UNITED STATES

NUCLEAR REGULATORY COMMISSION

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BRIEFING ON ACCIDENT TOLERANT FUEL

(PUBLIC MEETING)

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THURSDAY,

APRIL 12, 2018

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ROCKVILLE, MARYLAND

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The Commission met in the Commissioners' Hearing Room at the Nuclear Regulatory Commission, One White Flint North, 11555 Rockville Pike, at 9:00 a.m., Kristine L. Svinicki, Chairman, presiding.

COMMISSION MEMBERS:

KRISTINE L. SVINICKI, Chairman

JEFF BARAN, Commissioner

STEPHEN G. BURNS, Commissioner

ALSO PRESENT:

ANNETTE VIETTI-COOK, Secretary of the Commission

MARGARET DOANE, General Counsel

NRC STAFF:

VICTOR M. McCREE, Executive Director of Operations

MICHELLE F. BALES, RES

CHRISTOPHER J. FONG, NRR

MIRELA GAVRILAS, NRR

RAYMOND K. LORSON, NRR

ANDREW PROFFITT, NRR

ALSO PRESENT:

DANNY BOST, Southern Company

EDWIN LYMAN, Union of Concerned Scientists

BILL McCAUGHEY, US Department of Energy

THOMAS P. MILLER, US Department of Energy

NEIL WILMSHURST, Electric Power Research Institute

P R O C E E D I N G S

9:00 a.m.

CHAIRMAN SVINICKI: I would ask the participants of the first panel to be taking their seats as I make some opening remarks.

So, the Commission convenes this morning in open session to receive an update on the status and issues associated with the path to licensing what is termed accident tolerant fuel, or you'll hear the acronym AFT today, for use in commercial nuclear power reactors.

We will begin with a panel of external participants providing perspectives.

We will have a brief break and then we will hear from a collection of NRC staff executives and experts.

I look forward to today's meeting. I think there's been a lot of activity in this space. I think the meeting is well timed. And, I think that we'll get into some depth on the issues which is always enjoyable.

Before we begin, I ask my colleagues if they have any opening remarks here.

Hearing none, we will begin, as I noted with an external panel that consists of a number of individuals.

I think what I'll do is just read the names and do a brief introduction of the panel and then we will begin to my left and they can -- if the participants could hand off to one another, we can move through their presentations and move to the question and answer period.

So, the panel consists of Bill McCaughey. Have I pronounced that correctly?

MR. MCCAUGHEY: McCaughey.

CHAIRMAN SVINICKI: McCaughey, thank you.

Bill McCaughey, Acting Director of Advanced Fuel Technologies of the Office of Nuclear Energy at the U.S. Department of Energy.

Joined by also Thomas Miller, Director, Office of Accelerated Innovation of the Office of Nuclear Energy at the Department of Energy.

In addition, we have Mr. Danny Bost who is Executive Vice President and Chief Nuclear Officer of Southern Company and the Executive Sponsor of the industry's Accident Tolerant Fuel Working Group.

Also, we have Mr. Neil Wilmshurst who is the Vice President, Nuclear and Chief Nuclear Officer of the Electric Power Research Institute.

And, concluding the panel's presentations will be Dr. Ed Lyman who is the Senior Scientist at the Union of Concerned Scientists.

Again, I thank you all for being here this morning. I look forward to your presentations and we will begin with Mc. McCaughey.

MR. MCCAUGHEY: Thank you.

Thank you, Chairman Svinicki, Commissioner Baran, Commissioner Burns. I'm happy to set the stage here for this meeting on accident tolerant fuel and brief you on the -- provide you with an overview of the Department of Energy's Accident Tolerant Fuel Program.

I manage Advanced Fuels Technologies. This is one of three offices under the Nuclear Technology Research and Development within the Office of Nuclear Energy.

The other two are Advanced Reactor Technologies and

Materials and Chemical Technologies.

In addition to accident tolerant fuel, other advanced fuels programs include the Tristructural Isotropic or Triso Fuels Qualification Program for high-temperature gas reactors and metallic fuels for sodium-cooled fast reactors.

These are the topics that I will address in my talk today, the congressional direction and the development plan that set the stage for our accident tolerant fuel program, the National Laboratory research and development support we provide to the industry and to the -- now to the Nuclear Regulatory Commission and also, a word or two about the cooperation we have with the Nuclear Regulatory Commission.

Our direction from Congress originated in the Senate Appropriations Committee report accompanying the fiscal year 2012 Energy and Water Development Appropriation Bill.

And, at that time, Congress also asked us for a development plan. That plan is 14 pages. It describes the vision, the mission, the scope and goals of the program.

Regarding the attributes of accident tolerant fuel, it emphasizes reduced hydrogen generation, improved fission product retention, reducing the cladding reactor with steam and reduce fuel cladding interactions in severe accidents.

The fuel, the plan goes on, the fuel is to be used in existing reactors. And, in order to speed development, reactor design changes and the need for significantly new and different fuel performance analyses should be minimized.

So, that is that anything that we thought could not be

accomplished in the 10-year time frame that Congress directed for the program.

The plan also contains -- states that the evaluation of accident tolerant fuel concepts should consider, in addition to accidents, accident conditions, normal operations, economic impacts and fuel cycle impacts.

And also, the plan addresses the capability needs such as the need for high temperature steam testing, irradiation testing, transient testing, post-radiation examination, fuel fabrication and the regulatory framework.

So, the development plan consists of these three phases. We have Phase 1 was the feasibility assessment and down selection of accident tolerant fuel concepts. This was completed at the end of fiscal year 2016.

Phase 2 is to take the most promising accident tolerant fuel concepts that were identified in Phase 1 and further develop and lead to qualification of those fuel concepts. And, that's what we are in now. We're in the second year of Phase 2.

And then, Phase 3 will be turned over to industry for commercialization of the fuel once we've supported the development and the qualification, and the vendors would then ramp up with core reloads and actual utilization of the accident tolerant fuel.

So, the -- a lot has happened since we put that development plan together and we are updating it right now.

The plan was developed during the early phases of the program. We have significant input from utilities and the Nuclear Regulatory

Commission.

And, it's now being updated to reflect the significant interactions that began in Phase 2.

In addition, the utilities working with the fuel vendors and the Nuclear Regulatory Commission have accelerated the development activity well beyond what we had envisioned in that plan.

The most significant change relates to what we considered to be our goal for the conclusion of Phase 2 in the plan which was one set of lead fuel assemblies in one reactor by 2022 and that that would lead then to the commercialization phase.

We actually have multiple accident tolerant fuel concepts being developed by multiple fuel vendors. And, in addition, there are going to be multiple lead fuel assemblies in reactors beginning as early as this -- beginning this year.

Next?

So, these are the three primary accident tolerant fuel concepts that we carried forward into the development and qualification phase at the start of fiscal year 2017.

As you can see, they are quite diverse. We believe that that increases the chances of success for the program.

Okay, moving on to our -- a word about our-- the support that the National Laboratories provide to industry and the NRC in addition to the R&D infrastructure that the fuel vendors possess on their own and that the utilities possess using Electric Power Research Institute, the National Laboratories offer these unique capabilities and are very important for the fuel development and qualification.

Probably the most significant addition has been the refurbishment of the transient reactor test facility at Idaho National Laboratory.

It came online last year at a cost of $55 million. And, the accident tolerant fuel program will be one of the first significant experimental programs in the reactor.

Advanced modeling and simulation is another significant capability the National Laboratories and will be the subject of Tom Miller's presentation who will follow me.

And, in addition to supporting fuel development and qualification, these capabilities of the National Laboratories are also supporting the industry in understanding the improvements that may be gained in plant performance for accident tolerant fuel and are supporting the Nuclear Regulatory Commission with providing the information that they will require.

On that NRC cooperation, the -- it increased significantly at the start of Phase 2. Our fuel vendor teams began discussions, licensing discussions with the NRC staff.

And, the information exchanges between NRC our laboratory subject matter experts increased in Phase 2.

In addition, we developed an accident tolerant fuel addendum to the Memorandum of Understanding that exists between the Nuclear Regulatory Commission and the Department of Energy. And, we did that in October of 2017.

So, in summary, Phase 1 is complete. It was successful. It resulted in several diverse accident tolerant fuel concepts that are undergoing further development, hopefully leading to qualification and use in

reactors.

Phase 2 was expanded from what we had originally planned and accelerated from what we had originally planned in our project plan.

The National Laboratories are supporting the industry teams and the NRC.

And, the cooperation with the NRC increased significantly in Phase 2 when we became more focused on the most promising accident tolerant fuel concepts.

Thank you, that concludes my remarks.

CHAIRMAN SVINICKI: Thank you very much.

Next we will hear also from the Department of Energy. Mr. Miller, please proceed.

MR. MILLER: Good morning.

Thank you for having me and giving me the chance to brief you our modeling and simulation programs and their application to the accident tolerant fuel concepts.

I will also, in my brief, touch on some of the initial engagement that we've had with the NRC staff.

With me here today is Dr. Jess Gehin, Director of the CASL Modeling Simulation Hub. He's going to back me up if there's any hard, technical questions that come out.

Next? Next slide? Thank you.

The Office of Nuclear Energy has two modeling simulation programs. They are complementary.

One is focused on light water reactors against the modeling simulation won't, or more commonly known as CASL.

And then, we have the what's called the NEAMS program, the Advanced and Simulation for Advanced Reactors.

Many of the researchers involved in these programs work collaboratively and in both programs. So, they are -- the benefits of doing their work and one also benefits the other programs.

And, we're seeing some of those as we look at accident tolerant fuels.

The hub was started in 2009. It's in its second five-year performance period and expected to complete in 2019. And, as I said, it's focused on light water technology... SMRs, included particular NuScale.

The hub's VERA tool set, the VERA being the Virtual Environment of Reactor Applications is a multi-physics modeling and simulation code coupling neutron transport, subchannel thermal hydraulics, power distribution, fuel performance and chemistry in a virtual environment.

VERA can also be coupled with other outside codes such as system level thermal hydraulic codes like TRACE or RELAP.

The VERA suite of tools have been demonstrated on the Watts Barr Units 1 and 2 reloads and the Watts Bar 2 startup.

The NEAMS modeling simulation program was started in 2010. And, as I said, it's focused on advanced reactors.

These modeling SIM programs provide a significant bridge between research by the reactor and fuel vendors through the game program for design and testing and analysis.

One note, in 2019, we plan to merge these two independent programs into one program within the Department -- hopefully gain some efficiencies there.

Next slide? Next one? No, I'm sorry, back up two. There you go.

The main part of the VERA suite and NEAMS suite is fuel performance. And, this is in the BISON code. It's -- well, I know folks have used a number of different animal names to cover their codes.

So, it advances the code development for ATF and extending the uranium zirconium to ATF fuel concepts addressing new cladding and addressing the new fuel pellet designs doped uranium oxide and uranium silicide.

The engineering scale modeling of the FeCrAl cladding performance in BWRs is also being applied with BISON.

So far, we've engaged the industry to some extent, mostly Westinghouse. The other two vendors, we understand are going to move forward of their licensing under AFT concepts using their own particular in-house codes.

Westinghouse is utilizing a VERA test stand and their nomenclature is an in-house capability using the modeling and simulation codes.

They're applying VERA with the BISON focus to their ATF silicon carbide concept.

And, we're going to be working with them continuously through that process.

Another industry engagement so far has been with NuScale. They also have a VERA test stand. It's not intended for use for ATF, but it's -- they are looking at it as a potential use of the modeling and simulation tools.

And, we've had some engagement with the Electric Power

Research Institute in how to apply our mod-sim tools in engagement with them.

Next slide?

So, our ongoing engagement with the NRC, we've been working with the NRC for some time now discussing how we can apply our tools in their -- for their use and analyses for licensing actions.

And, we organized an addendum to our R&D Cooperation Agreement with the NRC, so we have an ongoing addendum now.

We've had numerous interactions with the Office of Research on use of these tools. I'm sure you'll hear about that today.

The initial engagement is to couple the fuel performance coder of the VERA suite, BISON, with the TRACE thermal hydraulics code. And, that is an ongoing effort to couple those two so it's a seamless transfer of information.

My understanding is that's going very well. We continue to support that until it's, you know, it's a working tool for you.

We've also conducted some initial training on the BISON code and additional training technical support will be provided as required.

And, we're continuing to explore other modeling and simulation code utilization by the NRC for the advanced reactors. We've had ongoing conversations about specific technologies and how we might couple those with the NRC codes.

So, in summary, we think our codes are available for ATF and advanced reactor analysis. We believe there's still some work that needs to be done in validation of these codes, particularly for those concepts. We're going to continue to look to and work with the industry and use our test

program data to validate those codes with ATF.

We think there's a real value that can happen by this continued integration and discussions between us and the NRC staff on what that code needs to do in meeting that validation.

The extent to which you're going to drive the code and the transients it's got to be able to accomplish.

The Office of Nuclear Industry endorses the use of these modeling simulation codes, both by the industry and NRC.

And, that concludes my brief. Thank you.

CHAIR SVINICKI: Thank you very much.

Next, we will hear from the industry's Accident Tolerant Fuel Working Group.

Mr. Bost, please proceed.

MR. BOST: Thank you.

Good morning, I thank you, again, Chairman Svinicki and Commissioner Burns and Commissioner Baran. I really appreciate the opportunity to be here today to talk about accident tolerant fuel.

I don't have a lot of slides. You know, let the technical folks go through all the technical slides.

But, I do have some things that I think we need to consider in order to be successful with accident tolerant fuel for our existing fleet.

I think one of the common themes we're going to hear all day today from all of our presenters is potential. We believe there is potential safety benefit from going and working on accident tolerant fuel.

And, what I believe is in order for us to gain that benefit for the existing fleet, then we really have to look at having a very efficient and

effective program to get us there in the mid-2020s. And, it's just the way things are going to time out.

I'll go over that a little bit more as I go through my presentation, but I at least wanted to give that punch line up front because I think what we do all needs to support that piece.

So, we can move to my next slide, please?

So, this shows how the industry is organized to work on accident tolerant fuel. And, it's all done under the heading of our Strategic Issues Advisory Committee which consists of the Chief Nuclear Officers in the country working under NEI heading.

So, our working group that we put together is to guide industry policy and our industry actions on accident tolerant fuel. And, that's the group that I'm the Executive Sponsor for. So, I Chair that group and then we report out to all the Chief Nuclear Officers. So, we're gaining alignment across our industry as we go forward and work on accident tolerant fuel.

If you look at who our members are in this working group, it includes utilities and, it also includes all of our key fuel suppliers. So, we've put together those three task forces underneath that. And, I'll mention very quickly what those task forces work on.

The one on the left, the External Affairs is focused on ensuring adequate funding and communications.

The one in the middle, licensing, is focused on what's needed to the license accident tolerant fuel and, ultimately, get it deployed.

And then, over on the right, safety benefits, is focused on reviewing the safety and economic benefits of accident tolerant fuels.

And, if you look on over to the right, you'll see our -- the

research piece. And, we think that's essential to the progress on accident tolerant fuel. It's all that collaborative research that EPRI's leading and participating in and that's integrated across all of our teams.

And, Neil Wilmshurst will be covering that a little bit later in the presentations here.

The last thing I'd like to mention on this slide is that we do appreciate that the NRC staff has chartered a team to identify potential transformative changes that we can look at for the regulatory framework so that the Agency can be more agile.

And, when they're adapted to new and novel technologies such as accident tolerant fuel or recognize this is a piece where that's going to be looked at. So, we do appreciate that that team has been chartered and is working forward.

We'll move to the next slide, please?

This is a little bit of an eye test and I do apologize for that. I will trying to talk through the slide.

It does show what we believe is the path forward for accident tolerant fuel. So, I mean, our overall objective, again, is to enable initial deployment of accident tolerant fuel in the mid-2020s. We think this is how we're going to get there.

So, if you look over on the left at the research and development, that represents a collaborative effort between the utilities, the fuel suppliers. You'll see EPRI, the Department of Energy and NRC. We think everybody is in that R&D piece over there.

In the center, you see the licensee. That represents efforts that we need to do to license and deploy accident tolerant fuel.

And then, on the right, that -- with that safety benefits piece, focus on understanding the safety and economic benefits. And, charting the course to capitalize on them.

One thing you'll see is, this is not a series operation. These things are going on in parallel and we believe that that's very important in order for us to get this deployed when we believe it needs to be deployed.

If you look at how are we evaluating the fuel. We're looking at it across the spectrum. We'll look at it during normal operations.

We'll look at it in transient operations. We look at it for design basis accidents. And, we look at it for beyond design basis accidents.

We look at it across the whole spectrum.

We expect to have a better understanding of the safety performance and, therefore, the potential benefits later on in 2018. And, we'll be much better positioned to work with the NRC staff to look at what are corresponding changes that we think we need to get in order to go realize these benefits.

Now, the initial work that we've done so far, and this is what I think you're going to hear from everybody, the initial work shows there's a clear safety and then that's going to drive, also an economic case to continue forward. So, there's promise in the research and the results that we're getting.

And, there are ongoing efforts to further evaluate and further quantify what those benefits are.

If we can go to the next slide, please?

So, this is a lead test assembly that we want -- one of the lead test assemblies that we loaded for accident tolerant fuel in the plant Hatch

in February.

We did gain a lot of experience, I'll say, as we went through and put the lead test assemblies in plant Hatch.

And, one of them is, we need to have more, I'll say, certainty in the regulatory framework for handling lead test assemblies.

We were able to work with the staff and get this done, but it was a one-off. It was not an easy process. It was not an easy evolution.

The second piece I'll mention is, one of the styles that we installed was the steel rods. And, that's about as technical as I'm going to get with you.

But, it didn't have any fuel in it. And, it didn't have anything to do with -- we want to put in fuel, we want to put in rods without fuel. It had to do with shipping containers and licenses and can you get it here or not get it here?

And, we worked with the staff, but it was not going to be very timely. It was a very long and extended review process.

And so, what we chose to do with the vendor was, let's pull the pellets out and let's install the rods. And, we're going to get -- we're still going to get quite a bit of benefit out of this.

We're not going to get the pellet-clad interaction piece, but we're going to get all the rest of the piece. Plus, it'll be much easier for them to handle and evaluate and analyze after it's been in the core.

So, we think we're going to get a lot of benefits from it anyway. But, we would have preferred to have the fuel in there.

But, it did expose, okay, shipping containers, we've got to go look at this piece and make sure we're ready to ship all these lead test

assemblies that we're going to be needing at our facilities.

Heard a little bit about modeling and simulation in the earlier presentations. And, I think those need to be leveraged in order to meet our deployment schedule as well. I think there's been a lot of good work.

The role of modeling and simulation is key to I think changing the structure of how we're licensing our fuel from being in a series of tasks to being into more of a parallel process and looking at who's got this and who's got that, rather than, I'm doing this and now I can hand the ball off.

But, we've got to be working together at the same time.

I do look forward to working with the DOE and the NRC staff to ensure that the staff has the confidence they need. Certainly, they have to have the confidence they need to rely on these capabilities, agree with that.

So, just to close, and I don't really have a closing slide, but I will close.

I want to, again, thank the Commission for having the opportunity to be here today to speak on accident tolerant fuel.

I think initial deployment to the fleet, I may have said this five times, 2023 to 2026. I mean, we think that's -- that time frame is critically important to the industry. If you was to look and see when current licenses expire in the mid-2030s, you should see half or more of our licenses for the current light water reactor fleet will be expired.

So, if you back off of that and people are looking at second license extension, in order to take these benefits and use them in your decision making process, it's going to have to be available in the mid-2020s.

So, that's what's driving that time frame for mid-2020s for many in the fleet. And, it's strictly driven on, here's what their life span

currently looks like and when they'll have to make their decisions.

And, that is my presentation this morning. Thank you.

CHAIR SVINICKI: Thank you very much.

Next, hearing EPRI's perspective. We will hear from Mr. Wilmshurst.

Neil, please proceed.

MR. WILMSHURST: Thank you very much, and again, thank you to the Commission for the opportunity to speak about accident tolerant fuel.

Ours and the Commission -- probably where EPRI had the nuclear sector -- about half of our interactions are with non-U.S. utilities which gives us a fairly unique perspective on what's going on in many fields, including accident tolerant fuel.

And, that is probably one of the backdrops to my remarks today is, we're having a U.S. focused discussion, quite understandably and appropriately. But, there's other activities going on around us in this field as well.

So, there is a lot going on in the accident tolerant fuel world. And, to amplify what the previous speakers said, our assessment is, this is shaping up to be a potential win for the public, for the industry, for the vendors.

We do need to manage our expectations, however. There's been some belief that the benefits could be significantly more than the benefits of the unseen.

That doesn't diminish the fact there's a positive benefit. But, we need to keep our expectations grounded.

Also, we need to not minimize the challenge of hitting the

time frame that Danny talked about. Significant work, significant rethinking in order to get to a mid '20s deployment of fuel.

What I would comment on, though, is we're in a different world than when we last did something like this.

Modeling and simulation, how can we actually leverage modeling and simulation to minimize the amount of testing that has to go on?

But, as a counterbalance to that, what is the testing infrastructure left in the world to do any of that testing? What is the availability of that facility?

And then, the context of this industry is more global. We have to look at this whole development of global context.

So, that's the backdrop I'd offer.

So, my next slide, please?

So, as Danny mentioned, EPRI has been assisting the Industry Working Group on looking at the value case for accident tolerant fuel. And, we've been looking at it for some time. Started before Fukushima, but like many people, those efforts ramped up with a greater focus post-Fukushima.

The analysis we've done looking at the kind -- at the benefit side of the equation shows that elimination of core damage is, frankly, highly improbable. But, delay of onset of core damage is clearly possible.

The amount of delay depends on the technology, early technology, somewhat less than the longer term technology. But, there are benefits from delay of onset of core damage.

The challenge is to quantify the value of that delay, both in terms of safety and in operational effectiveness and efficiency. And, that is

the challenge in that balance in my first slide.

So, next slide, please?

So, we've moved on to what we called Accident Tolerant Fuel Evaluation 1.0, looking at the beyond design basis capabilities of the accident tolerant fuel capabilities looking at things like TMI-2, Fukushima and other accidents.

And, our conclusion is that some of the current concepts will -- that would have potentially limited a TMI-2 like accident.

Fukushima wouldn't really have had any impact in a Fukushima magnitude impact.

And, we're talking with the current concepts, the clad concepts -- two to three hour delay in the onset of core damage.

So, there are benefits. But, one of the big asks going through this was, if you change your focus to what are the potential operational benefits of accident tolerant fuel?

Bringing in new materials which may respond differently in expected operational scenarios, design basis accident or maybe the benefits of the licensing issues being opened and things you could do different, that might be the biggest side of the equation, the actual normal operation benefits in addition to any of the beyond design basis effects.

So, we are now moving on to a second phase of our evaluation trying to quantify just that, the operational aspects and cost benefit balance between the deployment of accident tolerant fuel.

So, moving on to my next slide, please?

This slide is really to show that there's a considerable amount of work that needs to be done. This slide starts at the top with some

of the early research we want to call the early stage options, coated zirconium fuel shows that many of the aspects need minimal work all the way from enrichment all the way through to disposal.

But, the more advanced we get moving down to non-zirconium, new fuels, the whole cycle of fuel enrichment through to disposal is going to need a significant or R&D in order to support deployment.

So, my -- they all appear to be valid things to follow. As I've said, the more advanced fuels clearly have potential to give significantly more benefit.

The message really is, there's a lot of work to be done and there is a lot of people doing pieces of this work.

The entire stakeholder community needs, I believe, to become more coordinated to drive this and coordinated to drive this and coordinate and collaborate in order to drive this to a resolution.

So, move to my next slide, please?

So, how do we get there in a shortened time frame? The top chart is what I'll call the traditional linear approach with testing and following more testing, following analysis, following licensing.

If the entire community of stakeholders is to deploy accident tolerant fuel in a shorter time frame to meet the mid 20s time frame Danny and others have talked about, we need, I would postulate, to figure a way to work collaboratively, to parallel path some of these activities.

And, this is where one of the global insights comes in. We're working very closely with OECD, NEA led by someone who's known very well in this building, Bill Magwood.

And, one of the challenges is, what is going to be the

acceptable acceptance criteria by regulators for these tests?

Is a world where the U.S. regulator has different acceptance criteria than say the French regulator, the most efficient?

Will that drive a never-ending cycle of more testing to answer more questions?

Is there an opportunity, maybe working through an organizing like NEA, for some alignment between global regulators on what an enveloping acceptable position may be on some of these technologies?

I know that is difficult, but let's not constrain our hope.

So, that is one of the issues because I would observe that, if a vendor is going to make accident tolerant fuel for a U.S. market, it's a different proposition than if they're making it for a global market.

And, if the entire community comes together and drives towards that, it's got to benefit everyone.

So, move to my next slide, please?

And, the solution we're working on through this, is a document we're referring to as the PIRT, the Phenomena Identification and Ranking Table which will lead to an issue resolution report.

We have done this before successfully with all stakeholders around the material issues in the industry.

It's a very similar approach, identify the issues, identify the priorities, identify how they're going to be resolved and align all the stakeholders around a common approach.

So, that is where EPRI is focused now on developing this PIRT and the issue management.

So, my final slide, please?

So, the summary, we've completed Evaluation 1.0. It shows there is benefit in deploying accident tolerant fuel.

We're started work on Version 2 to include more of the operational benefits.

We believe this PIRT gap analysis approach is a path to success and we concur with the previous speakers that there is a role for modeling and simulation in this to speed up the deployment.

Thank you very much.

CHAIRMAN SVINICKI: Thank you.

And next, we will hear from the Union of Concerned Scientists represented by Dr. Lyman.

Welcome and please proceed.

DR. LYMAN: Yes, good morning. On behalf of UCS, I'd like to thank the Commission for inviting our views on this very important topic.

May I have the next slide, please?

So, just to be clear, we are strongly supportive of the general development of accident tolerant fuels. And, this should be part of a comprehensive program to strengthen reactor safety after Fukushima.

But, that said, I would hate to be in a position where we end up opposing some of what the Commission is doing because we aren't happy with the licensing process.

So, the goal should be to increase safety margin and defense in depth, not to start out by looking for ways to relax safety and requirements and what I've heard referred to as margin exchange.

I think it's extremely premature to even begin those discussions.

And, although there may be ways to speed up the process without compromising safety, and we encourage that, but we don't think the NRC should weaken its licensing standards for ATF, either for the lead test assemblies or for the batch loading just to make industry time lines which may be unrealistic and are driven by economic factors which are not in your purview.

May I have the next slide, please?

So, our understanding is that industry would like this sort of blanket authorization for at least the nearer term ATF options, to demonstrate LTAs without NRC review and approval, and, without seeking exemptions from 5046.

And, the NRC staff sent a letter to the industry in June 2017 with what it set our preliminary positions which generally supported those views. And, that letter prompted a Differing Professional Opinion which is public only because it was referred to in an ACRS Subcommittee meeting in February.

And, the characterization of the objections were that that June 29th letter represented a significant departure from past practice for licensing LTAs.

Now, in addition to the need for a license amendment, a question whether NRC staff approved codes and methods would be used would be required for licensing the LTA demonstration and also whether exemptions would be needed from 50.46 for non-zirc-alloy fuels.

No, that's a mistake, it shouldn't say zero on there.

Next slide, please?

So, the NRC confirmatory testing is another issue.

The draft project plan from the staff on ATF states that it assumes our priority of the NRC will not perform independent confirmatory testing and that all necessary data will come from DOE, industry or other organizations.

So, we're concerned about what the implications of that blanket statement are for NRC's independence. And, we think, at a minimum, it seems premature to make that kind of an assumption and that issues may well arise and the NRC should reserve the right that it may need confirmatory testing and make plans accordingly.

Next slide, please?

And, I've noted there's this incredibly insightful comment from the NRC task force from the 2001 that circumstances can occur where the NRC may find it necessary to reproduce experimental or analytical data generated by the industry. And, I stand by that comment.

Next slide, please?

And, the one interesting example are breakaway oxidation times for ZIRLO and NRC contractor testing by Argonne found different and significantly shorter breakaway oxidation times for hydrided ZIRLO cladding. These have persisted through attempts to understand them.

The conclusion is, it's not clear one is right and the other is wrong, but it does illustrate that that phenomenon is very sensitive to the test conditions and the conditions of the fuel and that may not have been apparent if the NRC contractor had not done its own testing.

So, these are complicated systems and they need -- you need to maintain a broad perspective on the need for evaluating these phenomena.

Next slide, please?

So, in summary, on LTAs, we think the dissenting staff views have to be taken seriously and, at least for the time being, the LTA licensing practices of the past should be maintained until there's some rigorous technical justification for changing them.

I think there's violent agreement that a one-size-fits-all policy is not appropriate for the whole range of ATF concepts.

And, finally, NRC review of radiation plans, we think will provide opportunities for early engagement that the industry says it wants.

So, by cooperating on the early LTA test plan, it'll help the NRC evaluate the data we'll need for batch licensing and also what might be needed for verification and validation of codes, as we heard about.

And, as represented to the public, you know, we think the public and the NRC both need to know about experiments that are going on in power reactors.

Next slide, please?

So, there's a lot of talk about transformation. We think the most important way NRC can transform ATF licensing like today is just to authorize issuance of the final 50.46c rule. The draft rule has been sitting out there for more than two years.

It would provide, I quote, “a technology neutral performance based approach for developing design specific criteria for compliance of ECCS performance requirements.”

And, that sounds like it's consistent with NRC's goals in ATF licensing. So, we think that moving forward with that would be a big help, at least regarding the design basis ECCS piece of this.

Next slide, please?

We're concerned about all the talk about the ATF economic benefits. We think it's very premature to be thinking about those.

I quote, NEI's Framework for Regulatory Transformation, it suggests that they were thinking about ATF affecting security and emergency preparedness requirements and things like safety related electrical systems. We think that's really jumping the gun.

And, again, caution that these fuels are very complex. They're -- the behavior has to be validated with rigorous testing, some features may not pan out.

These -- often making changes to the fuel has beneficial and adverse effects. You need to look at the whole range of those. And, if increased fuel density or increased enrichment is required, which it may well be, that raises new safety issues that'll have to be evaluated.

Next slide?

And, in that context, to talk about risk is also premature. And, I give a quote, I won't read it, but it's clear that because of the crosscutting impacts of making changes to these systems, it's very hard to evaluate what the risk -- ultimate risk may be.

And, again, until the properties are validated, until the PRAs have been, you know, fully revised and validated with the new fuel performance criteria, it's really -- you can't really talk about what changes you may be making based on risk.

Next slide, please?

With regard to advanced modeling and simulation, I'd advise caution. The NRC staff itself said it's not aware of any computational tool that

would obviate the need for experimentation. And, I think that's appropriate.

There are plenty of examples where current modeling tools have failed to predict fuel behavior, even those that are based on actual data and extrapolation from real data.

Finally, next slide?

So, the -- we're -- the ATF development time lines, these abbreviated time lines that we've heard about, accelerating the schedule for fuel development by 5 to 10 years, we're a little skeptical that it can be done.

The Hatch example, I think, you look at it a different way. I think perhaps they were premature in trying to move that forward without making sure that all the various pieces were licensed, including transport.

And, it would just be pointless to deploy ATF unless -- if it introduces new safety risks and uncertainties. So, take the time to do it right.

Next slide, please?

And, finally, we have a modest proposal that, given the potential limitations in test reactor capacity, including the possible Halden shutdown in 2020, why not consider -- DOE consider buying one or two reactors that may be shutting down prematurely for economic reasons and devote them to aggressive testing of the wide range of ATF concepts.

We think that might be a better way to pursue a future test infrastructure than building a new test reactor that would be fast spectrum reactor with some moderation for thermal capabilities.

So, I'm just throwing that out there just to shock people.

And, I will stop there, and apologize for going over my time.

(LAUGHTER)

CHAIRMAN SVINICKI: Thank you very much, Dr. Lyman.

And, my thanks to each of the panelists for their presentations.

It's the practice of our Commission to rotate the order of questioning. And, we begin today with Commissioner Baran. Please proceed.

COMMISSIONER BARAN: Thanks.

Well, thank you for being here and for your presentations. I've been looking forward to this Commission meeting for a while and I'm glad we're doing it with a great external panel.

I want to start with a high level question, and Danny, you're probably the best able to answer it on this panel.

As a licensee, what are you hoping to get out of accident tolerance fuel from a safety point of view? From an operational flexibility point of view in terms of potential changes to existing regulatory requirements, what do you see as the ultimate goal of this technology?

MR. BOST: Thank you.

I see it coming in two areas for us. The first area is just how the fuel itself performs. The things that our fuel must meet, the margins, as I heard discussed, I see those getting better as a result of accident tolerant fuel and the technology moving it forward.

And, I believe that buys us an awful lot of margin in the way we operate our units, a lot of flexibility, and how we load our cores.

Just a tremendous benefit and improvement there.

Then, the second piece is, how much benefit are we going to get from this improved performance post-accident? And, that would certainly provide, number one, the safety benefit that Neil talked about.

But, number two, that could also drive some economic

benefits for the fleets as well if that delay -- onset delay is long enough, it would drive different benefits.

So, we see it in two different areas in the industry.

COMMISSIONER BARAN: Ed says that UCS supports the development of accident tolerant fuel if the ultimate result would be to increase safety margins and defense in depth.

But, if I understand him correctly, he's concerned that licensees might take the increased safety margin from accident tolerant fuel and seek to relax other safety requirements so that the ultimate safety results kind of net out.

How are you thinking about this?

MR. BOST: If we went through and changed our technology so that something was not required, I mean, we would advocate that we wouldn't want to require it.

And, I want to go out and say this, here's an example, but it could be any of the requirements that we place on our units.

Now as a result of our technology, current light water reactors, here are the postulated things that we must design for and respond to. If those were no longer applicable because of our fuel types and our fuel designs, then, yes, we would advocate that we wouldn't have those designs, that's correct.

COMMISSIONER BARAN: Ed, you have any additional thoughts about that or a reaction to Danny's comments on that?

DR. LYMAN: Yes. Again, I would stress, I think it's very premature to be able to make that. It may be possible, but it's going to require a lot more development.

And, again, we think the uncertainties generally are large enough. Take coping time, so, if there's an increased coping time of two to three hours, my review of FLEX plans in the past, I would think that there's uncertainty in implementing those plans that's probably on the order of a few hours.

So, I would see that, if that's the main benefit, I would see that as just increasing defense in depth and I would not want to shorten that margin by revising the FLEX plans.

COMMISSIONER BARAN: As several other presentations mentioned, the development time line for ATF has really accelerated over the last couple of years.

Looking back at DOE's 2015 report at that point, the goal was lead test assemblies by 2022. And, of course, we've already seen some of that in 2018.

And, it sounds like the new goal for industry is to have full batch loading starting in 2023.

Danny, to meet this schedule, do you envision any changes to NRC regulations or guidance?

MR. BOST: I think what we're going to have to change is the way we operate many of our processes in series. And, I think Neil probably put it best as he was going through and describing in his slides things that were once done in series now being done in parallel.

We've got to get all the work done. We've got to get the staff the confidence that the fuel's good and this is why it is and here's all the backup and the documents that we have and the data that we have that shows that.

But, I think we have to change the methods that we use to get there.

COMMISSIONER BARAN: And, do you see -- and, part of the reason I'm asking is, just trying to think if we're talking about a relatively quick time frame, rulemaking isn't always that fast, even guidance, you know, major guidance changes take a significant amount of time.

You know, as you're kind of looking at what you think would be necessary for this all to happen, do you see rulemaking as being necessary? Do you see major changes in guidance being necessary?

MR. BOST: I think changes in the way we implement the rulemaking, but I don't see major rulemaking having to happen to support the work that we're doing today.

COMMISSIONER BARAN: Okay.

In terms of the licensing reviews, and my sense is that code development may be the long pole in the tent.

The NRC staff's draft project plan says that the estimated time for code development for any given fuel type is three to six years.

And, the staff has stated that, since limited data will be available and uncertainties may be large, independent confirmatory calculations by NRC will be necessary.

It sounds like, based on the comments I saw from folks to the draft project plan, that industry's view is that NRC doesn't need to develop its own codes.

Is that right? And, if so, who's codes do you think we should be using? Are these DOE codes?

I don't know if Danny wants to chime in or others.

MR. WILMSHURST: Okay, I'll start and maybe I'll let Tom play cleanup.

I think there is a -- well, I know there's a growing discussion in -- across all stakeholders that the objective probably should be to have the best code. And, invest resources in ensuring there is the best code for which ever -- whatever application.

But, independent stakeholders and independently making sure they buy in to their own validation of that code.

And, I see month by month greater move towards that, that there is just a need to get the best resources onto the best codes.

So, I do see a global move to that aligning around a limited set of high quality codes.

MR. MILLER: From DOE's perspective, we see that the code development is going to bring value, additional information, additional detail to the information that comes out of the codes.

Do I think this is necessary for the schedule that they are doing? I can't answer that question.

Where I think we are -- we'll be struggling is to assure we have enough data from each of the concepts and that would cover those conditions where the PIRT says you have less margin. Okay? Or, your margin isn't as great.

Then, I think there's a place where we have to get the validation of those codes and the associated data to make those -- the claims like fuel is good.

I think that's where we're going to struggle a little bit.

COMMISSIONER BARAN: And, that's, I mean, I think

that's a good point because, regardless of whose codes are ultimately used, NRC would either validate the codes or the experimental data.

How long, and this is a question, anyone can jump in on, how long do you think it will take it will generate and analyze the necessary experimental data for any particular technology?

I know that may differ, depending on the technology we're talking about. But, if we're talking about one of the more near term technologies, for example, there's code development and there's validation.

What kind of time frames are we talking about for that experimental testing?

MR. MCCAUGHEY: Well, as far as data generation that's necessary for validation, it's -- we have a range of concepts. We have some simple ones such as code and ZIRLO like cladding with some doped U02 fuel where we have gathered a lot of data up to this point and it's available and it's being used in modeling right now.

Then, we have other concepts that are more of the silicon carbide cladding, the high density uranium fuel, the uranium silicide fuel which is a departure from what we've been analyzing and testing over -- and operating with over all of these years and operating with over all of these years.

And, that requires -- that's going to require a lot more data.

So, but, we have the means for doing this. We have the test reactors. We have invested at DOE a tremendous amount of money and state of the art post-irradiation examination equipment that gets into the -- the atomistic levels that we have never seen before which is used by the modeling and simulation and the code developers.

So, I think we are moving on that path. We have these -- we have the infrastructure in place to support these time frames.

MR. WILMSHURST: It is a very good question. And, you look at the data to support validation of codes. And, it gets back to one of the points I made in my presentation about the global infrastructures to do that testing.

If we just take, for example, the Halden reactor. Most or say many of the current concepts are being tested at Halden.

There are some questions around the future of Halden. What would be the impact of Halden not being there on this program? That is a question I think the entire community needs to look at.

And, this really reinforces the point I was making about the need for global collaboration. The way to secure Halden's future, one of the ways, is to have a global picture of what the workload coming to Halden is so they have security to continue to operate.

If there's a global community of stakeholders we don't form that dance card, for no better term, for Halden. That facility may not be there to support that validation data.

COMMISSIONER BARAN: Is there another facility currently where you can do BWR fuel design basis accident testing other than Halden?

MR. WILMSHURST: There are facilities. Some of them are in countries like Russia. To get facilities, there are limited facilities out there. I don't know if anyone else has got more perspective.

MR. MCCAUGHEY: Well, we've been -- not really, there aren't. It's very limited, very limited. But, that's not the end of this story.

We have -- we can -- we do a great deal with separate effects testing with out of reactor testing. And, we do have the capability of simulating BWR conditions in those concepts in those kinds of tests and experiments.

But, yes, make no mistake, Halden is, at this time, very important to all three of our fuel vendors.

COMMISSIONER BARAN: You know, I'm a little --

MR. WILMSHURST: And for their development plans.

COMMISSIONER BARAN: -- bit over my time, but I just wanted to ask Ed to kind of circle back around on the question of NRC potentially using DOE codes or other codes and data from DOE or other sources.

Do you have thoughts about that? You talked a little bit about the data piece, the testing piece, but do you have views on the codes and whether it's important for NRC to have its own codes versus using other codes?

DR. LYMAN: Well, if the NRC actually has access to the code and is familiar and knows how to, you know, knows its basis, knows what the assumptions are and if there's flexibility so it can vary assumptions, that's one thing.

If it's an industry proprietary code that gives one set of results and NRC doesn't have access to the actual code or has other codes that give different answers, that's a problem and that has happened in the past, let's say MAPP versus MELCOR.

So, I think it really depends on how it's used. Clearly, you know, there is -- it does look like it's inefficient if NRC has developed a

completely independent code on its own.

But, I think you do have to be mindful of the potential for -- to maintain its independence. And, do that, you know, proportionately to the significance of the issue.

COMMISSIONER BARAN: Thank you.

Thanks.

CHAIRMAN SVINICKI: Thank you, Commissioner Baran.

Commissioner Burns, please proceed.

COMMISSIONER BURNS: Again, thank you for the presentations this morning.

And, I want to start out by following up some of the discussion in terms of the -- what Mr. Wilmshurst talked about this global envelope or that there is.

And, we talked a little bit about Halden, and I know through members' countries that are working, I think, with Norway. In terms of Halden, it's not so much, I think, an issue of doing research, it's about ultimate disposition of fuel and -- or ultimate disposition of the facility itself.

But, let me focus on a different thing because I think you touched on and I'd be interested in your views and those of DOE.

Is that, the question of how one looks at accident tolerant fuels from a regulatory standpoint worldwide.

This had, you know, recalls for me things like the Multinational Design Evaluation Program in which the U.S. is a participant along with other countries. And, again, looking -- the desire was to look at different aspects of what were Gen-3-plus designs coming on starting out, you know, with the Finland, France and the United States looking at the EPR, you

know, looking at how we are the same, how we are different.

Digital I&C was one of the big issues.

So, my question is, to what extent are we doing that at all through the NEA context or some other context in terms of evaluating accident tolerant fuels so that we do have a baseline to consider in terms of the regulatory framework?

Again, understanding that the research and the results of research are critically important and are really provide the foundation for that.

So, I'd be interested in -- I invoke your name, Mr. Wilmshurst, so you can start off and I'd be interested in hearing from DOE or anyone else on the panel in that regard.

MR. WILMSHURST: Yes. So, we, EPRI, are working very closely with NEA on this. And, yes, it's a heavy lift. But, my perspective, which is shared by my colleagues at NEA is, that in order to try and assure a deployment, an effective deployment of accident tolerant fuel, the vendors would be far more likely if there was a global market for it.

And, the issue as in the standard plant design, it's a smaller version, as you say, for the fuels.

The concern is that, if every country has a different envelop that they accept, are you ever done in the testing? Do you ever have a clear design? What is it the vendors would be bringing to market?

So, EPRI, NEA are both aligned on this on the need for some progress to be made in that area.

We're also focused jointly on understanding the global R&D capacity. So, the conversations have started at NEA, but as you can no doubt be aware, they're not easy conversations.

COMMISSIONER BURNS: No.

MR. WILMSHURST: There is significant energy within NEA to try and move that forward. And, my desire is that as many of your colleagues, your peer regulators come together and help in that. Because, that will, I believe, help speed up the ultimate deployment.

COMMISSIONER BURNS: Okay.

Anybody from DOE?

MR. MCCAUGHEY: Well, our international collaborations have been very important from the start with. When we started considering accident tolerant fuel, one of the first things we did was formed an expert group with NEA which was an international collaboration on defining the attributes of accident tolerant fuel, the metrics we would use to determine viable accident tolerant fuel concepts.

And, we used that in our program in that Phase 1.

And, in addition, there are many countries, even outside the European community who are conducting research and development on varies types of accident tolerant fuel concepts.

And, we -- that's very important to share the R&D to set up these collaborations with other countries such as the Koreans, Japan and, of course, the European Union.

And, as was noted that they have set up some very significant programs at NEA now that are going to be very helpful in both the collaborations on the experimental and testing and how you link the experiments with the advanced modeling and simulation.

COMMISSIONER BURNS: Okay, thanks.

One of the things that's I think all the speakers touched on

is this issue in terms of the use or attention, that's at least how I see it, attention between modeling and simulation versus actual experimentation.

Again, I'm going to use what I said last time, I'm not the technical guy, I'm the lawyer. But, help me out on that. And, I think for all of you, in terms of where you see that tension playing out?

I think, and partly, because I think I got to hearing from Mr. Bost in terms of where the industry would like to get on this is that sort of a balance between those things, getting the, you know, getting the bang for the buck, if you will for modeling and simulation doing experimentation where necessary.

But, you've got to blend those together is what I'm hearing. So, I'd appreciate, you know, maybe start with the Department of Energy and go down the line.

MR. MILLER: Modeling and simulation in modern advanced modeling and simulation can give you a better set of information on what the fuel is expected to do.

So, you can understand and determine where your safety margin gets minimized during normal operation, during transients and beyond design basis events.

I think that's -- and there's uncertainties associated with that, based on what the code can do. I think it's that reduction or that knowledge of the margin and where that margin is reduced or small or changing that gives you a focus on what experimentation you might want to do.

COMMISSIONER BURNS: Okay.

MR. MILLER: And, that experimentation then helps validate or improve the model and then so that in subsequent runs, you have

a better model now because you have the data in that uncertain area. That's how I view it.

COMMISSIONER BURNS: Okay.

MR. WILMSHURST: I think Tom captured it pretty well. You've got the whole modeling and simulation capability continues to increase in its fidelity year over year.

So, the modeling and simulation techniques show those areas you need to focus on to do the real R&D.

And, of course, the thing we often forget is, doing R&D, you're testing something maybe once or twice. Using a model, you can maybe test it thousands or tens of thousand times with different parameters and work out the kind of -- the multiple different scenarios and the variability.

So, working the two together, the thousands of model runs and then identifying the places where you need to do one or two experiments. I think the ability to use modeling to refine down the experiments you really need to focus on how they're done is and where we need to go.

COMMISSIONER BURNS: Okay.

Dr. Lyman, do you want to add anything?

DR. LYMAN: Yes. I think we've heard it's an iterative process and that it can be slow. And, the problem is that the test data is very, you know, it's hard to do these tests, it takes a long time and it, you know, you don't get that kind of rapid feedback that you might need.

So, if you find -- well, you end up needing to extrapolate a lot because you can't validate the code with every particular circumstance you might need to understand it. And, it's that extrapolation I think is -- that's a problem.

And, that's been the empirical fuel performance codes I just reminded of one example with the M5 cladding where the growth under radiation of the guide tubes of a particular fuel design exceeded what was predicted and expected because -- and required not only the termination of the MOx-Li test assembly experiment, but also batch loading of fuels in think in a couple of reactors like TMI had to be taken out because of that unexpected behavior.

So, you know, I think the fundamental materials performance may be difficult. I'd like to see what the state of the art is with regard to understanding materials performance, but I think that might be lagging behind the more general neutronics in thermal hydraulics in the core.

COMMISSIONER BURNS: Thank you, Chairman.

CHAIRMAN SVINICKI: Well, thank you all.

And, we've covered a lot of ground already, there's a lot of content here. But, I'm going to hold up Neil's red-yellow-green chart because these are always really visual. A lot of us are visual type of people.

Our Commission, I'll characterize it, if my colleagues disagree, they can correct me, we've been confronted by congressional committees and others with questions along the general theme, they're not propounded this way, but it feels this way when you're asked this.

Is well, accident tolerant fuels, NRC, who could be against that? Aren't they game changers? And, why don't you get off the stick?

So, that's how it feels when we're asked that. And, I think, in general, I would characterize our answer has been, there is potential that is put forward to these fuels. There's a lot of work to be done. We've heard that from the panel and there's a lot to be demonstrated.

And then, this chart, the reason I like this is, it says within the gradations of what is even kind of going under the banner of accident tolerant fuels. There's a tremendous degradation -- gradation there of different potential improvements.

And, I think that Neil talked about, you know, a delay in core damage by a couple of hours. Seems to me, the part of the chart that is the red, meaning a lot of work to be done as opposed to modest -- more modest levels of work to be done, I don't know if that could be a day or two days or what. Like I don't know what the outer bound is. That's another area of uncertainty.

And, we've talked some, a bit about the tension between modeling and simulation and it's experimentation in the physical world.

I don't see it as a tension. I see as they have to coexist and there's a balance. And, what we've seen happen is a massive rise in, of course, the computational power that is available to researchers, but we all come to this with our life experiences.

I had some years where I worked with DOE's National Nuclear Security Administration over their stockpile stewardship program. And, there was a case where the nation had decided not to do the fundamental weapons testing. I'm not advocating for that here.

But, there was a circumstance where you had this explosive growth in the analytical and computational ability.

But kind of what they struggled with in NNSA is that, additional decimal places are not necessarily knowledge.

And so, that has to have its roots, all of the models have to have and the simulation has to have its roots in your knowledge base in the

physical world. And, that's where we get to making those judgments about what is that testing that needs to be done through validation?

There's been energy around whether the question of whether or not NRC needs to have its own codes.

We heard from our colleagues at DOE, I think it was, that, you know, maybe the model moves more to you improve the models themselves, the codes themselves and the term fidelity has been used.

To me, that means how much does it adhere to knowledge based in the physical world. A code that has high fidelity has a strong foundation in a knowledge base perhaps that we've proved through physical experimentation.

And then, the validation can be each users view of, did I participate in validation? Did the aspects of validation that mattered most to my applications of this code get done?

I mean, I think you can have multiple users participate in validation.

So, I think what I view in kind of big data space and what's happening with the -- through Moore's Law and other things.

You know, we've had more supercomputing capacity available to more users. But, what I've seen happen is, let's have, I think Neil called it, the best code. So, to me, that means the code that has the most integrity, that has the most fidelity.

Users have confidence of vary levels, depending on what kind of validation was done, how much their needs were reflected in that validation.

And, I would see that what's happening with accident

tolerant fuel is maybe a push to bring that model that's used in other sectors of research and bring that to bear here.

And, it is different than how we did it 20 years ago. And so, I don't see it as better or worse, I think that it poses its new challenges. We will have to learn new ways of approaching this kind of development that takes all of the enterprise and peoples' needs are brought together in their specific uses, in our case, independent safety validation.

We need to bring that and represent that in these development programs. So, I think it will cause NRC to have to -- well here, I'm kind of like the person who's seen the movie nobody's seen, I know some of what NRC's going to say on the next panel.

I think we're going to hear about how they're approaching it. And, they are recognizing that it's different and they're bringing that to this.

But, I find a lot to agree with in Dr. Lyman's cautions that he offers us. You know, decimal places and more computing power is not necessarily knowledge. It can appropriately validate it. It can really add to your knowledge.

I agree with Neil's view that you can do an experiment once or twice and Ed talked about how expensive and time consuming the experimentation is.

And then, with models, you can run all these variations. And, that's good if the experimental work you did was relevant to the, I'm going to use this, it's trite these days, but the known unknowns and the unknown unknowns, and if you really had some foresight in how you oriented all of that, then that's useful to do. I did a hundred runs of variations. Well, that's great, but it depends on what you're with as a foundation.

So, I'm encouraged that this is kind of an enterprise-wide thing. And, to me, if I foreshadow into the future and we look at the challenges that NRC may face, should advanced reactor concepts be brought forward and submitted to us for review?

I see this ATF work as a stalking horse for enterprise-wide approaches that I don't know how they wouldn't be absolutely essential to doing a design certification of an advanced reactor in anything less than 10 years.

I mean, frankly, I know that's -- Ed talked about kind of shocking people. People don't like to hear about time frames that long, but if this kind of approach has benefits, I think that those benefits will be needed for NRC's work on advanced reactor design certification should we get to that point.

So, I've kind of unpacked a lot there. There does require a lot of things in parallel.

I was intrigued as I was listening to some of the talk about series versus parallel.

Did doing things in series provide advantages? I can postulate a few, but I'll ask you instead of keep talking.

But, when you do things in series, there are certain benefits to that. Do we lose some things that were beneficial in the way historically that we did this in series?

Some of it could be the feedback loops and iteration. If you do that in parallel, you sacrifice some of that.

And, why is it acceptable to give up whatever we benefitted from in series? Neil, you've done some thinking about this, maybe I'll ask you

to react to that.

MR. WILMSHURST: I think part of it's driven just by where the industry and the vendors are. Meaning in previous eras, it was maybe a more of a national coordinated drive. Now, we're narrower, it's more commercial and people need more certainty.

There is a time frame things are going to be delivered.

I think it's probably driven more by that. The commercial realities that vendors are looking for certainty of a deployment time scale rather than something which might just extend.

CHAIRMAN SVINICKI: So, doing things in series is kind of a luxury of timing. And, given other existential circumstances, it's not relevant here.

Given that there could be such a variability and improvement on these different levels of kind of innovation and creativity here, do you postulate that there'd be a down select at some point?

Like, some of these that, and this is all hypothesis, I'm not talking about the specific vendors out there. I don't know enough, frankly, about what's proposed to be foreshadowing any NRC conclusions. So, it's not that.

But, if it delayed core damage by two hours, is there a point at which the qualification of it is so intensive in terms of everybody's resources that you just go, let's pitch that idea and look at the more innovated ones. Let's just kind of switch tracks and you more to that because it delays it and there's a lot more bang for the development and qualification buck?

MR. WILMSHURST: Well, my colleagues from DOE can talk to that. Already some down selected have already happened through the

natural process.

But, yes, I think in any technology, be it Gen-4 reactors with accident tolerant fuel, there does reach a point where some options just rise to the top just by the -- as their knowledge increases.

The research goes on, roadblocks are found, other people find a better path forward.

So, I think there will be a natural down select.

CHAIRMAN SVINICKI: But, specifically to the timing issue which it seems, as an industry, imperative, maybe I'm adding another level on what you just answered, thought, in saying, and again, this is all off the top of my head.

If the less challenging to quality, one takes 10 years and more challenging one to qualify takes 12 years, is there a point at which you would just acknowledge that and say, this one that isn't really going to be that innovative, let's just stop working on that one?

MR. WILMSHURST: I think it's a really good point. The challenge we have, I think as whole community is, who makes that decision?

You know, because there's so many stakeholders in there. So, I don't know how that decision for the down select would be made. I don't know if DOE has any --

MR. MCCAUGHEY: If I may?

We think about this all the time. We are -- we request funds every year for accident tolerant fuel program. Among other programs, we prioritize.

And so, as far as factors going into down selection, I think, number one, it's the performance of these accident tolerant fuel concepts in

our experimental programs.

And, we will look at the performance of coated claddings. Is it holding up in prototypic PWR conditions?

Are we getting with -- through the PIE? Are we getting the expected performance for thermal conductivity and that we expect? Those kinds of things.

And, each of these concepts has technology gaps, current technology that need to be addressed. And, I think at any point in time, we might find that one or more of these concepts is just not performing the way it ought to and it's not meeting the attributes of accident tolerant fuel.

And, we're ready, you know, that's number one.

Number two is, even if you have that, if the fabrication, the manufacturing, the market's not there for it. If the fuel vendors are not going to be able to produce this fuel in an economic -- and make a profit and the utilities aren't going to want going to buy it, that's another. That's another factor for down selection as well.

And so, we look to the industry constantly. I always -- every meeting I'm at, that's usually one of my first questions, how is it looking here? You know, what are you -- you know, we've got these concepts.

Is everything moving the right way?

And, at this point in time, what pretty much everyone is saying is, yes, we'd like to have -- we like where we're at right now, where we have multiple concepts right now so that it increases, like I had said, it increases the probability of success.

But, we're always --

CHAIRMAN SVINICKI: Okay.

MR. MCCAUGHEY: -- reevaluating that.

CHAIRMAN SVINICKI: And, so what I hear you saying is, the benefit right at this stage is to have different concepts along the continuum of either innovation or challenge, or however you put it.

But, that in terms of the federal R&D investment and justifying that, the DOE is in a consistent re-look at that because you've got to justify your own federal participation in this R&D work.

So, I appreciate that. So, at least that dimension of it would get re-analyzed on a routine frequency. And, I think that's helpful.

So, I would ask to my colleagues do you have any other last questions?

Okay, well, again, thank you all so much for you presentations. And, I believe at this point in the program, we will take a very brief five-minute break while we reset.

So, I would ask that we reconvene at quarter to.

Thank you.

(Whereupon, the above-entitled matter went off the record at 10:27 a.m., and went back on the record at 10:36 a.m.)

CHAIRMAN SVINICKI: If I could ask everyone to please retake their seats, and the presenters will come to the table. I appreciate that. I'm not pulling a fast one. It's not a quarter to two, but we have a clock that stopped and I was looking only at the minute hand earlier.

So we've had our five-minute break. We now will proceed with the NRC staff panel, and we will hear from a number of expert presenters but they will be started off by our Executive Director for Operations, Mr. Victor McCree. Please proceed.

MR. MCCREE: Thank you, Chairman, and good morning again. We're pleased to be here today to report to you on the status of our preparations to license and regulate accident tolerant fuel, or ATF, designs. We have a full presentation this morning, so we'll move right to the next slide. Slide two, please.

I'd like to start this morning by highlighting our commitment to enhancing our regulatory infrastructure to facilitate the use of new technologies. The qualities of efficiency, effectiveness, and agility, along with our principles of good regulation and our values, are of utmost importance in ensuring that we regulate with excellence as we move into the future. Through the efforts that began in Project Aim and now continue with our Transformation Initiative, we're looking to improve and learn while evolving our culture along the way, and we're committed to enabling the safe use of new technologies, including accident tolerant fuel, and appreciate the opportunity to share details of our preparations in this area.

We've had a couple of recent successes that demonstrate our leadership and our agility in enabling the use of new technologies, including the licensing of molybdenum-99, moly-99, production facilities and our activities related to cybersecurity at nuclear power plants. I believe we've begun to lay the foundation for a similar outcome as we prepare to and actually perform licensing reviews at accident tolerant fuel designs.

Slide three, please. With me at the table this morning to provide you with the details of our progress and preparations to licensing regulate accident tolerant fuels are Ray Lorson on my far right. He's the Acting Deputy Office Director for the Office of Nuclear Reactor Regulation, NRR. Ray will provide an introduction and overview of the agency's activities

in preparing to license accident tolerant fuel. Mirela Gavrilas to my right, the Director of the Division of Safety Systems in NRR will walk us through how the accident tolerant fuel project plan builds on the current licensing process. Andrew Proffitt to my left, the Project Manager for Accident Tolerant Fuel in NRR, will give a more detailed review of this plan, a brief description of the public comments received on the plan, and NRC's response to those comments. To Andrew's left, C.J. Fong, who is a team leader in NRR's Division of Risk Assessment, will discuss the potential impacts of accident tolerant fuel on licensee and NRC probabilistic risk assessments and on the risk-informed programs licensees currently have in place. Finally, Michelle Bales, to C.J.'s left, is a Senior Reactor Systems Engineer from our Office of Nuclear Regulatory Research. Michelle will conclude our presentation with an update on NRC's development of the capability to model and analyze accident tolerant fuel.

I'm encouraged by the team work and collaboration reflected in the staff's activities and decisions thus far as we prepare to license accident tolerant fuel. I think you'll recognize that as we move through our presentation this morning.

With that, I'll turn the presentation over to Ray Lorson. Ray.

MR. LORSON: Thank you, Vic. Good morning, Chairman. Good morning, Commissioners. I'm pleased to be here today to talk about the preparations that we have undertaken to proactively prepare the agency for efficient and effective licensing reviews of accident tolerant fuel designs.

Our first step was the establishment of a cross-agency

steering committee and working group who have worked over the past nine months to draft a project plan to regulate the use of accident tolerant fuel. This comprehensive draft plan was published in the Federal Register for public comment and is being updated over the next several weeks based upon feedback received. The plan is intended to be a living document which will evolve as we continue to learn, applicant plans solidify, and concepts mature.

The project plan was developed to cover the complete fuel cycle, including consideration of the front and back ends, in addition to covering the in-reactor regulatory requirements. The draft plan also includes an acknowledgment of the consideration for associated operational flexibilities that licensees may seek to utilize the additional safety margin provided by accident tolerant fuel designs. We will elaborate on this topic in the updated plan to be issued by mid-summer of this year.

Four major offices across the agency have worked diligently to develop this plan, including the Offices of Nuclear Reactor Regulation, Nuclear Regulatory Research, Nuclear Materials Safety and Safeguards, and New Reactors, to develop a high-quality plan to prepare for accident tolerant fuel. Upon finalization of the plan, it will address comments from a variety of stakeholders, including those received during the public comment period for the draft plan, feedback received from the NRC's Advisory Committee for Reactor Safeguards, Metallurgy, and Reactor Fuel Subcommittee, discussions at a February 2018 public meeting on the project plan, and their actions in various other venues including industry workshops, technical meetings, and international conferences.

Next slide, please. Go back one slide, please.

The staff have truly shown their commitment and dedication

to the agency's values during the development of the plan and they have had extensive engagements with our stakeholders consistent with our principles of good regulation and statutory requirements. We've held numerous public meetings with our stakeholders, including licensees, nuclear fuel vendors, industry groups, non-governmental organizations, and our international counterparts.

Our technical experts have heightened their engagement in nuclear fuel technical meetings and conferences where academia, the national laboratories, Department of Energy, and fuel vendors present cutting-edge research and data related to accident tolerant fuel designs and concepts. We have added accident tolerant fuel-specific addenda to our memorandum of understanding with the appropriate stakeholders.

Our memorandum of understanding with the Department of Energy allows us to engage with the department on plant testing of accident tolerant fuel designs under steady-state and transient conditions, as well as efforts to develop and validate material property correlations required to model accident tolerant fuel. I would like to highlight that our engagement with Department of Energy to date has been extremely productive, and we are looking forward to a workshop they are planning for NRC staff in May at the Idaho National Laboratory to showcase our capabilities associated with accident tolerant fuel, including towards the advanced test reactor and transient reactor test facility.

Our memorandum of understanding with the Electric Power Research Institute can be used to facilitate data sharing and coordination on expert elicitation.

Close engagement within the NRC and with our external

stakeholders, including groups such as the Union of Concerned Scientists, is of the utmost importance as we continue on this journey to the licensing of accident tolerant fuel for batch loading, typically considered one-third of the core into commercial power reactors, and we recognize that is a truly a critical piece of the project plan.

Next slide, please. Recent interest by the industry and among our licensees in pursuing accident tolerant fuel designs has led to a renewed focus on the use of lead test assemblies. These programs, which have been implemented safely over the past several decades with no adverse effect on public health and safety, have led to safety improvements in the design of nuclear fuel. Some examples include improved resistance to corrosion, improved thermal hydraulic performance, increased heat transfer properties, and significant increases in fuel reliability. Licensees have recently expressed interest in loading lead test rods or lead test assemblies of near-term accident tolerant fuel designs into the reactor cores. In fact, Hatch recently loaded lead test assemblies containing two accident tolerant fuel concepts into their Unit 1 earlier this year.

These lead test assemblies assist vendors in developing the full technical bases require to support batch loading into commercial power reactors. We recognize that lead test assemblies are an integral part of the research and development necessary to gain industry approval for batch loading of ATF and are working to respond to feedback with concerns related to the use of existing guidance for implementing LTA programs.

Lead test assemblies, in general, and especially those which meet the standard technical specification language of limited number which are placed in non-limiting core regions have very low safety

significance. With that being said, NRR has established a steering committee separate from the accident tolerant fuel group to clarify NRC expectations related to the use of lead test assemblies by issuing draft guidance in early summer. As always, we will continue to engage our stakeholders to address any concerns while we work through our processes to improve clarity on our expectations.

I would like now to turn the presentation over to Mirela Gavrilas to take us through the high-level objectives of the NRC's project plan. Mirela.

MS. GAVRILAS: Thank you, Ray. Good morning. As the Chair of NRC's Accident tolerant Fuel Steering Committee, I am pleased to be here today to brief you on the overarching goals of the ATF project plan. We are confident that the steps we are taking now will appropriately prepare us for effective and efficient licensing of accident tolerant fuels.

The project plan presents the high-level strategy that we will follow to ensure readiness when ATF topical reports or licensing actions are received for review and approval. At this point, the strategy is concept and technology independent. We did find concepts as a family of ATF designs with largely similar characteristics. Examples include chromium-coated zirconium alloy claddings, steel claddings, silicon carbide claddings, or metallic fuels, as shown on this slide.

Variations within each concept may be implemented by individual vendors of specific technologies. For example, the different methods that are used to apply chromium coatings would be identified as separate specific technologies. Concepts that are more near term in the project plan include the coated claddings I just discussed that are intended to

reduce corrosion and the extent of metal- water reactions, doped fuel pellets in which material is added to uranium dioxide to reduce pellet clad interaction, and steel claddings such as the iron-chromium-aluminum alloy which is made of materials from the steel family instead of zirconium. Longer-term concepts include ceramic, silicon carbide claddings, uranium silicide fuel pellets, and metallic fuels. In general, we expect that the safety benefits will be greater for the longer-term ATF concepts.

Next slide, please. The first version of the ATF project plan will be high-level and concept independent. As more information is developed, the plan will be augmented with concept-specific licensing road maps. The licensing road maps will then enable each vendor to pursue a suitable licensing approach to obtain NRC approval for their specific technology. This is important as there may be several vendors pursuing the same or similar accident tolerant fuel concepts, but they may take a different path to obtaining approval for batch implementation as shown on the right side of the graphic. Because of feedback we received through public comments, we will better describe their hierarchical approach in the first version of the plan.

An important prerequisite in the development of concept-specific road maps is the conduct of PIRT exercises where PIRT stands for Phenomena Identification and Ranking Table. As the name suggests, a PIRT exercise is one in which foremost experts in a particular discipline come together to collectively use available data to identify and rank phenomena that impact the safety of a system. Therefore, PIRTs are a systematic way of mapping hazards associated with a fuel concept to the regulatory infrastructure. This mapping will show where potential gaps exist and where

we refinements are necessary.

PIRT exercises are critical to the regulatory predictability and stability envisioned by the project plan. Another important note on PIRTs is that the experts can only correctly identify and rank phenomena if they consider the full operational envelope expected for the particular fuel concept. For example, if a coating is added to an approved alloy to enhance surface wear resistance under normal operation, the new phenomena important to safety may be limited. However, if a coating is added to gain operational flexibilities, such as increased coping times during loss of coolant accidents, then the performance and adherence of the coating under accident conditions becomes important to the safety of the termination and should be considered in the PIRT.

Next slide, please. The development of the technical basis necessary to qualify a new fuel design is an extensive process both in terms of resources and time. This graphic depicts the basic steps applicants take towards obtaining the appropriate data and experience needed to license a new fuel design for batch loading in a U.S. commercial nuclear power plant. Even under ideal circumstances, the time and effort required to fully develop the technical basis is substantial. This is due, in large part, to the irradiated testing needed to fully understand and characterize how a design or material acts under transient and accident conditions. These characteristics, together with the ability to model and predict phenomena important to safety, represent the critical path.

It is possible that the vendors and organizations participating in the development of the technical basis for accident tolerant fuel designs may be able to leverage advanced modeling and simulation

capabilities to expedite the development time line. Insights gained from mechanistic computational tools could improve testing programs and thus limit or eliminate failed experiments. This would allow for data to be gathered more quickly.

We are currently unaware of advanced computational capabilities which could altogether obviate the need to perform experimental testing. However, we recognize the need to monitor advances in the state of the art that could potentially contribute substantial time line constriction, especially for longer-term concepts.

Before we step through the time line, it's important to note that different accident tolerant fuel concepts are at very different places along the time line. The technical basis for near-term designs, for example, may be near the end of the time line, whereas longer-term concepts may be still in the pink or orange boxes.

The graphic depicts the relative order of testing needed to develop the technical basis. First, we have shown in pink un-irradiated material testing, which is the testing necessary to fully characterize the material mechanical, chemical, and thermal properties of a new design.

The second box in orange, test reactor irradiations and testing, is where the vendor characterizes the evolution of those properties obtained in the first box with irradiation and time spent in reactor. Lead test assembly irradiations and testing shown in yellow provide the integral testing to fully characterize the fuel and prototypical operating conditions. They also provide donor material for the next step.

Transient irradiations and testing shown in green typically use fuel segments harvested from LTAs to perform tests that mimic transients

and accident conditions. These are key to ensuring safety.

Along the bottom of the graphic is source term and other non-fuel performance testing, which includes testing to characterize fission product release, core melt progression, core relocation, mechanical and chemical interactions.

Updates to the analyses of record involve the development, calibration, verification, and validation of analytical models which simulate the performance of the new fuel under normal and accident conditions. This also requires the quantification of uncertainties and the definition of an application methodology.

Next slide, please. The graphic on this slide contains a simplified depiction of the development of the technical basis and focuses on differences between activities under the old fuel licensing paradigm and those enabled by the project plan. In the old paradigm, which existed prior to the development and implementation of the strategy outlined in the ATF project plan, the regulatory infrastructure was essentially developed before or soon after commencement of the technical basis development activities, such as experimental testing programs. This is because, over the past several decades, most light water new fuel designs and characteristics have been relatively minor changes within the uranium dioxide-zirconium alloy fuel matrix.

Licensing activities, generally in the form of topical report reviews, would then follow upon completion of the development of the technical basis with little or no interaction with the staff along the way. This lack of interaction produced a number of issues, including cases where additional testing that required irradiation, was necessary prior to approval

which caused extensive delays.

Recent initiatives related to accident tolerant fuel are leading the largest potential departures from the basic uranium dioxide-zirconium alloy fuel matrix which has been utilized in this country and in reactors around the world over the past 50 years. This potential transformational technology being pursued by industry has given us time to reflect on our fuel licensing process and determine where improvements to efficiency and effectiveness can be gained.

The ATF project plan captures these new thoughts and represents a significant paradigm shift. It enhances regulatory stability and adds efficiency to the time line required for licensing activities following the completion of the technical basis.

As you can see in this graphic, the success of the strategy outlined in the project plan relies on conducting a thorough and meaningful PIRT exercise for each concept and then maintaining the results of the PIRT as the collective state of knowledge evolves. The outcome of the PIRT will allow the staff to refine the regulatory infrastructure as needed for each concept, which, in turn, will facilitate the development of concept-specific licensing road maps. These activities will proceed in parallel with the continued development of the fuel technical basis by the vendor.

The refinement of the regulatory infrastructure will be done in real time and with significant communication with our stakeholders, such that transparency is maintained and regulatory expectations are clearly communicated to the vendor as early as possible in the process.

The process plan also envisions that licensing activities will proceed in parallel with much of the development of the technical basis for a

specific concept. Data sharing and close engagement with the applicant during this time will be critical to enabling the schedule efficiency shown here on the graphic.

The staff will need to perform as much pre-work as possible in preparing to conduct the most efficient reviews of accident tolerant fuels, topical reports, and license amendments. It is the overall goal of the project plan to develop and communicate our expectation for the technical basis in real time. This will minimize the time between the completion of the technical basis and the licensing of accident tolerant fuel designs to their full potential.

Next slide, please. In addition to efficiencies that are already built into the project plan, the staff is continually exploring other innovative and transformative ideas and solutions to further improve our approach. Some of the examples we are currently pursuing are: The use of NRC vendor inspection program to validate experimental testing and provide certainty to vendors regarding the sufficiency of their data. This will also expedite the technical review once a topical report has been submitted. The development of an approved change process for topical reports which will allow vendors to incorporate newly-acquired data or newly-identified information into their empirically-derived models. This would improve phenomena prediction and reduce uncertainty. Staff use of the Department of Energy-developed or other advanced computational capabilities, where appropriate, to enhance and expedite the staff's ability to perform confirmatory analyses during the review of accident tolerant fuel designs. And, finally, enhancements to our internal processes for issuance of regulatory guidance such that efficiencies gained by augmented communication and feedback between the NRC and stakeholders enabled by the plan can be realized in a

timely manner.

I would now like to turn the presentation over to Andrew Proffitt to walk us through a more detailed outline of the plan and address the major public comments we received. Andrew.

MR. PROFFITT: Thank you, Mirela. Good morning, Chairman and Commissioners. We intend for the ATF project plan to be a living document that remains up to date as applicants' plans and concepts evolve. The plan implements the high-level strategy that the agency will use to prepare for licensing accident tolerant fuel designs and is a concept-independent document. The plan outlines the activities associated with this preparation and will enable the agency to conduct efficient and effective reviews of ATF designs.

We began the development of the project plan with the current regulatory framework in order to optimize timing and resources, and with the confidence that our regulations, in particular with regards to fuel, provide the appropriate starting point and flexibility to accommodate ATF designs. With that said, we are always looking for ways to further increase efficiency and we will continue to engage our stakeholders on specific suggestions.

The comprehensive plan, which is nearly 50 pages in length, covers the assumptions made by the staff to inform development, an outline of proposed stakeholder interactions, initiating staff activities, and a description of the preparatory activities related to in-reactor performance, fuel cycle transportation and storage, probabilistic risk assessment activities, and analysis capability development. We will go into more detail on each section of the plan as we progress through the next few slides. The plan also

includes preliminary estimates for lead times necessary to complete activities in each area, which are identified in the activity tables in the front portion of the document and included in each subsection.

The plan was issued in the Federal Register on December 21st, 2017 for a 45-day comment period which closed on February 5th, 2018. We received nearly 80 comments from ten entities.

Next slide, please. We are confident that the constructive comments we received will allow us to enhance the plan through clarifications and augmentations of ideas or concepts which have been identified in recent interactions with our stakeholders. We recognize that we cannot complete the plan in a vacuum and truly value the feedback we have received.

There were several major themes to the comments on the plan, and we have attempted to address them all during the appropriate portion of our presentation today. But I would like to take a moment to walk through some of the most prolific themes now, the first being concerns with the regulatory requirements associated with the use of lead test assemblies. To address these concerns, NRR has established a steering committee and currently plans to issue draft guidance by early summer.

Many commenters highlighted the importance of communication and coordination to the successful implementation of the ATF project plan. The staff wholeheartedly agrees with this notion. We see enhanced communication and coordination as the lynchpin to the success envisioned by the project plan.

Several commenters also offered concerns with the terms "evolutionary" and "revolutionary" as used in the plan to describe accident tolerant fuel designs. We have committed to change our terminology to near-

term and longer-term when trying to designate between the two, and we will also enhance the language in the plan to clarify that the acceptability of each individual design will be based on its own merits.

Industry highlighted the opportunity accident tolerant fuel presents to transform our fuel licensing process. We have sought to optimize our process with the development of the plan and continue to hold brainstorming sessions with the working group on further efficiencies. But, again, we welcome specific suggestions.

Some commenters shared concerns with NRC's preparation and licensing time line. In response, we are committed to efficiently and safely licensing accident tolerant fuel designs in accordance with our mission and the principles of good regulation. We believe that the project plan has positioned us to do this well.

Lastly, in the comments received, there was a theme that the staff should leverage the use of DOE or advanced computational capabilities in our licensing reviews. Michelle will expand on our thoughts related to this suggestion, but our overall response is that we will use and seek to always use the most optimal means of confirmatory analysis in carrying out our mission.

We plan to issue along with the finalized project plan a companion document which contains our disposition of the stakeholder comments that we received during the official comment period.

Next slide, please. We believe that the regulatory framework for in-reactor performance is largely compatible with the current near-term accident tolerant fuel concepts and the time exists to refine the framework for longer-term concepts, so NRC will be prepared to license those

designs upon submission for review.

Additional work will be completed following the concept-specific PIRTs to fully evaluate the applicability of existing regulations and guidance for each accident tolerant fuel design. These exercises will inform the development of the concept-specific licensing road maps detailed by Mirela, which will clarify the regulatory criteria that need to be satisfied for batch loading of accident tolerant fuel design and the regulatory options available to applicants and vendors.

If required, we will identify policy issues and present them for Commission consideration and initiate any rulemaking or guidance development activities well in advance of licensing submittals. Some examples of where the current framework may need refinement are Title 10 of the Code of Federal Regulations, Part 50.68, Criticality Accidents, which prescribes a five-percent enrichment limit for fuel and an acceptable approach for meeting General Design Criterion 35, Emergency Core Cooling, as 10 CFR Part 50.46 is the means for which all currently-operating reactors show compliance with GDC 35 and that is purely based on zirconium clad uranium dioxide fuel.

Next slide, please. Our counterparts in NMSS have been fully engaged with the accident tolerant fuel steering committee and working group, including the development of the project plan, from day one. The regulations that are applicable to fuel cycle activities found in Title 10 of Code of Federal Regulations, Part 70.71 and 72, are general in nature and identify performance requirements rather than design approaches or design requirements. This type of regulatory language has been necessary because of the broad spectrum of facilities and designs that are licensed under these

regulations. We believe that these existing regulations can accommodate the accident tolerant fuel concepts under development.

Current review guidance addresses issues raised by industry designs for fabrication, transportation, and storage of zirconium clad uranium dioxide of up to five-percent enrichment. It is possible that some of this guidance may need to be supplemented to address safety-related issues that could arise from certain accident tolerant fuel designs or the facilities and systems used to produce or manage ATF.

We will remain engaged in proactively establishing lines of communication with relevant stakeholders to ensure we stay abreast of applicants' progress in fuel cycle licensing strategies.

I would now like to turn the presentation over to C.J. Fong who will highlight a few key areas related to PRA and our risk-informed programs that are particularly important with regards to ATF. C.J.

MR. FONG: Thank you, Andrew. Good morning, Chairman and Commissioners. I'm pleased to be here today to discuss the NRC staff's plans for incorporation accident tolerant fuel into our PRA models. My presentation will cover three subjects. First, I will discuss the regulatory basis for enhancing our PRA models to account for accident tolerant fuel. Next, I will describe the benefits that we will expect to gain by accurately modeling accident tolerant fuel in PRA. Finally, I will outline the technical information that is needed to perform these updates and why we believe that more clarity on accident tolerant fuel performance is needed before we can begin executing them.

Since their inception, PRAs have been periodically updated to reflect newly-acquired data and to incorporate hardware and operational

changes. We plan on continuing this longstanding practice with accident tolerant fuel.

It is important that, consistent with the Commission's PRA policy statement, these updates are performed in a manner that uses state-of-the-art PRA methods and data so that we can achieve the most realistic results practicable. Doing so will provide several benefits that I will outline on my next slide.

As the Commission well knows, PRA use has evolved since the IPE and IPEEE days, and PRA models and the risk insights they provide are now used to make day-to-day operational decisions across the fleet. Examples include, but are not limited to, tools used by licensees to assess and manage their day-to-day risk in accordance with the maintenance rule; licensee PRA models used to support risk-informed licensing actions; and NRC PRA tools used to support reactor oversight decisions and the prioritization of generic issues.

PRA models that are unrealistic or that use overly conservative assumptions can mask important risk insights which, in turn, diverts licensee and NRC resources from those operational and design issues with the greatest safety significance. We should avoid this scenario by upgrading our models to incorporate accident tolerant fuel. The question is not if but when.

Next slide, please. So when is the right time to update our models? One aspect of PRA that is often overlooked is that accurate thermal hydraulic calculations and/or test results are needed to predict plant performance in the accident sequences modeled by PRA. Accident tolerant fuel has the potential to change some of the key assumptions that are used in

PRA today. For example, many PRA models use a calculated peak cladding temperature limit that is distinctive to uranium dioxide fuel with a zirc-based cladding. We recognize that this temperature limit will not necessarily apply to all ATF concepts.

The challenge is that we don't yet have the thermal hydraulic calculations to support a different value, and until that data is available it simply does not make sense to begin our model updates. The NRC PRA staff and the Offices of NRR and Research will, therefore, continue to monitor the industry's progress toward batch loading of accident tolerant fuel. As stated in our project plan, we will update our models and guidance as more information about ATF performance becomes available so that our risk models will continue to provide credible insights following the first ATF batch load.

With that, I'll turn things over to Michelle Bales. Michelle.

MS. BALES: Good morning, Chairman and Commissioners. I will be discussing our efforts related to developing analytical capabilities for accident tolerant fuel and our next steps with regards to PIRTs.

In the ATF project plan, four technical disciplines were identified where a computational capability is needed to support safety review of topical reports and license amendment requests. Those disciplines are fuel performance, thermal hydraulics, neutronics, and severe accidents.

Fuel performance codes are used to demonstrate that specified acceptable fuel design limits, or SAFDLs, are maintained and to provide initial conditions for design basis accident analysis. Additionally, fuel performance codes are used to support safety limits for loading and storing spent nuclear fuel in storage casks.

Thermal hydraulic codes are used to demonstrate that reactor design basis transient and design basis accident criteria are met. Neutronics codes are used to demonstrate the criticality requirements for reactor accidents and spent fuel transportation and storage casks are met. They're also used to calculate decay heat rates, core power, and reactivity values that are used in thermal hydraulic and fuel performance codes.

Severe accident codes are used to calculate the design basis source term to establish the adequacy of siting for commercial power plants and to ensure adequate radiation protection for control room and technical support centers.

NRC has developed a suite of codes to analyze these disciplines, and they have been used successfully to support regulatory decision making. We believe that further development of these codes is appropriate to ensure that we have the capability to analyze ATF designs. Having tools that the staff can use to analyze ATF will be particularly important because applicants will use computational tools to demonstrate their fuel safety criteria are met and, in some cases, the ATF properties and models within the computational tools will be based on limited experimental data.

Next slide, please. The schematic on this slide shows the general elements of code development and it's relevant to all safety analysis codes, whether we're speaking of those developed by the Nuclear Regulatory Commission, Department of Energy, or the industry. One of the things illustrated in this figure is that code development requires testing and data to feed model development and validation. Developing codes to demonstrate the accident tolerant fuel can be used safely includes updating codes with accident tolerant fuel material properties and models, as well as the validation

of the updated code against relevant experimental data. It is the validation exercise that ensures a code appropriately models key phenomena and accurately predicts the parameters of safety importance.

The data sets used to develop models often come from separate effects testing, while code assessment and validation often uses data generated in integral test programs. PIRTs, mentioned earlier by Mirela, are helpful for planning test programs and code development activities since they help to ensure that all phenomena important to safety have been identified and are considered in the plans.

In some cases, existing codes developed for current light water reactor fuel have aspects of a zirconium cladding uranium dioxide fuel system hardwired into their architecture. In that case, code architecture updates will be needed in order to use the codes for accident tolerant fuel.

The diagram on this slide is relevant for all accident tolerant fuel concepts, but we recognize that some concepts have limited new phenomena and, therefore, the duration and breadth of each element will vary for each accident tolerant fuel concept.

Next slide, please. Our independent confirmatory analysis of topical reports and license amendments follow a graded approach which varies based on the complexity of the application, the safety significance of the issues presented, and the uncertainty of the key phenomena involved. We employ a range of tools to verify the safety case made and presented by an applicant. In some cases, staff can perform their confirmatory analysis and reach a safety determination by drawing on previous knowledge, accumulated expertise, and the information presented by the applicant. In other cases, confirmatory calculations are performed by the staff and can

allow for more effective and efficient review.

We typically perform independent confirmatory calculations to assist in reaching our safety findings in reviews where uncertainties are large and margin is small. In some cases of large safety significance and large uncertainty, we've actually pursued independent confirmatory testing commissioned by the agency prior to reaching a determination on the application.

When the staff does perform confirmatory calculations, we have experience using both NRC- developed and non-NRC codes. NRC-developed codes include the fuel analysis in steady-state and transient, or FAST, code for analyzing thermal mechanical performance of fuel under steady-state and accident conditions. Codes like NRC's FAST are specifically developed and tailored to demonstrate acceptable performance against the defined regulatory criteria.

NRC has also partnered with the Department of Energy to develop codes such as SCALE, which performs reactor physics, criticality safety, radiation shielding, and spent fuel characterization for nuclear facilities and transportation storage designs. SCALE is also used by some licensees to support licensing applications.

We also have experience using commercial tools to perform confirmatory calculations, for example in the evaluation of structural performance of components under seismic loading. It is important to note that if we do elect to perform confirmatory calculations, the NRC staff member performing the calculations must have a clear understanding of the assumptions and limitations of the computational tools they use.

Next slide, please. NRC will take the most efficient and

effective approach to verify the safety case presented for each accident tolerant fuel concept. A critical assumption in the ATF project plan is that the data from external sources will be provided to the NRC in time to support the steps we need to take to verify the safety case. The plan also assumes that NRC will not need to conduct independent confirmatory testing.

In support of these assumptions, NRC has added addenda to our memorandum of understanding with the Department of Energy and the Electric Power Research Institute to facilitate data sharing. We also continue to follow international multi-priority research projects, such as the Halden Reactor Project in Norway where accident tolerant fuel concepts are being tested.

When confirmatory calculations are warranted, we will select an approach that weighs several factors. These factors include the level of effort necessary to modify an NRC code and the level of effort needed to understand and validate a non-NRC code. This information will be considered as we develop concept-specific licensing road maps.

Based on the information that we have so far, we believe that for near-term concepts, like chromium-coated cladding, it will be more efficient and effective to use existing NRC tools which can be modified with minimal effort. For longer-term concepts which require greater effort to adapt NRC existing tools, stronger consideration will be given for the use of non-NRC codes.

Next slide, please. Our next step is to conduct concept-specific Phenomena Identification and Ranking Table exercises. One of the things that became clear as we worked through the project plan was that now is an appropriate time to conduct formal expert elicitation to determine if all

new phenomena of safety importance have been identified for accident tolerant fuel concepts. We believe that an adequate body of evidence exists and knowledge is available for most of the ATF concepts to enable a systematic expert elicitation using the PIRT process.

NRC has significant experience utilizing the PIRT process and will follow expert elicitation best practices, including assumption actions to minimize bias. We have initiated discussion with our stakeholders and expressed our desire to conduct PIRTs in coordination with applicants, Department of Energy, and international partners. We expect the PIRTs to be used by different entities for distinct purposes. Where applicants would use PIRTs to develop their safety case, NRC would use PIRTs to inform regulatory requirements and DOE would use PIRTs to prioritize research.

We all share a common goal of ensuring the safe use of accident tolerant fuel concepts; and, therefore, coordinating on the PIRT process will minimize unnecessary duplication of effort.

I would now like to return to Vic to close the presentation. Vic.

MR. MCCREE: Thank you, Michelle. As you've seen and heard through our presentation here this morning, we believe we are well positioned in our preparations to license accident tolerant fuel and we're ready to begin work related to concept-specific activities.

To summarize the key next steps, they include publishing for public comment a draft memorandum from the NRR office director clarifying the staff's position on the requirements associated with the use of lead test assemblies and to engage our external stakeholders to ascertain what, if any, additional guidance is necessary by June of this year.

Secondly, completing the incorporation of comments and enhancements based on stakeholder feedback and to the ATF project plan and finalize the plan by mid-summer of this year. Thirdly, continuing our enhanced stakeholder engagement and interaction related to accident tolerant fuel and, fourthly, beginning coordination of the PIRT process for near-term accident tolerant fuel concepts.

Finally, I'd like to emphasize or re-emphasize that for NRC to ensure that reviews of ATF designs are carried out effectively and efficiently, as was outlined in the presentation this morning, it's imperative that we receive reliable and predictable schedules from the industry on the concepts they plan to pursue. To this end, we've begun interactions with a wide variety of stakeholders, including the nuclear fuel vendors, to better understand ATF implementation schedules in the near and long term.

In closing, I'd like to take this time to thank the many people, some of whom are here in the room today, that have worked diligently over the past several months to get us to this point.

Thank you for allowing us to brief you on this important topic. That concludes our presentation.

CHAIRMAN SVINICKI: Thank you, Victor and to all of the NRC presenters and to your NRC colleagues who have contributed to the progress that you reported on today. We will begin again with Commissioner Baran.

COMMISSIONER BARAN: Thanks. Well, thank you for your presentations and for all the work that's gone into preparing the draft project plan. Andrew talked about this a little bit but, based on what you know now, aside from the 50.46(c) rulemaking which would move us to technology-

neutral performance-based standards for fuel designs, have you identified any changes to NRC regulations or guidance that you think will be necessary to prepare for the licensing and oversight of ATF?

MR. PROFFITT: I'll take that one. So as we mentioned on the slide, obviously 50.46(c) is mentioned and then 50.68 criticality accidents with the prescription of a five-percent enrichment limit. Other than that, we really are awaiting to see the outcome of the concept-specific PIRTs and fully understanding the use of the fuel to go any further. We could speculate at this point, but I think to do it with more certainty following those activities would be the better way to proceed.

COMMISSIONER BARAN: On the first panel, we talked about code development a bit, and the draft project plan includes an estimate that it would take three to six years to develop the necessary codes for any given fuel type. But one clarifying question I had is whether that was an estimate specific to NRC doing the code development or someone else doing the code development or it didn't matter. Basically, I think it's three to six years regardless.

MS. BALES: So the project plan, our quotes and our estimates include time to await data and to do the validation exercises and, in that way, all of the codes, whether they're NRC's or the industry's or DOE's, are kind of all in the same place. We're all waiting for data to complete validation experiments. Some of the mechanics of actually updating the code to add new models are relatively simple, and so the estimates in the project plan, I would say, reflect the time frames for all codes, whether they're NRC or external.

COMMISSIONER BARAN: And that three to six-year

estimate, that includes validation of the codes?

MS. BALES: There are assumptions about when data will be available and the time that it would take to conduct validation exercises.

COMMISSIONER BARAN: Okay. And I understand it's early days on this and we're talking about a variety of different technologies, but how solid are these estimates, you know, this three to six-year estimate, and what has to happen to basically start the clock running on that three to six years?

MS. BALES: So I'll speak to the schedule part and then I'll turn it back over to one of my colleagues for the starting the clock part. So I would say that the estimates are relatively well informed based on the information we have of planned test programs, and we continue to need to coordinate with Department of Energy and applicants to ensure that we're always keeping up with updates to their schedule so that we can plan accordingly.

MS. GAVRILAS: So what's important is having some, having a clear idea of the schedule that the vendor has because, for example, you update the infrastructure and the code on which you overlay material properties and other detailed model specific to the technology that you're studying and then you validate the code. So what you need is you need sufficient data for your model improvements, so code modification cannot start until you have the special effect data. And then the completion is when you have all the data from integral tests that you can validate your tests, so that's the integral part and it's highly specific. For example, for some of our fuel performance codes, we have already started that effort with preparing the infrastructure to receive the data, but those are early efforts that we can do for

chromium clad for example.

COMMISSIONER BARAN: On the first panel, there was talk of a goal being to have batch loading starting as early as 2023. How aggressive does the staff see that schedule as being and is it feasible?

MS. GAVRILAS: So we did a mental exercise and we basically said, in an ideal world, for the near-term concepts, and our result amongst ourselves is yes. But let me emphasize in an ideal world for near-term concepts.

COMMISSIONER BARAN: Slide 21, talking about the codes again, says that with appropriate control staff can use non-NRC codes while maintaining independence, and Michelle talked about that a little bit. What controls do you have in mind there?

MS. BALES: I can answer that. I think that some of the controls are about the ability for the staff using the codes to really understand the assumptions and limitations of the code. So that includes being able to have time and information to do their own validation exercises in areas where we're applying the code and as well as, in certain situations, have access to the source codes that we understand that we know what is going on in the code. And so those would be some of the controls, but I think it's really going to be dependent on the situation and should be considered on a case-by-case basis.

COMMISSIONER BARAN: And if we're talking, and maybe we're not talking, we're talking about DOE code for example, with our current, you know, interaction with DOE, do you think we're on course to have the kind of access the staff would need to those codes to use them in that way?

MS. BALES: I think so. I think that the interactions that the NRC and DOE staff have been having at the developer level have been very productive, and there is really great communication and a willingness on both sides to come to a better understanding of what codes are capable of and what the needs of NRC are. A lot of that is still ahead of us, but the general demeanor of interactions has been, I think, very productive.

COMMISSIONER BARAN: Another conversation we were having on the first panel is this question of balancing modeling with experimental testing. Clearly, there's going to need to be some experimental testing I think to validate these models. I think everyone agrees on that. As slide 22 notes, the draft project plan assumes that independent confirmatory testing by NRC would not be necessary. What will it take to ensure that NRC gets the data it needs from DOE and applicants?

MS. GAVRILAS: So let me take that one because I was taking notes during the first panel presentation and one thing that jumped up at me was when Ed Lyman said techniques, experimental conditions, and assumptions. We would have to be comfortable that the techniques used in the experimental program, the experimental conditions of the experimental program, and the assumptions made in the experimental program fully satisfy our needs to reach our safety findings.

I want to also clarify that that's a planning assumption. The staff has not made any decision a priori that no confirmatory testing will be needed. If we have questions about these three elements, we will reconsider, of course, doing confirmatory testing.

COMMISSIONER BARAN: So there are situations which you can envision that NRC would need to do confirmatory testing?

MS. GAVRILAS: There could be. What we are planning to do is working close enough with the entities that are acquiring this data so that there are no surprises when it comes to techniques, assumptions, or experimental conditions.

COMMISSIONER BARAN: So I understand, practically speaking, the idea is if someone is going to go off and do an experiment, we would engage with them ahead of time and say, just so you know, if you want to satisfy our needs for data to make the regulatory findings we need to make, we would need to see the following things in this experiment?

MS. GAVRILAS: That's right. You would need to acquire this temperature reading, this pressure drop, and so on.

COMMISSIONER BARAN: Okay. And we talked a little bit about the Halden Reactor on the first panel and really the lack of alternatives for design-based accident testing for BWR fuel. Can the staff talk a little bit, how confident are we that Halden will continue to be available to us for this purpose?

MR. LORSON: I think the thing to keep in mind is we do have active engagement with the international community on what is necessary to ensure the continued viability of the Halden Reactor. Mark Thaggard from the Office of Research is the NRC's lead person in this regard.

I would say that I'm confident from the perspective that I think both internal and national external, excuse me, international and national stakeholders understand the importance of the Halden Reactor. However, I say that with the realism that, while individuals and countries may recognize the importance and are committed to understanding the continued viability of the reactor, at this point in time we're still under discussions about what's

necessary to ensure that the reactor will continue to operate and countries, including the United States, they'll have to agree to the certain funding requirements to ensure its continued success.

COMMISSIONER BARAN: And this isn't, I don't want to be pessimistic and I don't want to get into a lot of speculation, but, in the event that Halden were not available, do we have a plan about, you know, or does anyone have a plan about where we would get that data?

MR. LORSON: Well, I would say that there are some capabilities with the Department of Energy. We're going to be visiting the facility in Idaho in the first week in May. It's not clear to us whether or not the facilities there can completely replicate all of the individual capabilities that are at the Halden test reactor. What I've heard from some of the experts in industry and some from the NRC staff is that there is not currently an additional facility to do that type of testing.

So if the Halden Reactor were not to continue to operate beyond 2020, we'd have to go back and revisit that section of the plan to see how it would impact schedules and time lines.

COMMISSIONER BARAN: Okay. And let me ask just one more question. You know, a key part of all this planning and preparing for ATF applications is having enough staff with the right expertise to do this work. Where do we stand on staffing resources now and what are our plans going forward?

MR. LORSON: We are keenly aware of the need to have the right levels of staff with the right skills and developing the plan to this point would not have been possible with high-performing staff that we have here, like Andrew, C.J., and Michelle.

Having said that, there's really three components that we are mindful of and keenly focused in as we look at our future staffing plans. One is, I think Vic had alluded to the need to maintain continued close engagement with industry so that we have a good appreciation for what work is going to come in front of us and what's the time frame. Secondly, at NRR, as you know, we're involved with the merger activity with the Office of New Reactors, and so we're looking at what the overall organization looks like and what staffing levels look like. As part of that integration, we're keenly focused in on needing to maintain the right skill sets in the right technical disciplines to be able to complete the work, so it's not only having enough staff but also having them with the right skills.

We recognize that the technical skills that are in Mirela's group are of critical importance to this effort and, in fact, in this year, even though we've done limited hiring, we actually have brought in new employees. So we are focused in on that aspect, and that's a keen area of focus for us moving forward.

COMMISSIONER BARAN: Okay. Thank you.

CHAIRMAN SVINICKI: Thank you. Commissioner Burns.

COMMISSIONER BURNS: Thank you again and thanks to the staff, both those at the table and the others who have been working and been engaged on this topic. I want to start off maybe a follow-up to an answer Mirela gave to Commissioner Baran regarding this 2023 time frame in an ideal situation. And being one who believes that we do not live in the best of all possible worlds, what are the big, what are the things in terms of that narrow aperture that would concern you most about that 2023 date?

MS. GAVRILAS: So there are, the development of the technical basis has to somehow link to our licensing review. So the things that concern me most is did we have enough exposure to everything that went on in the development of the technical basis until now so that we don't find ourselves having to iterate back to a previous box? That's the main concern.

So if we assume that what was done until now is acceptable to the staff and that the boxes that I showed on my technical basis box have indeed been completed without having to send back, then we can do it in 2023. That's the uncertainty.

COMMISSIONER BURNS: Okay. Thank you. And along those lines, I think Michelle put up a diagram, you put a diagram up and Michelle put a diagram up and we saw Mr. Wilmshurst put a diagram up in terms of, I think the one that the Chairman used during her remarks in response to the first panel.

When you look at that diagram versus what you're looking, you know, I can't necessarily, looking at it right offhand, see the fidelity between the two, but it doesn't have to match 100 percent, but are both of you comfortable that that's, we're sort of looking at it similar ways or close enough?

MS. GAVRILAS: So my answer would be, from a high level, the color scheme looks right to the staff.

COMMISSIONER BURNS: Okay.

MS. BALES: Yes, I would agree. I think that the industry slides implied a use of modeling and simulation that isn't captured in our discussion so far, but I think, otherwise, there is alignment with the idea to do parallel activities versus activities in series and to have a lot of interaction so that you're sure the work that you're doing is the right work and that it's going

to lead to the outcomes that you want from a safety technical basis development. So I would say that they're aligned.

COMMISSIONER BURNS: Okay. Thanks. And this might be addressed to Vic. Since you're still the CNRA member or chair actually at the Committee on Nuclear Regulatory Activities under the NEA auspices, but I'll post to you, Vic, sort of the question, the similar question I posed to the first panel with respect to efforts at international harmonization. A lot of talk about Halden and, you know, experimental data, experimental research, which is important, too. But has there been any engagement in terms of what I'll call this, I guess you could call regulatory harmonization or at least maybe the first step is understanding? And, again, I go back to the multinational design evaluation program as a way we've tried to do that, you know, in the new reactor, the Gen-3, I guess even Gen-4, we're moving to Gren-4 there. So any thoughts or comments on that?

MR. MCCREE: Commissioner, thanks for the question. I think it's a very good one. I think it's a very appropriate and timely initiative that NEA has embarked upon ad is engaging EPRI on. Suffice it to say, we're in very early stages of moving in this area, as the CNRA, Committee on Nuclear Regulatory Activities, has actually not taken this issue up yet. The Committee on the Safety of Nuclear Installations, which has a working group on fuel safety, in fact the CSNI tasks the working group, WGFS, Working Group on Fuel Safety, with developing a research plan. And that plan would identify those countries that perhaps have research and development facilities that could be made use of or could contribute to R&D in the area of accident tolerant fuel.

I do anticipate some presentation, conversation on that at

the June meeting, the CSNI meeting. And there will be a joint meeting on day two, day three actually, where we'll have an opportunity to understand where that committee is coming out in its research plan. But suffice it to say, it's in the very early stages, but I look forward to the conversation.

COMMISSIONER BURNS: Okay, all right. Good. Thanks. A couple of other things. One of the things, I know when, you know, there has been some debate over approaches toward particularly the implementation of lead test assemblies. One of the questions I would have is, as you go forward, are you documenting sort of the legal and technical bases for the decision-making you have? Because I know, as you say, there's been some controversy over that. I can actually go back and think of when the first steam generators were replaced. This is how old I am. And there was controversy over whether 50.59 versus a license amendment ought to be used.

So what I'm asking is, maybe it's a rhetorical question, are you getting good fidelity in terms of your documentation about how you're moving forward in these areas and what types of considerations, both legal and technical, that you're putting into that type of decision?

MR. LORSON: Yes, I'll take that. In terms of the documentation or guidance that we're planning to issue here in the near future, it includes both the technical and legal considerations. We certainly won't put out the draft guidance without consultation with the Office of General Counsel. In fact, the Office of General Counsel was a member, has provided a member of the steering committee, so we appreciate that so it can help us, you know, make sure that we're not introducing potential pitfalls as we develop the guidance.

We're also keenly aware of the need to ensure that the guidance is technically sound, and I think that's a key focus area for the group. And what we're doing is we're not really developing new guidance on how to implement a change because the NRC change processes are well established and licensees use them every day to make changes at their operating facility. What we're really trying to do is we're taking a couple of the terms that we believe the industry and perhaps NRC staff have had difficulty in terms of interpreting, terms like limiting number, limited test location. And so we're trying to define precisely, to the extent we're able to, better some of those terms that will allow facilities to use existing change processes with better clarification of some of the terms that are used throughout regulatory documents.

COMMISSIONER BURNS: Okay, good. Thanks. And I think my last, I'll end with the question, in terms of planning and, you know, particularly resource planning as you come up, has the staff seen any areas where resource constraints are challenging or would challenge the ability to continue with the efforts that were ongoing?

MR. LORSON: I think we're okay for addressing the near-term expectations that will be in front of us in terms of products that are going to come to us for review, and that includes items such as topical reports on some of the near-term fuel designs. Where I have the concerns is, depending upon how the evolution of the testing occurs, if we were to get some type of fuel design that's perhaps more radically different than what we're currently experienced with, that could create a challenge and we'll have to figure out how to address that, or if we get a lot more work through the front door then what we're currently expecting based upon some of our informal discussions

we'll later formalize through, you know, formal interactions with the industry. So those would be the two areas that I would be concerned about.

COMMISSIONER BURNS: Okay. Vic.

MR. MCCREE: So while I would echo what Ray said, this is an area where our enhanced strategic workforce planning initiatives and efforts come into play. I think it was noted that, you know, that we've been able to capitalize on the great talent we have here and then other areas of the agency, and there are certainly some areas where we can re-deploy, if necessary, or train folks to make sure we have the right people in the right place when the work comes. But we have done some hiring and it was, in part, based on some strategic workforce planning discussions we've already had and would pivot to Mirela to confirm those areas where we have brought in new hires in areas specifically because of anticipated expected work on ATF.

MS. GAVRILAS: Yes, we've been very fortunate. We made two new hires. One is more of a generalist with fuel experience, but one is a true fuel expert with experience in the field. So we've been very lucky.

COMMISSIONER BURNS: Okay. Actually, I had one other question that I want to ask. We talked a lot about codes, demonstrating the fuel, etcetera and etcetera, but I think it was either Andrew or C.J. noted the other things, like transport, fuel casks, and things like that. Can you give me a little more granularity about what types of things we might be looking at there and what are their regulatory type challenges we might have? I presume, you know, for casks, you know, it's a different cask design or cask characteristics in light of the larger, the greater percentage, you know, over

five percent in the fuel and all.

MR. LORSON: Yes. The plan includes support from our Office of Nuclear Material Safety and Safeguards. And just a couple of items we look at, as I mentioned, we were looking at the complete fuel cycle. So whether it's fabrication of the fuel under 10 CFR Part 70, we have our engagement with our stakeholders in the Office of Fuel Cycle Safety and Safeguards. From the standpoint of transport of the new fuel to the facility, that would require a license amendment under Part 71. Again, that would be issued by the Office of NMSS. And then also, ultimately, kind of the storage and ultimately disposal of that fuel would also include support from the office of NMSS.

So that's all complete part of the plan, and that's something we're looking at as part of both, throughout the licensing process.

COMMISSIONER BURNS: Good. And I think the important thing is you all are talking to each other and engaging each other on those issues because, as they say, our big focus and much of our discussion today has been what that actual fuel looks and acts like in the reactor, but we always have some of these secondary and tertiary issues.

Thanks very much. Chairman.

CHAIRMAN SVINICKI: Well, thank you all for your presentations. And I just wanted to reflect that I compliment the staff on the work they've done. I see a strong parallel in the approaches that you've described in all the different areas to what your colleagues are doing in preparation for advanced reactor reviews. I talked a little bit about these parallels in my response to the first panel.

You know, I think through the development of plans that will

pace along with what the vendor's planning is, knowing those schedules, as Victor talked about, but maintaining a certain flexibility of approach here. I'm hearing from the technology development community that that's very important, and I think we are confronted with both this diversity of innovation in fuels but also, on the advanced reactor side, there's a lot of diversity, more than what we're currently regulating in operational space right now.

So I think that having approaches that allow for a bit of a stylized application of the regulatory process, a little bit of a stylized application of the regulatory framework, is really essential.

And, you know, I kind of interpret this as an outgrowth of the hard work we've done under Project Aim where agility was a component. And what I see you all bringing to this is kind of work on enterprise-wide risk management, which is, I see that in the flexibility of how you're drawing in experts of various disciplines and from various organizations. So I think you're to be complimented on that, and you realize that it's going to be dynamic for you going forward. I think you're baking that in to your approach, and I think that that will serve the agency well going forward.

Andrew talked about looking at the entire fuel cycle and all the components. As Commissioner Burns mentioned, Mr. Wilmshurst had a similar thing of all the different parts of the regulatory framework that get impacted, and fuel is so foundational to that. So I think that the agency's success in having a predictable regulatory time frames and a process that's understood from the outside will be a key showing for us, a demonstration of the kind of agility that we've been trying to build.

It's funny, as I look at the parallels with advanced reactors, I'm reminded of, I still make references to Seinfeld, even though that makes

me seem very old because that show ended a long time ago. But Jerry was buying a new car, and he's talking to Puddy who happened to be the sales agent there. Some of you are nodding your head, and others are like what is she talking about? But he's going through all the dealer add-ons, and he's trying to explain why the price is so much higher and he's going, oh, you know, the coatings and everything. And then he goes, "The keying charge," and Jerry stops him there and he goes, "You're charging me for a key for the new car?" and Puddy just looks up and he goes, "How are you going to start it?"

So fuel is foundational to everything to come, and I think that the world of fuel has been static. I don't think that's because there's a failure to innovate in the vendor community. I just think that some of the situational imperatives weren't there.

So I do want to learn more. We don't need to do it today. It sounds like with the Hatch LTAs there was some kind of obstacle in transporting something to the site, if I'm understanding that, and, as a result, they removed the nuclear material and inserted dummies. I don't mean that as a pejorative, but they inserted things that were just the structure. We heard from Mr. Bost that they'll still get useful information from that. As an engineer, I understand that, yes, they'll irradiate some of the materials and that that's valuable.

But I'm wondering if that had something to do with not bringing along all components of NMSS, you know. I realize that they're not really the pointy tip of sphere here, but it just points out that this is a big integrated system. And so, again, I compliment you on the teaming and the way you're drawing in people at the right times to work on the right things. Again, I attribute some of that to the hard work we've done through the years

of Project Aim. Organizational agility was one of the central of the three-legged stool of Project Aim. That was a key element for us.

Nevertheless, there are things that the proof will be in the doing and they require a lot of exquisite discipline in our carrying them out. One of them would be, as I listened to both Mirela and Michelle talk about some of the research pieces, I know one of the elements that the NRC staff talks about is integrated effects and that makes me think of, like, downstream effects with GSI-191 on containment sump clogging.

And so as we look at the integrated system and every layer that goes out, you could, in a research capacity, make that a very undisciplined process. Mirela, do you have any quicky thoughts about the mechanisms through which one keeps discipline in that process to achieve a level of adequate certainty and not absolute certainty?

MS. GAVRILAS: So it goes back, in my view, to the PIRT. The PIRT collates all the data that we have, all the knowledge, in a very disciplined manner. It pulls the information together, and it says these are the important phenomena. But that's a --

CHAIRMAN SVINICKI: Can I just on that, do you think in the expert elicitation we do, do you think we're going to find good alignment in the PIRT process of what are the phenomena of interest, because you could just have an endless laundry list and an endless list of phenomena, and then maybe more difficult is the relevance of the individual phenomena.

MS. GAVRILAS: So that's why we have actually some – a white paper. It might be more on how to conduct an expert elicitation. The experts --

CHAIRMAN SVINICKI: I think somewhere in George

Apostolakis's ears are perking up because we know there's a disturbance in the force there.

MS. GAVRILAS: So the important thing is the experts start from a body of knowledge, and that's what goes into the phenomena, that goes into the ranking. It's a body of knowledge. And they might say I don't have enough data here, I don't have enough data. But their opinion is not just their opinion. Their opinion is basically formed on a very solid technical basis.

CHAIRMAN SVINICKI: Okay. So it's not just an accretion of everybody, like this is the thing of greatest interest to me, I want to add it to the list?

MS. GAVRILAS: No. And if we do the expert, if we choose our experts carefully, we choose the experts who have the credentials to be, you know, we look at things like what academia does, the citation index, and that's the kind of people. And we had very good advice from the ACRS recently who said, you know, get some skeptics, get some cynics, because they, too, add value, they, too, will add value to the process. So we intend to do all that in forming these PIRT panels.

CHAIRMAN SVINICKI: Okay. Thank you for that. Well, like I said, I'm very excited about it and very intrigued I did see the thought piece or white paper. I haven't had a chance to read that. I hadn't realized you had an ACRS engagement on that. I may look that up, as well.

MS. GAVRILAS: With the subcommittee.

CHAIRMAN SVINICKI: At the subcommittee level. Okay. Thank you for that. Michelle, I wanted to ask you, on slide 22, you communicate that, based on the information we have so far, we believe that

for near-term concepts, like some of the cladding changes, it's more efficient and effective to use NRC tools which could be modified with minimal effort.

Once you make that kind of, take that fork in the road, is that something that, depending on how the development goes in terms of the near-term concept itself, if you discover something about it, can you kind of switch horses there and decide that you could use an industry code or, once you decide that you're going to make revisions to an NRC code, is it best just to stay locked into that approach no matter what happens with the technology development on the ATF fuel?

MS. BALES: I think that goes more to how much effort it would take to have a staff become an expert in a new code, and so not so much whether the technology is a near-term or a long-term one. And so I think if we have the ability to have staff available to gain expertise and they have the bandwidth to do that, then, yes, like I said, it's more about the timing and the staff availability to gain expertise than it is about, I think, a particular concept. And I think that some of the work that we're doing now makes sense because this is our current plan and just having those codes available to make assessments in the near term makes sense now, but it could be revisited as new information becomes available.

CHAIRMAN SVINICKI: Okay. Thank you for that. So it is something that you'll just kind of assess that as you go along and it's not locking in because there's been some concern that NRC is getting kind of too in favor of the comfort of using its own codes. If we felt it was advantageous to just develop the staff expertise on a code that wasn't ours, we're not somehow resisting artificially doing that?

MS. BALES: No, I don't believe so.

CHAIRMAN SVINICKI: Okay. Thank you. And my last question is going to seem complicated, and it's not really a trick question, but it is a bit philosophical. I don't know. I was tempted to direct this to C.J., but it would be like picking on him because he was kind enough to do a temporary assignment in my office. I don't really want to pick on him, but he's the risk guy and it's about risk.

MR. MCCREE: Chairman, you should feel free to --

CHAIRMAN SVINICKI: Free to pick on him? Okay. Well, then maybe I will since the crew on this side of the table is the one everyone is saying that they're going to really carry us to success on this, so maybe I should direct it to that end of the table.

Is it a true statement that, if a current licensee comes to us and says I want to make a modification at my plant and I invoke the appropriate regulatory processes, our position in determining our review of that proposed modification, it doesn't have to increase margin, does it? As long as it doesn't have a negative effect on margin to an extent that we'd have a regulatory objection, can people make changes to their plants, including to their fuel, and we would say, well, it doesn't do anything that violates what we have, it doesn't enhance margin. And the fact that it doesn't enhance margin, that's not a basis for regulatory denial, is it?

MR. FONG: By itself, no, it's not. And I would point out that if the change is risk informed, we do look at the safety margins to make sure there's not a significant decrease in margin. But licensees are not constrained only to changes that add margin.

CHAIRMAN SVINICKI: So if these weren't marketed in a Madison Avenue kind of way as accident tolerant fuels, if they were called

advanced fuels, would we take a view that we will only approve them if they enhance margin? Would that be legitimate for us to do?

MR. FONG: Well, as the risk guy here and since Vic volunteered me, I would point out that, from a risk perspective, we look at the Commission's safety goals, and so we look at how safe is safe enough and we have subsidiary numbers that we use to help us make that determination.

CHAIRMAN SVINICKI: Okay.

MR. FONG: So we wouldn't try to impose a policy decision beyond that --

CHAIRMAN SVINICKI: Okay. And I realize there's other prongs here and I'm not trying to be cheeky about it. It was a congressional initiative. Our DOE colleagues pointed out the fact that, you know, after Fukushima, funding was provided to DOE to kind of kick this thing off because there may have been a congressional expectation that this was an enhancement to safety.

But laying all that aside, if the label weren't accident tolerant fuels, would we have a basis to deny something just because it wasn't some sort of significant enhancement to margin? I assert, obviously, from how I'm asking this, I assert that we would have no basis to do that, and I'm not trying to put it on you, but I know that there may be some sort of kind of expectation about it, but I think these are going to come in under like the Westinghouse XYZ fuel. I mean, the fact that they had their origins in something called accident tolerant I don't think really is central to the finding that we have to make.

So I think, I just want to be honest about that expectation because we don't do Madison Avenue here. This isn't marketing, you know.

We will move forward under the framework that we have, and we will make the findings that we're required to make under law and that's what we'll do. So I know that's provocative. Victor, do you want to say anything or do you want C.J. to respond?

MR. MCCREE: Well, I think C.J. has responded. I hired C.J., so I thought we'd set him up that way. As you were asking, posing the question, Chairman, I know nothing in our regulatory construct that would require us to assert or affirm or even in our acceptance review that a design adds margin, nor is there a Commission policy that would compel a vendor to move in that direction for such a fuel design. Of course, there's policy in new reactor space that indicates that it's the Commission's expectation that there would be an increase in margin, safety margin, but I don't believe that translates to fuel designs.

CHAIRMAN SVINICKI: Okay. Thank you. Well, I didn't mean to end on such a dramatic note, but do my colleagues have any further questions? You're tempted. Okay, all right. Anyone? No. Okay.

All right. Well, I thank everyone again and also the panelists who joined us in the first panel. And, again, I compliment and thank the staff for their hard work, and we are adjourned.

(Whereupon, the foregoing matter went off the record at 11:59 a.m.)