UNITED STATES

NUCLEAR REGULATORY COMMISSION

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OVERVIEW OF ACCIDENT TOLERANT FUEL ACTIVITIES

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TUESDAY,

JANUARY 24, 2023

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The Commission met in the Commissioners' Conference Room, First Floor, One White Flint North, Rockville, Maryland, at 9:00 a.m. EST, Christopher T. Hanson, Chair, presiding.

COMMISSION MEMBERS:

CHRISTOPHER T. HANSON, Chair

JEFF BARAN, Commissioner

DAVID A. WRIGHT, Commissioner

ANNIE CAPUTO, Commissioner

BRADLEY R. CROWELL, Commissioner

ALSO PRESENT:

BROOKE POOLE CLARK, Secretary of the Commission

MARIAN ZOBLER, General Counsel

EXTERNAL PANEL:

BILL MCCAUGHEY, Director, Office of Advanced Fuel Technologies, Office of Nuclear Energy, Department of Energy

BRADLEY ADAMS, Vice President of Technical Compliance, Engineering, Southern Company, Member, Industry Accident Tolerant Fuel

Working Group

RICH AUGI, Light Water Reactor Fuel Product Director, Global Nuclear Fuel

JEFFREY BRADFUTE, Senior Vice President, Americas PWR Fuel, Westinghouse Electric Company

DR. EDWIN LYMAN, Director of Nuclear Power Safety, Union of Concerned Scientists

NRC STAFF:

DANIEL H. DORMAN, Executive Director for Operations

ANDREA KOCK, Deputy Office Director for Engineering, Office of Nuclear Reactor Regulation (NRR)

KEVIN HELLER, Nuclear Engineer, Division of Safety Systems, NRR

DAMARIS MARCANO, Chief, Containment, Thermal, Chemical and Fire Protection Branch, Division of Fuel Management, Office of Nuclear Material Safety and Safeguards (NMSS)

JAMES CORSON, Senior Reactor Systems Engineer, Division of Systems Analysis, Office of Nuclear Regulatory Research (RES)

ALICE CHUNG, Reactor Systems Engineer, Division of Systems Analysis, RES

P-R-O-C-E-E-D-I-N-G-S

9:00 a.m.

CHAIR HANSON: Good morning everybody. I convene this meeting to hear an update on the status and issues associated with the path to licensing accident tolerant fuels. It's important to keep the public informed of the agency's developments in this area of high interest, so I thank you all for supporting this meeting today, and I look forward to a great conversation.

We're going to hear from two panels this morning. First we'll, and we'll take a short break in between. First, we'll hear from a number of outside experts. With each panel, we'll hold the questions till the end. We have a lot of material and I know you all are enthusiastic, as is the NRC staff about this, so I do ask you to be mindful of the time so we can get to some good discussion between all of you and the Commissioners.

So with that, I'll ask my colleagues if they have any comments they'd like to make?

(No audible response.)

CHAIR HANSON: No? Hearing none, we will begin this morning with Bill McCaughey. He's the Director of the Office of Advance Fuel Technologies, and the Office of Nuclear Energy at the Department of Energy. Bill, the floor is yours.

MR. MCCAUGHEY: Thank you very much.

Thank you, Chairman Hanson, and your fellow commissioners for the opportunity to provide an overview of the Department of Energy's accident tolerant fuel program, and answer any questions that you may have.

Do we have the slides? There we go, next one, please.

Okay, so leading off the panel, I'll describe the participants within the accident tolerant fuel program, and also give you, frame the scope of the program. And then I'll describe the support that the Department of Energy provides industry.

Next. So the key to the success of the program is the constant communication, and the close coordination among the program participants. Industry leads the way with the concepts being developed by the U.S. fuel vendors, and that's guided by their customers, the U.S. utilities. They're supported by the Department of Energy, with the experimental facilities and subject matter experts we have at the National Laboratories.

The Nuclear Regulatory Commission is also in constant communications and close coordination with all the program participants. And then universities and our international partners make valuable contributions to the program as well. And this recent photo you see here was taken at our Annual Fuels Integration Meeting. More than 70 participants were on hand from represent, you know, representatives from all of those program participants you see listed on the slide there.

Next. Thank you. So to frame the program, we have, there is a sharp divide right now between the near-term, and long-term concept development. And that's due to funding limitations and also the industry's desire to prioritize the near-term concept development. The long-term concepts you see listed here will require more research and development, but they do have the potential to provide even greater performance benefits.

Now I did want to speak to the uranium enrichment as well. You did have a briefing on advanced reactor fuels last month. And the high-assay, low-enriched uranium was discussed quite a bit, and there were quite a few questions there. But for accident tolerant fuel, it only requires enrichment

between six, seven, eight percent to achieve the high burn up that's desired by the industry. And there's a key difference between accident tolerant fuels enriched to those levels, and advanced reactor fuel enriched to greater than 10 percent. Above 10 percent, there are additional requirements for nuclear material control and accountability, which includes physical security requirements. And there are additional costs associated with nuclear criticality, safety analyses, both the analyses themselves and also the, to implement the controls resulting from those analyses. So this is why high-assay, low-enriched uranium for advanced reactors requires government assistance to provide incentives for the industry, while high-assay, low-enriched uranium for accident tolerant fuels does not.

Next, please. So these are the test facilities that provide much of the data that industry needs to qualify their accident tolerant fuels concepts for use. And the Department of Energy has invested a great deal into experimental test capabilities at these facilities. The dedicated water loop at the advanced test reactor; a new loop being installed in the MIT reactor. Our refurbishment and restart of the transient reactor test facility. And the installation of the severe accident test station at Oak Ridge National Laboratory.

Now the severe accident test station's not a reactor, it consists of two modules. One for integral loss of coolant accident testing and one for beyond design basis accident high temperature testing. Both of these are in hot cells at the Oak Ridge National Laboratory, allowing for the testing of irradiated fuel samples.

Next, please. So we also provide support to industry with post-irradiation examinations. It's a major achievement and a credit to industry that we have installed lead test rods of accident tolerant fuel concepts in nine

commercial reactors at this time. The National Laboratories conduct post-irradiation examinations of the test rods discharged from these reactors, and shipped to them. The first shipments began in 2020 and they will increase in 2023 and beyond. Because of that, the Department is preparing a national shipping and PIE plan. And in order to make sure that future shipping campaigns are routine and that they are coordinated, the PIE is coordinated among the national labs that have that capability.

Next, please. So this is how it all comes together. This is how the constant communications, the close coordination, and investment in the state-of-the-art test facilities, and post-irradiation examination equipment come together to address the issues of importance to accident tolerant fuel development.

This issue is the potential for fuel fragmentation, relocation, and dispersal of high burn up fuel under large-break LOCA conditions. Idaho National Laboratory and Oak Ridge National Laboratory devised this test plan in close coordination with industry, the NRC, and Studsvik, which is the Swedish organization that conducted similar experiments in the past and is continuing to do so.

You can see at the little picture on the left, the report cover is the test plant. The one on the right is the comment response document, 25 pages. It's evidence of the commitment to coordinate closely with all of the program participants, and make sure we have the best test plan available to gather the data that's necessary to study this issue.

And, you see the little pictures on the right. That is the upper one is at Oak Ridge Lab. That's the severe accident test station I just mentioned. And, the bottom is the, actually, most of it is the experimental

device that the fuel samples would be loaded in and dropped into the TREAT reactor.

Next, please. So to summarize, communications, close coordinations are key, and we attribute the success of the program to that. And the current focus of the program is on coated cladding, and the doped UO_2 for the near-term deployments. Again, enrichment levels to achieve the higher burn up for the accident tolerant fuel can be obtained without government assistance in the accident tolerant fuel program, unlike what the advanced reactor developers need for the higher enrichment levels. And DOE supports industry's needs with its unique test facilities and state-of-the-art and examination facilities. And, thank you. Thank you, Chairman Hanson. Look forward to your questions later on.

CHAIR HANSON: Thanks very much, Bill. Really appreciate it. Next we'll hear from Brad Adams. He's the Vice-President of Technical Compliance Engineering at Southern Company, and he's a member of the Industry Accident Tolerant Fuel Working Group. Mr. Adams?

MR. ADAMS: Good morning. On behalf of our industry stakeholders, the Accident Tolerant Fuel Working Group appreciates this opportunity to brief the Commission on our strategic aspirations, recent accomplishments, and technical and regulatory developments of accident tolerant fuel, or ATF. We previously briefed the Commission in 2018 and 2020, and our message remains the same. ATF represents an innovation with significant potential to not only enhance nuclear safety, but also improve plant economics.

The January 2019 Nuclear Energy Innovation and Modernization Act, defines ATF as a technology that 1) makes an existing

commercial nuclear reactor more resistant to a nuclear incident; and, 2) lowers the cost of electricity over the license lifetime of an existing commercial nuclear reactor. The industry has embraced this Congressional direction and is developing diverse and innovative technologies that enhance our resiliency to nuclear events, and improve economic viability of our commercial nuclear assets for years to come. It is important to emphasize that these are not mutually exclusive concepts.

The suite of technologies includes near-term and longer-term solutions that are being developed with strong Congressional support through DOE-administered awards. The ATF working group was established in 2016 to coordinate industry's licensing, research, policy, regulatory, and communications activities. The working group members include utilities, all fuel vendors, licensing and engineering support organizations, and the Electric Power Research Institute.

Next slide, please. The industry, through the ATF Working Group, has translated the Congressional direction into a set of strategic aspirations to align and guide the ATF stakeholder community, towards sustainable commercialization of these bold innovations. In addition to the opportunity to enhance safety and resiliency, the most impactful benefit we have identified from ATF technology advancements, is the enabling of greater fuel utilization through increases in burn up and application of slightly higher enrichments. With enhanced accident tolerance and operational resiliency enabling this continued evolution in fuel utilization, the industry fundamentally believes that we can reduce the cost of electricity for the existing nuclear fleet.

Further, ATF technologies improve the economic case for complimentary asset enhancements, such as power uprates, or cycle

extensions while preserving and enhancing safety. The future sustainability of our U.S. nuclear fleet depends in part, on the industry's ability to timely deploy innovative technologies like ATF, which will allow plants to remain economically competitive with other rapidly advancing energy technologies. Achieving the regulatory framework and licensing infrastructure in the mid-2020s, enables predictable outcomes that are required before a sustainable commercialization with broad adoption of these technologies by utilities will be achieved.

Next slide, please. With the strong support investment from Congress and DOE, the industry has achieved significant advancements of fuel technologies on timelines that were never believed to be possible in the past. Commercial reactor radiation of lead test rods began in 2018, and continues to progress across all three fuel suppliers with a spectrum of ATF technologies.

As ATF technologies have matured and commercial testing programs have ramped up, the ATF program is at an inflection point where the complexity of our licensing interactions has grown. This complex approach with exemptions and cycle-specific license amendments, generates greater uncertainty for licensees, which is not viewed as sustainable for broad commercial adoption of re-load quantities of ATF attributes.

The recent regulatory engagements of the Plant Vogtle ATF lead test assemblies with increased enrichments, and the Byron ATF higher-burn up program, are two examples that highlight the increasing complexity of recent licensing interactions. We believe each of these programs can affirm that we can move forward within the existing licensing framework with license amendments and exemptions. However, realized uncertainties and inefficiencies reinforced the need for more modern ATF technology, including optimization of the regulatory framework.

The industry would like to take this opportunity to highlight the effectiveness of recent interactions, such as pre-submittal meetings and audits with the NRC staffs in our efforts. We recognize the resource-intensive nature of these advanced ATF licensing interactions, and we appreciate the NRC staff's professional and effective engagements with the industry. We believe that it is critical that the staff continues with themes laid out in the project plan. Likewise, we ask that NRC continue to support fee exemptions for generic regulatory activities that promote efficient, stable, and predictable licensing.

Next slide, please. The industry is focused and coordinated on deploying the near-term ATF concepts with increased enrichments, and higher burn ups, and seek an efficient, predictable, and durable regulatory process to support this deployment. The next few years will be decisive on whether large-scale deployments of ATF technologies will occur. Outcomes depend on creating an efficient regulatory framework that can support licensing near-term ATF technologies, including increased enrichments and higher burn ups.

While an industry-phased approach with exemptions to existing regulations and a licensee specific basis to demonstrate compliance with safety requirements moves us forward, we should recognize this unsustainable burden that that places on all stakeholders, including the NRC. A modern, streamlined, holistic, and technology-neutral regulatory framework is essential to providing efficiency and predictability, that enables the capital investments both at fuel suppliers and the utilities, to broadly adopt ATF concepts.

The industry appreciates the recent momentum and the proposed rulemaking for increased enrichments. We see even greater

opportunity to look at the full suite of near-term ATF attributes. For example, burn up, and consider the need for modern rulemaking and updated regulatory guidance to support efficient and predictable reviews in the future.

ATF innovations offer a new paradigm of opportunities from the traditional fuel technology evolutions. These higher performing fuels can improve resiliency, increase fuel efficiencies, reduce the amount of waste generated, and improve plant economics. Furthermore, ATF technologies compliment or enable asset enhancements, such as power uprates and 24-month fuel cycles, to generate more carbon-free electricity generation with existing assets.

We look forward to further engagements over the coming months and years, to modernize the regulatory infrastructure to enable efficient and predictable license engagements with the staff. With the continued support and leadership of Congress, our DOE partners, and the research community, we believe the industry is up to the challenge of moving forward. Thank you very much.

CHAIR HANSON: Thank you very much, Mr. Adams. Next, we'll hear from Rich Augi. He's the Light Water Reactor Fuel Product Director at Global Nuclear Fuel. Mr. Augi?

MR. AUGI: Good morning, Chair Hanson, and Commissioners. On behalf of the GE-led team, we thank you for the opportunity to be here today, and to provide a briefing on our ATF program and overall readiness.

Next slide, please. The GE program is multi-dimensional and focused on several cladding technologies, motivated to substantially strengthen fuel performance under accident conditions. Our ARMOR and IronClad

technologies, and the companion higher enrichment and high burn up aspects that bring a variety of benefits to the industry and promotes industrial application of ATF fuel.

So the goal of the program is to develop ATF technologies that further strengthen safety through resistance to high temperature steam, improve the durability of the fuel during normal operation, and also provide economic benefit. One of the substantial long-term benefits of the DOE's ATF program is the industrial collaboration. We judge that the ATF initiative has resulted in a more cohesive and effective multi-stakeholder group, pertaining to fuel and the reactor core.

We are working with multiple partners across industry from GE research to the National Labs, to utility partners Southern, and Constellation. And we expect those benefits to persist into the long term.

Next slide, please. ARMOR stands for Abrasion Resistant More Oxidation Resistant. This is our coating that would be applied to existing Zircaloy cladding. The benefits from ARMOR will be resistance to high temperature oxidation, protection against debris fretting, and improvements to thermal margins.

IronClad is our iron chrome aluminum cladding. GE conducted research into this family of iron-based alloys in the 1960s, and it still remains a promising candidate. This would be a complete replacement of Zircaloy cladding. Testing shows that IronClad enhances debris fret resistance, and exhibits a significant reduction in hydrogen generation resulting from a severe accident.

Note that the natural concerns over increased absorptions in the cladding resulting in increased fuel costs have been largely mitigated. The

properties of IronClad support a thinner cladding, and we see an IronClad fuel system that is cost neutral with today's Zircaloy clad fuel system.

We've been successful in installing and operating lead test assemblies of both ARMOR and IronClad at Plant Hatch and the Clinton Power Station. And have successfully transported irradiated material from Plant Hatch to the Oak Ridge National Lab. These early installations and ongoing examinations provide key performance information, needed to drive technologies to industrial application.

Higher enrichment up to eight percent enriched uranium, and high burn up, can be viewed as a set. The benefits of high burn up motivate higher enrichment, and higher enrichment enables higher exposure. But they are largely distinct. One principal motivation here is to improve fuel cycle economics, providing an offset to the expected higher cost of ATF technologies. But also reduces used fuel volumes, and can enable even longer refueling intervals than 24 months for the existing BWR fleet.

The nuclear provisions of the Inflation Reduction Act, are a motivating and renewed look at power uprates. We have a long and successful history of uprating boiling water reactors, and higher enrichment and high burn up are synergistic with the next era of power uprates that tend to drive peak exposures higher and desire higher enrichments.

Pertaining to the next step in exposure, the industry is responding to the evolving view on both FFRD, and approaches to dose and source term evaluations. While there are many common interests and concerns between PWRs and BWRs, there are some differences in these two. BWRs tend to be less sensitive to FFRD, owing to differences in LOCA response. But BWR, being a direct cycle system, may be more sensitive to the

manner in which dose evaluations are performed.

We see the ATF program as a vehicle to apply risk informed thinking to decision making. We also continue our work on ceramic nature composites, alternate ceramic fuels, and engineering methodology improvements.

Next slide, please. Looking at the timeline for our focus technologies, we view ARMOR and higher enrichment and higher burn up as being in the first generation of ATF development deployments, with IronClad being a second generation as it represents a larger change. For ARMOR, we're working towards another round of lead test assemblies, along with testing in the I-Loop that is intended to simulate BWR conditions in the advanced test reactor at INL. ARMOR licensing activities are expected to be later in the 2020s.

Higher enrichment and higher burn up has been more of a focus. We've been setting up the infrastructure to support this product through engineering method submittals over the last 12 months, along with facility and transport container submittals to increase the enrichment up to eight percent. This work will continue over the next 12 to 18 months, with three more submittals planned.

And I do want to highlight here the benefit of pre-submittal application meetings. We've been using those as part of each of our submittals and find them to be a very valuable tool. Our experience in working through these submittals with the staff has been very healthy.

As far as IronClad, we continue to develop this technology, gathering data from lead test assemblies, and working towards another round of leads in the coming years. Licensing for IronClad will be later in the decade,

and will go into the early 2030s.

Next slide, please. We've been working with Oak Ridge to develop iron chrome aluminum variants, to perform a myriad of tests on both the ARMOR and IronClad, and on the post-irradiation examination of the Hatch armor rods, and now the IronClad rods that have come out of Hatch. We'll continue our relationship with Oak Ridge, as we are working to harvest the next round of IronClad rods from Clinton this year. And we expect periodic shipments evolving after this current phase as well.

At the Idaho National Lab, the ATR has been busy irradiating fuel rod prototypes, and the hot cells have been examining both ARMOR and IronClad. This work is anticipated to continue with future variants of each technology.

We've also been partnering with Los Alamos, for the study of advanced fuel ceramics, and we are working with the Nuclear Energy Advance Modeling and Simulation team, to perform advanced modeling of IronClad material to accelerate material property development.

Next slide, please. Once again, I just want to thank the DOE for their support of the ATF program and their leadership, and thank the NRC and our colleagues at INL, Oak Ridge, and Los Alamos, that have been working closely with the GE team as we move forward with ATF.

We are very excited about the future of accident tolerant fuel and where it will lead. And we see ARMOR as our near-term ATF concept, and IronClad as the next generation cladding. Both of these technologies will be enhanced by the application of higher burn up and higher enrichment.

There is still more work to do to take these concepts to fully commercial products ready for the market, and we look forward to working with

the NRC as we move forward. Thank you.

CHAIR HANSON: Thank you, Mr. Augi. Next up we have Jeff Bradfute. He's Vice-President, America's Fuel Delivery for Westinghouse Electric Company. Mr. Bradfute?

MR. BRADFUTE: Good morning. Westinghouse greatly appreciates this opportunity to brief the Commission on the elements of our EnCore accident fuel program. The suite of ATF products being developed support both, support both near-term goals, and enhance plant economics, as well as product features with longer term development timelines that may benefit both LWR and advanced fuel technologies.

With support from DOE, National Labs, NEI, EPRI, utility partners including Southern Nuclear and Constellation, and the NRC, we have made significant progress developing our near-term and long-term ATF features, and have implemented or planned irradiation programs with research reactors, and utility partners to assess performance, and obtain data for model validation. In parallel, we are updating codes, methods, fuel and shipping topicals, in support of ATF, and high-energy fuel licensing.

Next slide, please. Westinghouse's EnCore program is comprised of advance cladding and fuel pellet features designed to improve margins and enable higher burn up. Our advance claddings include cold spray chromium coated zirconium for near-term implementation, and SIGA, silicon carbide, a General Atomics product being developed in partnership for longer term applications.

Our advanced fuel includes ADOPT UO_2 dope pellets for near-term implementation, and high density, high conductivity uranium nitride fuel pellets for longer term. The NRC safety evaluation report for ADOPT

pellets was received in 2022, and the first PWR region implementation in the U.S. will occur in 2025. Once chromium coated cladding and ADOPT are approved for higher burn up and higher enrichment, utilities with higher power density plants, will be able to implement 24-month cycles, power uprates, or a combination of the two with improved margins and improved plant economics.

Next slide, please. Westinghouse achieved significant milestones across its ATF program in 2022, and is now focused on maintaining this momentum into 2023. The items shown in red denote program milestones tied to the U.S. NRC. I commend the NRC for their responsiveness and professionalism and their approvals and acceptance reviews, also enhanced by pre-submittal meetings.

Important 2022 milestones include the topical submitted for the extension to 68k megawatt-days per MTU; the final Safety Evaluation Report for ADOPT; our cold spray chromium coated technologies down selection; and, Vogtle and Byron LAR submittals for greater than five way percent anti-burn up.

For 2023, we will continue our work on both near-term product developments related to the Vogtle-Byron LTAs, and topical submittals. We will also continue our work on the long-term development milestones related to NROD sensors, uranium nitride pellets, and the General Atomic silicon carbide SIGA cladding concept.

Next slide, please. Westinghouse initiated its first ATF lead test for our program in 2019 at Byron Station that includes a limited number of chromium coated peripheral rods, with ADOPT pellets. Visuals and poolside exams of these rods after one and two cycles, showed excellent performance with respect to corrosion, growth, and grid-to-rod fretting.

Three one-cycle rods were shipped to Oak Ridge National Lab in 2021, and two discharged second cycle rods had been prepared for insertion in the fall of '23 to achieve greater than 75,000 megawatt-days per MTU by the spring of 2025. A Belgian Doel 4 lead test program with chromium coated rods, has shown similar good visual results.

ATF LTAs utilizing chromium coated ADOPT rods in all assembly rod locations, and a limited number of greater than five weight percent, chromium coated ADOPT rods will be manufactured by the fall of '23 for Vogtle Station. Chromium coated ADOPT test rods are also planned for an EDF reactor in the same timeframe. These programs are critical to confirm expected performance and obtaining data for model validation and licensing.

Next slide, please. Recent post-irradiation exams of the one-cycle ATF rods sent to Oak Ridge from the Byron campaign in '21, had excellent results. Importantly, the chromium coating integrity was excellent, with complete protection of the underlying zirconium substrate, and a significant reduction in corrosion and hydrogen pickup in the coated sections relative to the uncoated sections was measured. Additional ATF and high burn up shipments are planned to both Oak Ridge and INL.

Next slide, please. In addition to ADOPT pellet topical approved for use with current enrichment and current burn up limits, Westinghouse has also received approval for the PARAGON2 to the IELTS physics code for up to 10 weight percent and the travel of fuel shipping container for enrichments exceeding five weight percent, U-235.

Our ATF high enrichment, high burn up program is developing the codes and methods that will be required to address fuel fragmentation, relocation, and dispersal, and enrichments above five weight percent for NRC

licensing. These topical submittals are planned for the ‘23-‘25 timeframe and will address coated cladding, high enrichment and burn up, along with codes supplements for fuel performance and safety analyses.

Next slide, please. So in summary, Westinghouse is making good progress on all fronts for the implementation of ATF fuel product features, that will enable high burn up using greater than five weight percent fuel.

As noted, the ADOPT fuel pellet topical and near-term region application, the lead test assemblies being prepared for insertion in 2023 at the Vogtle Station, along with high burn up lead rod insertion at Byron for greater than 75,000, the PIE testing that's underway with good results to date, and more planned.

The required topical reports are all under development and being prepared for submittal in the ‘23-‘25 timeframe. With an ATF regulatory framework established that promotes efficient, stable, and predictable licensing, U.S. utilities will be positioned to make final enterprise-wide decisions regarding the introduction of these product features, that enable efficient operational strategies through end of license life. Thank you.

CHAIR HANSON: Thank you very much. And finally, we're joined online by Dr. Edwin Lyman. He's the Director of Nuclear Power Safety at the Union of Concerned Scientists. Dr. Lyman?

DR. LYMAN: Yes, good morning, thank you Chairman and Commissioners. And I apologize for not being there in person today. I'm pleased to present the views of the Union of Concerned Scientists, on the important subject of accident tolerant fuel.

Next slide, please. UCS is strongly supportive of efforts to develop fuels that would genuinely increase safety. But unfortunately, even

though we had high hopes for this program at the beginning, it is becoming increasingly clear that it is not accurate to call what's going on now, a development of accident tolerant fuels. And, that that is actually a distortion of the original goals set by the program and what I believe taxpayers are hoping to get out of funding for development of these fuels.

It's clear now because of the economic link between ATF technologies and higher burn up, and increased enrichment, that the NRC staff have now consider those components all part of the ATF program. And I think it's also clear from the industry participants today, that ATF features are only going to be considered for the future, in connection with what they consider economic advantages, including higher burn up and as we hear now, power uprates. And, this raises a strong possibility that whatever safety margin is going to be acquired from the accident tolerant features, may be completely consumed or even outweighed by the increased uncertainties associated with going to the high burn up regime.

Next slide, please. So it's clear that even for the near-term concepts like the chromium-coated cladding, there is still uncertainties and trade-offs, and it's not completely clear that they are going to deliver all the safety benefits that have been promised. The NRC's reviews as part of the process, especially with regard to severe accident risk, has pointed out that there are still uncertainties in the data, concerning things like fission gas release during normal operation. Also, the lack of data for the behavior of ATF concepts under severe accident conditions. Now hopefully, that will be remedied by the excellent research program that we heard about from DOE, but that's going to take time. And, all the analyses so far have indicated that there's only going to be a modest increase in coping time, associated with any of the

concepts that have been studied. The bigger benefit is reduction of hydrogen generation, which is clearly important, but again, the additional uncertainties and accident risks associated with pushing the fuel to a burn up regimes, now power operates beyond current limits, could again possibly outweigh that benefit.

Next slide, please. And in particular, we are concerned about the industry's approach to addressing fuel fragmentation, relocation, and dispersal. My understanding is that the Electric Power Research Institute is, and industry is pursuing an approach which would essentially allow a entire class of events to be excluded from consideration for this phenomenon, which could pose severe accident challenges in the high burn up regimes.

And the industry is already dealing with high burn up issues, even under the currently licensed limit of 62 gigawatt-days per ton. You just have to look at the Susquehanna tube reactor, and the issues they're having with control rod friction, due to high burn up problems in the ATRIUM 10 fuel assemblies to know that this is already a current issue. So trying to push burn ups even further without resolving the issues that exist at the current limits, I think is a great concern.

Now, it is good to hear that DOE is planning the actual accident testing for FFRD. But again, that data's going to take a long time to be acquired. And I would also note that the NRC's, the process that they conducted did not look at ATF concepts, and increased enrichment higher burn up in the same context. They didn't consider the synergies between them. The staff has informed me that they don't believe that's necessary, but I think until that study is actually done, it would be hard to make that conclusion a priori, given that the issue we're considering here is whether those accident tolerant

fuels concepts, would actually enable pushing burn ups and power uprates to regimes that are not currently allowed or considered safe.

Next slide, please. Another aspect that I don't think is getting adequate attention is the impact of any of these technologies on long-term fuel management. As I discussed at the last meeting, I was part of the National Academy of Sciences panel that looked at advanced reactor fuel cycles. But their conclusion with regard to spent fuel is the same as it is here. That there should be, that they back end management issues should be given the same priorities as those associated within reactor operation, because who knows how changes to cladding fuel materials and fabrication methods could affect the management of spent fuel over the long term and dry storage, for example. So that needs to be an integral part of the program.

Next slide, please. And finally as I've pitched at every meeting on this topic so far, the 50.46c rulemaking is the necessary but not sufficient condition for I think moving forward with a, the kind of holistic regulatory regime that we heard from Mr. Adams, with whom I'm in violent agreement. But I do think there does need to be a consistent approach for addressing the safety of different fuel and cladding types, for loss-of-coolant accidents, as well as the entire suite of other accidents that could be affected. And on simply approving 50.46c I think would go a long way toward closing that gap.

Next slide, please. Yes, and so that concludes my remarks and I look forward to your questions. Thank you.

CHAIR HANSON: Thank you, Dr. Lyman. We'll begin questions this morning with Commissioner Crowell.

COMMISSIONER CROWELL: Thank you, Mr. Chair. So I'm

going to hopefully start with a softball question here, either to Mr. McCaughey, or Mr. Adams. If I were an average citizen living in proximity of a nuclear plant that was considering using accident tolerant fuels, I could probably sit here today and discern the economics, economic benefits of doing so. I don't know if I could discern the safety case. So could you give a, take a shot at giving me a laymen's, layperson's version of why the safety case for accident tolerant fuels is persuasive?

MR. MCCAUGHEY: Go back to the origins of this program, and post-Fukushima. What we did was we got together the fuel vendors and the laboratory experts and said, what, we were directed by the, by Congress to develop accident tolerant fuels. And so we got the experts together and said well, what attributes of this fuel would be necessary to make it more accident tolerant?

And it's the same, what we have today is the same, are the same types of fuel improvements that would reduce, reduce the, or improve the oxidation response in a severe accident at high temps with steam. Reduce the hydrogen generation, so you don't have hydrogen accumulating in explosive quantities. Limiting the fission product release, the fission gas release. These are all things that are attributes of coated cladding, doped U, and the doped UO_2. And, then the long-term concepts offer even potential for greater benefits than that.

So people talk about you know, in the beginning there was a lot of, there was a lot of hope for long, long time period, longer time periods of coping, coping time, which were over estimated, but that doesn't mean that this current, these current fuel concepts that we're developing are somehow deficient.

It think what we find over time also, is that there are other safety benefits. It's more than just a Fukushima-type accident that, where we'll see performance improvements. It's a whole range of accidents. It's normal operations. There are a lot of, there's a lot of issues out there that this type of fuel would, would help.

COMMISSIONER CROWELL: Thank you. Mr. Adams, if I lived near Vogtle, why should I feel better about this?

MR. ADAMS: It's a really good question. I would tell you that I think it comes down for the public, you know, what the public sees, they see containment. They see security. They see emergency planning zones and criteria.

And when you look at this concept, you know, our current design is based on almost the immediate release of the source term in a nuclear, you know, hypothetical accident. Anything that we can do with respect to the fuel that delays, reduces, or even potentially eliminates, and Mr. McCaughey talked about you know, the, maybe that was an overestimate at the time. But anything we can do to delay or, or reduce that source term has a significant impact on nuclear safety.

And I think that's explainable to the people that live, live close to the plants and the general public. And I think we can do a better job as an industry in terms of explaining that to folks. They understand the economics, I'm sure, but that part of it, I think, is something that we need to do a better job on.

COMMISSIONER CROWELL: Kind of like you know, the buy more time to address an incident if it happens.

MR. ADAMS: That's correct.

COMMISSIONER CROWELL: Okay. So the operational components of accident tolerant fuels is one thing. But I want to talk about the full fuel cycle here real quick. And Mr. Augi, I think you referenced the back end briefly, so I'll toss this to you and Dr. Lyman, if you want to jump in as well.

But tell me about the pros and cons of the back end of the fuel cycle for accident tolerant fuels. Is it truly less, less waste produced, and if so, is the lower volume of waste of higher or lower radioactivity say, then traditional high level waste? Is it, is the relative half-life different that traditional high level waste? Like, what are the advantages on the back end?

MR. AUGI: So with the near-term technologies, coated claddings, the industry has been working with EPRI through the transport group and the extended waste disposal group and do not see a major issue there. There is some difference in the treatment of the coated claddings, but it is minor in terms of long-term waste.

The benefit is really going to come from the higher enrichment. So when you can get to higher enrichment and higher burn up, you can reduce the batch fraction. So you're putting in less fuel assemblies, which will mean less waste on the back end. And that's where the real benefit's going to be, is the ability to reduce the number of assemblies that will have to go into long-term storage.

COMMISSIONER CROWELL: And I'm not an expert like others in the room on this, but if you're using higher enriched fuels with a higher burn up rate, is the resulting smaller volume of spent fuel more challenging to deal with, or less challenging to deal with than traditional spent fuel?

MR. AUGI: I cannot answer that question. I would look to some of the others in the room.

COMMISSIONER CROWELL: That's fine, and I can, I'll reserve it for the next panel, which hopefully the NRC staff can weigh in on. It's an area I think probably needs more research and I'll press on it in the next panel, as well. But Dr. Lyman, did you want to add anything on this front?

DR. LYMAN: Yes, just to point out yes, if you have longer fuel cycles and you generate less volume of spent fuel but it's at higher burn up, the fuel assemblies themselves are going to have higher quantities of fission products. The quantity of fission products generated is related to the amount of power generated, not the volume of spent fuel.

So, and the other issue is the uncertainties associated with high burn up that have been seen with current fuel types. And the issues associated with the cladding embrittlement and dry cask, long-term dry cask storage. Those issues are only beginning to be understood, I think with the current fuels where there's already real time evidence to be collected.

So, changing cladding and fuel types that are going to introduce uncertainties, will require additional research, I think.

COMMISSIONER CROWELL: Thank you. And, I just have one more question and I'm going to stick with you, Dr. Lyman. As pointed out I think by Mr. Adams, you know, NEIMA does call for looking at both the safety aspects, as well as the economic aspects of accident tolerant fuel.

Dr. Lyman, in your presentation, you mention a number of you know, shortcomings in this area that need to be further explored, but you shared the larger goal. If you had to identify one area that is most important for getting right, or bridging the gap on accident tolerant fuels, what would you highlight for that most important thing?

DR. LYMAN: Well, I would highlight, and I think going back to

the original goal, and that's improving the safety of fuels as they're currently, at this point.

And there are uncertainties, you know, that have not been resolved with regard to the burn ups that are currently approved, with regard to LOCA performance, with regard to the reactor reinsertion accidents, and now with FFRD, which can occur at burn ups that are currently approved. So I would say stepwise, you should be developing fuels toward addressing or reducing the risks that are at currently licensed burn up limits, before you start contemplating pushing the fuel to higher burn up regimes, where you're going to increase the uncertainty again that potentially cancel out the benefit of additional safety margins. So I know NEIMA contemplated achieving both at the same time, but I'm worried that one is occurring at the expense of the other with the current approach.

COMMISSIONER CROWELL: Understood, and I appreciate your perspectives. That's all I have, Mr. Chairman.

CHAIR HANSON: Thank you, Commissioner Crowell. One of the themes that I think that emerged in kind of the conversation this morning, is kind of the balance between regulatory development and research activities. Right, if you have regulations that maybe get out in front of the research, it may be some folks may perceive that as you know, insufficiently risk informed.

If you've got research that kind of gets out in front of the regulatory development, then the regulations can potentially hinder the deployment of technologies. So kind of around that theme that I think is pretty relevant here, Mr. Adams, let me start with you.

In your discussion, you talked, you know, you highlighted the importance of a more streamlined regulatory infrastructure. I certainly am

supportive of what's been called, I think. by John Williams at Southern, regulatory line of sight. For some of these technologies, I think that's really important. And you talked about a holistic modernized, technology neutral performance base. So you know, what specific regulatory issues do you think the NRC should be looking at in this context?

MR. ADAMS: Well, the industry needs certainty. The industry and the fuel vendors particularly need certainty. And, so the regulatory approach that we advocate is one that is obviously risk informed. And we understand that there are you know, the rule making that's out there on 50.46, you know, is currently under, under review. And, that has been out there for quite some time. And there are some aspects of 50.46 that we think are positive.

But in general, it wasn't developed in an age of being risk informed. And our belief is that we should take the positive aspects of that, and along with the other review and analysis, and attributes of accident tolerant fuel and come up with a new strategy that allows us to take advantage. And it needs to be technologically, technology-neutral so that we advocate for all of the various you know, forms of ATF technologies that are out there. So that's really what we're looking for in the future, so.

CHAIR HANSON: Interesting. That kind of tee's off of one of my other questions is my understanding, obviously I wasn't here, but something on you know, 10 years ago there was a draft final rule that would have provided a risk informed pathway on 50.46 requirements. And the initiative was terminated at the time I think, because of you know, kind of fact of life and industry changes. Conditions may be different, but does the industry have a view on whether this rulemaking should be revisited?

MR. ADAMS: I guess I would look to my friends behind me at NEI to be able to provide that, so.

CHAIR HANSON: All right, Al, do you have anything that you would like to add to that?

MR. ADAMS: Yes, phoning a friend. It's important. Yes, I think you're on.

MR. CSONTOS: Okay, Al Csontos, Nuclear Energy Institute. I think you're referring to the 50.46a rulemaking. I think that's the 10 years ago rule, and that was a risk informed activity to, risk-inform LOCA criteria for 50.46.

I think there are parts of 50.46a, and parts of 50.46c, that combine together with the increasing enrichment rulemaking that you have right now before you, or that's being developed by the staff. I think the combination of all those with the ATF features, because there are some ATF features that really mitigate against some of the issues that we identified in 50.46c. And, some of those that we agree with on the industry side.

So in respect with all of those, there is an approach here that we think could be taken with 50.46a (parts of it), 50.46c (parts of it). The increased enrichment rulemaking and ATF features combined together, could become a really powerful rulemaking for the future to make a streamline path for not just one ATF feature or concept, but all the technology, being technology neutral and performance based. You can then focus it on what it is that you expect from those fuel technologies. Not specific and deterministic and prescriptive to one or another type of concept.

CHAIR HANSON: Okay, thank you. I appreciate that. In the near-term though, Mr. Adams, does industry believe there is sufficient clarity on the regulatory process for lead test assemblies used to qualify ATF and other

new technologies?

MR. ADAMS: We do with the caveat that as we have gotten into the programs, it feels like it's gotten more complex and difficult to wade through. We have been working with the staff quite effectively, I believe, in terms of this. But the deeper we get into the programs, and this is not just my experience but you know, collective experience from others that have, that have participated in the lead test assembly programs and whatever, that it's become more and more complex.

And, so there is some concern there. And really from the industry standpoint, we really need clarity to really continue to focus this on the long term, so.

CHAIR HANSON: Okay, thank you. Mr. McCaughey, I was really interested to hear about the LOCA experiments that DOE is planning. And any you know, effort you know, the foundation of any effort to kind of risk informed our regulations really has to you know, has to rest on, on data.

And so you know, how does the timing of those LOCA experiments then kind of compare with the you know, licensing time frames either by utilities or by fuel vendors? And then also, are and I'll ask the NRC staff a little bit about this later, about you know, the timing's kind of laid out in our ATF project plan.

MR. McCAUGHEY: Well, I could tell you about the timing of the experimental test plan. Starting this year we'll be doing commissioning tests at both the severe accident test station and commissioning test. We'd be sort of calibrating the devices with the reactor and with the -- to make sure that we can -- that the -- it's predictable, it's working the way it should. And we factor that into our modeling codes and the modeling and simulation to make

sure that when we do put the actual test articles in the reactor we're getting meaningful results and we'll understand those results. So that's all happening this year.

The real test and there's a series of nine of them, will start in 2024 and run for three years, two or three tests a year. And they will be dual tests. We'll be using the same samples at both the severe accident test station and at -- and the TREAT reactor. And so this will go on until 2027, but we start getting results right away. So it will be very informative from the start, as soon as we get the first test. It kind of builds -- we'll be building on it.

How that dovetails into industry's plans and the regulations and the data that's needed is yet to be determined. I think what I've heard is that we're not going to have everything tied up in a nice, neat bow before we begin to try to get the benefits out of this fuel. So it could be an incremental process by -- on the part of industry.

CHAIR HANSON: Okay.

MR. McCAUGHEY: Yes.

CHAIR HANSON: Thank you. Mr. Bradfute, related of course to the LOCA analysis is this resolution of the fuel fragmentation, relocation, and dispersal issue. So I wondered if you could say maybe a little bit more about how Westinghouse is involved in resolving that issue and getting -- kind of accumulating the right data that we need.

MR. BRADFUTE: Thank you. Yes, so certainly we're heavily involved with NEI and EPRI with the activities going on with this -- addressing FFRD, but our PIE programs are really producing the material that will ultimately provide additional data at INL that will help quantify the effects of FFRD at the high burnup and hopefully resolve some of the questions that exist

in that regime.

CHAIR HANSON: All right. Thank you very much. Commissioner Baran?

COMMISSIONER BARAN: Thanks. Well, actually I'm interested in following up and staying on that topic because it's one of the key issues, I think. On FFRD, maybe just to broaden it to the whole panel, I'm interested for whoever wants to weigh in on what research and testing needs to be done in this area. And then overall how you think applicants at NRC should address the FFRD issue. Any folks want to weigh in on that?

Bill, can you talk a little bit about -- in terms of the testing that DOE is working on how that relates to FFRD?

MR. McCAUGHEY: So FFRD, it's a complex issue. There have been tests done before at -- I mentioned Studsvik. There is a limited number of tests that the NRC cites in their regulatory information letter on the subject. And what we're trying to do is to provide controlled tests that are well characterized, that will be prototypic of what you would expect in the U.S. reactors, and make sure that these tests are providing results that are prototypic.

There are many aspects to fuel fragmentation, relocation, and dispersal. We're looking at the cladding, the ballooning of the cladding, the size of the breach and of course, then the characteristics of the high burnup fuel inside, sizes. But we also then have to look at the relocation and dispersal aspect of this. And so, where is it going to go and what are the consequences?

So there's many aspects to this issue and we're -- and so there are also, aside from this big LOCA test that I was showing you, we have many other efforts going on that we would call separate effects tests of, gee, if

we had this kind of fragmentation, where would it go? We can do tests outside of the reactors and at labs, even at universities. And we're doing that sort of thing as well.

COMMISSIONER BARAN: Okay. Any other thoughts on FFRD?

MR. BRADFUTE: Just to add, in addition to testing we're also focused on the alternative licensing strategy to really quantify the low probability of having that condition and seeing how that would factor into risk-based rulemaking.

DR. LYMAN: (Audio interference) --

CHAIR HANSON: Oh, go ahead. Go ahead.

DR. LYMAN: Sorry. If I could just, right, so as I said in my talk, I don't think at this stage -- and so my understanding is that that alternate strategy would essentially take a whole class of events, I guess large break LOCA, and exclude them from not needing to consider FFRD. And there seems like there are both technical and policy issues involved in that kind of decision, and the staff has raised some concerns with that. And I would share them. I don't think given the potential serious consequences of this event that it would make sense to take a whole class of events where it could be the most significant at consideration. Thanks.

COMMISSIONER BARAN: Okay. Thanks. Topical report reviews are an important aspect of licensing new fuel designs. We've been talking a lot about the regulatory framework and the topical reports are a key part of that. I'd be interested in hearing any perspectives on how the topical report reviews have been going. Any thoughts on that?

MR. AUGI: Sure. So GE's had multiple topical reports that

have been submitted. The reviews are going well, we feel, it's been good interactions with the staff. The timeliness has been what the staff is committed to. So we see that continuing; no reason that it would not. That's across our engineering methods and our facility license, and our transport and container license also.

COMMISSIONER BARAN: Okay. Jeff, any thoughts?

MR. BRADFUTE: I'd just echo that view and also note that we have annual performance update meetings with the NRC that allows us to step back and give the full picture of all the activities that Westinghouse is working on and where that interfaces with the NRC. So I think that in combination with the specific topical submittals, pre-submittal meetings is very helpful.

COMMISSIONER BARAN: Great. Following up on the conversation earlier that you were having with Commissioner Crowell on safety benefits, increased accident coping times, reduced hydrogen generation, can you give us -- do we have a good sense now of the quantification of those likely benefits? And if not, do you have a sense when the process we would have a better sense of what kind of improved coping times we'd see, what kind of reduced hydrogen generation, other safety benefits?

MR. AUGI: So for our IronClad technology we've -- anticipating about a 40-percent reduction in hydrogen --

COMMISSIONER BARAN: Okay.

MR. AUGI: -- is what we're predicting.

COMMISSIONER BARAN: Yes.

MR. BRADFUTE: I was going to ask Aziz Kerudis our Chief Engineer make a few comments.

MR. KERUDIS: Aziz Kerudis from Westinghouse. We've been doing a lot of testing and we're sending the rods to a hot cell at Oak Ridge, for example, and we are definitely seeing an improved corrosion benefit and also reduced hydrogen intake into the cladding due to the coating. And the coating is a harder surface, so good dry fretting -- there's a good dry fretting benefit. And we have proof of that by taking the bundle apart and looking at the rods. And so we're seeing benefits in quite a few places.

The coating actually provides a benefit in terms of protecting the cladding for high temperatures and you could even -- maybe even go into DMB-type conditions and see quite a bit of protection. So we'll begin to collect a lot of data, and of course a lot of that data will go into our topicals and so should support a lot of the benefits that we're talking about.

COMMISSIONER BARAN: Okay. Thanks. Any other thoughts on those issues? (No audible response.)

COMMISSIONER BARAN: All right. I'll turn back over to you, Chair. Thanks.

CHAIR HANSON: Thank you very much, Commissioner Baran. Commissioner Wright?

COMMISSIONER WRIGHT: Thank you, Chair.

Good morning and it's been a very informative panel, so thank you for being here. And for the record, Jeff lives not far from me in Columbia.

(Laughter.)

COMMISSIONER WRIGHT: So, Brad, I'm going to come back to you here. Southern's been at the leading edge, right, on the whole accident tolerant fuel thing at Hatch and Vogtle. From that edge, from that leading edge, I'd be interested in hearing from you any recent insights or

lessons learned you might be willing to share. And maybe while you're talking about it, just what do you think is maybe the biggest challenge left as we move forward? And you all could weigh on that as well on that last part.

MR. ADAMS: Well, I would tell you that the biggest lesson learned for me -- and I've been in the business for 40 years now and involved in some aspects of this in one way or the other during that entire time. One of the things that excites me today is the fact that we have made so much progress in the period of time. We really started talking about this 10, 12 years ago, and it really came to fruition in 2016 when we formed the ATF Working Group.

But the things that we're talking about now were conceptualized and put into place. And historically it's always taken 15, 20, 25 years sometimes to bring in new innovations like this. And I think we have the opportunity here to really hit a home run for the country and the industry by improving nuclear safety and improving the economics of this critical asset going forward.

And so for me, that's the biggest lessons learned is that thinking big and pushing big and working together with our stakeholders: DOE, the NRC, and industry throughout, has been the biggest lessons learned for me personally. And I think going forward, obviously I talked a lot about -- certainly we need line of sight for licensing and the strategy. And for the type of capital investments that this is going to take within the fuel vendors and the nuclear industry to go full forth we need a line of sight on the licensing strategy. So that is really critical to us going forward. But I can tell you in my own personal belief, and I'm speaking on behalf of many in the industry, we really, really believe that this has the opportunity to change the landscape for the industry going forward.

COMMISSIONER WRIGHT: Do you all have any other

comment?

MR. AUGI: So on the lessons learned I would -- once again the pre-submittal meetings have been invaluable for us, and that kind of highlights communication. I mean you cannot over-communicate. And that goes across the partnerships with utilities to NEI and then the licensing activities with the NRC. And as far as transport of irradiated materials, start early. It takes time. It's a large effort and it's something that needs to be not underestimated.

COMMISSIONER WRIGHT: Jeff?

MR. BRADFUTE: Yes, just would agree with Brad that the perspective 10 years ago was that it was a 20-year minimum effort to develop fuel, but what's different here is that in many cases in the past when a vendor's developing a product, it is a push to develop it and make sure that it's available at the right time and then you actually have a saleable product.

This is different in that it's an industry pull, and that's made a big difference with NEI, EPRI getting involved. So that's -- and really facilitating discussions like this, so there's more communication, so that we can make progress. And I see the momentum year over year truly building where we have an opportunity to move forward and implement. But where we're -- really need to make sure -- and it comes back to the regulatory framework and line of sight is that it is a big investment and therefore when there's questions asked about that investment -- and I go to -- any one of us were to go to our Boards, you have to have some certainty behind that business and that investment.

And it's no different than if you go listen to a conference on the front end with the miners and the converters and enrichers. They'll stand up in front of 500 people and talk about needing bankable contracts. And we will

have to get to that point where we have that certainty so that if the decision is made to invest on -- all across the value train from enrichers to vendor/shippers and ultimately the utilities, there has to be that level of confidence that justifies the business decision to move forward. And it really lays on this foundation of having that regulatory framework.

COMMISSIONER WRIGHT: Right. Rich, you talked about communication and that, believe or not, was my next question because it is -- you can't over-communicate. I agree with that. And I just was wanting to probe a little bit how the engagement has been. It sounds like it's been going very well. And I guess the others -- you all could weigh in as well. But where can we improve? That's something we can always learn from is those things where we may be falling short. So are there areas that we can improve in and where are they?

MR. AUGI: I mean what we've seen is the predictability. That is probably the biggest area because as we're planning out, as we're trying to cut a 20-year development down, the regulatory part of that, the licensing aspects is one of the big unknowns. So the more predictable that those interactions can be and knowing it will take 12, 18 months, whatever it is, as long as we know it and we can plan for it, I think is the biggest thing.

So I would encourage the staff to just be realistic on timing. We'll give you what our goals are, but if that's not realistic, then we need to know. So I'd probably put it there.

COMMISSIONER WRIGHT: Anybody? Good?

(No audible response.)

COMMISSIONER WRIGHT: All right. Thank you. Bill, welcome. So I did have the privilege of visiting INL. Pretty extraordinary place.

Lot going on. And you talked a lot about what was going on, but I want to talk a little bit more about the post-irradiation examination shipping campaign. What type of coordination is going to be involved with any other federal partners like the Department of Transportation? How is all that going to work?

MR. McCAUGHEY: There's a great deal of coordination for shipping irradiated fuel and it involves many, many agencies you mentioned. You mentioned one. The Nuclear Regulatory Commission, states, in addition to the Department of Transportation. And then we also have the utilities and the fuel vendors and the Oak Ridge. For example, these first two shipments were Oak Ridge. So we have the Oak Ridge site office, which is the DOE federal staff that oversees the operations at the Oak Ridge level. All of them are part of this shipping campaign. And the first one we did was a little rough. It took, and there were many reasons for it, I'm not going to get into all of the reasons, but it was not at all a smooth process where everybody was on the same page all the time.

That's why I wanted to make a point of letting you all know, we understand that and we know with many shipping campaigns in our future, that we are going to be taking the lessons learned from that and putting together, and we really can, I mean the folks at Idaho who are leading this effort. They know what we can do to make this more routine and to streamline it. That's why it is a priority for us this year to get that shipping plan together.

You mentioned PIE as well. We have three laboratories that have capabilities and we need to get them all working and coordinated on this effort because we can't rely on just one. There's too much material to begin with and then you also have, things happen, you have issues. And you need that redundancy throughout the system. That's the other part of our planning

that's going on. But I'm confident that we do have the capabilities at these labs collectively and we will make shipping routine.

COMMISSIONER WRIGHT: Okay. Thank you, Mr. Chair.

CHAIR HANSON: Thank you, Commissioner Wright. Commissioner Caputo?

COMMISSIONER CAPUTO: I'm just going to start by saying thank you, gentlemen, for being here today. This obviously is a very important issue. It gets a lot of attention. It's very high profile. Certainly we have responsibilities we have to meet given to us by Congress with respect to NEIMA. So I thank you for being here and for contributing your time today.

Mr. Adams, you mentioned the need for an optimized regulatory infrastructure that's efficient, predictable, and durable. We've also heard 50.46c come up a few times today, so I think I'm going to follow up on the Chairman's questions and discussion on 50.56a and c.

In November, the Commission indicated to the -- sorry, staff indicated to the Commission it believes the implementation of the requirements in the proposed 50.46c would effect a negligible change in overall risk for operating reactors using currently approved emergency core cooling system evaluation models. Staff also indicated that it is not aware of a licensee for which implementation of an ECCS evaluation model that would meet the 50.46, the proposed 50.46 requirements, would affect a substantial improvement in public health and safety.

I want to confirm my understanding. Mr. Adams, from what I can gather, the industry's costs, if the Commission was to impose 50.46c, would be in the tens of millions of dollars.

MR. ADAMS: Yes, that's correct. I think the cost estimate

originally was probably on the low end for 50.46 implementation. I think the 35 million that was part of the cost benefit analysis, I think, is underestimated pretty significantly.

The other thing that I think the concern is from my perspective, the resource that's required to analyze and implement 50.46 is the same, in many cases, the resource that would -- is working on accident tolerant fuel, analyses and other things. And I think the danger is that we would detract from the progress that we've made with ATF by implementing 50.46 as it is currently written, and at a pretty significant cost, and I also think to the detriment of the long-term benefits from accident tolerant fuel.

COMMISSIONER CAPUTO: So in the discussion earlier there was some talk about parts of the 50.46c proposed rulemaking still being useful in combination with the 50.46a effort, et cetera. Can you or your experts just sort of provide us some sort of a high-level summary of what you think is still useable in this -- in some sort of a combined effort here with increased enrichment and high burnup?

MR. CSONTOS: Al Csontos, NEI. I think that we recognize that the degradation mechanisms in 50.46c are real and that they need to be addressed. The question is how you address them. And ATF provides alternatives to how you address them that were not considered in the original 50.46c. Plus I think that there are other activities that methods -- codes and methods, the latest codes and methods also -- so it's a -- that's why we identified the need for a modernized combined rule, because I think that that's the aspect of this, that part of it that the rule is -- I don't want to say old, but it's getting out of date now with respect to the current understanding of where we're heading with ATF technologies and such.

COMMISSIONER CAPUTO: So sort of overtaken by events more or less?

MR. CSONTOS: Yes.

COMMISSIONER CAPUTO: Okay.

MR. CSONTOS: Yes.

COMMISSIONER CAPUTO: All right. Thank you. I think this question may be more or less for the whole panel. Mr. Bradfute, you mentioned the importance of the business case and predictability and even going so far as to talk about the need for bankable contracts in certain situations. Certainly when we had our Commission meeting in 2020, I asked about industry engagement on the front end with suppliers in terms of readiness for bulk loading of ATF and securing supplies of enrichment in transportation canisters, et cetera.

So how are we doing on that? Where is progress? Have we gotten to the point where there is enough happening and enough is predictable, that we're reaching the state of bankable contracts yet or are we still far afield? Or can you say?

MR. BRADFUTE: I think certainly there are certain things that we can't talk about just from the customers that are involved, but what I can say for Westinghouse is that the interest is there. It's over multiple utilities. Especially our larger utilities, but actually some of the smaller utilities see a benefit in introducing ATF. And I think frankly, the utilities are kind of gauging their interest and participation somewhat on the resources they have to be really heavily involved up front. So I would say they're on the bus, but some are kind of on the back of the bus just waiting for some of this initial upfront work to be done, to get some of the PIE testing resolved.

We're working separately with groups of customers going through the business case where you can set it up. It's enterprise-wide because this is not just about fuel cost. It's the levelized cost of electricity that's really at the CNO, at the oard level, and trying to make sure we have models set up where, yes, there's uncertainty in these inputs, but there's general agreement these are the right models. And then we're working to refine what will be the cost as you go through the value train: enrichment, fabrication, shipping. And then on the utility end it's really what are their upfront costs required to prepare the site for --

COMMISSIONER CAPUTO: I'm sensing a lot of optimism there, but not --

MR. BRADFUTE: No, but it is optimism, but if you would look at where we were at in 2016 compared to where we're at in 2023, there's good reason for optimism.

COMMISSIONER CAPUTO: Okay. Mr. Adams, you want to add to that?

MR. ADAMS: Yes, the one thing that I would tell you today that I think is different is I think there's more clarity in the complexity of some of the technical issues facing us. And obviously we hear about uncertainty, but things like transportation and higher enrichment and burnup and fuel -- dry-cask storage and those kind of things -- from our view most of those issues are not huge technical lifts. So in reality I think we have more clarity with respect to that part of the equation today than what we did three, four, five years ago.

And I would tell you that, yes, just like other industry initiatives typically there's players in industry that lead and there's players in industry that follow.

COMMISSIONER CAPUTO: Yes.

MR. ADAMS: We've seen that in subsequent license renewal and elsewhere and this is no different. But I would tell you I think there's pretty broad consensus within the industry that this is a valuable cost benefit improvement to nuclear safety and that it warrants full implementation going forward.

COMMISSIONER CAPUTO: Okay. I guess I'm struggling a little bit with -- there has to be a lot of progress, there needs to be predictability, there's clearly a lot of optimism, and this is a very important issue certainly for the industry's future. I'm trying to gauge how far we're making progress. I mean there's a big difference between being interested and participating, contributing, engaging versus signing contracts and filing license amendments. And so I'm just trying to get a feel for where are we on that track? We're making progress, right, but how far are we in the progress? And it sounds like it's really not something that you can either comment on or gauge at this point.

MR. ADAMS: The only thing that I would add to that, we've got nine plants that have -- nine units that have done lead test assemblies of rods. And they cover a spectrum of licensees. And I think that would tell you that there's pretty broad interest here.

With respect to the contractual negotiations and things like that I really can't or won't comment on that at this point, but I would tell you that I think given the discussion and levels we're at, yes, there are ebbs and flows in this program just like everything else, but I think I'm pretty optimistic about it at this point going forward.

COMMISSIONER CAPUTO: Okay. Maybe I'll try to just get a little more vague. A lot of this is chicken and egg. Have we gotten to the point

where we've cracked one? Nothing?

(Laughter.)

MR. AUGI: Well, so we have submitted our license amendment for facility. SNM-1097 has been revised to go up to eight percent enrichment. So that's in the NRC's queue right now. It's being reviewed. That was submitted -- I believe it was August of last year. So that is the first step.

And you've heard us mention infrastructure. So there's a lot of infrastructure related to high enrichment, whether it's advancing engineering methods, it's our shipping containers -- which I know Westinghouse has gone through with their traveler. We're in process with our RAG-2 container that's also been submitted to go up to eight percent. So there's a lot of work that has to go in to set that infrastructure up and to establish it for that product.

So it is a lot of work that has to be done. We have to take into consideration funding levels. There's large capital investments. So it is a business case that has to be reviewed periodically because the market does change, the situations do change. But we are still pushing forward with it and, like I said, setting up that infrastructure so that we are positioned to actually begin delivering a product.

COMMISSIONER CAPUTO: Okay. I think at the end of the day one of the things I struggle with with this is when this issue arose there was a lot of optimism and a lot of engagement and the time frame seemed a lot closer. Now that we're several years into this the time frames are sort of pushing out. I noticed from your slides that there's a lot of activity in increased enrichment and high burnup, not necessarily as much in the ATF in the near term.

So I'm trying to discern -- I've been resisting making this

correlation. I'm just going to do it. A lot of progress was made for a very, very long time at this agency on digital I&C and it's still not implemented. I would hate to see us on that path here. So my trying to get a sense for progress being made is you can have lots of meetings, lots of positive discussions, lots of optimism and make lots of progress without culmination of objective. And so I'm trying to get a sense for when these results are really going to manifest. So I appreciate that's a tough question. I think that's a tough question for the industry and the agency, but that's part of the reason I'm asking it.

MR. BRADFUTE: I was going to add, in my presentation I spoke about the Southern Nuclear LTA Program that will be completed for manufacturing in the fall of '23. For us, we viewing that as cracking that egg because that's essentially testing our entire global manufacturing base supply chain for the manufacture of a fully comprised ATF assembly that includes greater than five weight percent rods. And so it's exercising the NRC regulatory process, but also shipping and the licensing and activities that have to take place at the Vogtle site. So this is a big milestone for us in 2023. And we'll begin that process of really testing what this is going to look like as we ramp up to region quantity.

COMMISSIONER CAPUTO: Good. That's good to hear. Thank you.

CHAIR HANSON: Thank you, Commissioner Caputo. All right. Thank you all for our first panel. Really appreciate you being here offering your perspectives. Thank you, Dr. Lyman, for joining us online. And with that we will reconvene, I don't know, let's call it 10:37 or so. All right? Thank you again.

(Whereupon, the above-entitled matter went off the record at

10:29 a.m. and resumed at 10:37 a.m.)

CHAIR HANSON: All right. Thank you. Welcome back. The second panel will be kicked off by the NRC's Executive Director for Operations Dan Dorman. Dan?

MR. DORMAN: Thank you, Chair. Good morning. Good morning, Commissioners. The staff appreciates the opportunity to provide an update this morning on the work being done across the agency to prepare for the safe deployment of accident tolerant fuel, or ATF, in the operating reactor fleet. Staff across the agency is working collaboratively to ensure we are prepared to review in-reactor fuel performance and to address fuel cycle transportation and storage issues.

Our success has been supported by strong intra-agency partnerships, proactive engagement with applicants, and coordination with domestic and international partners. You'll hear today that we continue to make substantial progress in implementing the strategies laid out several years ago in our ATF Project Plan to enable the safe use of emerging ATF concepts and that we are ready to safely license and in some cases have already approved near-term designs. And we are also exploring ways to improve infrastructure to maintain safety while enhancing efficiency, clarity, and reliability.

Next slide, please? From this panel you'll hear from Andrea Kock, the Deputy Office Director for Engineering in the Office of Nuclear Reactor Regulation, or NRR, who will provide a strategic overview of the NRC's ATF activities.

Kevin Heller, a nuclear engineer in NRR, will give an overview of NRC's operating reactor licensing activities, engagement, and collaboration efforts related to ATF.

Damaris Marcano, a branch chief in the Office of Nuclear Material Safety and Safeguards, or NMSS, will discuss licensing and oversight activities related to the enrichment, fabrication, transportation, and storage of ATF.

James Corson, a senior reactor systems engineer in the Office of Nuclear Regulatory Research, will highlight NRC's preparation of confirmatory analysis tools and international collaborative research activities.

And finally Alice Chung, a reactor systems engineer in the Office of Nuclear Regulatory Research, will explain our activities to modernize and enhance staff expertise and to leverage tools to regulate advances in fuel technologies.

I'll now turn the presentation over to Andrea. Next slide, please?

MS. KOCK: Good morning, Chair and Commissioners. It's a pleasure to be here this morning to give you an update on the significant progress that the staff has made in preparing for and licensing ATF.

Next slide, please? The staff is actively monitoring the ATF landscape to ensure our readiness to review ATF concepts, higher burnup, and increased enrichment. Current fuel designs use uranium dioxide pellets enriched to five percent uranium-235, or U-235, and a Zircaloy alloy cladding with a burnup limit of approximately 62 gigawatt-days per metric ton of uranium. Near-term ATF concepts include different cladding types, such as chromium and doped pellets. For these designs the NRC can largely rely on existing data, methods, and models to do its evaluations. Longer-term ATF concepts include silicon carbide cladding, high-density pellets, and extruded metallic fuel. For these concepts, substantially new data, models, or methods may be needed to

support the NRC's safety evaluations.

Both near and longer-term ATF concepts may include enrichment greater than five percent U-235, also called high-assay, low-enriched uranium, or HALEU, and it may increase burnup to 75 or 80 gigawatt-days per metric ton of uranium. Based on our interactions with the industry we are expecting requests for licensing actions for incremental deployment of certain near-term ATF concepts in the next few years and then licensing actions including the entire suite of near-term ATF concepts by the late 2020s.

Next slide, please? We are making the safe use of ATF possible by seeking innovative solutions, applying risk insights in decision making, and ensuring we have the appropriate expertise. We're accomplishing this through close interagency collaboration on ATF that addresses the entire nuclear fuel cycle. On this slide you'll see a timeline listing some recent collaborative work that the staff has completed across the agency to ensure our readiness to review licensing actions related to the safe deployment of ATF.

The staff has accomplished several important milestones through the application of innovative licensing approaches. When we last briefed you, we had issued one amendment for the use of ATF, we completed three reviews for the transportation of ATF, and we had completed one phenomena identification and ranking table exercise, or PIRT. These identify the most safety-significant aspects of a technology, and we completed this on chromium-coated cladding.

We've since made substantial progress to prepare for and licensing ATF. This slide contains some of the main accomplishments since the last Commission meeting that other speakers will touch on, so I'll just give you a few highlights.

We used that first PIRT to develop guidance on chromium-coated cladding. We accepted for review the first two license amendments for the use of ATF with increased enrichment and high burnup and we've issued three license amendments to support enrichment facilities and fuel fabricators possessing and using greater than five percent U-235. These accomplishments represent several major building blocks to support the licensing of near-term ATF concepts across the fuel cycle.

Next slide, please? We're using risk insights to inform our decision making and focus our work for activities across the entire fuel cycle. While the current framework is sufficient to successfully review ATF concepts, we are using evidence and risk insights to consider changes to our regulatory infrastructure to improve our review efficiencies while maintaining the agency's safety goals.

For example, we're proactively using risk-informed approaches on issues such as fuel fragmentation, relocation, and dispersal, or FFRD. We've approved a transportation package that allows enhanced flexibility for leak rate testing, and we're also working on an innovative approach to environmental reviews for ATF by using a bounding concept that can be referenced by our licensees.

Next slide, please? We're committed to ensuring that we have a highly skilled and engaged workforce with the necessary knowledge and expertise to review ATF. We've been successful in ensuring we have sufficient staff with the right skills to support our current ATF work. And we continue to take steps to recruit new staff and retain the staff that we have. We're providing relevant training and we're ensuring strong knowledge management through updating our public web page and also using our internal ATF dashboard.

These provide a centralized means to access information on our ATF activities. And we're also developing Nucleopedia pages.

As you'll hear from several of the speakers, we recognize the importance of early and frequent engagement with our stakeholders as noted by the external panel and we're looking to proactively support these early engagements. We're also continuing to identify and address knowledge gaps on new fuels through the use of PIRTs, literal reviews, and the evaluation of technically-complex issues, such as FFRD.

I'll now turn the presentation over to Kevin. Next slide, please?

MR. HELLER: Thank you, Andrea. And good morning, Chair and Commissioners. Pleasure to be here.

Next slide, please? We are ready to license the use of near-term ATF concepts in the cores of light water reactors. Per the ATF Project Plan, the staff assessed the NRC's regulatory framework and concluded that existing regulations and guidance will support the licensing of near-term ATF designs. Similarly, the staff found that the regulatory framework supports licensing of fuel designs with increased enrichment and higher burnup.

I'd like to provide some examples of our readiness to review ATF applications and the progress that we have made on recent submittals. The Interim Staff Guidance for Coated Cladding Fuel Designs is complete and ready for use when the industry submits applications. The staff has also made progress in its review of several topical reports that are in various stages of review.

Topical reports provide a means for generically approving a technology, computer code, or method of analysis for application under specific

conditions instead of reviewing and approving them on a plant-specific basis. The topical reports for the Westinghouse ADOPT dope fuel and the AXIOM cladding ATF products have been approved in the past year. So in this instance, licensees can add the Westinghouse ADOPT and AXIOM topical reports to their licensing basis via a license amendment request and subsequently use these fuel products in the reactor core. And finally, the Vogtle licensing amendment request for increased enrichment in ATF lead test assemblies was recently accepted for review.

Next slide, please? So as I mentioned earlier staff found existing regulations and guidance support the licensing of fuels with increased enrichment and higher burnup; however, the staff noted that significant additional restrictions, plant systems, or analyses may be required of licensees adopting some of the fuel designs with increased enrichment and higher burnup under the current regulatory framework. Licensees have in the past submitted exemption requests; therefore; the staff is exploring enhancements to the regulatory framework that may increase efficiency and clarity of our licensing and technical reviews while providing increased regulatory certainty all while continuing to assure safety.

As part of the rulemaking process, the staff is evaluating changes to the regulations that could facilitate using fuels with enrichments greater than five weight percent uranium-235. This could provide a more efficient licensing pathway and increased certainty for the industry, as opposed to exemption requests. A rulemaking could also allow for a generic resolution that continues to ensure safety, while also increasing transparency by providing multiple opportunities for specifically engagement. Staff is currently in the process of developing a regulatory basis.

With regard to higher burnup current regulations do not explicitly restrict fuel burnup; however; review of requests to increase existing burnup limits requires consideration of the potential impacts of FFRD, for which the current regulatory framework may require additional restrictions or analyses. Consistent with the Commission direction the staff is analyzing and addressing FFRD in the increased enrichment rulemaking regulatory basis. This will include any potential enhancements associated with the regulatory framework.

Next slide, please? We are ensuring stakeholder confidence through extensive engagement. For example, we are leveraging preapplication meetings, which play a critical role in our success. This type of early dialogue with industry promotes our understanding of the technologies that we will be asked to review and facilitates reliable, clear, and efficient licensing of ATF-related actions. Incorporation of staff feedback provided in pre-submittal meetings helps to ensure applications are comprehensive and to shorten review schedules. These meetings were vital to enabling the staff to accept the Vogtle licensing action proposing the use of increased enrichment and ATF lead test assemblies.

We are increasing opportunities for interaction to create transparency and understanding. We are holding vendor status meetings, attending industry conferences, hosting annual higher burnup workshops, and seeking early industry engagement. To cultivate this early industry engagement we issued a letter in January 2022 to industry stakeholders. This letter provides generic licensing timelines and encourages interactions on any Part 50-related topical report or site-specific licensing action that is targeted for approval or deployment by the mid to late 2020s.

We are also developing a Regulatory Issue Summary as a

follow up to this letter to ensure we have appropriate resources and staff to review applications. We issued a regulatory applicability framework, which communicates where existing guidance addresses ATF and identifies areas where supplemental information would increase the efficiency of reviews. Finally, we are developing a road map to readiness documenting the actions necessary to enhance our efficiency and reliability to support the licensing of ATF.

Next slide, please? Next, I want to speak to our collaboration and engagement activities on ATF. The NRC participates in multiple ATF programs, both foreign and domestic. The primary benefits gained from these programs are awareness of industry interests, obtaining information on the latest projects and research strategies, and the generation of new data on ATF concepts that can be used to update NRC codes and methods for confirmatory analyses in order to support licensing reviews. These activities contribute to our continued state of readiness.

An example of a foreign program is the ATF Testing and Simulation, or ATF-TS, with the IAEA. And an example of a domestic program is the Collaborative Research on Advanced Technology Fuels, otherwise known as CRAFT, which is led by EPRI. The NRC participates in these programs as an observer. The NRC also organizes and participates in periodic meetings with DOE to maintain awareness of the latest DOE-driven projects and research.

Next slide, please. The NRC also relies heavily on data gathered from research programs that advance our understanding and modeling capabilities of FFRD. For example, data from these research programs supported the development of the recent Research Information Letter

2021-13, which discusses FFRD at higher burnup. This document provides insights into the various phenomena that influence FFRD and an estimation of the conditions under which it may occur. This has allowed staff to better assess the analytical approaches and results presented within topical report submittals that seek higher burnup.

Due to the limited data this research information letter is conservative. As more data becomes available the staff will continue to evaluate FFRD. James will speak more to this in his presentation.

Thank you and now I'll turn the presentation over to Damaris. Next slide, please?

MS. MARCANO: Thank you, Kevin. Good morning, Chair Hanson and Commissioners. It is a pleasure to be here today to provide an update on our readiness and considerations for licensing and overseeing the enrichment, fabrication, transportation, and storage of ATF.

Next slide, please? We continue to effectively implement strategies to ensure our readiness to support safe deployment of ATF. We have leveraged our considerable experience and knowledge in licensing, certification, and oversight of fuel fabrication facilities and transportation packages to review applications with high enrichments. As a result, we have gained insights that allow us to conclude that our current regulatory framework is ready to support industry plans for the enrichment, fabrication and transportation of ATF batch loads with enrichments up to 10 weight percent of uranium-235.

We're also working with our partners in NRR and Research to actively gather technical information to strengthen our knowledge in the areas such as ATF cladding and pellet concepts, which will enhance the efficiencies

of our regulatory reviews. Although current regulations are sufficient to support the review of ATF-related licensing actions, efficient review of applications for ATF with enrichments up to 10 percent depends on early engagement by potential applicants and the quality and timeliness of applications. We have been communicating with the industry to encourage pre-application interactions and high-quality submittals. Early engagement will provide the opportunity for us to ensure that we are resourced appropriately and prepared for the review.

A high-quality application will permit a timely and efficient review. As stated in the Generic Milestone Schedule, the NRC must receive high-quality applications for new licenses for enrichment, fuel fabrication facilities, and new certification of storage casks or transportation packages three years before deployment.

Next slide, please. Since our last meeting in February 2020, we issued three amendments to fuel facilities related to the production of ATF. These include two amendments to fuel fabrication facilities, approving a modification to the licensee's minimum margin of subcriticality analysis, which the licensees could use in their analysis to support license amendments related to increased enrichment levels. We also issued one amendment to an enrichment facility permitting the possession and use of a special nuclear material with enrichment levels above five weight percent of uranium-235. We have also issued four certificates of compliance and one letter of authorization authorizing the transportation of ATF and increased enrichment fuels up to eight weight percent.

Our licensing process has proved to be effective to date for licensing ATF. Over the last three years we have performed accelerated reviews and approvals, consistently completing reviews related to ATF ahead of

our licensing metrics. For example, in June 2020 we received an application from Framatome requesting to transport a small number of ATRIUM-10 fuel assemblies equipped with inert test rods that will be supporting the development of ATF. In October 2020, we issued a letter of authorization for the shipment which was reviewed and approved within five months of receipt and well ahead of our three-year metric. The efficiencies gained on the reviews are a result of using the same interdisciplinary team of NRC staff for the reviews of ATF licensing actions. We continue to apply this approach to the licensing actions that are currently being reviewed by the staff.

Oversight is an important pillar of what we do. We continue to conduct a strong oversight program of fuel fabrication facilities and cask and package fabricators. During the inspections in the areas of design control, fabrication, and user operations, we verify that the necessary controls are in place to provide adequate protection to the health and safety of the public.

For example, last fall our inspectors traveled to Germany to inspect the management, design, and fabrication controls for the DN-30 transportation package, which has the same overbite design as the DN-30X package, which we're currently reviewing for enrichments up to 10 weight percent. Our inspection programs are risk-informed and provide assurance that the facilities are operated safely and securely, and packages are fabricated to meet the NRC safety standards in accordance with NRC regulations. As a continuously learning organization, we will continue to look for ways to enhance our reviews ensuring safety while providing a timely regulatory decision to the applications before us.

Next slide, please. We continue to focus on enhancing our reviews by actively evaluating our regulatory readiness for the front and back

end of the nuclear fuel cycle. This allows us to proactively identify and address regulatory and technical challenges which will enable the safe use of new ATF concepts, consistent with the industry timelines for deployment. Any design certifications for fuel facilities, fresh fuel transportation packages, spent fuel storage casks, or spent fuel transportation packages must demonstrate compliance with all NRC regulations such that ATF concepts can be safely managed in all phases of the fuel cycle.

As of today, we see no regulatory obstacles for certifying transportation packages with fresh ATF and reach up to 10 percent of uranium-235. As the enrichment increases, it is likely that the number of packages in a shipment may decrease due to higher reactivity. There are other potential areas of focus specifically related to the management of spent nuclear fuel that will benefit from more data, including radiochemical assay data for depletion code validation that will provide flexibility on the levels of margin for spent fuel criticality and shielding analysis, and short- and long-term in-performance -- in-reactor performance that may affect the materials' thermal and source term evaluations. We are maintaining awareness of higher enrichment lead type assemblies being put into reactors, and will pursue opportunities to obtain radiochemical assay data from this fuel when discharged.

We know that near-term ATF concepts are reasonably similar to the current fuels. But as we look towards the future, we will continue to perform generic technical assessments and research and monitor national and international activities for the entire nuclear fuel cycle to continue to identify and proactively address any challenges and/or data needs.

This concludes my remarks. I will now turn it over to James. Next slide, please.

MR. CORSON: Thanks, Damaris. Good morning, Chair and Commissioners. I am here to discuss ongoing efforts in the Office of Nuclear Regulatory Research that support ATF licensing activities. In particular, I would like to focus on two key areas: how we are developing our confirmatory analysis tools, and how we are participating in the international research programs to support ATF.

Next slide, please. As I mentioned, we're preparing our confirmatory analysis tools, some of which are shown on the slide here, to support ATF licensing actions, rulemaking activities, and regulatory guidance development. As a first step, we're updating our codes to be more modular and flexible. These innovations allow us to quickly implement new material properties in our codes, and to validate them using experimental data.

Material property and integral test data come from a variety of sources, including the national laboratories, the Department of Energy, and the international programs that I will describe shortly. Our co-development activities are informed by literature reviews and PIRT exercises. PIRT and literature reviews allow us to risk inform our research efforts to focus on phenomena that have a high impact on fuel safety and that have a high degree of uncertainty.

Subsequent research helps reduce uncertainties and allows us to remove unnecessary conservatisms in our regulatory decision making. Research staff meet periodically with our co-developing counterparts in the Department of Energy to maintain awareness of the latest innovations related to fuel performance and reactor system modeling. Our collaborations have demonstrated that our codes are adequate to support regulatory activities and represent the current state of the practice in these technical areas.

Next slide, please. We regularly participate in international research programs to inform our regulatory framework. Experimental programs like the Studsvik Cladding Integrity Project, or SCIP, QUENCH-ATF, and the Framework for Irradiation Experiments, or FIDES-II, provide data for code development and validation, and they help us better understand fuel and cladding behavior under normal operating conditions and during design basis accidents. Data from these programs inform our licensing regulatory guidance and rulemaking activities. I will speak more about these programs shortly.

We are also active participants in international working groups. For example, NRC led two Nuclear Energy Agency, or NEA, working groups on fuel safety task groups related to ATF, a technical opinion paper on ATF which was published last year, and a report on the safety implications of extended enrichment and high reactivity, high suppression core designs, which is currently going through the publication process. These documents identify research needs to support licensing of these new fuel types. And insights from these reports help guide our participation in joint research projects. NRC is also a key contributor to code benchmark activities organized through the working group on fuel safety and as part of FIDES-II, which improves our codes and facilitates knowledge transfer.

Next slide, please. I would like to return to the NEA joint experimental projects that NRC is participating in. I'll start with two programs that are providing data for fuel and cladding behavior during a loss of coolant accident, or LOCA.

SCIP has provided valuable information on the behavior of high-burnup fuel and cladding behavior during a LOCA. Data from the third phase of SCIP made up a significant portion of the information on FFRD in

Research Information Letter 2021-13, which Alice will describe in more detail.

The fourth phase of SCIP is ongoing. And it's providing additional data on the behavior of standard UO_2 fuel and on doped UO_2 fuel as well. SCIP-4 will finish next year. And NRC has already provided feedback to Studsvik on the next 5-year program, which will provide additional data to address uncertainties identified in the 2021 Research Information Letter on FFRD.

Recently, the NEA launched a new joint program, QUENCH-ATF, using the QUENCH facility at Karlsruhe Institute of Technology in Germany to study the behavior of ATF cladding in a LOCA. KIT completed a test on a rod bundle with chromium-coated cladding under design basis accident conditions last summer. And they will conduct tests on a similar bundle under severe accident conditions this year. The data from these programs will be used to develop a robust independent understanding of the safety significant phenomena and develop independent models for confirmatory analyses, which will directly support licensing reviews for ATF in increased burnup.

Next slide, please. One major development since our last ATF commission meeting is the launch of the NEA's FIDES-II program that includes three joint experimental projects related to ATF and high-burnup fuel behavior. The high-burnup experiments in reactivity-initiated accidents, or HERA project, including reactivity-initiated accident tests on high-burnup fuel and on doped fuel with chromium-coated cladding.

HERA tests performed in the TREAT reactor at Idaho National Laboratory complement tests being performed in France and Japan. The tests will help demonstrate whether changes in our regulatory guidance for

reactivity-initiated accidents would enhance the efficiency of our reviews of ATF and high-burnup fuel designs.

The power to melt and maneuverability, or P2M project, is studying the behavior of high-burnup fuel during slow power ramps using tests performed in the BR2 reactor in Belgium. This data will provide additional confidence in our code predictions for phenomena that impact cladding failure under power ramp conditions.

And lastly, the In-Pile Creep Studies of AFT, or INCA project, is performing experiments in the LVR-15 reactor in the Czech Republic to collect creep data for chromium-coated cladding. Creep leads to dimensional changes in the cladding which in turn impacts various fuel and cladding design limits. Data from INCA will be used to develop models to better predict coated cladding behavior to support our licensing reviews of this new technology.

I would now like to turn it over to Alice. Next slide, please.

MS. CHUNG: Thank you, James. Good morning, Chair and commissioners. This morning I will discuss how the agency is helping to modernize and enhance staff expertise by leveraging tools associated with the regulation of advances in fuel technologies. As previously mentioned, the NRC's efforts with international projects and national labs, along with the collaborations across the NRC offices, all allow staff to build a capacity of skills and regulatory readiness of ATF technologies.

In my presentation I will provide some specific examples of activities from the Office of Nuclear Regulatory Research that illustrate the application of these tools to maintain regulatory readiness. Before I jump into the examples, I think it's important to define what I mean by "tools." As James mentioned earlier, there are several computational and confirmatory analysis

tools that we work with at the NRC. And that may be what first comes to mind when we say "tools."

However, it's easy to forget the less obvious tools that staff is utilizing, such as technical expertise, engineering judgment, analysis, knowledge management and most importantly, the various communication tools within our regulatory framework that are critical to maintaining staff readiness on evolving topics and concepts, such as ATF.

Next slide, please. One example I'd like to highlight as it relates to communication tools is the research information letter, or RIL. A RIL, by definition, is a document or tool that the Office of Nuclear Regulatory Research uses to summarize, synthesize, and interpret significant research information on any given topic and to discuss how that information may be used in regulatory activities.

Recently, I, along with my colleagues in Research, published 2021-13, that speaks to fuel fragmentation, relocation, and dispersal during a LOCA. For this RIL, the team coordinated with fuel experts across the industry to synthesize experimental data from NRC-sponsored tests at Studsvik, and from international collaborative activities such as SCIP-3 and the Halden Reactor project, which in aggregate spans 15 years of research and experiments.

This was all in an effort to improve regulatory efficiency for the agency by providing the important and pertinent information to support the licensing and rulemaking activities on FFRD in a more digestible form. Or, as you may remember from our days at school, a CliffsNotes version. Being relatively new to the Office of Research, participating in the publication of the RIL provided me with direct experience in understanding of both the

phenomenology of fuel behavior during a LOCA, and the licensing and rulemaking process used at the agency.

So, in addition to serving as a basis for regulatory guidance and rulemaking activities on FFRD, the conclusions of this RIL also support other ATF activities such as higher burnup and increased enrichment. More broadly, it has provided foundational knowledge and management and expertise that has resulted in further dialog with the nuclear fuel community to identify and refine risk-informed future-focused research on FFRD, and to also utilize collective engineering judgment to reduce the uncertainties identified in the RIL so that it may, in turn, lead to better-informed and timely NRC analysis.

Next slide, please. The next set of examples I'll discuss speak directly to how we are modernizing the confirmatory analysis tools to support the regulatory activities for ATF, higher-burnup fuel, increased enrichment, and FFRD. First, we are using the scale code suite to support ongoing increased enrichment rulemaking from a neutronics perspective.

We have also been utilizing our fuel performance code, FAST, which stands for Fuel Analysis Under Steady State and Transience, along with our severe accidents code, MELCOR, to support Draft Guide 1389, which staff plans to issue as Regulatory Guide 1.183, Revision 1. This revision will expand existing source term guidance to near-term ATF technologies, including higher-burnup fuel of up to 68 gigawatt-days per MTU and increased enrichment fuel of up to 8 weight percent of uranium-235.

With respect to FFRD, we are applying a combination of all of the NRC sponsored codes displayed on this slide to estimate the mass of fuel that could be dispersed during a LOCA, which also supports the Commission directive to consider the impacts of FFRD as part of the increased enrichment

rulemaking activities. With all that said, I'd like to thank all of you for your attention. And I will hand it back over to Dan for his closing remarks.

MR. DORMAN: Thank you, Alice. And thank you again, Chair Hanson and commissioners for the opportunity to share with you the highlights of the work that we've accomplished to date in preparing for accident tolerant fuels, our readiness for the work that's before us in the near term, and the challenges that still remain.

I want to thank all the panelists today and all the staff who have contributed to the preparation for this meeting and to our ongoing work on ATF. With that, we'll conclude the staff's presentation and look forward to your questions.

CHAIR HANSON: Thank you, Dan. Commissioner Crowell.

COMMISSIONER CROWELL: Thank you, Mr. Chair. Thank you to all the presenters today. This is a complicated topic. And all of your perspectives are valuable in regard to understanding it. I'm still trying to wrap my head around a number of things and put it all in context.

But one thing, maybe Ms. Kock, I want to ask you or, Mr. Dorman, maybe you're in a better position to answer, but in terms of practical experiencing with using ATF or with higher burnup, where does the U.S. stand compared to our international partners in terms of, like, actual practical experience using these fuels?

MR. DORMAN: I'm not sure I can answer that with great specificity. But I think that you've heard a lot both from the external panel and from this panel of the work that's going on internationally on this. So, I think, but I think we are through the lead test assemblies, in recent years having more experience with the current near-term applications in the current irradiated

environments, current operating reactor environments and getting that data back. So, I think that's, that's a key element. But then the experimental pieces that take us, so those gives us generally lead test assemblies, or units in peripheral locations of the core that give us limited operational data. So, some of these other experimental pieces that you heard in the international program that are critical to understanding under more challenging conditions the performance of fuels are key partners in this effort.

COMMISSIONER CROWELL: So, in one respect we're leading, but at the very least we're not behind the curve. And then I'm not sure who to, is best to answer this one. Maybe on that end of the table. But how important is practical experience, the data gained from practical usage of different ATFs or higher burnout operations, how important is that in ensuring the safety case compared to codes, and modeling, and things more theoretical analysis?

MR. CORSON: Yeah, I can, I guess I can take that. Yeah, both -- so, I'd say our experimental programs and, and experience with, like, the lead test rods and so on is very important. I mean, we rely on our codes a lot. But we need to know that our codes are giving us the right answer. And so, that practical experience helps us gain more confidence that, that our codes are accurate.

Now, you know, sometimes we don't have a lot of practical experience. But maybe if it's a slight variation of where we do have some practical experience, we can take some conservative assumptions. We can look at different scenarios, different sensitivity studies to try to predict, you know, what, what changes we might see in the absence of practical experience. So, we use a combination of, yeah, experience, our codes, and then some

engineering judgment with conservative modeling assumptions to do our job to license these fuels safely.

COMMISSIONER CROWELL: That's helpful. And, Mr. Corson, I'll stay with you. And, Ms. Chung, please jump in on this. But if you had to identify one area of practical research or data that you would most benefit from at this stage, could you identify where the biggest data gap that would provide you the biggest benefit is?

MR. CORSON: So, I, I will say, you know, one area where we are a bit lacking in data is behavior of ATF under accident conditions. I think the industry panel talked a lot about how we have the LTA programs, we're gathering data under normal operating conditions.

There is less information about how these would behave in a design-basis accident. But, that is why we're participating in, in FIDES-II, why we're participating in QUENCH-ATF. So, we are gathering that data right now and being very active about it. So, hopefully, in the very near future we'll, we'll close some of those gaps. But that is probably the big outstanding one.

COMMISSIONER CROWELL: Ms. Chung, would you agree or do have anything particular you want to add?

MS. CHUNG: I would agree. And I have nothing to add on that.

COMMISSIONER CROWELL: Okay, thanks.

MS. CHUNG: Thank you.

COMMISSIONER CROWELL: I rarely pass over on a question without talking about the back end of the fuel cycle. So, Ms. Marcano, and others who want to jump in here, but it seems like on transportation storage on the front end of the fuel cycle we're pretty, looking pretty good. It sound like

on the back end there's still some uncertainties or some data gaps.

Can you talk to me about that a little bit more? Like, what is the impact of ATF or high-burnup on spent fuel pool storage containers relative to radioactivity, all that stuff that's important for ensuring the safety of the back end of the fuel cycle?

MS. MARCANO: Sure. So, so ATF is light-water reactor fuel. So, starting from that point, the information we have to date give us certainty that our regulatory framework is flexible enough to accommodate the licensing of the back end of the ATF.

We have no indications that there is challenges in the technical feasibility of the safe storage and disposal of ATF. There are some, there are some, as you can see, research that has been going on. And I will defer the pool portion after my response to Mr. Kevin and his expertise over there. So, as of now, we can say that it will be safe to store and dispose ATF based with the information we have now.

COMMISSIONER CROWELL: And when you say "store," you mean on-site, either in the spent fuel pools or in --

MS. MARCANO: Uh-huh.

COMMISSIONER CROWELL: Mr. Heller, anything to add?

MR. HELLER: Yeah, I believe I can add a couple of things to that. So, we have done some investigations into ATF designs in the spent fuel pool. And we haven't observed anything that would suggest that there's a major impact beyond the way that current fuel management is being performed within the spent fuel pool.

There is some preliminary assessments that have been done that suggest that in the realm of increased enrichment and higher burnup that

perhaps the spent fuel would have to stay -- or, excuse me, the discharged fuel would have to stay within the spent fuel pool for a little bit longer before it could be put into a dry cask storage system. But some of that research I believe is ongoing. And I can ask James to jump in if he has any that can facilitate further discussion on that?

COMMISSIONER CROWELL: Please. Because that's exactly where I was going to go next. So, Mr. Corson?

MR. CORSON: Yeah. So, we have done some preliminary studies through our contractors at Oak Ridge to look at some of the effects of higher burnup and increased enrichment on things like decay heat or criticality safety. We published those reports. They're available on our website.

I'll say there's, there's a lot of tradeoffs. So, higher burnup you have more fission product so you, you know, generally have higher decay heat. Increasing the enrichment actually can reduce the decay heat through less activation and generation of transuranics. So, combining those two effects, it depends on what burnup you go to, what enrichment you go to, what the net effect will be on, on the decay heat.

And, like I said, we've also done some studies on criticality safety as well. These are preliminary. We don't have the full understanding of how fuel would be managed at a power plant because, I mean, the industry is still working on this. But we're confident that our tools are giving us reasonable predictions. And we do have some ideas of the trends at least, right now.

COMMISSIONER CROWELL: I guess my thought is to please stay vigilant. Obviously, there's a lot of anxiety in the public about the management of spent fuel on-site, transportation, eventual storage in more long-term fashion somewhere. And we don't want to add to that anxiety. We

want to alleviate that anxiety. So, the more you know and can provide confidence in that regard is better. So, let's just be vigilant in that regard.

Ms. Marcano, did you have something to add? Yes.

MS. MARCANO: Yeah. I just wanted to add that we are keeping awareness through our routine engagements with the Department of Energy, EPRI. We do international conferences in the Extended Storage Collaboration Program. So, we are keeping aware of what's going on. And we are ready to make sure that if we need to update or revise our guidance because of new information, that we're going to be able to do that.

COMMISSIONER CROWELL: Good. I appreciate that there will be no cutting corners and looking to maintain the best and highest standards for this type of activity. So, thank you. Thank you, Mr. Chair.

CHAIR HANSON: Thank you, Commissioner Crowell. Thank you all for being here this morning. And thank you for the ongoing work here conducting, and the rest of the staff are conducting to kind of develop a responsive and flexible, but also robust regulatory framework for accident tolerant fuels. And particularly as we get into higher enrichment and higher burnups.

Mr. Heller, I'd like to start with you this morning. And, you know, we brought up in the previous panel 50.46c. Obviously, it's been in front of the Commission for a while. But the way I saw this rulemaking, it would provide a performance-based framework to license all light-water reactor fuel designs, including non-zirconium alloy cladding, update the fuel performance criteria based on, you know, current research, and kind of avoid unnecessary regulatory exemptions and hopefully provide a transparent process for stakeholders.

So, can you talk a little bit about how 50.46c would kind of fit into the framework in terms of an effective and efficient licensing process for ATF with burnup enrichment extensions?

MR. HELLER: So, to kind of build off of what it is that you already stated, 50.46c does offer a consistent and robust performance-based approach towards utilizing various fuel designs. And that particular approach is equally applicable to both ATF and contemporary fuel designs, which is important because -- or, I should say, it's pertinent for near term ATF designs because it's expected and understood at least for the designs that we are seeing coming in that they perform substantially similar to existing fuel designs.

CHAIR HANSON: Okay. Yeah, thank you. I mean, I, I think, you know, I acknowledge that, at least for my part, that, you know, 50.46c isn't the entire, isn't the whole picture. It's part of the picture with kind of regard to ATF. But if we didn't have 50.46c in place, kind of what would be the impact on kind of finalizing regulatory certainty and having some clarity? And would, would there be an impact potentially on the quality of applications, on the staff's ability to conduct those reviews efficiently?

MR. HELLER: So, one of the major benefits that 50.46c does offer is that it eliminates the need for exemption requests when licensees are seeking to use various fuel designs. So, without 50.46c in place, a licensee could still submit an exemption request. There's nothing that prevents them from doing that. But obviously that would add some increased time to the review effort because now one has to consider the exemption.

Additionally, while 50.46c does provide the performance-based approach, without it in place, it would not substantially impact the review efforts. We are aware of the types of questions that we would need to ask in

order to ensure safety, and just through a lot of the communications that we've had with the various vendors and applicants over the years, they're also aware of the kind of information that they would need to submit.

CHAIR HANSON: Thank you. Yeah, I appreciate that context very much. You mentioned, Mr. Heller, the kind of roadmap to readiness. And I mentioned the ATF kind of licensing project plan. What's the relationship between those two, just kind of for my own and maybe the public's edification?

MR. HELLER: So, really the roadmap to readiness kind of it's born out of the ATF project plan. It's a graphical representation, really, of -- a graphical communication tool to help facilitate a more rapid understanding of the various pathways that are available for an ATF technology to be licensed.

It also includes, then, illustrating potential risks associated with licensing those applica -- or those technologies. And it's, again because of its graphical nature, it helps to illustrate where along the particular pathway towards license that guidance could be utilized, or where additional research may become beneficial. But, really, the whole point of it is aimed at illustrating what is necessary in order to maintain meeting a late 2020 deployment for a particular ATF technology.

CHAIR HANSON: It's the project plan, but for us visual learners in the audience?

(Laughter.)

MR. HELLER: Yes.

CHAIR HANSON: Okay. Thank you.

MR. HELLER: Sorry if I, if I wasn't quite so succinct.

CHAIR HANSON: No, no, that's just fine. No, I appreciate it very much. You were helpful.

Ms. Kock, I was really pleased, I think in the previous panel, to hear some positive feedback about our topical report reviews. Obviously, you know, the topical report reviews can be a way to kind of deal with a number of kind of complex issues, and a way to get some data in front of the NRC, and so forth.

I guess I'm curious about kind of efforts to improve the topical review report process and kind of lessons learned from the substantial number that we've reviewed in this area, either in terms of the substance of the regulations, or just how the -- about how to kind of refine our review process. Could you talk a little bit about that?

MS. KOCK: Sure. I appreciate that. So, about a year and a half ago the staff looked at the topical report process to see where we could streamline it a bit. And what we did was we looked at kind of binning topical reports into different categories so that if they're less complex we could complete them in a shorter time frame. And then more complex one would take a different path. So, that has really helped us. We've incorporated that into our procedures internally.

And then, you know, we don't ever rest on our laurels. So, we said, is there, you know, what else? What have we learned? How, you know, what else might we do? So, after that we consolidated best practices within NRR to see, you know, what are the things that have been successful? And those are the things that you've heard of time and time again: it's completing audits so that we get to the bottom of issues with licensees and communicate, pre-application meetings, you hear that as a common theme. You've heard that from the external panel how important those are. We are looking at efforts to complete templates for SEs to kind of shorten the time frame for putting the

documentation together.

CHAIR HANSON: SEs?

MS. KOCK: Yes. Oh, I'm sorry, safety evaluations.

CHAIR HANSON: Thank you.

MS. KOCK: Thank you. We forget that sometimes, don't we? And so, we kind of binned all of those best practices and put those out to the staff as, you know, ways that we can really keep our eye on the ball.

CHAIR HANSON: Thank you. Thank you very much. I think I'd like to finish up with Mr. Corson and Ms. Chung. I was really kind of pleased to hear a lot of the, you know, research efforts that both we're sponsoring and also, of course, the DOE's gotten engaged in. And I've been really impressed with the FIDES project and how that's come together and started to kind of augment or replace some of the international research capabilities.

I guess, and I'm, and I'm glad that we're -- Mr. Corson, I think you summed it up really succinctly in response to Commissioner Crowell about this, you know, gathering data about how the performance of these fuels under accident conditions and how important that is.

As we go about this, we have this issue, I think as we gather data under our regulatory basis on a regular, you know, kind of under normal conditions, which is kind of how much is enough data? You know, what are those, what are those key gaps? And as we address those gaps, at what point do we kind of consider them filled?

There's also, I think, a use for confirmatory data out there. And I know a lot of our university partners do a really great job in supporting code development and code validation at the NRC. But in terms of kind of the front line, you know, research and regulatory development organization, how do

you guys kind of see this problem?

MR. CORSON: It's a really complicated problem. And it, it depends in part on how far we diverge from what we already know. So, for the nearer term concepts you probably don't need as much data because we expect they perform pretty similarly to the existing fuels. So, you know, maybe you can get away with only a few data points and leave it at that. And recognize that there are still uncertainties but, but deal with them.

For the longer term stuff they, they're going to behave differently. We're probably going to need more data. That's why, you know, we need more time for the development as well.

But, yeah, it's pretty complicated. We are very sensitive to not waiting until we have just a complete picture before us. We recognize there's always going to be some uncertainties. And that's why we have methods to address them and conservative assumptions as well.

CHAIR HANSON: Ms. Chung?

MS. CHUNG: I don't have much to add on this because, obviously, it couldn't have been said any better.

(Laughter.)

CHAIR HANSON: Oh, come on. Give it a try.

MS. CHUNG: There is one thing that I, I guess, I could piggyback on is the fact that our collaborations through these international projects, as well as kind of the diversity of views in which the fuel community is looking at these problems, is also really helpful in terms of not just identifying the gaps, but maybe also, you know, having a better understanding of how to prioritize those gaps. So, you know, talking amongst the research communities is really engaging and helpful, but also expanding that viewpoint to industry, to

the national labs has been really helpful as well.

CHAIR HANSON: Thank you. Commissioner Baran.

COMMISSIONER BARAN: Thanks. Well, thank you all for your presentations and for you work on accident tolerant fuels.

To follow up on topical reports, I was also glad to hear it sounds like that from applicant perspective is going well. I'd just like to get an understanding of the scope of that work. Could someone talk about how many accident tolerant fuel topical reports are under review now or expected in the near term?

MR. HELLER: I think I can take that one. So, as far as a number of ATF-related topical reports, there are, I believe, three topical reports that we have completed today related to ATF. And those are predominantly associated with doped pellet technology.

There are, I believe, another nine that are currently in-house. And if my memory is serving me well, there are two that are nearing completion of those nine. Taking a look down the road over the next 12 months, we anticipate somewhere on the order of seven additional topical reports to be submitted. And those, the ones currently in-house, those nine as all, as the ones that we expect within the next 12 months, they, they run the gamut, so, coating cladding technologies, doped pellets, increased enrichment, as well as burnup.

COMMISSIONER BARAN: And what kind of -- I know there's probably no standard time frame, you know, for reviewing those, but what kind of range or time frames are you looking at? And what are some of the factors that contribute to it being longer or shorter reviews?

MR. HELLER: So, really the length of review associated with

a topical report is really dependent on the scope and the complexity of the topical. But speaking generally, I guess a standard expected review time for a typical topical report is approximately 2 years. For a complex topical report, we would expect it to take slightly longer than 2 years. And then for a topical report of exceptional complexity, it could take as long as 3 years.

With regard to the ATF technologies, we are operating under the assumption that those are complex topical reports. So, they're falling in that middle category. So, we would initially expect slightly more than 2 years. However, we've been leveraging the new paradigm that was presented within the ATF project plan of the frequent and early communication. And we've been, through that, able to effectively reduce the review times on a number of these topicals. So, of the three topical reports that I mentioned we've completed to date, two of those were completed in just under 2 years, and one was completed in just over 2 years. And that one, again, was due to some of the complex nature of the material.

COMMISSIONER BARAN: Okay. And if we, if we're talking about the universe of the nine pending now and the seven expected, does the staff have the resources to review all of those? And, if not, how do you prioritize that work?

MR. HELLER: So, I can take a stab at that and then I can hand it off if anyone wants to facilitate additional discussion on it. But, again, because of the ATF project plan and the frequent and early communication that we have, we're aware of the technologies that are being explored, and we're getting a much better understanding of the anticipated timelines for submittal.

Additionally, I mentioned within my presentation there's the 2022 letter that went out. But more importantly, even more importantly, the

research, the Regulatory Issue Summary letter that we're in the process of developing which is really seeking to solicit some input on what is expected to come down the pike? What do you anticipate providing or seeking to adopt as far as these technologies?

Because that information is what we need in order to make sure that we have appropriately allocated our resources, that we have the expertise on hand in order to perform the reviews, and we actually have the reviewers ready to go. So, I'll stop there and see if there's any additional.

MS. KOCK: Couldn't have been said any better. But I'll, I'll just put a finer point on it. So, just to be very clear, we have the resources to review the topicals that we're aware of, like Kevin said. But it just emphasizes the importance of that early engagement to make sure we have those resources aligned.

And, you know, one additional piece of information is when topicals come in. We work closely with applicants to understand what their need base is. And quite, quite frequently those schedules change based on needs of the applicant.

So, one of the things we did -- back to the question on what have we done with the topical report process -- is link the topicals to potential licensing actions, and put those closer in time so that we can gain the efficiencies from the topicals in the licensing review.

So, we look at part of that when we set the schedules. And then we track those schedules very closely. We have meetings once a month where we go through all of them. We have metrics that we make sure that we make on those to make sure we meet the schedules we've committed to.

COMMISSIONER BARAN: Great. Well, there's been a lot of

discussion about fuel fragmentation, relocation, and dispersal, or FFRD. Can someone just kind of give us maybe the 2-minute high level overview? How is the staff, you know, at a high level approach to this issue?

MR. CORSON: So, I can take a quick shot at it. Basically, this is a set of phenomena that we've observed in some of our experimental programs. It's shown that under conditions of a LOCA or, potentially, other accidents, the fuel can finely fragment, move axially within the rod, and then get out into the coolant if, if the rod balloons and bursts, which it can do under these types of conditions.

So, there has been a lot of studies done and a lot of experiments really focusing on, basically, everything up to the point where it gets out of the cladding. So, that's, like, the SCIP program, some Halden tests, and so on. So, we've looked at a lot of that and have a fairly good understanding of that behavior.

The complicated thing is what happens once it gets out of the cladding, and where it goes, and what the consequences are. And we have done some, some very preliminary studies of this. But I think this is a big area where we're, we're looking more into the future and trying to prepare ourselves.

Alice mentioned we did some calculations to try to estimate how much could get released and to exercise our tools. And that's sort of the first step in this process to, to figuring out more what the consequences are, how it impacts fuel coolability, how -- or core coolability, how it impacts our radioactive dose, and all those other things.

COMMISSIONER BARAN: That's really helpful. And there was discussion earlier of the research information letter on this and, you know, updating it as new data becomes available. My sense is that a lot of the data

out of specific designs is proprietary. How -- first of all, is that right? But then, secondly, if so, how does that affect your ability to synthesize it, and use it, and update a document like that letter?

MR. CORSON: So, one thing I will say is that a lot of the vendors do participate in these international programs and they use their own, you know, fuel that's irradiated in commercial reactors or elsewhere. So, we do have access to some of that data. With the international programs the data is proprietary to the international programs. But we can petition to have it released. That's what we did for the SCIP-3 data and Halden data that's in the research information letter. So, as long as the data is coming from these international programs that we're part of, we have a way of, you know, arguing to the management boards that this is in the interest to release this information.

For the stuff that's truly proprietary, that's only coming from the vendor, obviously that is, you know, it does complicate things, unfortunately. But we can review, you know, vendor-specific information as appropriate. Maybe we can't put it in our guidance available to the public, but we can include that in the licensing process. But, again, fortunately, a lot of the data comes through the experimental programs that we can at least share potentially.

COMMISSIONER BARAN: Okay, great. That's very helpful. Andrea, you mentioned the staff's efforts to identify the knowledge gaps for new fuel designs so we can fill those gaps. Can you talk a little bit about what gaps we're identifying and how we're tackling those?

MS. KOCK: Sure. A lot of them have come up during the discussion but I will put a --

COMMISSIONER BARAN: First of all, none of it's evident today, but a lot, a lot of expertise in this panel.

MS. KOCK: I agree. Just proud to be here. So, knowledge gaps. So, I would say, like, what we're primarily looking at is those longer term ATF technologies. So, I mean, you've heard a lot today about how there's more uncertainty around those technologies. And we're just starting to look at those.

And we're trying to keep that line of sight: when is the right time to engage with those? You know, not -- we don't want to be too early where we're working on something that may not come to fruition; right? So, we're keeping our eye on those. Coordinating with our partners, coordinating with the industry, coordinating with DOE, involving ourselves in the international research to get more information on those. And then when we determine that it's ripe for review, we'll do additional literature searches or PIRTs on those specific topics. So, that would be one area of knowledge gaps I'd point to.

James already talked about how there's less information on the behavior of ATF during accidents. So, that's another area where we're gathering more information and knowledge through international engagements and our partners with Research.

And then I, I kind of think about a third bin of knowledge management and that's what I call regulatory policy. So, when you think about FFRD and the implications of the impacts of FFRD in terms of consequences, and what that means for our regulations, there's a lot of history there.

And not everybody is aware of that history. We have new staff coming on board. So, knowledge management in terms of, you know, what has the Commission said about things like fuel coolability? Does that require a change to our regulations? How can we risk inform in this manner? So, to me, that's more of a regulatory craft knowledge management that's also ongoing with the staff.

COMMISSIONER BARAN: I'm really glad I asked that question because I was really thinking of it, I interpreted your comments with a workforce type point that you were making. Were there skill sets that we had to have on the staff? But it sounds like, really, you're comment was more geared towards just the data that we still need and kind of the information.

MS. KOCK: Uh-huh. I think the skills that are needed for ATF are not wildly different than what we would see for other fuels.

COMMISSIONER BARAN: Okay.

MS. KOCK: We have those skill sets. It's the knowledge.

COMMISSIONER BARAN: Great. Thank you, all, appreciate it.

CHAIR HANSON: Thank you. Commissioner Wright.

COMMISSIONER WRIGHT: Well, you all are answering all my questions.

(Laughter.)

COMMISSIONER WRIGHT: I'm struggling here. First off, Miss, I was impressed in your delivery of your presentation. I don't think you looked at your notes hardly at all. That was awesome. I haven't seen that before. So, you were very comfortable with what you were saying. And your answers today to the questions from the commissioners have been very clear. So, thank you for that. It helps. It helps me understand things better. So I do appreciate that.

Andrea, I'm going to come to you here. You just had the conversation about knowledge gaps. And then right at the end Commissioner Baran focused on just the skill sets or expertise, and you mentioned that it wasn't much different from the other fuels, right?

So, is there, is there anything out there that you lack or that you feel that going forward that you might need? And, if so, is there anything the Commission can do or needs to do in order to support you in those efforts? Right? Especially in identifying, maybe, or recruiting, or retaining staff that we need?

MS. KOCK: So, I think in terms of skill sets, again, I think we have fundamental skill sets. And one of the things that we're trying to build is agility in the staff. So, we have folks from Research come over and work in NRR. We have people move from NMSS to NRR. And build that kind of skill set across the different areas of expertise that we need.

So, I feel on the subject of skill sets that we're there. We have been, you know, recruiting and retaining the staff that we have. Nuclear engineering is where ATF fits in with regard to our workforce. We have identified it as our high priority gap in our workforce in the future when you look at where we might have potential attrition and the workload that comes in. So, it's been identified as a gap from that perspective in terms of the work and the people. We're actively working on that.

We have been success recently bringing in several new nuclear engineers into the agency. I'm sure you've noticed a lot of new faces. So, that's been very, very helpful. And we are aggressively looking at that area.

So, in terms of what the Commission can do, I would say keep doing what you're doing. Support our requests for staffing and budget, which you have in this area, because we all recognize it's a priority. Vote on the policy issues that are in front of you, and give us your guidance in that manner so that we have clarity to move forward. And you've been doing that. So, we appreciate that.

COMMISSIONER WRIGHT: Thank you. I'm going to stay with you and maybe, Kevin, you can jump in if you need to as well. But we've had the conversation about 50.46c a little bit. From the first panel we heard the, I guess, there was some desire maybe to look at resurrecting 50.46a, maybe combining the best parts of those things along with the enriched rulemaking as well. And, you know, we heard about communication, the value of that, how important it is. We also heard in that first panel that some of the parts of maybe 50.46c could be a little bit outdated or overcome by events over time here.

And then, you know, we also heard from the first panel that there was -- that the cost that was pegged might actually be much higher than the 35, I think it was 35 million that was talked about as a base. But it could be much higher than that. And that it might, if we just, if we went with 50.46c as presented, maybe it would slow progress, right, get industry taking their eye off the ball so to speak, right?

So, I guess my question is I'd like to hear, give you the opportunity to kind of, like, talk about the intersection or connection of all those they brought up in the first panel that was talked about, and to see one has -- have you been communicated to about this, the possibility of this? And are you thinking about it? And, you know, kind of give me your thoughts, you know, about it going forward, you know, with, for example, with resurrecting 50.46(a), right, and blending the good parts of all those things together. Would it really, you know, what kind of role would that play? And would it, you know, how good would this thing end up being if we did something like that, I guess?

MS. KOCK: You said you were out of questions, but that was a really good one. So, let me start. I might have to phone a friend here to my left.

So, let me start with 50.46c. So, I mean, you've heard that our view with regard to 50.46c in ATF, in that intersection, we see a benefit there in terms of reducing the number of exemptions that would need in bringing regulatory clarity.

In terms of the other parts of 50.46c, those, that part of the rule is technology neutral. So, I mean, it would apply to ATF, current light-water reactor fuel. And we see those as necessary for safety and to bring the rule to the current state of knowledge. So, I don't see those two things in conflict necessarily.

We have thought about, I think as you already heard, 50.46a, and what that might look like. And to me, some of this is, is timing. So, there are certain parts of our rules that we see value in moving forward with now to bring predictability and clarity. The increased enrichment rulemaking that we're working on I think we see as something near-term to support the deployment schedules that we see in the future. 50.46a, you know, we've thought about how you can risk inform, how we do LOCA analysis.

But right now, we don't know enough about the approaches that might be pursued to know what would need to change in the rule to make that effective. And to be honest, I, myself, question is a rule change needed? What I find sometimes is that we're a little bit conservative in the way we interpret our regulations. And there may be more flexibility there than we recognize. So, I would hate to see us go down the pathway of rulemaking and then figure out, you know, you may not have needed that if you look at it more holistically.

So, we are actively thinking about it. We're stepping back and asking ourselves that question. Our folks in NMSS in rulemaking are always

helping us to kind of connect the dots to see where there might be synergies and how to move forward. But that's what I would say as far as 50.46c, a, and kind of stepping back and looking at our framework. Did anybody else want to add?

MR. DORMAN: I'll just maybe take it up 10,000 feet and go back to the Chair's comments in the earlier panel about sometimes we get the research out ahead of the rulemaking. And that has inefficiencies. And sometimes the rulemaking is out ahead of the research. And that has inefficiencies. And then sometimes it's kind of rolling over each other in time. And I think that's a little bit of what's happened with 50.46, is we presented you a rule at a point in time that it was -- that it fit. And the whole effort to develop ATF by the industry has been overtaken by events, which is the term Commissioner Caputo uses. I think there's elements of that that may have been overtaken by events.

So, I think an active consideration of where rulemaking may be most helpful in the current environment to address it because there are some things, as was even touched on, you know, just some of the lead test assemblies are even getting us into exemption space. And so, as we get some of these technologies closer to batch loading, I think that we will need to work through some things that would be in the licensing space not as efficient as we would like. And maybe some rulemaking following up on that can solidify that framework for the fleet going forward.

COMMISSIONER WRIGHT: Kevin, do you have anything?

MR. HELLER: So, I can expand, I guess, on a little bit of one thing. And maybe it might preempt a question further down the line. But the -- with regard to your inquiry about 50.46a and the increased enrichment

rulemaking. And we've heard that there is some relationship there. From a very basic level, yes, the staff has been considering 50.46a and, you know, how various portions of it might be beneficial in the modern environment. But this is really cutting edge, so to speak, hot off the presses. This is something that has been coming into minds of the staff and under consideration very recently. So, it's a little too early to be able to say, or I guess to answer your question of what would that look like?

But the staff is in the process of assessing it, along with some other considerations, and documenting that within the regulatory basis of the increased enrichment rulemaking. And that is anticipated to go up to the Commission and the SECY in the near future here, and then to be published for public comment.

COMMISSIONER WRIGHT: And in the last few seconds I have just make a little comment. I appreciate your comment about maybe sometimes you don't -- maybe the flexibility's in the regs already, you know, and we need to take a hard look, a deeper look and to be sure of that. Because sometimes we might jump the gun and do a rulemaking very prematurely here, especially when that has maybe been overcome by events. So, thank you for that. And I appreciate your comments.

CHAIR HANSON: Thank you. Commissioner Caputo.

COMMISSIONER CAPUTO: Thank you all for being here today. I appreciate your comments as well. I've learned a lot just about the nature of the research that's being done here. So, I, I appreciate that.

I'm going to stay with Andrea here and follow-on what Commissioner Wright was asking about. So, you discussed the nature of our 50.46c is important to bring our state of knowledge, I think is how you put it, to

bring it current. But if the staff indicates there are negligible gains in safety that are going to resort from that rulemaking, what's the basis for establishing a requirement rather than making this optional for licensees?

MS. KOCK: I turned it off instead of on. So, when I referred to bring the rule up to the current levels of knowledge, the basis for the rule is that there is research out there. Again, I can't underestimate how much we rely on our folks in Research to provide information that the information we had in the original rule may not be applicable or sufficient for new fuel types. And so, that's what the rule was trying to accomplish.

The statement that there is negligible safety provided when you look at the current fleet, that's true. But when you look forward, the risk you may have is you may have a new fuel type where you are outside the box, and there is no longer safety. So, what the rule is trying to do is establish technology-neutral, performance-based criteria for safety limits, no matter what fuel type that you have. And, yes, for the current reactors we've satisfied ourselves and done analysis that they remain safe. But that may not always be in the future without a rule that would compel us to look.

COMMISSIONER CAPUTO: But if someone is going to adopt a new fuel technology, they would have to update their analyses to accompany that, that new change in fuel, correct? So, it's not necessary to mandate it for the status quo because they would need to pursue updating their analyses if they changed their fuel. Correct?

MS. KOCK: They would have to update their analyses if they had a change to the fuel. Which in my mind, again, just stepping back at a very high level, the purpose of a rule is to set a safety limit to provide a performance-based limit of how you can assure yourself that the fuel is safe. So, yes, you

have to update your analyses. But the purpose of the rule is for the regulator to set those safety limits.

COMMISSIONER CAPUTO: So, in saying that, are you suggesting that we don't have appropriate safety limits right now?

MS. KOCK: The purpose of the rule --

COMMISSIONER CAPUTO: As you said that current fuel is safe.

MS. KOCK: Because we're continuously evaluating the safety of that fuel. And we're actually right now, we do an analysis every year to satisfy ourselves that the fuel that is being used is safe. Our licensees also do that. But, I mean, as a regulator we have a responsibility, I think, to independently verify that.

COMMISSIONER CAPUTO: Okay. The staff's response to some of the questions I posed last fall included indicating that the staff is unaware of any licensee for which imposition of the rule would result in substantial safety improvements. So, I'm kind of, I'm trying to square that with the nature of what you're telling me here.

MS. KOCK: Again, in my mind it goes back to that if you look forward. So, we've satisfied ourselves that for the current fleet and the fuel that's being used, there not a large incremental change in safety for the current fleet. That doesn't guarantee that if somebody comes in with a completely new fuel type that those limits would be sufficient. We are continuing to assure ourselves that safety is assured currently. But it doesn't assure that future look. Does that help?

COMMISSIONER CAPUTO: Well, but then once again we're back to the nature of if someone's going to change their fuel type they have to

update their analyses at that point. So, it's a little redundant for us to require everyone across the board and do it now, without having a change in fuel type.

MS. KOCK: The rule would set the performance-based standards for the results of that --

COMMISSIONER CAPUTO: I'm sorry, Dan, do you want to contribute? (Laughter.)

MS. KOCK: Go ahead, Dan.

MR. DORMAN: No, I, I understand where your question is heading, Commissioner. And, you know, I think it's true that over time, as licensees have updated their, their analyses to address new knowledge around their either new mechanisms for their existing fuels or otherwise, that our process within the existing rule has provided assurance of the ongoing safety that has resulted in some changes in the outputs of licensees' analyses in terms of the peak clad temperatures, and so forth.

And so I understand your question about, you know, if the imposition of this rule would then cause them to have to go redo the analysis that they'd been updating all along. That I think Commissioner Wright touched on the comment from the previous panel that, you know, that could create a body of work for the people with the skill set that may detract from other, perhaps, more beneficial activities. So, I think it's a question, I think, for us to take back, yes.

COMMISSIONER CAPUTO: Okay. Well, I think for me it really comes back to our principles, and the fact that regulatory activities should be consistent with the risk reduction achieved. And if the acknowledgment is that we're really not going to necessarily be reducing risk through 50.46c, then I question why we would dedicate the time and resources to it, especially when

there's a, you know, very compelling workload headed down the pipe toward us on ATF. So, therein lies my question on that.

Andrea, I'm going to stay with you. On the heels of this discussion on 50.46c, earlier you indicated that for near term ATF concepts the staff can largely rely on existing data, models, and methods for its valuations. And Kevin told us about the staff finding existing regulations and guidance sufficient for licensing new fuels with increased enrichment and higher burnup.

He also said that additional requirements for new fuels might be needed. So, how are you planning to ensure that the rulemaking that's underway on increased enrichment and higher burnup is going to be consistent with the risk reduction achieved? How are we going to make sure that this is risk informed?

MS. KOCK: Well, I think that's fundamentally part of the rulemaking process. So, again, looking at it from a 50,000-foot level -- it looks like some of my friends are wanting to jump in, so I'll be brief and then let them jump in.

So, at a 50,000-foot level what we're trying to do is provide more flexibility in the regulations for increased enrichment. And in doing that, from a safety perspective we will look at how, how can we do that in a risk informed manner, providing flexibility, focusing on what's important, without imposing undue regulatory burden? And so that, that -- and we'll be seeking that feedback as part of the rulemaking process. When the reg basis is issued we go through pros and cons, costs and benefits, as well as through the proposed rule. So, didn't know if anybody else wanted to jump in.

MR. HELLER: I don't think there's much that I can add on to that other than to reemphasize that, yes, part of the rulemaking process is the

consideration of risk informed. And I think it becomes a little bit more apparent when we compare performing a rulemaking versus not, when it comes to increased enrichment.

At present, taking a look at the history of our regulations, in particular 70.24 and 50.68, which was promulgated out of numerous exemption requests in the '90s, numerous exemptions to 70.24, when we take a look at the technology that's coming in-house even as we speak, we recognize that there's a likelihood for increase -- an increased number of exemptions again.

So, in an effort to be efficient, we consider a rulemaking process. One of the advantages that offers is instead operating by exemption, there is a more -- there is an approach available with increased regulatory certainty, as well as increased opportunity for stakeholder interaction.

COMMISSIONER CAPUTO: Okay. Ms. Marcano, I have a question for you. You mentioned using metrics in tracking reviews and how you had an example of accomplishing a review in 5 months rather than the 3-year metric. So, I have a question, what does that tell you about your metrics? Is this, is this new approach to the review something that can be replicated against other reviews so that you more or less achieve a new level of efficiency or duration in these types of reviews such that the metric really becomes outdated and should be updated? Or was this sort of a one-time bit?

MS. MARCANO: So -- sorry. So, our metrics, I was referring to our NEIMA metrics. And our NEIMA metrics encompass many of the reviews. In the case of ATF licensing reviews, we use the interdisciplinary team or a Tiger Team approach. And I think we are seeing some of the efficiencies on the ATF licensing actions between we're using the same interdisciplinary team for all of the licensing actions.

So, you're going to have that team that is already know what -- they know what to expect. They know what to look for in the specific action. So, you will see efficiencies on the timeliness of the reviews, specifically when in ATF because you're using that kind of approach and you're using the same project manager, and the same technical reviewers in the different technical areas.

We do look at our metrics every year. And we do ask ourselves if there is a need for us to, to make changes to that metric based on the information that we have gathered from previous years, and our timeliness on those. But it just depends on the complexity of the cases across the board, not just for ATF.

COMMISSIONER CAPUTO: Okay. Thank you.

CHAIR HANSON: Thank you, Commissioner Caputo. And thank you, again, to our staff panel.

COMMISSIONER BARAN: Chair, can I ask a quick clarifying question?

CHAIR HANSON: Oh. Yes.

COMMISSIONER BARAN: Not to go on and on on 50.46c, but I worry that this last exchange that maybe folks were talking past each other a little bit. So, I just want to ask a clarifying question to make sure we're on the same page.

My understanding of 50.46c, which I voted a while back, was that there are two real aspects to it, at a high level. One is about safety and adequate protection for fuel today or tomorrow. And the other is basically moving in a more technology neutral performance-based approach so that that would facilitate ATF reviews or anything else, any kind of new technologies.

And so, that piece, for example, we have in the regs, you've got to use Zirlo or Zircaloy, you know, cladding. So, if you want it to be anything other than that, you, as we're hearing about today, you have to go for exemption. So, so that's one piece. And it's very forward looking from a technology point of view.

But I think, Andrea, the question started to get into the other aspect of this, which is that there was, like, a decade or 15-year period of research that revealed new degradation mechanisms, hazards associated with the fuel today that showed that today's regulations are, in fact, not adequate to provide adequate protection.

So that the staff does something, I think, pretty unique in this area which is that at the end of every year you look backwards at the analysis of the prior year to determine whether they were safe in the prior year, but don't actually have assurance for the next coming year in the future because we don't have a standard in place that's strong enough to actually account for all of the research.

Is that, is that right? I mean, so when you were talking about forward-looking I think, I think Commissioner Caputo was talking about forward looking technologies, new technologies, new fuel designs. And when you were talking about forward-looking, you were talking about, like, next year for the fuel we have in cores right now, and what level of assurance we have on that based on the current regulation being outdated. You know, can you talk just for a minute, make sure we all leave with kind of the same understanding of what we're talking about?

MS. KOCK: I can start. Others may want to chime in. So, I think the way you characterize it is correct as far as the two pieces, the rule

wanting to establish a technology neutral, performance-based system for all fuel types. And the example you gave was Zircaloy cladding is exactly right. If you want to use a different kind of cladding, you would need an exemption. And it also provides safety standards based on the research leading up to us issuing that rule.

So, I think the way you characterized it is correct. We are doing that backward-looking assessment every year to assure ourselves. That's why I said we are assured plants are safe, because we have been doing an analysis to make sure, given the new information, that plants remain safe. It also, again, sets the standards for new fuel types so that under those new fuel types plants would be required to do an analysis for those new fuel types to make sure that those safety limits were met.

So, I think the way you characterized it is accurate. When we said that there is no large risk reduction in the current fleet that's because, like I said, we've done the analysis that's backward-looking to assure ourselves it's safe. What the rule does is for the future, should a plant adopt a new kind of fuel, ATF, whatever, it is fuels that we can't anticipate yet, that standards are put in place for safety. So, I think you characterized it correctly. And I'll see if any of my esteemed colleagues want to weigh in more articulately.

MR. DORMAN: Well, the one thing that I want to touch on, I think, the way I heard you express it was we don't have adequate assurance going forward. And I, I don't agree with that.

COMMISSIONER BARAN: Okay.

MR. DORMAN: We do have --

COMMISSIONER BARAN: Even though it's an adequate protection rulemaking.

MR. DORMAN: We do -- Yeah, so we do have reasonable assurance of adequate protection based on the analyses that have been done to date. What happens is from time-to-time research information or operating experience gives us new data that suggests that factors in the fuel analysis should be updated. I'm thinking of thermal conductivity degradation in the last decade is an issue where we asked licensees to go back and re-analyze their fuel.

And so it's, it's updating to current information. So, sometimes that, but that process is built into the rule as it currently exists. So, I think that's where the, that's where the conversation can focus is what would -- so, as you -- if the Commission imposed the rule before them, then that caused everybody to then have to go do another analysis, is it going to be that significant difference in impact to safety? And I think that's where the staff response to Commissioner Caputo said, no, we don't really expect that would be the case. So, I think that that's, that's the challenge.

COMMISSIONER BARAN: Okay. I think that, I think that helps clarify the back and forth on that.

CHAIR HANSON: Thank you, Commissioner Baran. I'm happy to recognize other commissioners if they've got follow-up questions from Commissioner Baran's. Yes?

COMMISSIONER CAPUTO: I would just make the point that I think what I'm struggling with here is that this regulation doesn't create a significant safety improvement, that it's classified as necessary for adequate protection, but we're confident that the plants are safe as is.

So, I have to tell you I have issues with this because I think this, to me, becomes symptomatic of the confusion that ends up resulting if we

don't rigorously adhere to our backfit rule, and make sure that our regulatory actions are consistent with the risk reduction achieved.

And I think that has impacts with regard to reliability and stability of the regulatory framework with regard to whether or not we are going to hold ourselves to that standard and measure our reactions against it. And I think that that has a lot to say about, about reluctance for certain licensees to come forward in certain activities when they're concerned about the stability of the process. So, that's all I have to say, Mr. Chairman. Thank you.

CHAIR HANSON: Thank you. Thanks again. Let me try this again. Thank you all for being here. Thanks to the staff and the panel. Thank you for our external panelists as well. I think we touched on a lot of the key issues today. Thanks to my colleagues for highlighting and enumerating those issues.

I'll take the liberty, once again, of referencing and, hopefully, honoring Commissioner McGaffigan. I think there's real learning that's happened here in the way we've highlighted, and vetted, and probed on these really important issues for both the agency and our licensees. So, thank you all again. And with that, we're adjourned.

(Whereupon, the above-entitled matter went off the record at 12:11 P.m.)