for irradiation and characterization, particularly molten salt characterization, so we're developing a Molten Salt Thermophysical Examination Capability facility called MSTEC. That's the acronym for it.

We don't really have good capabilities in the United States to characterize irradiated molten salts, and so that was a gap that was identified by the molten salt -- one of the technology working groups that Lori referred to those earlier, and they've been really useful to us in identifying key needs, so we're pursuing that.

We've had a few other things come up over the last few months that we're working to scope solutions to. One is a helium component testing facility that seems to be needed by several of the high temperature gas reactors, and then some creep frames that are needed for some of the materials

qualification for some of the reactors, and we don't have the adequate creep frames in hot cells in the complex that are available right now.

So, we're trying to be agile, and when needs come up, seeing how we can figure out to work together with multiple companies and address those needs in the experimental space, and also work together with the R&D programs of DOE-NE.

MEMBER PETTI: Ashley, are you aware there's a lot of work done under NGNP on a component test facility that's exactly what you're talking about for the helium test facility, initial cost estimates, scope, and the like?

Those reports sit in the INL electronic document storage, so you should be able to access that, and there's still a few engineers who worked on that still at INL if you need names.

DR. FINAN: I do. Thank you, Dave.

MEMBER PETTI: Okay.

DR. FINAN: I will reach out to you.

MEMBER PETTI: Okay.

DR. FINAN: That's great, appreciate it.

MEMBER BALLINGER: Now, this is Ron again. Is there not a helium test facility now associated with Sandia at some of the break and cycle test

facilities and things like that?

MEMBER PETTI: No, that's supercritical CO2 you're thinking about, Ron.

MEMBER BALLINGER: Oh, maybe that's it. I'm sorry.

MEMBER PETTI: Yeah, and I'm not sure where that is. DOE cut the funding.

MEMBER BALLINGER: I thought they had it up and running there for a while, but it's probably quite easily to check on.

DR. FINAN: Well, I'll check on that at Sandia and just verify whether or not it exists. We certainly don't want to duplicate it.

MEMBER BALLINGER: Dave, it is Sandia, right?

MEMBER PETTI: Yeah, they were doing work on supercritical CO2 and it was funded jointly between EERE and NE, and NE pulled their side of the funding, so I don't know what happened, whether they were able to, you know, go forward with just EERE or not.

MEMBER BALLINGER: Okay.

DR. FINAN: Thank you. We have some activities also, you know, for empowering innovators and regulatory risk reduction, and I'll cover those in more detail in the next slide.

We have a virtual test bed, which is an effort to take the various NEAMS modeling and simulation tools, so that's the Nuclear Energy Advanced Modeling and Simulation program within NE.

And so there's a great suite of different tools, but what we're doing at NRIC is working with the NEAMS team to take those tools and integrate them into specific use cases, so a specific surrogate HTGR, a surrogate FHR, and a molten salt reactor to catalog some full demonstrations on how you would integrate these tools to simulate an advanced reactor prior to demonstration.

And it's a fairly small effort, but we hope that it really leverages the investment that's been made in mod/sim and makes it translatable to what industry needs for their demonstrations.

And then the NRIC resource team is modeled after the ARPA-E resource team or some of the DoD resource teams, and the goal there is to provide some very small levels of supports for demonstration companies, the companies seeking to demonstrate advanced reactors, and get them access to subject matter experts across the lab complex with very little paperwork and contracting and just try to be really quick.

We do a couple of different screens. They can be done in, you know, a couple of hours really assuming that the company has been developing things like a project plan and a design, and then they're just sharing those, showing us that they have those, passing some restrictive party screening, and then we have 200 hours of SME time to help them with basic planning, and costing, and scheduling, and really help them dive a little deeper than they can get into, you know, in an initial conversation into what the lab resources are and how they can use them, and so that's the resource team. Next slide, please?

And then in the area of regulatory risk reduction, so our objective here is to anticipate required regulatory preparations that are common to the NRIC stakeholders and take actions to increase certainty, reduce risk, and accelerate demonstration.

So, we have some activity areas here that include some research into microreactor transportation and decommissioning regulations, just kind of compiling what are the various regulations that exist, where are there gaps, and how are we going to manage transporting microreactors.

We coordinate with NRC and we're working to be able to coordinate with them on demonstration

projects. The pictures on the right-hand side, the one on the bottom right is an addendum to the memorandum of understanding between the DOE and the NRC for advanced reactor demonstrations, and this addendum specifically pertains to NRIC and how NRIC is going to help with this coordination.

We envision potentially having some shared resources for staff, so maybe having some staff rotations where we could get some NRC expertise, perhaps helping us with the development of work on the test beds that I described earlier or having a learning opportunity for NRC staff in advanced reactor safety analysis for some of those demonstrations.

And some of those might be DOE authorized, but we want a pathway for them to get, you know, familiar with the NRC and vice versa so they can move to a commercial license once they've moved to their commercial product.

We also see opportunities for engaging with NRC on some of the advanced technologies like digital engineering or advanced construction technology, and then, let's see, I got off my list here.

We have several demonstration projects that will use the DOE authorization process, and so

we're developing some guidance on that because while many folks think, well, maybe it's more flexible and it can be more agile, it isn't as well documented as the NRC processes, and so there's a lot of misunderstanding or just opacity around the process, so we've been working on some guidance for that.

We're working to identify issues that could come up when you try to site an NRC-licensed reactor near DOE authorized facilities, and those issues are numerous and complicated but should be resolvable, so we are working with DOE and NRC and some private sector companies to resolve those things and make sure we get clarity on how we manage those.

VICE CHAIRMAN REMPE: So, Ashley, I was interested in this bullet about the DOE authorization process guidance.

Many years ago, there was an effort that DOE had investigated about some of the folks who ran the facilities at DOE laboratories wanted to switch to the NRC because they found the authorization process so fuzzy, they'd rather have a regulator who had everything written out and they weren't subject to another DOE monitor coming in and interpreting it differently. In your efforts for this guidance, are you -- is that an issue you've identified and you're

trying to resolve?

DR. FINAN: Yeah, well, actually, I mean, DOE helped identify that, so they must have learned from that experience, and what they asked us to do was to work to develop a standard review plan for the DOE authorization process for an advanced reactor demonstration.

I don't know that it will be particularly applicable to other DOE facilities, but for an advanced reactor demonstration, it really tries to take the -- it looks at the NRC processes and tries to make the DOE process more well documented and transparent as those NRC processes are, so I would say it's probably responsive to exactly what you were hearing.

VICE CHAIRMAN REMPE: It will be interesting to see what they have for this standard review plan because a lot of them tend to get technology specific.

I mean, we did design-specific review standards for some of the advanced light water reactors, so coming up with something that will work for a molten salt, and a gas reactor, and whatever other type at the same time might be hard.

MEMBER BALLINGER: And with respect to NRC

versus DOE, there are a number of projects, not necessarily good ones, but out in Hanford where they said they were going to adhere to what they called NRC equivalents. I never really knew what that meant, but it may be that somebody does.

VICE CHAIRMAN REMPE: Well, I think a lot of the DOE standards are actually the same as what you see within the NRC, but the problem was that they didn't have all of the guidance and specific things that have been developed in the NRC, you know, over the years that got rid of some of the subjectivity.

MEMBER BALLINGER: Well, it may be that somebody did some project or something that identified these issues.

VICE CHAIRMAN REMPE: I remember there was -- there were two facilities that had actually gone to NRC regulation. Now, this was something that I was involved with like 15 years ago. It was a while back.

MEMBER BALLINGER: Yeah, the spent fuel --

VICE CHAIRMAN REMPE: But it just is something I've been seeing this come up again. It's interesting to me.

MEMBER BALLINGER: Yeah, the end reactor spent fuel dry storage facility was one of them and I don't remember the second one. I would say that it's

ongoing, but I would be mistaken because that one's been ongoing for a generation.

VICE CHAIRMAN REMPE: Well, this was a Lawrence Berkeley facility was one of the two.

MEMBER BALLINGER: Oh.

VICE CHAIRMAN REMPE: I can look that up because I was involved in a document that cited the two, so it's just my memory has forgotten the names of the facilities, but I'll look it up and send you an email. Anyway, go ahead, Ashley, sorry.

DR. FINAN: No, no problem, it's interesting to hear the conversation and the history, and I did just look it up and it is the generator review plan that's specific to microreactors, so that does narrow it down somewhat, though it doesn't give you a specific fuel, but I can dig up that document.

It was finished last, the end of our calendar year, so I'll dig that up and see if I can share that, and maybe it would be of interest.

Then we have, let's see, so I described our NEPA approach, which is to develop this plant parameter envelope which we developed with PNNL as the lead authors on that, and that's on our website in the resources section.

That was released a couple of weeks ago

and I'm excited about that, not just for INL where we are looking at whether we can get some NEPA coverage for potential reactors, but also elsewhere.

And it's designed to be ultimately, we hope, very compatible with the NRC's advanced reactor generic EIS because we have been coordinated with them on that. We've been meeting on a weekly basis with the NRC's environmental team on the plant parameter envelope effort, so --

MEMBER KIRCHNER: Ashley?

DR. FINAN: -- we're going to be coordinated there. Yes?

MEMBER KIRCHNER: This is Walt Kirchner, nice to hear your voice again. I would commend to you to look at the Oak Ridge early site permit that was issued recently, well, recently now being, I think, 2019, but for the Clinch River site there. They did use the plant parameter envelope approach.

DR. FINAN: Yes.

MEMBER KIRCHNER: So, it's been, how should I say? It's been christened, or it's been exercised, or it's been used, so there is something to build on there.

DR. FINAN: Absolutely, and that has been a really important precedent for us because we've had

some, I guess, raised eyebrows about the approach, but it's been proved, so that's fantastic.

And that was an important precedent and something that the PNNL team has good expertise on, and we were able to take that, and that was, of course, more focused on light water small modular reactors. Our plant parameter envelope is not light water focused.

It's advanced reactor, and we did a survey and received a good deal of information from the potential demonstrators on their reactors and worked to envelope those, so Clinch River was an important model for it.

And then so finally, the advanced construction technology and digital engineering are two important areas of technology that I think will be important for scalability in the future.

And one of the things that we're doing is working on a public/private partnership for demonstrating some advanced construction technologies, and we're working closely with innovators to use and demonstrate digital engineering approaches for advanced reactors as well.

And these are, all of the things we're doing here are widely used in other industries, but

haven't really been applied successfully or pervasively in the nuclear industry, at least in the western nuclear industry.

Digital engineering is used to great effect in Korea and perhaps elsewhere, but not here, so we're trying to utilize that extensively in our work and open source some of the tools we're developing to make them available to innovators.

On the advanced construction side, we have some, a project that we're working to execute or to initiate, I guess. We're looking to make an award from an RFP where we would demonstrate some different advanced construction technologies.

I'm not going to get into more detail right now, but it includes some things that would help on the civil construction side of things to reduce excavation costs, reduce engineered fill, and reduce the costs of the steel and the concrete, which we know drives, overruns, and costs in general, but these are technologies that have been used elsewhere.

We need to make sure that they can be used in the nuclear sphere successfully, which means including the NRC in their demonstrations, figuring out how is the NRC going to inspect these things and ensure that they're up to their standards.

And that's what we want to do through some of the projects that we're initiating, and we've had great enthusiasm from the NRC on cooperating on these things. So, next slide, please?

So, next I want to talk a little bit about how we're looking to deliver successful outcomes and I'm almost done, so next slide, please?

We're working to coordinate and collaborate with all of the key parties who need to work together to make these successful, so that includes, of course, the DOE and the NRC, the advanced reactor demonstration program companies, and there are other elements of the advanced reactor demonstration program that we're working with that are focused on licensing, on safeguards and security, and on other elements of these projects.

We're working with GAIN and many of the laboratories, and we're developing a cross-functional core team at NRIC. We have a diversity of backgrounds.

We're drawing from, you know, folks who have built complex energy and complex aerospace projects, so not all nuclear backgrounds, but more -- you know, some nuclear backgrounds certainly, but there's a lot of that expertise in the lab.

What we need to bring in are people who know how to demonstrate complex technologies, who know how to work with the government and the private sector, who know how to do digital engineering and systems engineering, and can help us supercharge this effort and make it not just research, but in fact, demonstration towards scalable deployment in the end.

And then other things here, I've talked about digital engineering. I've talked about advanced construction technology. I think those are really important for scalable, affordable technology that really moves the ball forward on climate change.

And then construction project management is another area where I'm developing a program. We don't have activities there yet, but I think it's very important, so I'm in conversations with some potential partners on how do we take care of that major issue that we've seen in nuclear projects.

And then we're coordinated very closely with the integrated energy systems project at DOE led by Shannon Bragg-Sitton.

One of our mandates is to further the demonstration of non-electric applications of nuclear, and so we're working to develop a conceptual design of some demonstrations of either integrated energy

systems or non-electric applications, and I don't have a lot of detail on that yet.

We've been working hard on that this fiscal year and we're going to be doing a request for expressions of interest to get some input from industry partners on what they would like to see and what they would like to be involved in there, so we hope to really demonstrate some interesting things with advanced reactors in that space. Next slide?

And then finally, NRIC is a national program, so I want to remind folks of that, and we're an essential integrator for partners and collaborators. And these aren't all of our partners and collaborators, but I could only fit so many on our logo. I did the best I could.

There are a lot of really important stakeholders in this and a lot of folks who need to work together to make these demonstrations successful, and our goal is to help everyone work together more efficiently and move this forward.

So, my next slide is just a thank you very much for the opportunity to talk to you, and thank you for your questions so far. I have a few to follow up on, and if there are any more questions, I'm happy to try to answer them.

MEMBER PETTI: Ashley, I have a question that might not be fair, but I'll ask it anyways. You know, this is a really broad mandate that NRIC has, and there's so much coordination and collaboration that has to happen. I mean, if you just look at the DOE sphere and the way the programs are organized, they're not organized the way industry would look at it probably.

Is there any movement in DOE to kind of align what it's doing and how it does it to focus, to help your mission get fulfilled because that's a big stumbling block, one of the many, you know, big challenges you have?

DR. FINAN: Yeah, I think that's a great question, Dave, and there's a natural intention here that is important. So, I think the answer is yes, well, there's an intent, and there's a recognition that we have this big goal and we want to demonstrate these advanced reactors, and we need to align.

We have funding pressure. We just have to align these programs towards that goal, and I think that that's very positive and I think that as we, you know, as we look to the future, I'd expect that we'll see that as DOE continues to develop changes in that area.

So, the intent and the recognition, I think, are there. Of course, there's a transition right now, so I don't know exactly what, you know, that will look like, and there's not a lot of change happening right now in the structure of DOE, but they recognize it, Dave.

But the other intention is that, yes, we want to demonstrate these reactors, but we can't forget that there's a long game and we need to have basic research and development, and we can't, you know, we can't let that all go.

So, there's this intention in the funding to try to make sure we don't lose the potential for game-changing innovations because we strip R&V, so that's my thought on that one. I don't have the best answer.

CHAIRMAN BLEY: Ashley, thank you very much. I know you've gotten most of your questions from those of us who have spent a lot of time with DOE. For the rest of us, it's been very informative and it's getting extensive where some of the, how some of the gaps that we've been worrying about might get filled in the future.

I'll go back to the members. Are there any members with any further questions for Ashley?

MEMBER RICCARDELLA: Yeah, this is Pete Riccardella. I just have a more general question actually to both speakers, and that is, you know, the programs you're talking about and the outreach efforts that I heard in the earlier presentation, they were all focused on five percent or ten percent of the U.S. public.

Who's concerned about outreach to the other 90 percent? That's really why we have -- our industry is in the problems that it's in. It's by and large very unpopular.

DR. FINAN: Lori, I'll let you take the first answer to that one if you want to.

MS. BRAASE: That last goal of ours on the GAIN presentation is focused on that. It's reaching out to folks who don't include nuclear as part of the renewable definition.

We're trying to reach out to states, and local entities, and to these groups, and to the public in general. That's what we've been focused on the last several months, and it's a little bit harder to do from webinars, but our social media and our efforts are trying to do that.

We have different connections with groups like Envoy Public Labs and with a few other groups on

public outreach so that we're trying to touch that audience.

MEMBER RICCARDELLA: I hope we can do it.

MS. BRAASE: Yeah.

MEMBER RICCARDELLA: It's a good story to tell, but unfortunately, it's a very complicated one, and I think most of the public doesn't have the appetite to listen to this kind of complexity.

MS. BRAASE: You're seeing Bill Gates, and Microsoft, and Google, and all of these folks coming up with their goals and their 100 percent renewables, and --

MEMBER RICCARDELLA: Yeah.

MS. BRAASE: -- carbon neutral, carbon negative goals, and I don't think that that's possible without nuclear, and so Bill Gates certainly includes it in his portfolio. So, I think the conversations are there. We just need to push to have them. I mean, I think we're right on the verge.

MEMBER RICCARDELLA: I hope so.

DR. FINAN: And Pete, I did want to add --

(Simultaneous speaking.)

DR. FINAN: That's okay. I just was going to add that, you know, I think that, as Lori said, GAIN is working to reach broader audiences. I think

with advanced reactors, we have an opportunity to communicate better, but also to actually do better with how we --

MEMBER RICCARDELLA: Yeah.

DR. FINAN: -- interface with society, and so one of the things that we're looking at is how do we innovate in our sociotechnical systems, not just our technology?

And we're working with Argon, Oak Ridge, and the University of Michigan's Fastest Path to Zero to develop some citing tools that allow us to look at socioeconomic and sociopolitical aspects of sites.

And we're working with some graduate student researchers and things to look at environmental justice aspects of citing and how we can incorporate environmental justice into how we cite advanced reactors and really do a better job, and then also, I think, demonstrating what nuclear can do.

Really getting to demonstration and showing what it offers is going to be critical to communicating with that other 95 percent who doesn't really care about, and rightfully doesn't care about the details of this technology. They want to know what it's going to do for them.

MEMBER RICCARDELLA: Okay, well, thank

you, and thank you for some very interesting presentations today.

CHAIRMAN BLEY: Was that you trying to get in?

MEMBER KIRCHNER: Yes, I don't know how to phrase this, Dennis, but --

CHAIRMAN BLEY: Oh, go ahead.

MEMBER KIRCHNER: -- just an observation that there are additional concepts, whether you call them advanced reactors or not, that might be in the mix in the near term and perhaps even be deployable faster than the time scale that we were discussing today, and just an observation.

I'm not -- so that's not a criticism. I'm just thinking how the efforts of both GAIN and NRIC might support those other advanced reactor concepts.

DR. FINAN: You know, I'm really interested to talk more about that. Perhaps maybe I could reach out to you and you could give me a little more detail.

I know of a few interesting concepts that are moving quicker and maybe those are the same ones, but they might not be, so maybe we could connect on that.

VICE CHAIRMAN REMPE: Well, are you precluded from funding advanced light water, small

modular light water reactors, Ashley?

DR. FINAN: No, we're not precluded. We've had discussions with Holtec, for example, about how we can support them. We don't directly fund demonstration projects, so that's funded via DOE. We're helping provide support, but not that kind of demonstration cost share at this point.

CHAIRMAN BLEY: Okay, good, well, thank you. Thomas, can we get the public line open?

PARTICIPANT: The public line is open for comments.

CHAIRMAN BLEY: Thank you. If there is anyone on the public line who would like to make a comment, please state your name and give us your comments.

PARTICIPANT: Hi my name is Li Chao (phonetic) from the DOE Loan Program Office, and I want to make a comment.

DOE does the funding through NE and through GAIN for the advanced reactors, but our loan programs also support the advanced reactors. For example, we have the loan to the Vogtle project. So, it will be a more mature project now, the R&D project, so I just wanted to add that comment here.

CHAIRMAN BLEY: Thank you. Anyone else?

Thomas, I think we can close the public line. Lori and Ashley, I want to thank you again for spending the time with us. We really appreciate it. Any last comments from any members? Then at this time, Mr. Chairman, I turn it back to you well within the two-hour time allotted.

CHAIRMAN SUNSERI: Thank you. Thank you, Dennis, and I'll add my compliments to the presenters today. Both of the presentations were fantastically interesting and delivered in an equally captivating way, so thank you for that, and thank you for the interactions with the members. It was very good.

Let me bounce this off the members. We have some time left today. I would like to get into the letter that Charlie has prepared in response to the reconciliation from the last meeting that we had.

I propose that we'll take a 15-minute break here to allow the transition. We'll bring the letter up and Charlie can read it in, and we can get main comments in, but I do want to end around 6:00, so as close to 6:00 as possible because, you know, this is a long day for everybody. Is that acceptable to the committee? Sandra is ready to go. She's in standby.

(Whereupon, the above-entitled matter went off the record at 5:08 p.m.)

NEI 12-16, Rev. 4 - Guidance for Performing Criticality Analyses of Fuel Storage at Light-Water Reactor Power Plants

ACRS Meeting

Ben Holtzman (NEI)

March 3rd, 2021

NUCLEAR ENERGY INSTITUTE

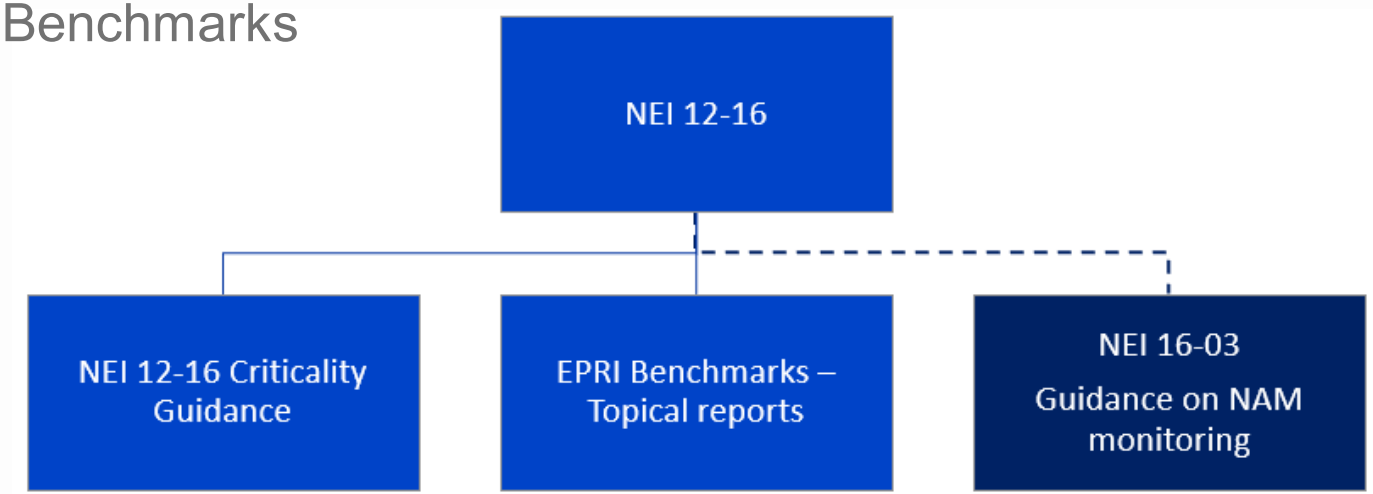
NEI 12-16 Background

Goal: Provide durable guidance for consistent criticality analyses for applicants and reviewers

- Historically, Spent Fuel Pool (SFP) Criticality Safety Analyses (CSA) were simple but over time they became more complex
- Increased application complexity with no comprehensive guidelines for application preparation, expectations, and the review process
  - More NRC Requests for Additional Information (RAIs)
- NEI 12-16 project inventoried, categorized, evaluated, and reached agreement on numerous issues
- EPRI Benchmarks were developed to quantify depletion uncertainty and determine if the 5% (Kopp Memo) is conservative

NEI 12-16 History

- NRC, Industry and EPRI spent significant efforts in the development of NEI 12-16
  - Numerous RAIs and Public Meetings
  - Full week audit
- Four Revisions of NEI 12-16
  - Additional approvals of EPRI Benchmarks and NEI 16-03



NEI 12-16, Revision 4 - Guidance for Performing Criticality Analyses of Fuel Storage at Light-Water Reactor Power Plants

Presenters:
Hatice Akkurt, EPRI
Bob Hall, EPRI

Spent Fuel Pool (SFP) Criticality and Depletion Uncertainty and Bias

- No critical experiments using spent fuel
- Critical experiments are very expensive
- Using fresh fuel assumption for spent fuel causes loss of SFP storage space
- How to account for uncertainty and bias for spent fuel?

1998 Kopp Memo:

"In the absence of any other determination of the depletion uncertainty, an uncertainty equal to 5 percent of the reactivity decrement to the burnup of interest is an acceptable assumption."

1998-2009

Easy to use, implement, justify; subsequently, used by many utilities

NRC: What is the technical justification or where is the documentation for 5% decrement?

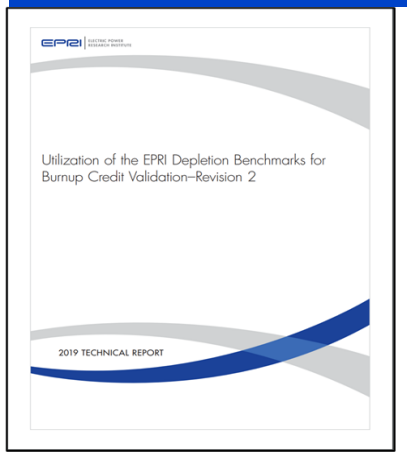
Burnup Credit Approaches

- ORNL: Chemical Assay Based Approach*
  - NUREG/CRs
    - 7108: Validating isotopics for BC
    - 7109: Validating isotopics for k_{eff}
- EPRI: Depletion Benchmarks Using Flux Maps
  - EPRI reports
    - 1022909: Benchmarks for Depletion
    - 1025203: Utilization of EPRI Benchmarks

*Funded by NRC

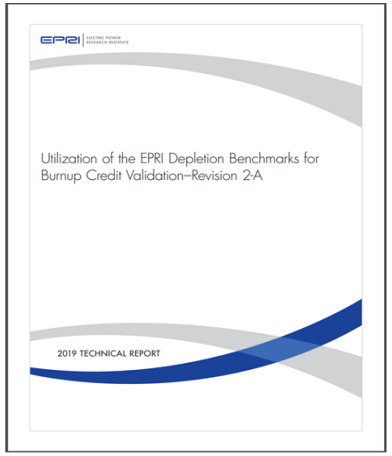
EPRI Benchmarks

Received final SER on July 26, 2019



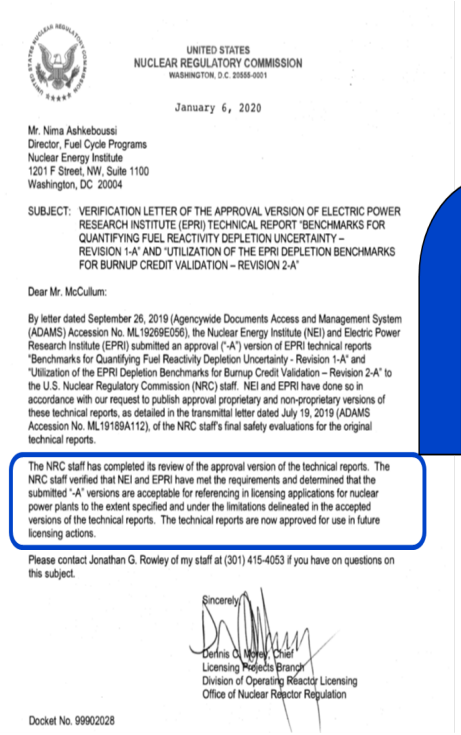
3002016888, *Utilization of the EPRI Depletion Benchmarks for Burnup Credit Validation - Revision 2*, published **August 29, 2019**

3002016035, *Benchmarks for Quantifying Fuel Reactivity Depletion Uncertainty-Revision 1-A*, published **September 18, 2019**



3002017254, *Utilization of the EPRI Depletion Benchmarks for Burnup Credit Validation - Revision 2-A*, published **September 18, 2019**

Burnup (GWd/MTU)	EPRI Uncertainty (%)	Additional NRC Bias (%)
10	3.05	0.0
20	2.66	0.0
30	2.33	0.0
40	2.12	0.15
50	1.95	0.35
60	1.81	0.54



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

January 6, 2020

Mr. Nima Ashkeboussi
Director, Fuel Cycle Programs
Nuclear Energy Institute
1201 F Street, NW, Suite 1100
Washington, DC 20004

SUBJECT: VERIFICATION LETTER OF THE APPROVAL VERSION OF ELECTRIC POWER RESEARCH INSTITUTE (EPRI) TECHNICAL REPORT "BENCHMARKS FOR QUANTIFYING FUEL REACTIVITY DEPLETION UNCERTAINTY – REVISION 1-A" AND "UTILIZATION OF THE EPRI DEPLETION BENCHMARKS FOR BURNUP CREDIT VALIDATION – REVISION 2-A"

Dear Mr. McCullum:

By letter dated September 26, 2019 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML19269E056), the Nuclear Energy Institute (NEI) and Electric Power Research Institute (EPRI) submitted an approval ("-A") version of EPRI technical reports "Benchmarks for Quantifying Fuel Reactivity Depletion Uncertainty - Revision 1-A" and "Utilization of the EPRI Depletion Benchmarks for Burnup Credit Validation – Revision 2-A" to the U.S. Nuclear Regulatory Commission (NRC) staff. NEI and EPRI have done so in accordance with our request to publish approval proprietary and non-proprietary versions of these technical reports, as detailed in the transmittal letter dated July 19, 2019 (ADAMS Accession No. ML19189A112), of the NRC staff's final safety evaluations for the original technical reports.

The NRC staff has completed its review of the approval version of the technical reports. The NRC staff verified that NEI and EPRI have met the requirements and determined that the submitted "-A" versions are acceptable for referencing in licensing applications for nuclear power plants to the extent specified and under the limitations delineated in the accepted versions of the technical reports. The technical reports are now approved for use in future licensing actions.

Please contact Jonathan G. Rowley of my staff at (301) 415-4053 if you have on questions on this subject.

Sincerely,

Dennis C. Morey, Chief
Licensing Projects Branch
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 99902028

The NRC staff has completed its review of the approval version of the technical reports. The NRC staff verified that NEI and EPRI have met the requirements and determined that the submitted "-A" versions are acceptable for referencing in licensing applications for nuclear power plants to the extent specified and under the limitations delineated in the accepted versions of the technical reports. ***The technical reports are now approved for use in future licensing actions.***

Received final approval letter on January 6, 2020

EPRI benchmarks showed that Kopp memo (5%) is conservative and provided technical justification for additional margins

NEI 12-16: Depletion Uncertainty Resolution

Option 1: 5% for PWR & BWR, no additional work

Option 2: For PWRs, use EPRI benchmarks for additional margin provided EPRI benchmarks are modeled

For BWRs, applicants may use alternate methods like peak reactivity

Applicants may use alternate approaches when technical basis is provided

Impacts on K_{eff}

- *Significance is determined based upon the overall effect on the total uncertainty, and on the margin to the regulatory limit. Because the total uncertainty term is typically dominated by a few large uncertainties, an individual uncertainty that is less than 10% of the total uncertainty may be considered insignificant.*

- **Safety significance vs. effort for applicant and reviewer**
- **Uncertainty items with low reactivity effect can be considered insignificant given typical total uncertainty**

$$k_{max} = k_{eff} + \sum_{i=0}^{m} Bias_i + \sqrt{\sum_{j=0}^{n} Uncertainty_j^2}$$

Uncertainties:
- Depletion Code Uncertainty
- Criticality Code Validation Uncertainty
- Fuel Manufacturing Tolerances
- Rack Manufacturing Tolerances
- Burnup Uncertainty (BU)
- Facility Structural and Material Uncertainties
- Uncertainties for Validation Gaps
- Monte Carlo Calculational Uncertainty

Biases:
- Depletion Code Bias (Applicant Depletion Code Bias)
- Criticality Code Validation Bias
- Moderator Temperature Bias
- Design Basis Fuel Assembly Bias
- Eccentric Positioning Bias

NEI 12-16 - Criticality Analysis Checklist

- Inventory of the list of items that may need to be included
  - Intended to reduce the number of RAIs
- Useful for pre-application meetings
  - Discussion of proposed application can be methodical and directed
  - Highlights presence or absence of typical content
- Useful for applicant
  - Applicant confirms content is complete
- Useful for reviewer(s)
  - Reviewer can quickly confirm key items are addressed
  - Applicant can use notes area to identify report section numbers for each item or add short explanations to streamline review

Subject	Included	Notes / Explanation
1.0 Introduction and Overview		
Purpose of submittal	YES/NO	
Changes requested	YES/NO	
Summary of physical changes	YES/NO	
Summary of Tech Spec changes	YES/NO	
Summary of analytical scope	YES/NO	
2.0 Acceptance Criteria and Regulatory Guidance		
Summary of requirements and guidance	YES/NO	
Requirements documents referenced	YES/NO	
Guidance documents referenced	YES/NO	
Acceptance criteria described	YES/NO	
3.0 Reactor and Fuel Design Description		
Describe reactor operating parameters	YES/NO	
Describe all fuel in pool	YES/NO	
Geometric dimensions (Nominal and Tolerances)	YES/NO	
Schematic of guide tube patterns	YES/NO	
Material compositions	YES/NO	
Describe future fuel to be covered	YES/NO	
Geometric dimensions (Nominal and Tolerances)	YES/NO	
Schematic of guide tube patterns	YES/NO	
Material compositions	YES/NO	
Describe all fuel inserts	YES/NO	
Geometric Dimensions (Nominal and Tolerances)	YES/NO	
Schematic (axial/cross-section)	YES/NO	
Material compositions	YES/NO	
Describe non-standard fuel	YES/NO	
Geometric dimensions		
Describe non-fuel items in fuel cells	YES/NO	

Checklist is 6 pages long and finalized with the NRC staff during 1 week-long audit

Checklist aimed toward bringing consistency for applicant and reviewer

Regulatory Guide 1.240

- NEI 12-16 is endorsed in Reg Guide 1.240 along with the already approved EPRI benchmarks and will provide the basis for a stable regulatory framework.

- Additional clarification is needed for exception A
    - The example lacks the clarity needed in a guidance document
    - Uncertainty regarding NRC expectation for “controls or documents”

Lessons Learned

- Separating issues into stand-alone documents was a successful strategy that improved regulatory stability and predictability, but extended the overall duration by reducing urgency on NRC

- NUREG/CRs without quality assurance (QA) appeared to be given more weight than industry reports of similar pedigree

- NRC management oversight of long running issues is essential to bring them to a timely closure

Questions

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Regulatory Guide 1.240 Fresh and Spent Fuel Pool Analysis

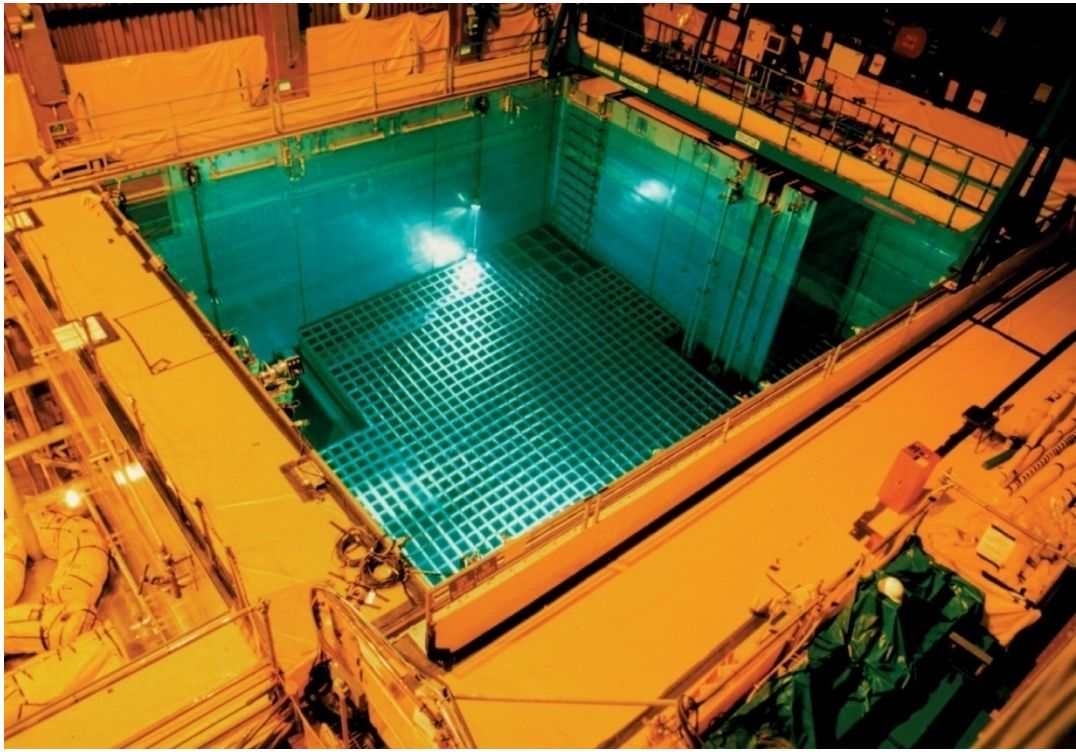
Kent Wood
U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation

Advisory Committee on Reactor Safeguards
March 3, 2021

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Overview

- Background
- NEI 12-16 Clarifications
- Going Forward



Picture: Spent Fuel Pool

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Protecting People and the Environment

Background

- Initial Design/Construction
  - 10CFR70.24/GDC 62
- 1st Re-Rack Wave
  - No reprocessing
  - GL 78-11
- 2nd Re-Rack/Re-Analysis Wave
  - Boraflex Degradation
  - 10CFR50.68
- 3rd Re-Rack/Re-Analysis Wave

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Protecting People and the Environment

Reg Guide 1.240

- NRC Staff worked with NEI, EPRI, and other industry representatives to develop NEI 12-16
- Intent is to achieve regulatory certainty
- NEI 12-16 R4 already being used by the industry
- Endorse NEI 12-16 with 17 clarifications
  - Includes three exceptions
  - Public comments on three of the clarifications

U.S.NRC
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Protecting People and the Environment

Exceptions

- C.1.i: Eccentric position
- C.1.m: BWR cold critical measurements as benchmarks
- C.1.n: Code to Code comparison as validation for criticality code

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Clarification C.1.a

- Clarification: Double Contingency Principle
  - Based on an actual LAR
- Comment takes exception using a miss installed SFP neutron absorbing panel as the example because licensees have controls to ensure a miss installed SFP neutron absorbing panel does not go undetected
- Clarification states that if there are controls to prevent it, it doesn't have to be considered part of the normal condition

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Clarification C.1.a

- As with all safety related modifications, NRC expects licensee QA and Maintenance procedures to provide the controls necessary to preclude consideration of an incorrect modification or installation of SFP storage racks during the design and licensing phase
- Should those controls identify an issue during installation, the licensee's chosen remedy will determine the next course of action

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Clarification C.1.b

- Graded approach/Margin control
  - Graded approach is essentially incorporating 'risk' considerations into the review
- Comment implies all margin is the purview of the licensee
  - Licensee is responsible for margin control
- The clarification is a caution that when large margin is the basis for a graded approach, not all of that margin is available for future changes

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Clarification C.1.k

- Soluble Boron for the Rx depletion modeling.
- Based on an actual LAR
- Industry standard practice is it is a ‘cycle average’ soluble boron
- Commenter wants to use a different method to determine the ‘average’
- Clarification that the guidance is ‘cycle average’
- Other ‘averages’ will be an exception to the guidance

U.S.NRC
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Protecting People and the Environment

Going Forward

- NEI 12-16/Reg Guide 1.240 will increase regulatory certainty with regard to Fresh and Spent Fuel criticality analyzes
  - NEI 12-16 already being used
- ATF, increased enrichment, and higher burnup levels will need to be evaluated to determine if any changes to NEI 12-16/Reg Guide are necessary
  - Clarification C.1.o

U.S.NRC

UNITED STATES NUCLEAR REGULATORY COMMISSION

Protecting People and the Environment

Regulatory Guide 1.240 Fresh and Spent Fuel Pool Analysis

Kent Wood

U.S. Nuclear Regulatory Commission

Office of Nuclear Reactor Regulation

Advisory Committee on Reactor Safeguards

March 3, 2021

NRIC National Reactor Innovation Center

Advanced Reactor Demonstrations & NRIC

March 3, 2021

Ashley E. Finan, Ph.D., NRIC director
ashley.finan@inl.gov

NRIC Vision

Commercial Advanced Nuclear by 2030

5-Year Program Objectives

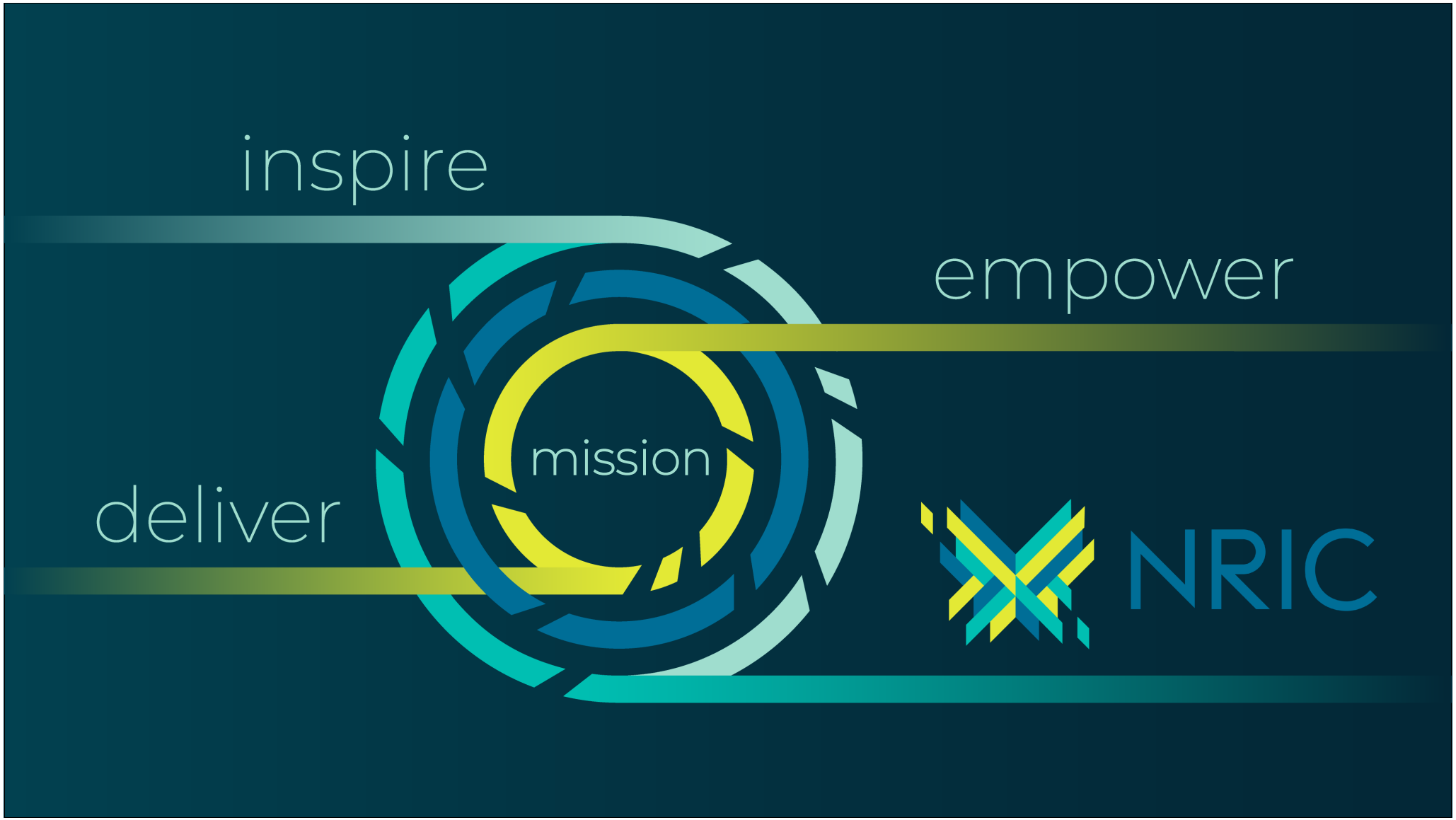
Enable demonstration of at least 2 advanced reactors

- Make available infrastructure, sites, materials, expertise
- Provide regulatory support
- Best practices in public engagement

Prepare DOE/labs for continuing innovation and demonstration

- Develop best practices for planning/construction/demonstration of nuclear projects
- Develop enduring infrastructure and expertise
- Establish methods for efficient coordination among laboratories

NRIC


inspire
empower
mission
deliver
NRIC

NRIC Stakeholders

Public
- Local citizenry
- Local governments

Industry
- AR developers
- Supply chain
- Users

Government
- DOE
- NRC
- Congress
- Others (DOD, NASA)

Researchers
- Laboratories
- Universities

NRIC

Historical Context

- **Reactor Demonstration Programs**
  - Atomic Energy Commission
  - National Reactor Testing Station
  - Production Reactors
  - Cooperative Power Reactor Demonstration Program
  - International Development
  - NGNP
- **Recent Policy Actions**
  - Nuclear Energy Innovation Capabilities Act
  - Nuclear Energy Innovation Modernization Act
  - Advanced Reactor Demonstration Program
  - Energy Act of 2020

U.S. Advanced Reactors

- Dozens of companies
  - Sizes range from ~1MWe to ~1000MWe
  - Variety of coolants (gas, sodium, salt, lead, water, etc.)
  - Private investment
- Motivation
  - Clean, reliable, increased efficiency
  - Potential for improved nuclear resource utilization and reduced nuclear waste
  - Diverse markets

Image courtesy of GAIN and Third Way, inspired by the *Nuclear Energy Reimagined* concept led by INL. Learn more about these and other energy park concepts at thirdway.org/blog/nuclear-reimagined

NRIC

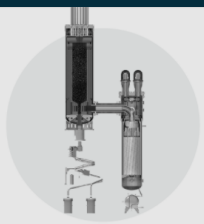
Advanced Reactor Demonstration Program

- Objectives:
  - Develop, construct, and demonstrate several advanced reactors with beneficial capabilities
  - Support diversity of advanced designs
  - Stimulate private sector companies/supply chains
- Funding pathways aligned with varied maturity levels:
  - Advanced Reactor Demonstration (Demos) awards
  - Risk Reduction for Future Demonstration (Risk Reduction) awards
  - Advanced Reactor Concepts-20 (ARC-20) awards

NRIC

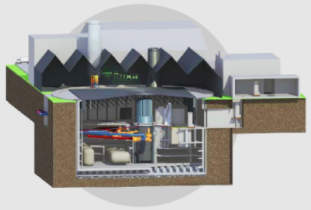
Demonstration

Natrium Reactor
Sodium-cooled fast reactor + molten salt energy storage system
TERRAPOWER

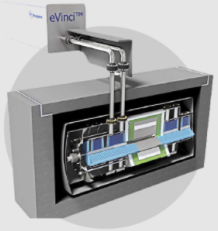


Xe-100
High-temperature gas reactor
X-ENERGY

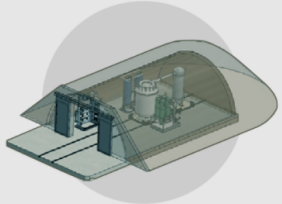
Risk Reduction



KP-FHR
Fluoride salt-cooled high-temperature reactor
KAIROS POWER

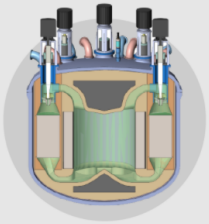


eVinci
Heat pipe-cooled microreactor
WESTINGHOUSE NUCLEAR



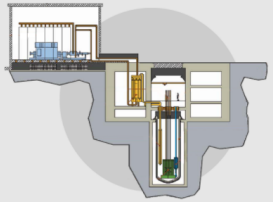
BWXT Advanced Nuclear Reactor (BANR)
High-temperature gas-cooled microreactor
BWX TECHNOLOGIES

SMR-160
Advanced light-water small modular reactor
HOLTEC INTERNATIONAL



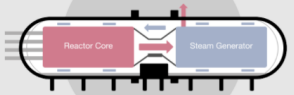
Molten Chloride Fast Reactor
SOUTHERN COMPANY

Concept Development



Advanced Sodium-Cooled Reactor Facility
ADVANCED REACTOR CONCEPTS

Fast Modular Reactor
GENERAL ATOMICS



Horizontal Compact High-Temperature Gas Reactor
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

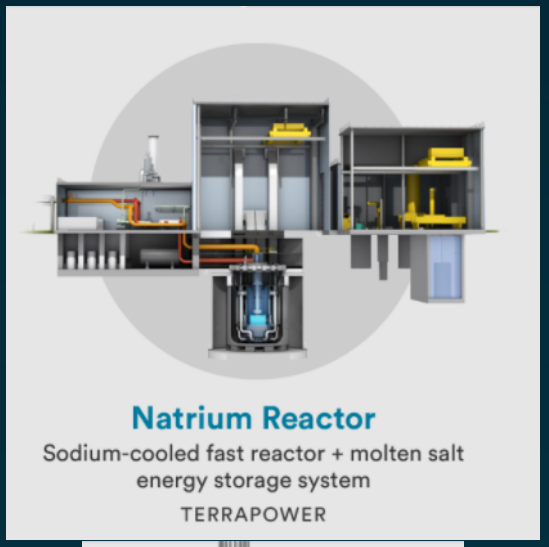
NRIC

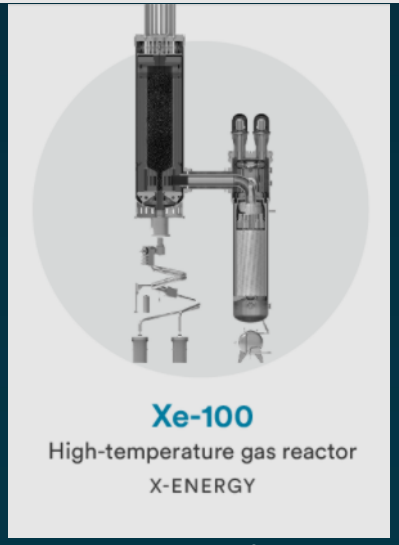
Slide content courtesy of U.S. DOE-NE

Demonstration Pathway Selected Technologies

- TerraPower LLC – Natrium Reactor
  - SFR that leverages decades of fast reactor and metallic fuel development
  - High temperature reactor coupled with thermal energy storage for flexible electricity output
  - New metal fuel fabrication facility
  - Visit: https://natriumpower.com/

- X-energy – Xe-100 reactor
  - HTGR that leverages decades of reactor and robust TRISO fuel form development
  - Provides flexible electricity output and process heat for a wide range of industrial heat applications
  - Commercial scale TRISO fuel fabrication facility
  - Visit: https://x-energy.com/

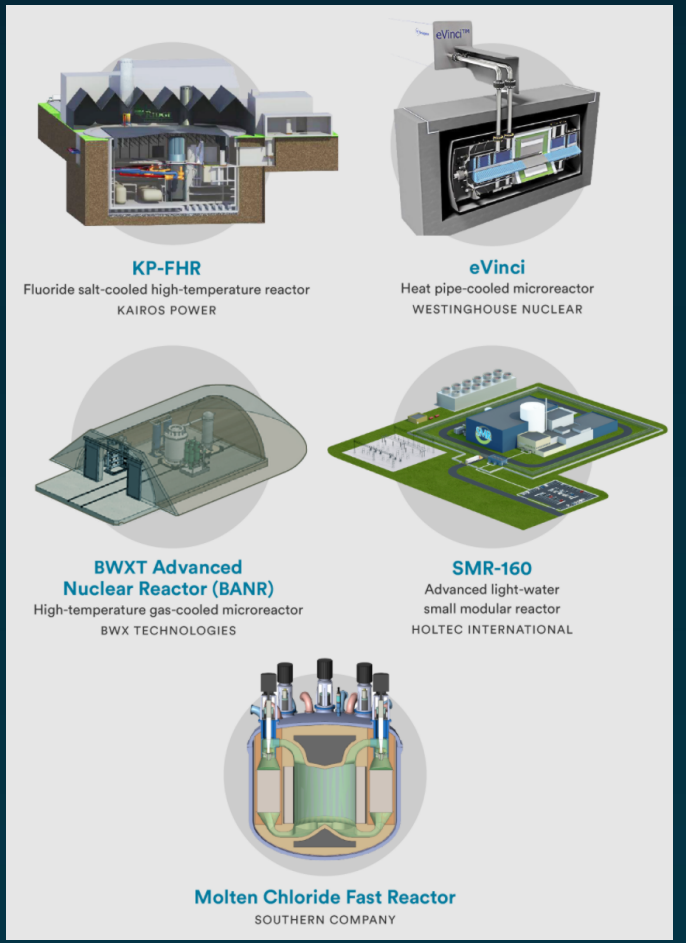




Slide content courtesy of U.S. DOE-NE

Risk Reduction Pathway Selected Technologies

Prime Recipient	Commercial Target Reactor Type and Fuel	Risk Reduction Project Key Deliverables
Kairos Power. LLC	KP-FHR - 140 Mwe thermal spectrum fluoride salt-cooled MSR, TRISO annular pebble fuel	Design, construction and operation of Hermes reduced-scale test reactor (precursor to commercial-scale KP-FHR)
Westinghouse	eVinci - 4.5 MWe heat pipe-cooled microreactor, TRISO UCO compact HALEU fuel	Technical risk reduction for moderator design, wick manufacturing, refueling and licensing.
BWXT	BANR - 50 MWt transportable microreactor HTGR with UN TRISO	Maturation of technology, including the development of UN TRISO fuel, to improve the commercial viability of BANR
Holtec	SMR-160 - 160 MWe LW-cooled natural circulation PWR	Early stage design, engineering, and licensing activities for the SMR-160.
Southern Company	Molten Chloride Fast Reactor – 180 MWt pool-type MSR fast reactor with liquid salt fuel	Design, construction and operation of Molten Chloride Reactor Experiment (MCRE)



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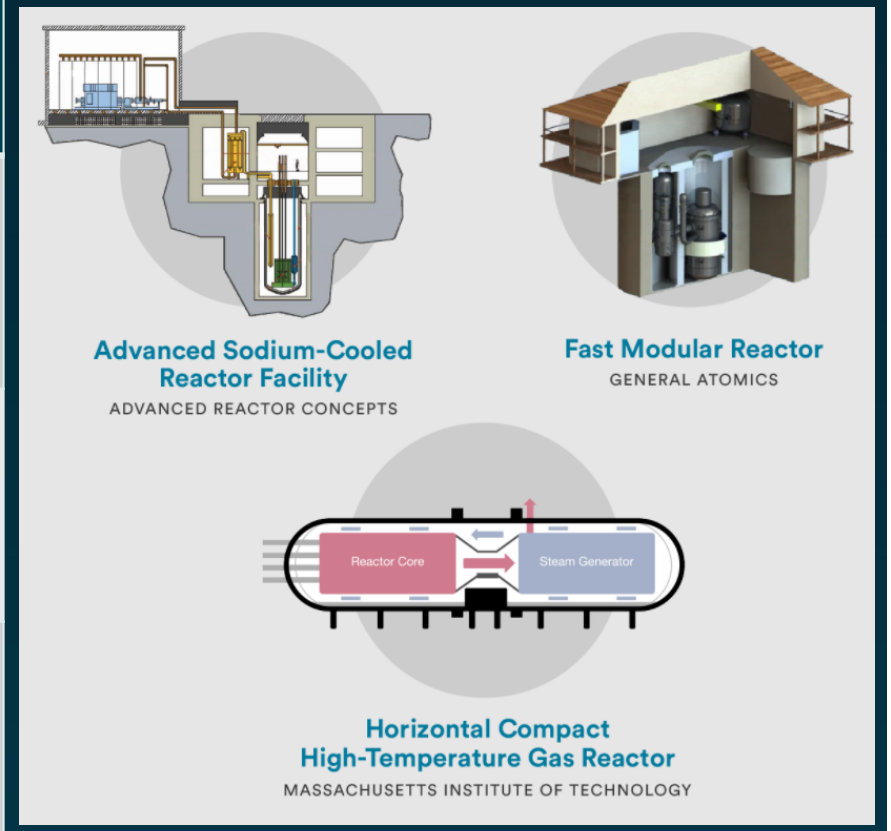
Slide content courtesy of U.S. DOE-NE

ARC-20 Selected Technologies

Prime Applicant	Commercial Target Reactor Type	ARC-20 Project Key Deliverables
Advanced Reactor Concepts	**ARC-100 100 MWe pool type sodium-cooled fast reactor**	Conceptual and preliminary design of a seismically isolated advanced sodium-cooled reactor facility
General Atomics	**GA-EMS 50 MWe gas-cooled fast modular reactor**	Conceptual design of the GA-EMS 50 MWe FMR, increase TRL on systems and components, develop prelim. cost estimates
MIT	**Modular Integrated Gas-cooled High Temperature Reactor (MIGHTR)**	Conceptual design for MIGHTR and support for future commercialization as a safe and cost-competitive HTGR concept



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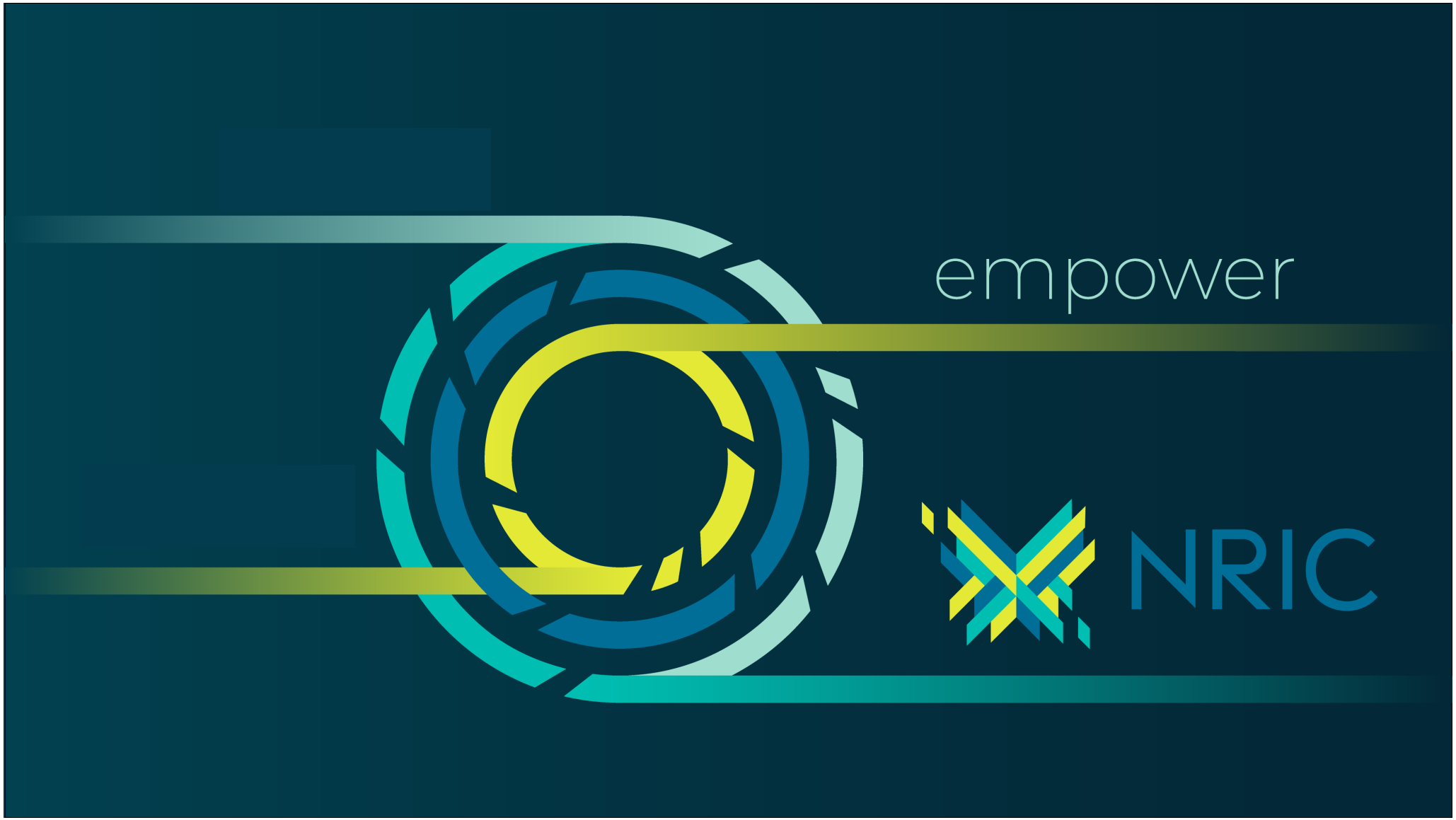
Slide content courtesy of U.S. DOE-NE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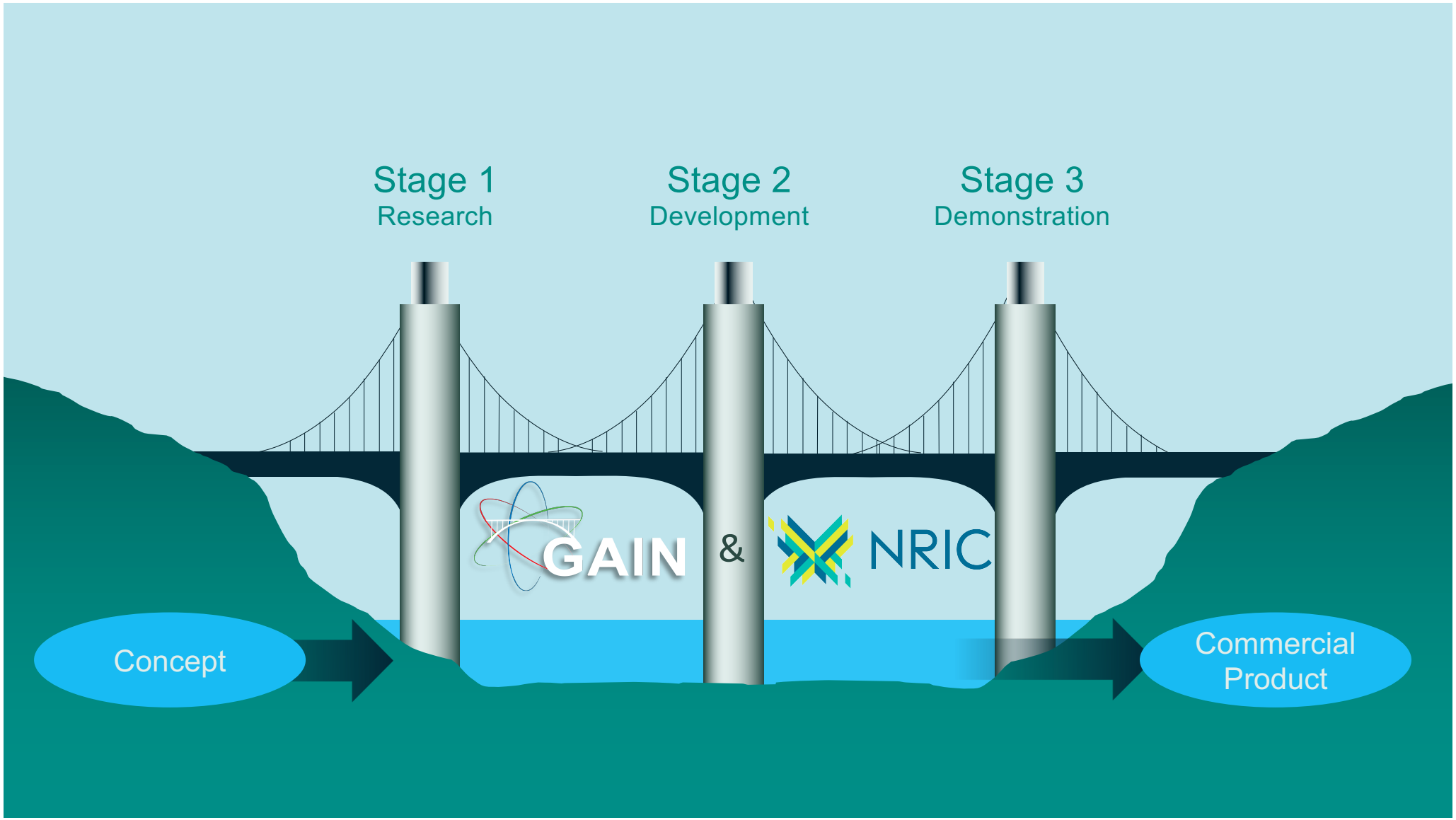
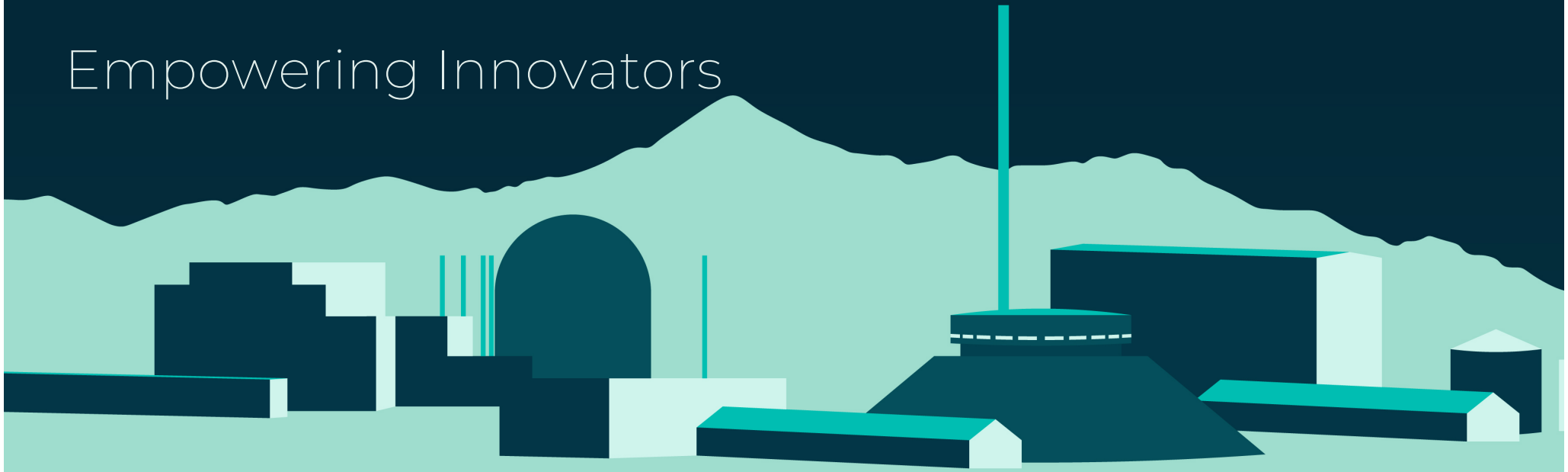

Stage 1
Research
Stage 2
Development
Stage 3
Demonstration
GAIN
&
NRIC
Concept
Commercial
Product

Empowering Innovators



- Demonstration Resource Network
  - Test beds & Demonstration Sites
  - Experimental & Fuel Facilities
    - Irradiation & Characterization
    - Component testing (sodium, helium, molten salt, lead, etc.)
- Regulatory Risk Reduction
- Virtual Test Bed
- NRIC Resource Team

NRIC

Regulatory Risk Reduction

Objective: Anticipate required regulatory preparations common to NRIC stakeholders & take actions to increase certainty, reduce risk, and accelerate demonstration.

Activity areas:

- Microreactor transportation and decommissioning
- Coordination with NRC on demonstration projects
- DOE authorization process guidance
- INL site safety authorization or licensing issue identification and resolution
- NEPA (INL and general)
- Advanced construction technology and digital engineering regulatory engagement

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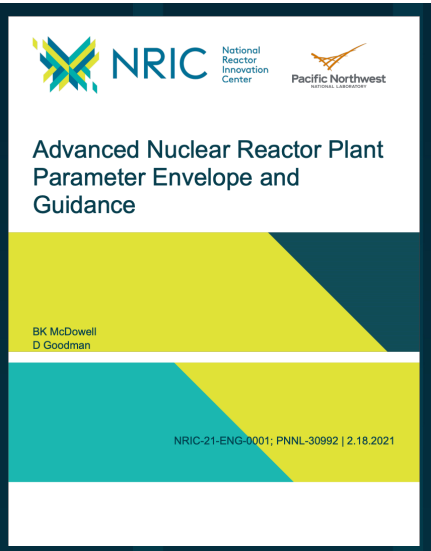
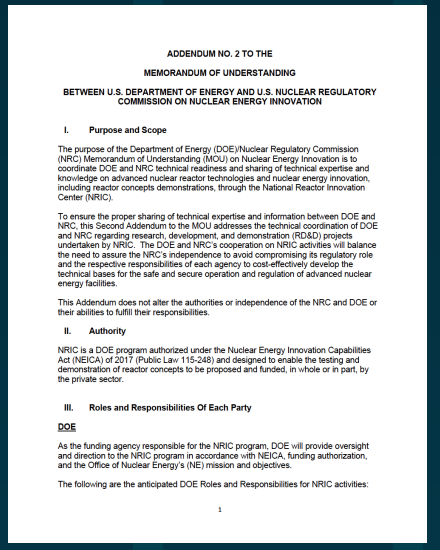

NRIC National Reactor Innovation Center

Pacific Northwest NATIONAL LABORATORY

Advanced Nuclear Reactor Plant Parameter Envelope and Guidance

BK McDowell
D Goodman

NRIC-21-ENG-0001; PNNL-30992 | 2.18.2021


ADDENDUM NO. 2 TO THE

MEMORANDUM OF UNDERSTANDING

BETWEEN U.S. DEPARTMENT OF ENERGY AND U.S. NUCLEAR REGULATORY COMMISSION ON NUCLEAR ENERGY INNOVATION

I. Purpose and Scope

The purpose of the Department of Energy (DOE)/Nuclear Regulatory Commission (NRC) Memorandum of Understanding (MOU) on Nuclear Energy Innovation is to coordinate DOE and NRC technical readiness and sharing of technical expertise and knowledge on advanced nuclear reactor technologies and nuclear energy innovation, including reactor concepts demonstrations, through the National Reactor Innovation Center (NRIC).

To ensure the proper sharing of technical expertise and information between DOE and NRC, this Second Addendum to the MOU addresses the technical coordination of DOE and NRC regarding research, development, and demonstration (RD&D) projects undertaken by NRIC. The DOE and NRC's cooperation on NRIC activities will balance the need to assure the NRC's independence to avoid compromising its regulatory role and the respective responsibilities of each agency to cost-effectively develop the technical bases for the safe and secure operation and regulation of advanced nuclear energy facilities.

This Addendum does not alter the authorities or independence of the NRC and DOE or their abilities to fulfill their responsibilities.

II. Authority

NRIC is a DOE program authorized under the Nuclear Energy Innovation Capabilities Act (NEICA) of 2017 (Public Law 115-248) and designed to enable the testing and demonstration of reactor concepts to be proposed and funded, in whole or in part, by the private sector.

III. Roles and Responsibilities Of Each Party

DOE

As the funding agency responsible for the NRIC program, DOE will provide oversight and direction to the NRIC program in accordance with NEICA, funding authorization, and the Office of Nuclear Energy's (NE) mission and objectives.

The following are the anticipated DOE Roles and Responsibilities for NRIC activities:

1


deliver
NRIC

Delivering Successful Outcomes

- Coordination & Collaboration
  - DOE/NRC
  - ARDP
  - GAIN, Labs
  - Cross-functional core team
- Digital Engineering
- Advanced Construction Technology
- Construction Project Management
- Integrated Energy Systems

NRIC

NRIC is a National Program and Central Integrator for Partners and Collaborators

NRIC

Thank you!

Questions?

NRIC

GAIN Overview

Advisory Committee on Reactor Safeguards (ACRS)

Christine King, Director
Lori Braase, Program Manager

March 3, 2021

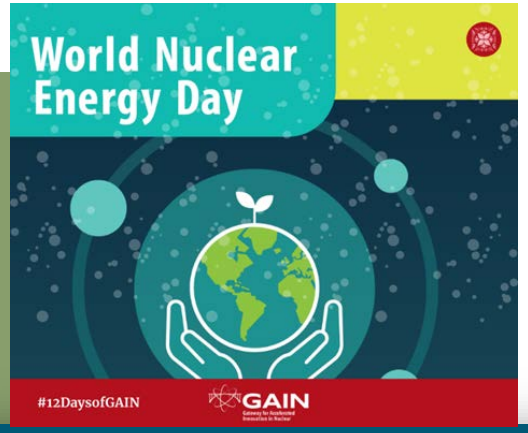
GAIN
Gateway for Accelerated Innovation in Nuclear

@GAINnuclear
gain.inl.gov

Mission and Vision

Vision (2030)

The U.S. nuclear industry is equipped to lead the world in deployment of innovative nuclear technologies to supply urgently needed abundant clean energy, both domestically and globally.

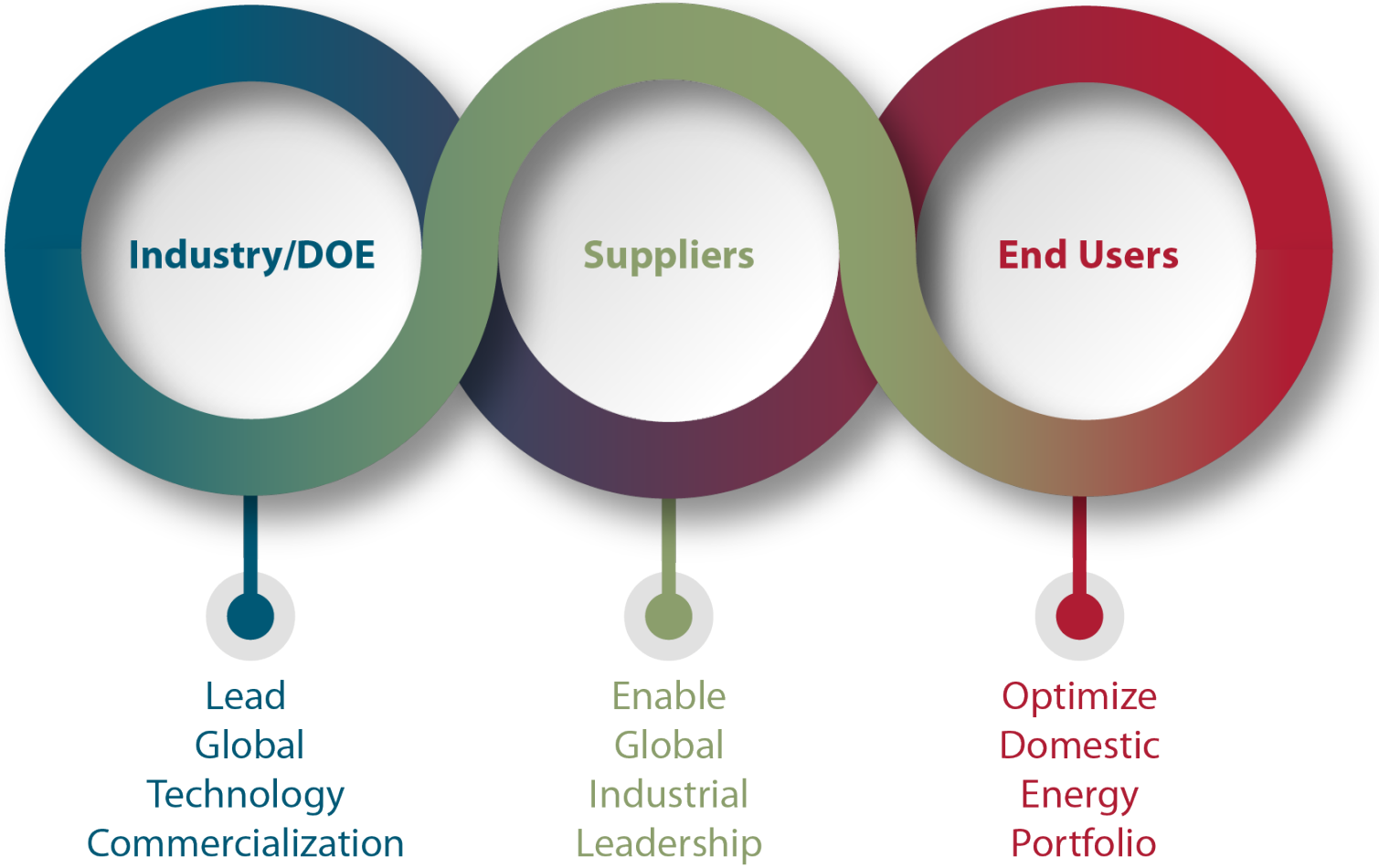


Mission

Provide the nuclear energy industry with access to cutting-edge R&D, along with the technical, regulatory, and financial support necessary to move innovative nuclear energy technologies toward *commercialization* in an accelerated and cost-effective fashion.

GAIN
Gateway for Accelerated Innovation in Nuclear

NUCLEAR ENERGY STRATEGIC GOALS



NRIC and GAIN are Complementary and Coordinated Efforts to Support the Nuclear Energy Industry

GAIN

- Established in November 2015 as a resource for accelerated development of nuclear innovations with lab partners
  - Enables comprehensive resource to entire nuclear innovation ecosystem at all development stages
  - Provides streamlined access to testing, experimental facilities, lab expertise, and legacy data
  - Provides regulatory expertise (e.g., NRC advanced reactor licensing strategy support)
  - Manages NE Vouchers

NRIC

- Equipped for building and demonstrating reactor concepts
  - Provides focused program to enable innovators nearing demonstration stage
  - Enables access to sites, required upgrades, site services, fuel material/fabrication facilities, and demonstration process support
  - Provides regulatory assistance related to demonstration
  - Facilitates NRC observation/learning

GAIN Goals for FY 2020-2025:

Goal #1. Provide nuclear industry entities access to financial support opportunities and national laboratory capabilities (facilities, expertise, and tools) to accelerate commercialization of innovations through research, development, demonstration, and deployment.

Goal #2. Work with industry to identify gaps, gather needs, and develop viable paths forward to inform DOE research programs and remove barriers for industry.

Goal #3. Work with industry stakeholders and NRC as means of communicating and resolving common (industry-wide) issues through regulatory interactions.

Goal #4. Facilitate the advanced nuclear industry's access to information to support their technology commercialization efforts.

Goal #5. Contribute tailored, factual information to key stakeholders to motivate the integration of clean nuclear energy for long-term success.

How to do Business with GAIN

- Provides *Contract Mechanisms* on one side and *Funding Opportunities* on the other
- Information applies to all DOE national labs in their contracting discussions with industry

How to do Business through GAIN

GAIN Gateway for Accelerated Innovation in Nuclear

Funding Opportunities

Funding Opportunities	Description	Timeframe	Funding*
Advanced Nuclear Technology Development (iFOA)	Provides funding to support innovative, domestic, nuclear industry-driven designs and technologies that have high potential to improve the overall economic outlook for nuclear power in the U.S. The iFOA is comprised of three tiers focused on first-of-a-kind demonstration, advanced reactor development, and regulatory support. gain.inl.gov	Continuously open Award: Quarterly Duration: up to 3 years	Tier 1: $10-40M Tier 2: $0.5-10M Tier 3: $50K-0.5M (Tiered cost share)
Consolidated Innovative Nuclear Research (CINR)	Provides competitively awarded access to the Nuclear Science User Facilities (NSUF) by industry for non-proprietary nuclear materials and fuels research. CINR is the primary means to award irradiation and post-irradiation examination (PIE) access. It also supports DOE-NE mission and program directed work scopes primarily led by universities or national labs with the possibility of industry participation. gain.inl.gov	Call: August Award: July Duration: up to 3 years for R&D; up to 7 years for PIE and testing	Up to $500K for R&D Up to $4M for irradiation and PIE (NSUF) (0% cost share)
GAIN Nuclear Energy (NE) Vouchers	Provides competitively awarded access to DOE national labs for U.S. businesses to tap into the intellectual and technical resources needed to overcome critical technology challenges for their advanced energy products and gain a global competitive advantage. Awarded funds are sent directly to a national laboratory to perform work on behalf of an awardee. gain.inl.gov	Continuously open Award: Quarterly Duration: 12 months	$50–500k (20% cost share)
NSUF Rapid Turnaround Experiments (RTE)	Offers an avenue for researchers to perform irradiation effects studies of limited scope on nuclear fuels and materials of interest utilizing NSUF facilities. R&D funding is not provided, and work is to be completed within 9 months. nsuf.inl.gov/Page/rte	3 times per year Duration: 9 months	Up to $50K (0% cost share)
Small Business Innovation Research (SBIR)	Offers competitively awarded funding to small businesses to encourage development and commercialization of their technologies. SBIR targets the entrepreneurial sector and seeks to offset the risk and expense of necessary R&D. SBIR is comprised of three phases, each contingent on building from the results of the previous phase. science.energy.gov/sbir/funding-opportunities/	Phase 1: 6 months Phase 2: 2 years Phase 3: Refer to website	Phase 1: up to $150K Phase 2: up to $1M Phase 3: $0 SBIR Funds (Refer to website)
Technology Commercialization Fund (TCF)	Seeks commercialization of laboratory technology with industry partners. Leverages R&D funding in applied energy programs to mature promising energy technologies that are originally conceived at national laboratories with the potential for high impact. gain.inl.gov	Call: February Award: July Duration: 1-2 years	Topic 1: $100 - 150K Topic 2: $250 - 750K (Refer to website)

*Contingent upon Congressional appropriations.

Note: DOE National Laboratory (lab)

Contact gain.inl.gov for additional information.

3/11/19

How to do Business through GAIN

GAIN Gateway for Accelerated Innovation in Nuclear

Contract Mechanisms

Agreement	Description	Highlights
DOE Cooperative Agreement	A contract that is signed by DOE and an industry awardee to perform work at the Awardee's facilities and/or national lab. This is the mechanism used by DOE to fund awards made through the **iFOA**.	• Allows DOE to fund competitively awarded research directly.
Cooperative Research and Development Agreement (CRADA)	DOE lab partnering with one or more non-federal entities (including industry) that facilitates private sector research utilizing, for example, lab technologies, facilities, R&D capabilities, or expertise. The CRADA participant must contribute in-kind resources (personnel, equipment, facilities, etc.), and/or cash. A funding source for the lab work must be identified before work can start; this may be either participant funds, federal funds, or a combination. Commonly used for **GAIN NE Voucher** awardees who are large businesses or foreign influenced. Terms and conditions are non-negotiable.	• Up to 5 years of data protection. • Both parties may take title to their own inventions. • May negotiate exclusive license to inventions. • Advance payment required if participant is contributing funds to lab.
GAIN Small Business Voucher CRADA	Used ***exclusively*** for a **GAIN NE Voucher** awarded to a small business/non-profit voucher requester with NO foreign ownership/control/influence. Terms and conditions foster commercialization and are non-negotiable. This CRADA is intended to speed up the process of signing an agreement to complete awarded GAIN NE Voucher work.	• In addition to standard CRADA terms, provides the participant a nonexclusive license, at a minimum, to inventions conceived or first reduced to practice under the CRADA.
Nondisclosure Agreement (NDA)	Establishes the obligations regarding the exchange of proprietary or confidential business information between a DOE lab and an industry entity in order to allow them to progress toward a specific objective, commonly a contract under which work may be performed.	• Enables business relationships to develop work scope for joint projects.
Strategic Partnership Project (SPP) (Work for Others)	This is a fee-for-service contract that enables industry, non-profit institutions, and other non-federal entities to pay labs to perform a defined scope of work or tasks. Work must draw upon the unique facilities, equipment, or personnel intrinsic to the lab. The rights to the inventions and data (subject inventions) may vest in the sponsor if the sponsor is a U.S. entity and pays for the work with private funds; however, if the sponsor is providing federal funds to the lab to support the work (typically received through a competitive process) or if the sponsor is a non-U.S. entity or has foreign influence, then the rights of subject inventions will vest with the lab performing the work with no rights for protection of generated data.	• Generated data may be designated as proprietary. • Sponsor typically retains right to elect title to subject inventions. • Advance payment required.
User Facility Agreement	A User Facility Agreement provides access to facilities to conduct research. It may be possible to perform proprietary or non-proprietary (e.g., **NSUF**) research at the designated user facilities. In certain circumstances, access to facilities is available to U.S. companies on a full cost recovery basis. Access generally begins with an invitation from an employee or through submission and approval of a peer-reviewed proposal.	• IP belongs to inventor/company. • No charge for users who are performing non-proprietary research. • Non-proprietary users are expected to publish results.

Contact gain.inl.gov for additional information.

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GAIN NE Voucher Awards for Round 1, FY2021

- TerraPower is the first voucher awarded for work at LANL and involves characterization of plutonium chloride salt properties using neutron beam imaging in the LANSCE facility.
- The two ORNL vouchers involve the use of modeling and simulation capability in support of innovations in additive manufacturing.
- NE Vouchers Round 2 closed on February 1, 2021.
- iFOA Round 1 closes April 30, 2021.

GAIN 2021 1st Round NE Voucher Recipient	Awarded Proposal	Partner Facility
Exelon Generation Kennett Square, PA	Advanced Nuclear Fuel Pellet Designs	Oak Ridge National Laboratory
TerraPower, LLC Bellevue, WA	Density Measurements of Plutonium Bearing Salts via Neutron Beam Dilatometry	Los Alamos National Laboratory
Westinghouse Electric Company, LLC Columbia, SC	Multiphysics Design Optimization and Additive Manufacturing of Nuclear Components	Oak Ridge National Laboratory

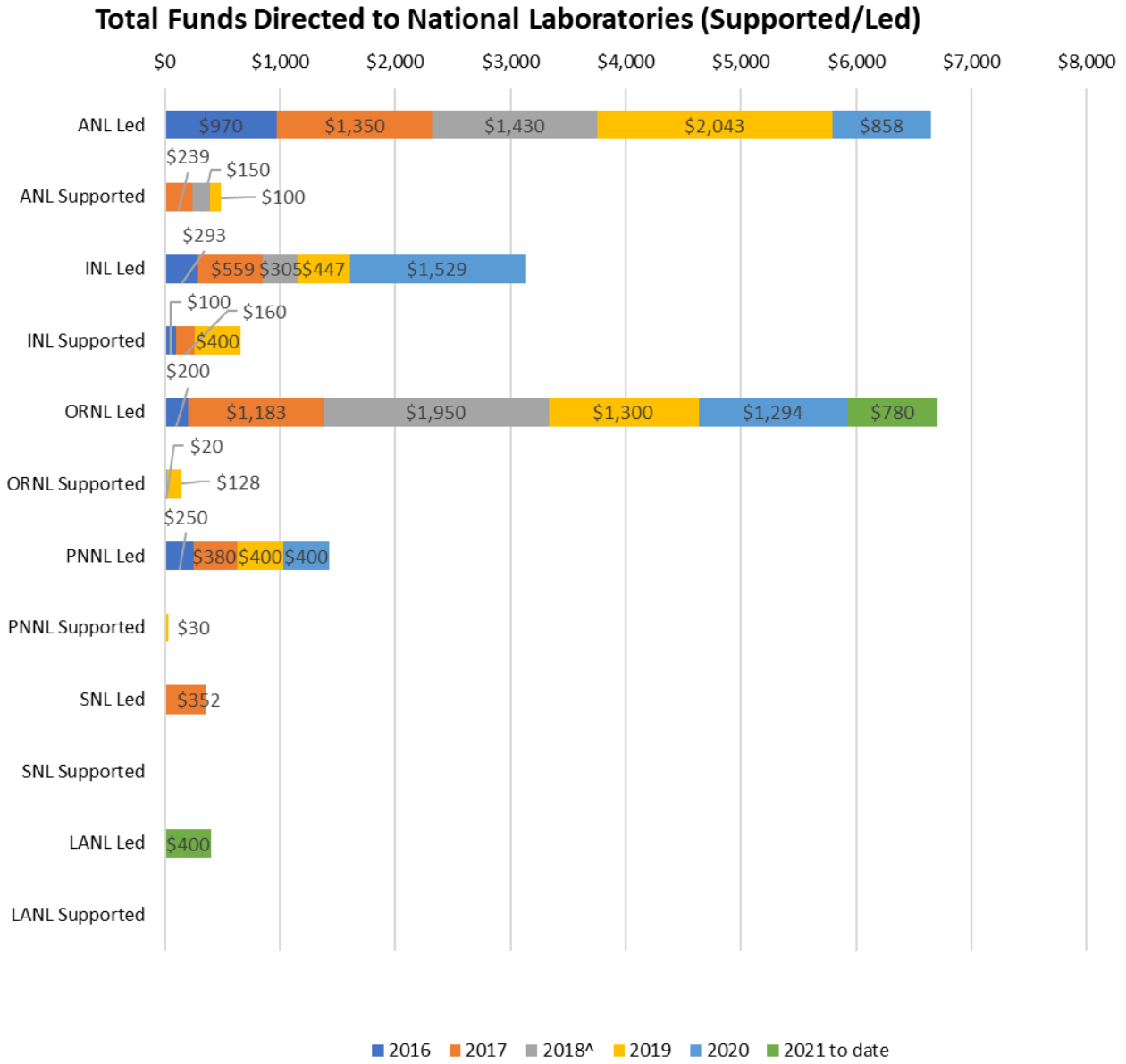
GAIN FY2020 Voucher Awards

FY 2020	Voucher Recipient	Proposal	Lab
Round 1	Hydromine, Inc.	On-Line Lead/Water Heat Exchanger Sensor/System Feasibility	PNNL
Round 1	Lightbridge Cor	Advanced Test Reactor experiment design for measurement of Lightbridge Fuel™ thermophysical properties	INL
Round 2	Neutroelectric	Combined effects testing of high-temperature and neutron fluence to support qualification of NE-300, a high-temp Neutron shielding Material	ORNL
Round 2	Oklo, Inc.	Address gaps in legacy data on fuel steel interactions	INL
Round 3	SMR, LLC	Coupled neutronic and thermal hydraulic analysis of a natural circulation based small modular reactor using VERA-CS	ORNL
Round 3	Ultra Safe Nuclear Corp	Graphite finite element model verification	ORNL
Round 4	Kairos Power	Pebble Bed Large Eddy Simulations for Lower Order Methods Benchmarking and Uncertainty Quantification Development	ANL
Round 4	Natura Resources, LLC	RELAP5-3D Development and Assessment for Liquid-fuels Molten Salt Reactor Licensure	INL
Round 4	TerraPower, LLC	Thermophysical Properties Measurements of NaCl-PuCl3	ANL

GAIN Voucher Impact 2021 Round 1

Voucher Summary

- 57 Awarded
- 28 Completed
- $20 M to National Labs
- Total Project Costs $25.3 M



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GAIN Assistance on Process Improvement

NE Advance Class Patent Waiver

- DOE forgoes taking title to patentable inventions conceived using DOE funding
- Advance: Available when contract negotiations begin
- Class: large domestic businesses interested in DOE-NE related funding opportunities. (Note: small business can use the Bayh-Doyle legislation)
- This waiver will accelerate negotiations for iFOA and ARD awards and reduce uncertainty in negotiations

More information is available at
gain.inl.gov

GAIN Access CRADA (in process)

- Enable an industry partner to sign an agreement with a single lab that grants them simultaneous access to other labs in the complex
- Conceptually:
  - Industry partner has work scope that crosses multiple labs
  - A “lead lab” is identified and the CRADA is negotiated
  - Partner Labs review and accept the CRADA
- Allows single agreements across DOE Offices of NE, Science, and NNSA

Legacy Documents / Industry Access

Initial **Fast Reactor (FR) Technology List** provides access to 4250 openly published FR documents available from OSTI (December 2018)
Initial **Molten Salt Reactor (MSR) Technology** List provides access to 210 cataloged MSR documents available on OSTI (February 2017)
OSTI Spreadsheet of 12,000 Applied Technology (AT) Documents with abstracts provided to GAIN. List released with abstracts on February 28, 2019. Provided to TWG Chairs on March 8, 2019.
Clinch River Breeder Reactor (CRBR) Project documents. Contract initiated in Feb 2020. Scanning on hold (COVID-19). Iron Mountain will proceed as soon as possible (235 boxes + 75 reels of microfilm).
LOFT and other LWR Experiments. Fauske and Associates developed a pilot knowledge preservation activity in March 2019. Phase II contract will proceed in FY2021.
New Production Reactor (NPR) documents at INL Storage (125 boxes-Idaho Falls). Working with Red Ink to scan and organize files for Export/Classification Reviews. Effort is underway.
Loft Experiment Data for code validation (Box of data –INL – to be scanned & reviewed. **PBF Documents** (3 boxes at INL) will be scanned and reviewed.

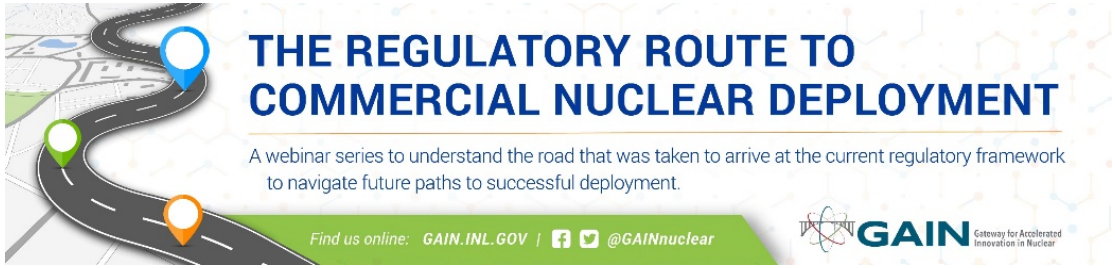
Databases of Experimental Information

Database	Lab	Status (25Jan21)
TREXR TREAT Experiment Relational Database	ANL	https://www.trexr.anl.gov/ External access available by application
NaSCoRD Sodium System & Component Reliability Database	SNL	https://www.sandia.gov/nascord/ Phase II Complete – FY20.
ETTD EBR-II Transient Testing Database	ANL	https://ettd.ne.anl.gov/ External access available by application
FIPD EBR-II Metallic Fuel Irradiation Database	ANL	https://fipd.ne.anl.gov/ External access available by application. Data for U-Zr fuel type employed in commercial designs being qualified in accordance with NRC approved QAPP.
FFTF Passive Safety Testing & Metal Fuel Irradiation Database	PNNL	Available FY21. External Access Plan Complete
OPTD Out of Pile Transient Testing Database	ANL	https://optd.ne.anl.gov/ External access available by application
EBR-II and FFTF Metal Fuel Experiment PIE Data	INL/ANL	Organized effort to supplement the FIPD and FFTF Databases. Complete in 2021.
MSRE Molten Salt Reactor Component Reliability Database	ORNL/EPRI	Available FY-21– Currently being populated with operations, maintenance, and experimental data.

All databases will have links available at gain.inl.gov

What's New? GAIN Workshops and Webinars - 2021

GAIN Webinar Series Focused on Multi-Industry Stakeholders



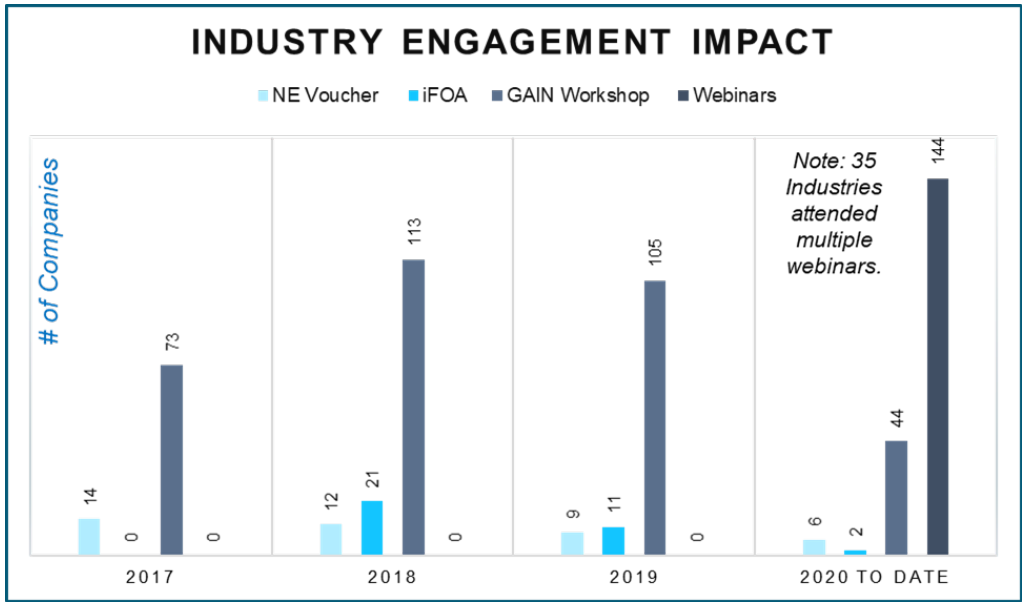
Workshops Focused on Advanced Nuclear Needs and Feedback

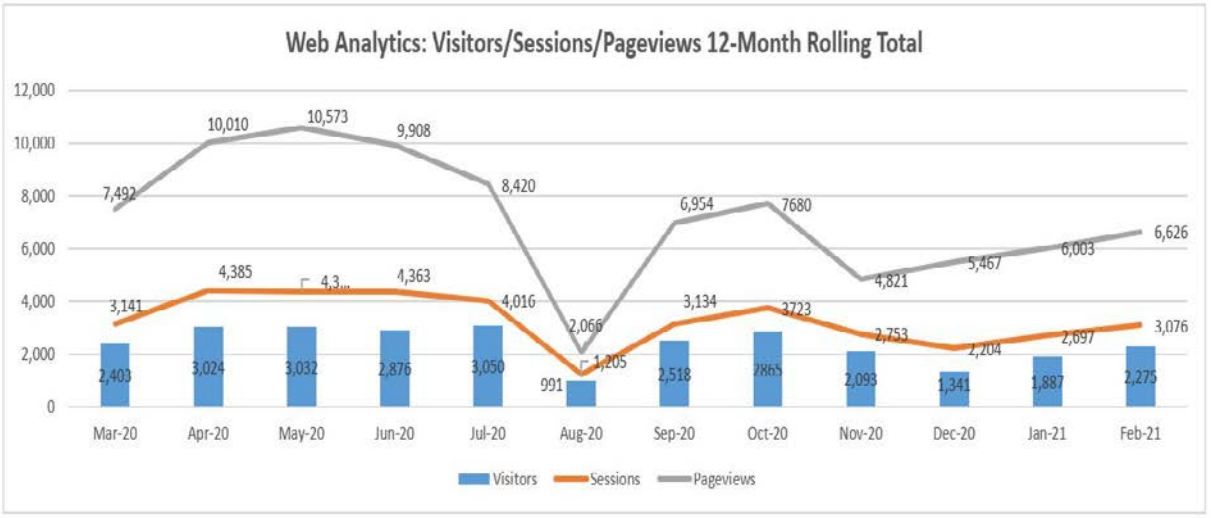
- April 13-15. 2021: GAIN-EPRI-NEI Advanced Reactors Safeguards & Security Virtual Workshop
- May 12-13, 2021: GAIN-EPRI-NEI Microreactor Virtual Workshop
- August 24-26, 2021: GAIN-EPRI-NEI Advanced Methods for Manufacturing Qualification Workshop

GAIN Outreach

Nuclear-focused Collaborators

- Nuclear Energy Institute
- Electric Power Research Institute
- Envoy Public Labs
- Third Way
- Clearpath
- Titans of Nuclear
- Generation Atomic
- American Nuclear Society
- Nuclear Innovation Alliance





1,208 Facebook Followers

1,388 Facebook Reach

2,546 Twitter Followers

26.8K Twitter Impressions

836 Instagram Followers

212 LinkedIn Followers

GAIN Social Media – February 2021

Titans of Nuclear GAIN-NRIC Miniseries: Realizing the Nuclear Future

Titans of Nuclear produces podcasts featuring interviews with experts across technology, industry, economics, policy and more.

"Connect with what excites you about nuclear today and imagine nuclear tomorrow."

Ep. 287, GAIN-NRIC Miniseries: Christine King — Dec 7, 2020

1) Christine King reflects on her time at EPRI where she focused on solving inherited material problems related to the use of Alloy 600 in steam generators
2) Christine shares her personal journey to find purpose and how it impacted her career path in the nuclear sector
3) The role of GAIN in the nuclear sector and the many ways it supports developers, investors, end users, and government programs
4) A look at how new technology demonstrations ...

Listen, Watch, View Shownotes & More...

Ep. 288, GAIN-NRIC Miniseries: John Jackson — Dec 14, 2020

1) John Jackson shares his experience growing up living off-the-grid and how he got involved in mechanical engineering and fracture mechanics
2) How John reconnected with the Idaho National Lab and got involved with the Gateway for Accelerated Innovation in Nuclear
3) How the GAIN vouchers connect nuclear technology developers and the resources available at the National Labs
4) Why the nuclear industry must unite to work towards demonstrations o...

Listen, Watch, View Shownotes & More...

https://www.titansofnuclear.com/

Ep. 289, GAIN-NRIC Miniseries: Nicholas Smith — Dec 21, 2020

1) How Nick Smith's early professional career on the football field led him to the energy industry in an unconventional way
2) Nick reflects on his personal discovery of nuclear power and how it led to a major career shift to advanced nuclear R&D
3) An overview of the current projects underway at the National Reactor Innovation Center (NRIC) to enable advanced reactor demonstrations
4) The role of the Zero Power Physics Reactor (ZPPR) and the Exp...

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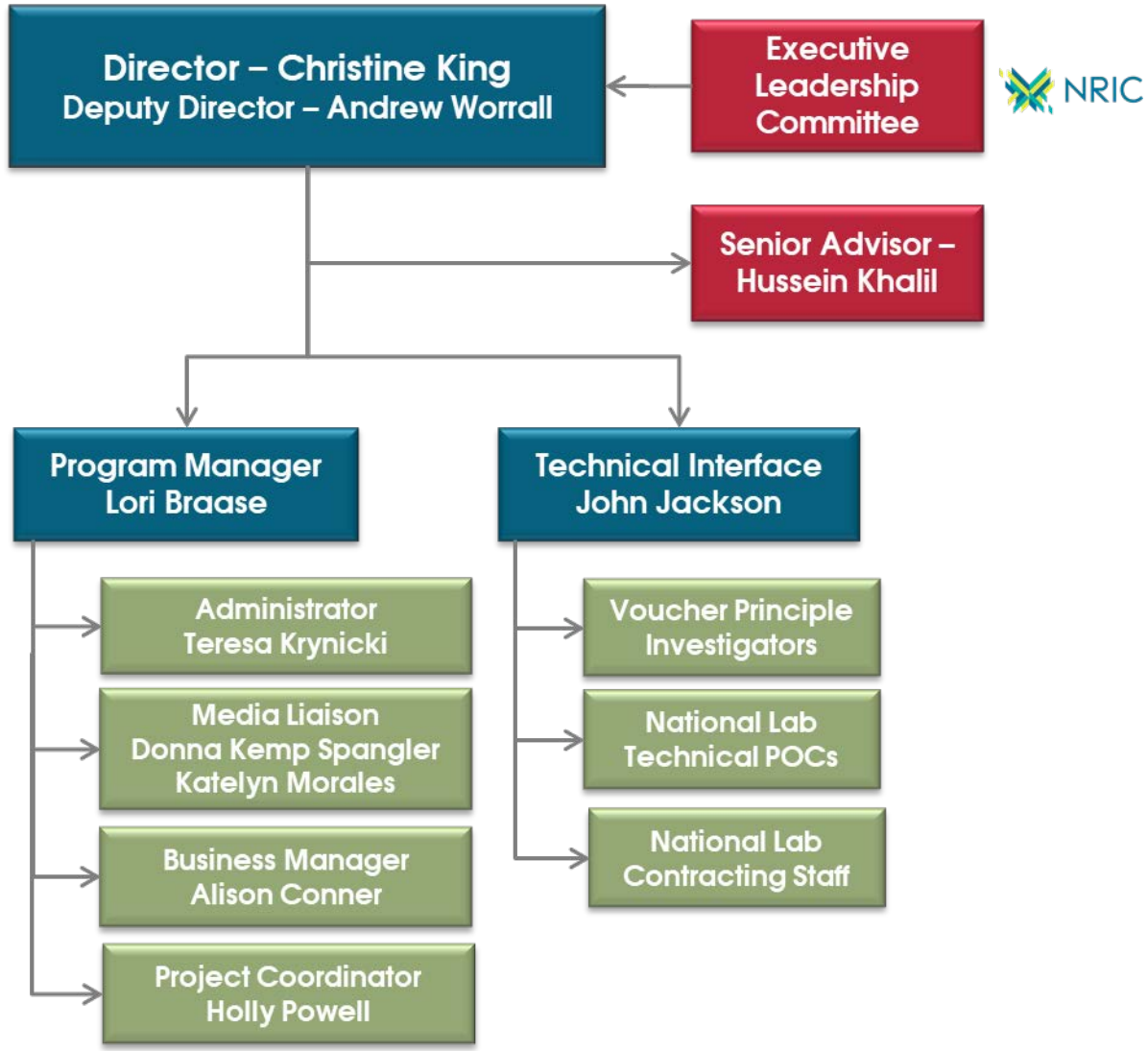
GAIN Organization



Gateway for Accelerated Innovation in Nuclear

- 'Accelerated' must match advanced nuclear developer pace and reflect the market window (next 5-10 years).
- Innovation is not just about technology. Creativity, with a bias to taking risks, is key.
- Focus on initiating and completing projects that support commercial deployment.

Questions? Reach out to gain@inl.gov (or one of our team members.)