United States
Nuclear Waste Technical Review Board (NWTRB)

Transcript

2024 Summer Board Meeting

Thursday
August 29, 2024

PUBLIC MEETING
In-Person and Virtual

NWTRB BOARD MEMBERS IN-PERSON

Nathan Siu, Ph.D., Chair
Ronald Ballinger, Sc.D.
Kenneth Lee Peddicord, Ph.D., P.E.

NWTRB BOARD MEMBERS VIRTUAL

Steven M. Becker, Ph.D.
Allen G. Croff, M.B.A
Scott Tyler, Ph.D., Deputy Chair
Brian Woods, Ph.D.

NWTRB EXECUTIVE STAFF MEMBERS IN-PERSON

Daniel Ogg

NWTRB EXECUTIVE STAFF MEMBERS VIRTUAL

Neysa Slater-Chandler

NWTRB PROFESSIONAL STAFF MEMBERS IN-PERSON

Christopher Burk
Hundal Jung
Yoonjo Lee
Bret Leslie

NWTRB PROFESSIONAL STAFF MEMBERS VIRTUAL

Chandrika Manepally

NWTRB ADMINISTRATION STAFF MEMBERS IN-PERSON

Davonya Barnes
Jayson Bright

NWTRB ADMINISTRATION STAFF MEMBERS VIRTUAL

Kimberly Brown

SIU: Good morning. I know we're still getting set up here, but… and I apologize for not having enough chairs squared away. But we do have some folks online, so I think we should just get rolling. Good morning. Hello to everybody online. Welcome to the US Nuclear Waste Technical Review Board Summer Meeting of 2024 and hosted in North Augusta, South Carolina. I'm Nathan Siu. I'm Chair of the Board.

Before opening this meeting, I'd like to pay tribute to Dr. Rod Ewing, Former Chairman of the Board who passed away on July 13th. Many of you attending might remember Rod, for his time as Chairman between 2012 and 2017. He led the Board's evaluation of the DOE's management and plans for disposal of DOE spent nuclear fuel that was documented in our Board report here. It's quite a dense document with lots of, lots of information on the management and disposal of DOE spent nuclear fuel. Dr. Ewing's research spanned minerology, geochemistry, material science, nuclear materials, physics, and chemistry--leading to development techniques that predict the long-term behavior of materials used in radioactive waste disposal. We appreciate Rod's many years of service on the Board and his outstanding scholarly contributions he provided over the decades of research and teaching. In his honor, I’d like to ask for a moment of silence.

Thank you.

Okay, so let’s turn to today’s meeting. This meeting will, indeed, focus on DOE’s management and plans for disposal of DOE spent nuclear fuel. We’re holding this meeting in a hybrid format with the combination of both in-person and virtual attendance by presenters and as well as Board members.

Let me introduce our current Board. And I’ll also outline what we do for those of you who don’t know… who aren’t familiar with the Board.

Okay, in person, first of all, of course, I’m Nathan Siu again. I’m Chair of the Board. Professor Ron Ballinger is Professor Emeritus of Nuclear Science and Engineering of Material Science and Engineering at Massachusetts Institute of Technology. Ron, if you could just raise your hand, we’ll be able to see you on the camera. Next to Ron is Professor Lee Peddicord who’s Professor Emeritus of Nuclear Engineering at Texas A&M

University. We have four board members joining us virtually in alphabetical order: Steve Becker is a Professor of Community and Environmental Health in the College of Health Sciences at Old Dominion University in Virginia. Allen Croff is a Nuclear Engineer and an Adjunct Professor in the Department of Civil and Environmental Engineering at Vanderbilt University. Scott Tyler is Professor Emeritus in the Department of Geological Sciences and Engineering at the University of Nevada, Reno. And last, but not least of course is Professor Brian Woods. He’s a school head and professor in the School of Nuclear Science and Engineering at Oregon State University. Again, they are participating virtually.

One Board member who’s unable to join us today is Professor Tissa Illangasekare who is Amax Endowed Distinguished Chair of Civil and Environmental Engineering at the Colorado School of Mines. At present we have eight members on the Board and our full complement is normally 11. Our other positions are currently vacant. If you are interested in our backgrounds, you can find more information on our website www.nwtrb.gov.

Okay. Before rolling, you'll see that we have a lively group. Any of you who have attended previous meetings know that we don't withhold our opinions. Just please be aware these are the personal opinions of the Board members at the time of the meeting. The formal Board opinions are found in our reports and letters which are available on the Board's website. We do appreciate, of course, mentions to the Board's discussions at other meetings.

Okay. Let me give you a brief description of the Board and what we do. Again, I think many of you are familiar with the Board. Just to remind you, we are an independent federal agency in the Executive Branch. We're not part of the Department of Energy or any other federal department or agency. We were created in the 1987 Amendments to the Nuclear Waste Policy Act to perform objective, ongoing evaluations of the technical and scientific validity of DOE activities related to the management and disposal of spent nuclear fuel and high-level radioactive waste. Again, we are a technical review board. We don't get into policy. The Board members are appointed by the President from a list of nominees submitted to the National Academy of Sciences. We are mandated by statute to report Board findings, conclusions, and recommendations to Congress and the Secretary of Energy. And it’s very important to point out meetings like today are an important tool for us, help us perform our review. It provides us with the information we need to write our letters and reports.

So, the Board provides objective technical and scientific information on a wide variety of issues related to the management disposal of nuclear spent nuclear fuel and high-level radioactive waste, which tend to be useful to policymakers in Congress and the administration. We provide technical and scientific comments in letters and reports to DOE following our public meetings. All this information can be found on our website along with Board correspondence, reports, testimony, and meeting materials, including archived webcasts of recent public meetings. We do have a two-page document summarizing the Board’s mission and presenting a list of the Board members. That’s on our website. And we have a copy of our Board’s mission and some recent Board reports on the document table outside the room as you entered.

The meeting agenda and presentations have been posted on our website and can be downloaded and we'll have a public comment period today at 4:45 p.m. Eastern time. Those attending the meeting in person and wanting to provide oral comments are encouraged to sign the public comment register at the check-in table near the entrance to the meeting room. Oral commentators will be taken in the order that they are signed in. Depending on the number of commentors, we might put a time limit on the individual remarks; and we'll see how that goes. When making a public comment, please use the microphone that's available at the front of the room. Please state your name and affiliation so that you'll be identified correctly in the meeting transcript. And DOE staff and lab participants, also please if you use the… if you're asked to answer a question, for example, please use the microphone and identify yourself if you're called upon.

Public comments can also be submitted during the meeting via the online meeting viewing platform using the comment for record form. If you're viewing the presentation in full-screen mode, you can access the comment for record section by pressing the ESC key. A reminder on how to submit comments will be displayed during the breaks. The Board values these comments and we will read them as part of our deliberations on the meeting. Comments submitted online during the meeting will also be posted to our website shortly after adjournment. Written comments and any other written materials may also be submitted later by mail or email to points of contact noted in the press release for this meeting, which is also posted in our website. These will become part of the meeting record and will be posted on our website along with the transcript of the meeting and the presentations you see today.

This meeting is being webcast live and is being recorded, so you'll see cameras are in the room. Depending on where you're sitting, you might actually be part of the webcast and the recordings. Be aware. The archive recording will be available on the Board's website by September 4, 2024. And the transcript will be available by October 30th.

Okay. The specific purpose of this meeting. This is part of the Board's continuing review of DOE's activities related to the management and disposal spent nuclear fuel and high-level radioactive waste. The first part of this meeting will support the Board's ongoing review of DOE's Office of Nuclear Energy's efforts on federal consolidated interim storage facilities for commercial spent nuclear fuel using a consent-based siting approach and its storage, transportation, disposal research, and development activities. And our first speaker, Paul Murray, will address those topics.

The second part of the meeting, as I mentioned earlier in 2017 the Board completed a comprehensive review of DOE’s management and plans for disposal of spent nuclear fuel. And the rest of today’s meeting will provide information on the progress that DOE has made since then. That information forms a basis for the Board’s evaluation of the scientific and technical validity of DOE’s current management and plans for disposal of DOE spent nuclear fuel.

Okay. So, our agenda. Starting off, Paul Murray, Deputy Assistant Secretary for Spent Fuel and High-Level Waste Disposition from DOE’s Office of Nuclear Energy, will describe the reprioritization of storage, transportation, and disposal R&D activities. He’ll also provide an update on federal consolidated interim storage facilities for commercial spent nuclear fuel, sited using a consent-based process. Next, Jomaries Rovira from DOE’s Office of Environmental Management will provide an overview of DOE spent nuclear fuel storage, transportation, and plans for disposal. We’ll have a 10-minute break at 10 a.m. We will of course have time for questions after each presentation from the Board and staff.

Rod Rimando from DOE and Elmar Eidelpes and Gordon Petersen from Idaho National Laboratory will describe DOE’s EM’s spent nuclear fuel technology development program. Again, this is after the break. James Therrell from Savannah River Nuclear Solutions will present on the accelerated basin de-inventory project at Savannah River Site, (ABD).

We’ll have a lunch break for one hour and after that, we’ll start with presentation by Kiran Karanth, Lauren Ingalls, and Tanner McConkey, all from Savannah River Nuclear Solutions. They’ll describe spent nuclear fuel management activities at Savannah River Site L-Basin Facility. Next Steve Vitto from DOE and Anna d’Entremont and Xiankui Zhu from Savannah River National Laboratory will describe management alternatives for spent nuclear fuel after completion of the de-inventory project.

We’ll have a 10-minute break starting at 3:05, pretty precise. Following the break, we’ll have a two-part presentation on spent nuclear fuel management activities at the Idaho site. In Part 1, Steve Wahnschaffe from DOE Idaho Operations Office will present on storage facilities and the storage spent nuclear fuel, packaging of the spent nuclear fuel, and describe the Idaho Spent Nuclear Fuel Management Plan. In Part 2, Will Anderton from Idaho Environmental Coalition will describe the “road ready” spent nuclear fuel demonstration and the infrastructure needed to implement the Idaho Spent Nuclear Fuel Management Plan.

We’ll have a public comment period starting at 4:45 p.m. Eastern time. And we’ll adjourn the meeting at 5:00 Eastern time. At that time, the webcast will stop.

Much planning, much effort went into planning this meeting and arranging the presentations. I want to thank our speakers for making the presentations at the meeting today and those who traveled great distances to join us. Thanks to members Ron Ballinger, Lee Peddicord and Brian Woods who led the Board’s review on DOE’s management and plans for disposal of spent nuclear fuel and helped develop this particular meeting. Thanks also to the board staff, especially Bret Leslie and Jo Jo Lee for doing the hard work of putting the meeting together.

I want to say also that yesterday the Board spent some time visiting the spent nuclear field and high-level radioactive waste facilities at Savannah River Site. And we want to thank DOE’s Office of Environmental Management for hosting us and providing us with very informative tours of facilities. It was very well done, and we do appreciate the time. So, thanks again.

Okay. If anybody has their cellphones on, please mute them and let’s begin with what I’m sure will be an interesting, productive meeting. And let’s start with Paul.

MURRAY: Good morning, everybody. I’m Paul Murray. I joined DOE less than a year ago. I think last October was when I joined. I’ve got 44 years in the industry. I know many of you. So, let’s get straight into it. So, my office is responsible for the disposal of the spent nuclear fuel and high-level waste. Let me say first off there’s nothing technically stopping us from moving forward. It's all political trust and public trust. Ok? Next slide.

So, before we start launching off into where we’re going, it’s also worth stopping to see where we’ve been. So, back in 1950 with the start of a nuclear… In the US we decided we start to look at the need for a deep geological repository. In 1957, the [National] Academy of Sciences actually made the recommendation that the US needed a deep geological repository. In 1982, the Nuclear Waste Policy Act was prepared. This is a tremendous document. I keep saying this. It actually sits on my bedside table. I read it often. It was a consent-based process beside the geo- (sic) deep geological repository. At the same time, the Nuclear Waste Fund was established. So, the US utilities started to pay into the Waste Fund for DOE to dispose of the spent nuclear fuel that is being generated. Ok? Today, the Nuclear Waste Fund stands at $45 billion and generates about $1.5 billion in interest each year.

In 1986, we down selected from five sites for a repository to 3 sites. In 1987, the Nuclear Waste Policy Act was amended, and we jumped straight to a Yucca Mountain site as the site of the future deep geological repository. The important date that's not listed here is January 31, 1988. It was the date that DOE was supposed to start picking up the spent nuclear fuel from the commercial sites. We had a contract to pick it up. That contract started 31st of January 1988. 2010, the Yucca Mountain project got defunded. Between 2010 and 2024, we've been in a holding pattern, trying to maintain capability and expertise. Before I really start talking about everything the office is trying to do, I'd just like to point out I have 24 staff. That includes admins, everything. 24 members of DOE are trying to do this.

So, taxpayer liability for spent nuclear fuel. Every year this table is published. So, starting with the top line last year, 30th of September 2023, our total liability for not picking up the spent nuclear fuel was $44.7 billion. To date, we have paid for partial breach of contracts $10.6 billion. So, our outstanding liability is $34.3 billion. Every year this gets worse and worse and worse. We just lost a settlement with a reactor in Connecticut for $200 million. That happened a couple of weeks ago. This table does not include any of the liabilities associated with EM or with naval reactors. This is purely for partial breach of contracts.

So, what are we responsible for? So, DOE nuclear energy is responsible for picking up the fuel from the reactor sites and moving it to a consolidated interim storage facility and then to a future repository. We're also responsible for picking up EM's high-level waste and moving it to a deep geological repository. Naval Reactors will transport their own spent nuclear fuels to a deep geological repository. One of the things we don't have at the moment is we don't have a plan from where we are now through the closing of a repository. So, Bill Boyle who works for me, working in collaboration with EM and NR [Naval Reactors], is putting together a program plan to allow us to consider all options. Remember, as soon as we take title to spent nuclear fuel, we no longer have to pay that liability. So, if the government opens a consolidated interim storage facility, moves the fuel, we don't pay that liability anymore. So, if we move fuel to interim storage, the liability moves to EM. We then start moving the EM high-level waste first, the Naval Reactors fuel. All that will be considered as part of a program plan that Bill's putting together.

One other important thing here is the schedule. We plan to open an interim storage facility in 2038. With the current fleet of reactors, today I have 92,000 tons of spent nuclear fuel. At the end of their life, I'll have 140,000 tons of spent nuclear fuel. If I can move spent nuclear fuel at 3,000 tons a year, that's about 50 years to move the spent nuclear fuel. So, if I open an interim storage facility in 2038, 50 years to move that fuel. I open a repository. I start moving the 21,000 canisters of high-level waste that EM's going to generate. The Navy moves their fuel. Another 50 years for me to move the spent nuclear fuel, and then the repository has to stay open for 100, 150 years. That's about a 250-year program. If I go back 250 years, I believe George Washington was still alive. So, that's the type of timescale we're talking about here.

Very recently, in the last couple of months, the Advance Act was passed. This is a very important document. It's all about new nuclear, expanding nuclear. But hidden in this document is this section. It shines a spotlight on our program. Congress wants to know going back to 2008 how much money has DOE spent on managing spent nuclear fuel, the DOE EM high-level waste, the Navy Reactors' fuel? And how much of the liability have we bought down? This is a law, so we have to report in 2026 on what we've done.

Legacy R&D. So, I can tell you we spent over a billion dollars in R&D since 2008. A tremendous amount of great data is being generated. The program's going to stop. It's going to pause. We're going to look at all this great data we generated and actually try and take some liability off the table. So, we are working with industry. We're looking at the problems we have and seeing with all this data we've generated, all this money we've spent, can we actually take some liability off the table.

My priority is moving forward. Consolidated interim storage. The design is proceeding on schedule. The liability estimate assumes that we will open this facility to receive fuel in 2038. DOE will be – and this is really important – an NRC license applicant. We will have the organizational culture in place to allow us to design and build this facility to NRC requirements. Once again, this is really important. We will design, build, and operate to the current NRC regulations and guidelines. No R&D we will conduct from now on will question any of the NRC regulations or requirements.

How am I going to move all this spent nuclear fuel and high-level waste? Well, this is the Atlas Railcar. The Atlas Railcar was certified by the American Railroad Association earlier this year. It was designed in conjunction with the Navy. So, we have a railcar, the safest railcar in the world. It's fully instrumented. It's ready to go.

So, what are we going to do? So, this is the High Burn-Up Demonstration Cask at North Anna. NRC licenses the safe storage of spent nuclear fuel in dry storage for so many years. We have to generate data to show that after that time period everything's still good with the fuel. I want to point out, spent nuclear fuel is a really robust mechanical form. Nothing's happening to it. So, the High Burn-Up Demo project is collecting data to show that nothing's happening to the fuel in dry storage. Most of the fuel that is discharged from reactors now is high burn-up fuel. This cask is important to over 60 of the current commercial reactor fleet. Okay, so the data this cask has produced and supports 60 of the current commercial fleet. We need to move that cask in 2027. So, my program is focused on moving that cask to a new home in 2027. The cask contains about

15 tons of high burn-up fuel. The upcoming NRC “toll gate” requires that the cask is opened in 2029 and all the R&D to show that nothing has happened to the fuel is complete by 2038. We are working on options for where to move that cask, as we speak. We hope to be able to announce where it’s going in the next couple of months.

As I mentioned, public trust is everything to our success. We are going to start what’s called a “Package Performance Demonstration.” We’re going to take one of these packages. We’re going to drop it in a lake. Fish it out, set it on fire, put the fire out. We’re going to crash it into abutments. If we have enough money, we’ll crash a train into it. We’ll do everything to demonstrate that these packages are robust. We have an RFI [Request for Information] on the street right now for public comment. What does the public want to see? We have webinars going on asking for public input. Believe it or not, we’re getting a lot of interest both domestically and internationally for these tests. These tests will go on for a long period of time to demonstrate to the public that everything is good for spent nuclear fuel transportation. If anybody has any concerns about transporting spent nuclear fuel, I strongly encourage you to respond to the RFI, attend one of the webinars… Anything you want to do to demonstrate that it is safe.

Consent-Based Siting. We hear a lot about Consent-Based Siting. We have funded 12 consortia to go out and basically talk to people about spent nuclear fuel and high-level waste. These consortia are not trying to site anything. They are trying to raise public awareness of what spent nuclear fuel and high-level waste is. One thing that’s happened in the last few weeks is we have funded a tribal consortia. I did not think that the 12 consortia that we had, had adequate tribal representation, so we funded a tribal consortia to basically help us. Consent-Based Siting is an integral part of my program for storage and transportation and disposal. It’s not a standalone. It’s an integral part of my program moving forwards.

This slide is up on our website. Go look at it. Two things that I want you to take away from this slide. The bottom right is where the consortia are. The consortia are over halfway through what they’re trying to do. The bottom left is where DOE is. The major milestone for next year will be released in an RFI for host communities to come forward.

Storage R&D. At the end of the day, I'll have 140,000 tons of spent nuclear fuel from the current fleet. We talk about tripling nuclear capacity by 2050. But from the current fleet, I will have 140,000 tons of spent nuclear fuel. That equates to about 63 million individual fuel rods, different claddings, different burn-ups. One cladding, Zirc-4, from one manufacturer is not that same as Zirc-4 from another manufacturer. There's so many variables related to spent nuclear fuel. All the R&D will be consolidated into an international center for research, for storage, for spent nuclear fuel and high-level waste. It will be located wherever the high burn-up demo cask ends up.

I need enough data to be able to make determinations on storage of spent nuclear fuel. Other countries have the same fuel. They have the same high-level waste as we have. So, we will enter into collaboration and we're exploring collaboration with Germany, with Belgium, the UK, and Japan. Will they share that data with us, and can we share our data with them? The important thing is the center will move as soon as we locate a consolidated interim storage facility and start building it. The R&D center will be one of the first things that moves. It will be a tangible asset, tangible jobs, tangible revenue to that consolidated interim storage facility.

All future R&D that we conduct must be relevant, have a defined goal, purpose, and conclusion. I've been conducting some R&D programs for 30 years, no more. R&D must be risk informed and buy down my liability. We will collaborate with US industry and for the Board's information, we did sign an MOU [Memorandum of Understanding] with EPRI [Electric Power Research Institute] just over a month ago to enable that collaboration to take place. The Blue Sky R&D, we will leverage for any Nuclear Energy University Program and for small business innovation research rewards.

Because we are in litigation, all the results coming out of R&D related to the storage must be peer reviewed. They must be approved by DOE, and they must be approved by General Counsel before they are released and discussed publicly. That's something we are starting to do immediately. We will also start to implement a graded QA [Quality Assurance] process to make sure that when we call into question NQA-1 data from vendors or other people, that our program is compatible to them.

NE's Collaboration with EM. We have to be coordinated. We have to be integrated. What one party does affects everybody else. So, it's really, really important that we are integrated. So, any intents to collaborate closely with EM at Hanford, at Savannah River, and at Idaho, this takes time, but we are starting discussions right now. OK? It's probably going to take most of 2025 to agree together on what we're going to do, but we have started those discussions. DOE-NE is hiring a new lead for storage and transportation. We're hoping he will start in two weeks' time. We've hired a new National Technology Director, Dr. Paul Cantonwine from Oak Ridge National Lab. Paul started two days ago. DOE-EM, I believe, has hired a new Chief Technology Officer. We have requested support from DOE-EM and NE on this total program plan so we can start to collect everything. DOE, we are discussing the consent-based siting process, lessons learned from that consent-based siting process, and also lessons learned from siting WIPP and the Yucca Mountain project. We are collaborating with Savannah River National Lab in supporting the aluminum drying project that they plan to do here at the site.

So, at EM, at Idaho we had a discussion with Mark Brand just earlier this week again. We ask right now support in the loading demonstration for the DOE standard canister. We contribute a significant amount of money to that project.

We are considering completing licensing of the DOE standard canister that is not currently licensed for transportation. We are considering from NE-8 completing that license. We are also looking at the possibility of opening some of the commercial canisters that DOE-EM has at the Idaho site. So, the canister…the cask with the failed seal and we're very interested in the West Valley cask. Both of those will help buy down my liability on spent nuclear fuel.

DOE-EM is also spending a lot of money on guided wave technology at the Hanford Tank Farm. They have a test, I believe, starting in October and then they're going to deploy it in spring of next year. We want to be part of that testing. It's applicable to the monitoring and storage of the canisters. I want to be involved with that.

So, in conclusion, we spent over $1 billion of taxpayer money and generated a lot of data. We will stop and analyze that data and we will take some of the liabilities off the table. We're not going to rush ahead and generate more data. We're going to stop, pause, plan, and take some liability off. Any future R&D that we conduct has to be risk-informed and have a clear programmatic need that reduces risk and liability. I have a limited budget. I have to focus on problems. We will prioritize, you know. There's always more R&D to do than budget available. So, we will prioritize, and we will not fund. I have a 250-year program ahead of me. I will prioritize on what's important today. The most important thing is we do plan to cooperate very, very closely with DOE-EM and Naval Reactors moving forward. And that's it.

SIU: Thank you, Paul. Okay, we'll start with Board questions.

BALLINGER: Hi, this is Ron Ballinger. The statement about the R&D must be risk-informed and buy back liability. Are there some criteria that you can expand on?

MURRAY: Yeah. So, the Advance Act requires us to report on how much money we spent and what liability we bought down. At the moment, we don't have a risk register.

BALLINGER: That's what I was asking about.

MURRAY: So, we will produce a risk register that says this is for risk, this is for liability, this is for probability of this risk happening, and this is what we're going to do to manage the risk. So, we will produce a risk register moving forward.

BALLINGER: Is there any kind of schedule? I haven't read the Advance Act. So, does that have to be done by that 2026 period?

MURRAY: 2026, it's all got to be done. So, we're having discussions with GC [General Counsel] right now. Had meetings on it yesterday. We plan to have meetings with EM and NR because they are part of the discussion and we have to collaboratively put together this risk register.

BALLINGER: Thank you.

MURRAY: No problem.

PEDDICORD: [COUGHS] Excuse me. Lee Peddicord with the Board. A couple of questions. I think you highlighted exactly the challenge at the outset of your remarks on political and public trust. There seems to be good technical bases for the mission you're endeavoring to undertake and so on. So, with respect to that, a couple of questions. What we've experienced so far has demonstrated that the main impediment to siting a facility, an interim storage facility, is not so much at the local level. You had two communities step forward on a private basis indicating interest. But it's been at the state level in Texas and New Mexico where they've been blocked. So, is part of your effort the consent-based siting process, the consortia, and so on? How are you endeavoring to address these challenges at the state level and get over that hump to accept what local communities seem to be prepared to want to do? And it would be my opinion, you're probably going to get some positive responses from communities to your effort, which is very good. The hard part seems to be then at the state level. Where are you going with that?

MURRAY: Communication. Communication is everything, right? If we just go in cold and ask… We’re putting together a communications plan to allow us to release the RFI next year. We just can’t go out with an RFI and say, “We’re looking for host communities to come forward.” Or else we will run into the trap, as you say, the states won’t let us move forward. But once again, we have to move slowly. So, the corps of volunteers are the sites that are interested. It’s not a commitment from their part to take this facility. It’s not a commitment in DOE’s part to site the facility there. It’s a series of controlled, measured steps with lots of communication. So, we are turning to focus on that communication moving forward. So, my team will not… everybody that works for us, I’ve made this very clear. Yes, I want young people going to the ANS conference. But more senior people, we need to spread out, we start going to talk to the local communities. We need to be talking at all different levels in the state. We are leveraging other programs within DOE. So, Christine King and her program is out talking about new nuclear, coal to nuclear, everything like that. Great. At the same time, people ask about spent nuclear fuels. So, we’re starting to bring it into the conversation moving forward. But to succeed, it’s all about communication. Even to transport the high burnup demonstration cask from North Anna to its new home, we’ve got to be communicating along that route. I’ll go back to what I said right at the beginning. I have 24 people. I have four members of staff working for Marla in the consent-based siting team. We’re doing the best with what we can. And we’re making tremendous progress. I’m really proud of the team. But communication is everything and I have 24 staff.

PEDDICORD: So, with all due respect, it is my opinion, personal opinion, that along with that, again, you’ve got to really be engaging at the state level. I don’t think you want to have a community raising their hand and you have not informed the state leadership.

MURRAY: Oh, completely.

PEDDICORD: So, part of this is the timing. And, again, my experience has been that people at the state levels, governors, leading legislators, and so on, don’t want to be surprised when one of their communities raises their hands. So, that’s a comment. I have another question, Mr. Chairman.

SIU: Okay, but Brian also has questions.

PEDDICORD: Well, okay. So, mine is, you know, your international center, I think that to me is excellent. The countries you're engaging, also very good. The other comment though, I was surprised that in your collaborating countries it appears you don't have the two that are actually have sited and are operating an interim storage facility, a consolidated interim storage facility. And that's Sweden and Switzerland. And again, my opinion would be much to be gained by learning from their experience, both how they achieve the siting and the technical elements that are in their facility. So, I would recommend you engage also with those two countries since they are the ones doing it successfully for some years.

MURRAY: So, we did sign MOU's with both of those countries earlier in June of this year. We currently putting meat on the bones of those MOU's. We actually had a meeting earlier this week with the Finnish governments. But once again, we're trying to put the meat on the bones of an MOU. But you're right, we have to move forward with them.

SIU: Okay. I think we have some from Brian online.

LESLIE: Actually, we have questions from two Board members, but not Brian. This is Bret Leslie, Board staff, and I'll be asking the questions on behalf of the Board members. So, Scott Tyler, who's joining us virtually. Thank you, Paul, for your detailed presentation. While I realize that disposal was not the primary focus of your presentation, in your current review of any priorities and directions, can you discuss your vision for engaging with international partners on existing underground research laboratories? Or newly constructed geologic repositories?

MURRAY: Yeah. So, that's a good question. So, we are part of EDRAM. Sorry, I can't remember what EDRAM stands for, but it's all the countries that have the deep geological programs. And we meet twice a year. So, we met earlier this year in Japan. It's a very small group. It's 20 people in the room. And we have another meeting at the end of September, I believe. So, we're very closely tied in with what other countries are doing from that perspective. For underground research laboratories, they're part of my program. We spend a significant amount of money on supporting R&D in underground research laboratories overseas. I think it’s something over 10% of the disposal budget actually goes to supporting international R&D. It’s a tremendous way of leveraging my money to generate results. So, we are doing that, and we do have a very major program going on with that. I did not deliberately talk about the disposal part of the program here today because that’s still undergoing review. Okay. We finished the planning process for it. It was actually going to be presented to me. As you know, Bret, I tend to change things a little bit. So, once we have that locked in, then we’ll be prepared to present it to the Board. But we’ve got to change. I can say on disposal, we’ve been doing generic R&D since 2010. The rest of the world is moving forward with their repositories. We are the only nuclear country apart from the Ukraine that does not have a geological repository program. If I look out in the future, it can be another 25 years before I select a future repository. So, am I going to do generic R&D for another 25 years? No. I can’t. I have to get that program under control.

LESLIE: We actually have a… we do have a question from Brian Woods and he’ll come on the screen.

MURRAY: Okay.

WOODS: Yeah, thank you so much. Brian Woods Board. Paul, I do have a question and I do apologize because I actually lost audio for a few minutes a little bit ago. So, I’m hoping I’m not having any questions that were asked. But one of the questions I have is when you talk about reducing the liability, is that just really the liability in not taking a receipt of the fuel, i.e. when you talk about reducing liability, is it bringing the time that you open up the consolidated storage facility earlier than 2038 or is there something other than… some other liability in there as well that you’re trying to reduce, which is not just a function of receiving the fuel?

MURRAY: That’s a really good question, Brian. So, the entire program, the entire program has got to be focused on… for the moment we are focused on trying to stop the liability for a partial breach of contracts getting any bigger. We’re trying to do that. But at the end of the day, we can’t do that unless we look at the total system program plan that we’re trying to put together. And the liability is based on the assumption that we open an interim storage facility in 2038 and a repository sometime in the mid 2060's. That's a huge… and every year we slip. It's like $800 million at the moment. That number is getting bigger and bigger every year. So, to reduce the total liability, I've got to look at the total program plan. Remember, my budget is constrained at the moment, and so the easiest thing for me to do is to focus primarily on trying to reduce the liability related to the storage. But I really do have any eye on the overall program plan to help me direct R&D in the future. Okay? I think that for storage and transportation, it's really come together nicely. I've got to put the same level of effort into looking at the disposal R&D so I can reduce the overall program plan liabilities.

WOODS: Thank you. And one other question too, and I know you probably don't have a specific date or month or whatever, but I'm just kind of curious from like the order of magnitude perspective, when do you kind of think the shift over from looking at the legacy data to developing or starting a new future R&D plan? I mean, are we talking two years or a year or is it going to overlap? Anything you can speak about that at all?

MURRAY: Yes. So, this year’s going to be a planning year. Okay, I can tell you this year’s going to be a planning year for R&D moving forward. Then we’ll launch off for a new R&D program. So, 2020… we will start some late this year, but next October 2025 is when we really launch off the new R&D programs. The International Center has hopefully stood up. It will be the focus of this. We should have international collaborations locked in. The agreements with EPRI locked in. We’re not just doing the R&D in isolation. We are collaborating very, very closely with industry. There was a meeting two weeks ago hosted by EPRI to look at aging management for the industry. What can we do now with all this data to take liability off the table?

WOODS: Thank you.

SIU: Paul, I have a clarification question. When you say “risk informed,” risk means different things to different people. So, how do you define the risk when you’re talking about risk register?

MURRAY: That’s another good question. So, we will go back and we’ll look at, you know… we have to prioritize. So, we’ll go back and we’ll look at NRC as well. So, if NRC says something’s no consequence, then it’s a low risk. Okay? And then some of it has to be a judgment call for us as well. But primarily it will be NRC.

SIU: That would imply a safety orientation rather than, say, an enterprise orientation. The enterprise risk would be you’re not going to make your schedule, as opposed to something that’s going to be a hassle.

MURRAY: No, no, no, no, no. It’s if NRC said something is low consequence, then we won’t look at it anymore.

SIU: Okay. Understood.

MURRAY: We’re not… I want to be really careful of my words here. We are a safety culture organization. I have a very limited budget to move forward with. I have to prioritize. So, if NRC says something’s low consequence, low risk, then that can wait. It doesn’t mean we might not look at it in the future, but with my limited budget, I have to prioritize to higher risk.

BALLINGER: Excuse me. This is Ron Ballinger again. Okay, two things. To me what I'm hearing is liability means money. The cost to the country. Risk means what Nathan was saying and that is a safety case for the NRC.

MURRAY: So, no. Because, remember, if a package performance demonstration is going to cost us a lot of money. We're not trying to generate any data. We're not trying to prove the design of the package. We will spend tens of millions of dollars to build public trust that it's safe to move these packages around. Where we have an engineering project like the consolidated interim storage facility, any R&D that needs to be done will focus on that. At the same time, we have to build that public trust to be able to move the spent nuclear fuel.

BALLINGER: But the NRC has currently licensed commercial interim storage facilities. They're all tied up in courts and everything, but that part's effectively done.

MURRAY: Absolutely. And so, we will stop all R&D connected to that.

BALLINGER: Okay. That’s what I was trying to get at.

MURRAY: Yeah, yeah.

LESLIE: So, this is Bret Leslie, staff again, asking a question on behalf of Dr. Steven Becker, Board member. Consortia are reaching various communities in parts of the country. Will the communications plan also involve broader communication efforts that reach beyond the places being reached by the consortia?

MURRAY: Yeah. So, the 12 consortia are just a minor… not minor. They’re part of a bigger consent-based siting process that’s going on. So, as DOE we have funded the national labs to also do outreach to bring us back information, gather that information. And we really are starting to pull that together now into coherent plans. So, Marla is doing a tremendous job in changing. There was a lot of fundamental R&D going on before. That all is slowing changing to be more project focused, project orientated moving forward. We have to be.

BALLINGER: I’ll keep asking more questions.

MURRAY: Keep going. That’s what I’m here for.

BALLINGER: There are several SMR [small modular reactor] projects, several of how many knows how many hundred others that won’t ever happen. And I’m involved with evaluating some of those concepts. And in none of those concepts is there a single word other than the mandatory “We have to figure out a way to dispose of the fuel” in the future, which is just not much. Is there a way that you have an opportunity to get to these people that are SMR folks and get them to put some meat on the bones of disposal? Because sooner or later, you know, that’s another source of information to the public. And there’s a lot of public interest for good or ill on these SMR concepts. But there’s really not much in their presentations related to disposal and there’s an opportunity there I think.

MURRAY: Yes, there is. So, what we’re doing is we have what’s called the “Back End Management of Advanced Reactor” [BEMAR] working group going on. So, if we take a step back, you know, the NRC licenses the design of a reactor to say, “it’s safe.” Before you can get your construction license, you have to be in good faith negotiations with DOE to say, “We’ll consider taking your spent nuclear fuel.” Which people come to us, we will enter good faith negotiations. To get the operating license they have to sign an amended Standard Contract with DOE to accept the fuel. We have finished… We are concluding the BEMAR reports for X-Energy, Kairos, and Natrium. They will be finished in the summer. And then we will present it to Dr. Goff and then GC will have enough information to negotiate the cost of disposal of the spent nuclear fuel for those reactors.

BALLINGER: What I was trying to get at is, let’s take Natrium, the state of Wyoming. Can we encourage the Natrium folks and others as well to start talking about long-term disposal within that state? In other words, using these SMR’s as a resource to sort of move public opinion, if you will. Which is what’s important according to everybody. It’s really not the technology. It’s the public opinion.

MURRAY: As I said to Christine King in her program as she goes around the country talking about coal-to-nuclear, SMRs… and she does talk about spent nuclear fuel.

BALLINGER: She does. Okay.

MURRAY: She does. You reach out to Christine and talk to her about doing that for us.

PEDDICORD: Lee Peddicord from the Board again. So, somewhat along the lines of Dr. Ballinger's points of, you know, looking ahead and so on, that there are at least a couple of states, maybe more, that are doing now kind of full up state reviews of the future of nuclear in their states and advanced nuclear and SMRs and so on. I think Virginia is, Texas is, and so on. And at least the one in my state is getting ready to go to the governor. It seems like this would be an excellent point to make sure that the backend issues are highlighted. This again is how you get in front of the state-level decisionmakers. So, I'm wondering if you had a chance to at least track or be engaged with any of these. I know a report in Texas is about done and maybe there's still an opportunity to have something in there of you at the state need to think about these backend issues, storage, consolidating, and so on. So, have you had a chance to engage with the leaders of these studies in these states and others?

MURRAY: The problem is people want to talk to DOE. That's it. But if we engage, for better or worse, they want to talk to DOE. They want to press our bellybutton when they're talking. As I said, we have very limited staff. We have a constrained travel budget to do this. So, we recognize we have to do it, but it's one of my biggest risks moving forward is not having enough staff, not having enough travel budget. Communication is everything to the future success of this program. And I've got to admit, it is one of the things that keeps me up is the risk of the communication. Communication is going to be the thing that trips us up. But we recognize it. We are putting together a detailed engagement plan. But once again, can we execute in that detailed engagement plan?

LESLIE: Bret Leslie, Board staff. At this point, there aren't any other Board members. So, can I go ahead? So, Paul, I have a number of questions. But this last response kind of confused me because you just talked about this is the biggest risk for your program, yet your risk registry, which is to reduce the liability was, if I heard right, focused on safety. So, how…

MURRAY: Yeah, so there’s two bits to it. There’s programmatic risk and then there’s the technical risk register. So, if the programmatic risk is where I’m collecting these things. Okay? Because that’s for me to worry about. But the division directors have to worry about the technical risk. At my level I have to worry about the program risk.

LESLIE: But moving, do both the programmatic and technical go into your risk registry?, is the question I’m trying to ask.

MURRAY: No. Because the technical risk register is something we have to give to Congress. The programmatic risk register is a separate thing that helps me decide what we’re going to do. So, we need a communication plan before we launch off on the corps of volunteers. Okay? Who’re we going to reach? Who are we going to touch? Who’s actually going to physically do that? Because we can come up with a really detailed communication plan, but I don’t have the staff to basically go do it. Because remember, at the same time, the call for volunteers for interim storage, we also got to be planning for the transportation of that 15 tons of spent nuclear fuel. Which will also suck up a lot of time and resources.

LESLIE: So, Bret Leslie, board staff again. Another question. So, when does it make sense to reconstitute the Office of Civilian Radioactive Waste Management now that you've passed the CD-0, now that you need to transition from an R&D program into an implementation program with the NQA? And how would that occur? Is that something that DOE can do by itself, or does it have to get approved by Congress?

MURRAY: So, two things… one, we need a plan. It's pointless to me if it's built back before we have a plan. So, Bill is working on the plan. The first draft of that plan should be out next year. Then we start to tinker with the plan. '26 would be nice, '27 is what would be perfect. Remember, we're trying to change from being an R&D organization into an organization that can actually implement and deliver. That doesn't happen overnight. I wish it did, but it's not happening overnight. '27 would be the earliest we could do it.

BALLINGER: Are you talking about fiscal year or calendar year?

MURRAY: DOE fiscal years. And what’s stopping it? How come it still exists in the DOE organization?

SIU: Does the staff have any more questions?

LESLIE: Bret Leslie, Board staff. So, you indicated that looking at the West Valley and the Failed Sealed Cask at INL [Idaho National Laboratory], would be something that could reduce your liabilities. Can you expand upon it? How would that reduce your liabilities?

MURRAY: So, let’s take the cask with the failed seal. So, it been… it’s lost all its cover gas over 10 years ago. I want to do a work package this year to say, okay, what’s happened to that fuel? What can we discover by basically opening back the cask, pulling the fuel assembly out, looking at it? Is the oxide layer built up? Is there any major thing happened? If nothing happened, then let’s seal it up and do it.

The West Valley casks that were shipped, very interesting. There’s a lot of failed fuel in there. We talked extensively to the project manager who actually did the shipments. We got the lessons learned from how he shipped the cask. You know, why was he successful when the previous three attempts failed? But then also what’s actually in the cask is interesting. He says, and we need to just check this, that over 50% of that fuel was failed fuel. So, we can transport 60-something tons of failed fuel with no issue, no concerns, store it, and we open it up again. Can we look at that fuel, what risk, what liability does that buy down? Once again, the work package, we’ll look at that this year without making any commitments from EM side or NE side to actually do anything. But I think we can learn a lot by showing that 60 tons of failed fuel was successfully shipped and stored with no issue.

SIU: We have time for one more quick question. Hearing none, thank you very much, Paul.

MURRAY: Thank you.

[APPLAUSE]

SIU: Next up is Jomaries Rovira.

ROVIRA: Good morning, everybody. And thanks for all the attendees and presenters that are here in this venue today, as well as those that are joining us virtually. I want to take this time to also thank Steve Vitto from my team to help coordinate with all the presenters from the DOE side and National Labs. So, thanks so much for that, Steve. I know it's been a couple of months of coordination, so I really appreciate that.

So, I realize this is today's first presentation from the Office of Environmental Management or EM. So, I thought it was prudent to provide a brief introduction to the EM mission for those of you that are not very familiarized with the EM mission. But before that, I would like to introduce myself briefly. I'm Jomaries Rovira and I'm the Office Director for Nuclear Materials, Office of Environmental Management, within the Department of Energy. And I've been working for the department for the last 15 to 16 years.

So, the EM organization was created in 1989 to clean out the radioactive legacy resulting from the Cold War. Fifty years of nuclear production and energy research generating, as you can imagine, millions of gallons of liquid radioactive waste, millions of cubic meters of solid radioactive waste, thousands of tons of spent nuclear fuel and special nuclear material, along with huge quantities of contaminated soil and water. It is one of the largest and most diverse and technically complex environmental cleanup operations in the world. And the EM program has a mission to complete the safe cleanup of this environmental legacy.

Here's the outline of my presentation. I’m going go over the spent fuel definition, start with that, and expand then a little bit on the mission of the Nuclear Materials Office, discuss the major regulatory framework that governs the spent fuel. Then I will go over the EM management of this inventory of spent fuel. You’ll see how the inventory of spent fuel is spread out among a few locations across the United States. I’ve included some pictures so you can appreciate those facilities. I know that you had a chance to tour some of the facilities yesterday here at the Savannah River Site. But there are other locations across the US. So, pictures include the storage facilities and processing facilities for this inventory of spent fuel. And you’ll hear some of the challenges that we are facing with the spent fuel management, and what are the actions that we're addressing and starting to have conversations.

Okay. So, let's start with the definition of spent fuel. Spent fuel is defined by the Nuclear Waste Policy Act and the Atomic Energy Act and that is fuel that has been withdrawn from a nuclear reactor following irradiation, the constituents, elements of which have not been separated by reprocessing. And after the fuel is irradiated in a nuclear reactor, the fuel assemblies also contain byproduct materials. And that is basically any material that has been made radioactive in the process of producing or using special nuclear materials.

I already discussed briefly the EM mission, so I'm going to go ahead and focus on the second part, which is the mission of the Office of Nuclear Materials. So, we are responsible for safely managing nuclear materials on sites around the country, including a diverse complex inventory of DOE-managed spent nuclear fuel. And I want to stop here for a little bit just to provide a clarification when I say DOE-managed spent fuel. What that means versus the rest of the US inventory of spent fuel. So, when we talk about DOE-managed spent fuel, we're talking about the inventory of spent fuel resulting from nuclear weapons production and energy research. This spent fuel is stored or processed in DOE facilities and for which the Office of Environmental Management has some responsibility. Then the US has a bigger inventory of commercial spent fuel, and this is spent fuel that was used in commercial power reactors for the intent to produce power. And the organization responsible for the disposal of this inventory of spent fuel is a separate organization. That's the Office of Nuclear Energy and Paul Murray just talked a little bit about that.

I know this is a busy slide and there's a lot here and I don't want to spend much time on this slide. But here is the main regulatory framework that governs the DOE-managed spent fuel. So, I already mentioned the Atomic Energy Act and the Nuclear Waste Policy Act. These Acts give authority to the Secretary to utilize nuclear materials and manage radioactive waste and establish the federal responsibility to provide the safe disposal of spent fuel. Then we have NEPA, which is the National Environmental Policy Act, that requires federal agencies to consider the environmental effects of the proposed actions before making decisions.

So, there are other applicable regulations and directives through DOE and NRC that we follow. For DOE, it’s basically DOE directives. And the last one here I understand is specific to a site but has a big impact on how we manage spent fuel in EM. This is the Idaho Settlement Agreement, and it established Idaho site cleanup milestones. And I’m going to cover this a little bit more in more detail in a later slide.

Okay. So, Spent Fuel Inventory. We already mentioned that for the purpose of this presentation, I’m going to focus on DOE-managed spent fuel. So, everything that you’re going to see from now on is specifically on DOE-managed spent fuel. So, as I mentioned earlier, EM manages an inventory of spent nuclear fuel resulting from nuclear weapons production and energy research. The DOE-managed spent fuel includes about 2450 metric tons of heavy metal with about 300 different fuels with various fuel compositions, cladding, structural integrity, and fissile content. Most of this inventory comes from DOE production reactors. And I just want to give an example. It’s the B reactor at Hanford, which was the first large-scale plutonium production reactor ever built and that was in the 1940’s.

In our inventory we also have some commercial origin spent nuclear fuel. Under the Atomic Energy Act, DOE has authority to accept spent fuel for safety, emergency, and liability reasons. And that is the case for the Three Mile Island reactor core debris. There are some commercial power demonstration projects as well and that includes Shippingport, Peach Bottom, and others. So, in addition to the inventory that I just mentioned, DOE-EM supports other DOE programs in implementing their mission by receiving, storing, and managing spent nuclear fuel and other nuclear materials from foreign and domestic research reactors.

Okay. So, we've been working with this map for a long time so I'm kind of familiarized with it. This is a map representation of the storage locations of this inventory of spent fuel. Spent fuel is safely stored at four DOE sites. That's at the Hanford site… So, I'm going to start at the West. Hanford site in Washington State. Then there's Idaho National Laboratory and that's in the state of Idaho. The map also shows Fort Saint Vrain in Colorado. However, that inventory of spent fuel has been managed by the Idaho National Laboratory. Then moving to the East Coast, we have the Savannah River Site in the state of

South Carolina. And other minor amounts of spent fuel are stored at other locations, such as university research reactors. And then you might be familiarized with HFIR [high flux isotope reactor] reactor at Oak Ridge National Laboratory.

The total inventory of DOE management fuel, as I mentioned, is approximately 2450 metric tons of heavy metal. And just to provide a comparison, the United States has approximately 90,000 metric tons of spent fuel from commercial nuclear power generation. And although our inventory seems like a small portion of the entire spent fuel inventory, our spent fuel has different compositions, cladding, structural integrity that could become a challenge when we're talking about managing and storing it and packaging it.

Okay, so where is this inventory stored? As I mentioned, we have four sites. On the right side we have pictures of the storage facilities at the Idaho National Laboratory. Most of their storage facilities are dry storage facilities with the exception of the picture in the middle, which is a wet pool, similar to the L-Basin facility at the Savannah River Site. And I believe the Board had a chance to tour the L-Basin facility yesterday.

So, Idaho used to have spent fuel stored in a wet pool. However, as of last spring, all of the spent fuel has been transferred to dry storage facilities. So, kudos to the Idaho team on meeting the milestone before the schedule. This is one of the milestones from the ISA [Idaho Settlement Agreement].

The picture at the bottom shows underground storage. And on the back, this is all dry now, and on the back you could appreciate casks above ground where spent fuel is also stored. There are other spent fuel facilities at Idaho. However, EM is not responsible for those facilities and I'm not going to be talking about those facilities today. But you might be aware that Naval Reactors and that Nuclear Energy also have facilities at the Idaho site.

Moving now to the bottom center, those are the two facilities at Hanford that they store. These are all dry storage facilities. They store their spent fuel. It's the Canister Storage Building and the Interim Storage Building.

And then on your left, if you see the top picture, that's the L-Basin facility. Oh, Ft. Saint Vrain's also there, I just realized, not Savannah River, definitely not Savannah River. And you can appreciate, I really like this picture because you can appreciate the Cherenkov radiation, which I think makes it really cool to see. And hopefully, you were able to appreciate that in person yesterday.

Okay. So, not all the sites are storing spent fuel pending direct disposal. Here at Savannah River Site, we are processing the spent fuel inventory through H-Canyon.

The H-Canyon facility is the only large-scale nuclear chemical processing facility in the United States. The H-Canyon mission has varied throughout the years, from recovery of uranium to the current mission known as the Accelerated Basin De-inventory or ABD.

And what ABD does is it allows for dissolution of spent nuclear fuel with no recovery of uranium or any other nuclear materials with the goal to accelerate the disposal of Savannah River Site spent fuel. Once the spent fuel is processed, the resulting dissolved material, and hopefully that’s explained a little bit here in that picture, is transferred to the liquid waste system and then vitrified into a stable form, which is glass, pending disposition.

Okay. So, let’s now discuss transportation and disposal of this inventory. And at the moment, no spent fuel is being transported to a disposal facility. As you all know, there aren’t any disposal facilities available that can accept spent fuel. And the responsibility of the transportation and disposal of spent fuel falls under the Office of Nuclear Energy.

In the meantime, DOE designed a standard canister, the DOE standard canister, to store, transport, and dispose of the broadest spectrum of material, including spent nuclear fuel, using a standard, consistent approach. That’s a representation of the DOE standard canister.

And this is just one size of the DOE standard canisters. I believe there are four different sizes. And I’m sure that Idaho National Lab can discuss that a little bit more in detail later.

And then I provide approximate inventory through 2055 of how much we think at this point we’re going to… how many DOE standard canisters were going to be generated based on the inventory that we have now. This is preliminary and, for example, and I want to highlight Savannah River here with the ABD mission. It is unknown how many spent nuclear fuel we're going to be able to process through H-Canyon. So, we can expect those numbers to change depending on how much spent fuel we can process.

But at Hanford, the spent fuel is currently stored in multi-canister overpacks or MCO's. MCO's are similar to the largest of the four DOE standard canisters. Comparing the MCO's to the DOE standard canisters, they're both stainless steel, sealed, welded pressure vessels with similar pressure ratings.

At Idaho, there's a small inventory of spent fuel that will require conditioning beyond drying. And the majority of the inventory will require packaging and overpacking to be ready to be transported to a disposal facility whenever that is available. And as I mentioned with the Savannah River Site, there's still a lot of unknowns on how many DOE standard canisters we're going to need. This is just a high-level estimate. We have the spent nuclear fuel database to help us get this information. So, if someone has any questions, we can always go back to the database.

Okay. So, the Spent Nuclear Fuel Working Group. This is a working group that gets together once or twice a year to discuss and address policy and crosscutting issues impacting the handling, storage, and disposition of spent nuclear fuel. Our last meeting was back in April, I believe, at the Savannah River site and we had participation from the Board staff in that meeting. So, you're familiarized with our meetings. This group keeps growing. Initially we had maybe a dozen people showing up to this meeting. Now we have over 60 people going to this meeting. So, there's definitely value on getting together once or twice a year and discuss all these issues. We have participation from the Office of Nuclear Energy. We've been working closely with Erica Bickford as a co-chair of this working group. So, both organizations co-chairing, it's EM and NE. However, we also have participation from NNSA [National Nuclear Security Administration], Office of Science, Office of Naval Reactors, contractor organizations, and the national labs too.

So, there's a huge list here of all the accomplishments from the spent nuclear fuel working group and I'm not going to discuss in detail all of these accomplishments. However, I want to highlight some of them because the result of those reports or accomplishments have been the reason why we're doing things the way we're doing it today.

So, the first one is the strategic framework, which I think is just the basis for what we want to do with the spent nuclear fuel. And this was signed in 2021. However, I know that it took years to develop this plan. So, it was very well thought. And basically, what it says is when possible, reduce the inventory of spent fuel by processing it, and to package all remaining spent fuel into a road ready dry storage configuration. Like I said, there are several initiatives that we've worked before and that we're continually working that are from this strategic framework document.

Another accomplishment that I want to highlight is the report on aluminum clad spent fuel. This report identified gaps for the packaging and storage of the aluminum clad spent fuel. The findings from this report are the basis for most of the technology development [TD] work that we’re currently doing specific to the aluminum clad spent fuel. And we’re going to have a lot of discussion on TD activities and you’re going to hear more what we’re doing to ensure that we can safely store aluminum clad spent fuel long-term.

Another important one is the Analysis of Alternatives for the Savannah River Site Spent Fuel Disposition. This effort led to the Accelerated Basin De-Inventory or ABD mission, focused on reducing the inventory of spent fuel in the L-Basin at Savannah River site. And you’re definitely going to hear more about that later today.

I also want to highlight the evaluation of the NWTRB 2017 Report for any implications with respect to managing our technology development program and our spent fuel strategy. And some of the TD considerations will be reported in the next presentation.

Other accomplishments include an internal exploratory disposition roadmap report for spent fuel. I was actually the lead on that but I had support from many, many subject matter experts from all the sites. And basically, what it did was what are the options for disposition of specific categories of spent fuel.

Then we have a road ready dry storage configuration report, a formal analysis of alternatives for spent fuel at the Idaho site. And this AoA, I believe, spurred the development of the Idaho Integrated Spent Fuel Management Plan. So, with the Idaho Integrated Management Plan I want to stop and just say something for everybody’s information. It will be briefly mentioned today. However, this plan remains an internal document as we speak until we can have some alignments with other impacted organizations. So, we’re still working on that.

Other efforts that were initiated as part of the working group was trying to draft a definition for nuclear fuel. There was a lot of work being done with this working group. And then 435.1 team started their efforts and we were happy to give that to them. They took over that effort and now instead of being a product from this working group, now it’s the overall 435.1 revision effort. And there is work being done on that. And I don’t know, they have a very optimistic date on when they’re planning to release it, but I'm not quite sure if I can mention it here.

Okay. So, up till now I've been discussing all the great things that EM has done and how we've been safely and effectively managing the inventory of spent fuel throughout the various storage facilities and I also mentioned the processing facility capability at H-Canyon. Some of our sites are working towards the point in which we can package the spent fuel, ready to be transported to either an interim storage facility or a final repository.

However, there are some constraints that EM must work with. And I already mentioned the legislative basis on an earlier slide. But in addition to that, we have state agreements and milestones in place. And I'm going to repeat again the Idaho Settlement Agreement. This agreement not only covers spent fuel, it also covers all waste management activities. The ISA, or Idaho Settlement Agreement, was signed in 1995 with the goal to - and I like to use this word – incentivize the Idaho National Lab on getting waste out of the state. Others might think differently. The scope of the ISA goes beyond the spent fuel inventory as I mentioned. It also covers things like TRU [transuranic] waste, sodium-bearing waste, which I’m not going to be discussing today. But specifically to spent fuel, the ISA requires that all spent fuel be moved from wet storage to dry storage by 2023 and that milestone was completed ahead of time.

The big one is to have all spent fuel be removed from Idaho by 2035. And I think something that also impacts not only the DOE-managed fuel but other spent fuel in the country is the fact that there’s no repository or interim storage facility to send the spent fuel. So, that’s one of our biggest constraints. And as Paul Murray mentioned during his presentation, NE is working on the consent-based siting process to select an interim storage facility. But you understand all the constraints that they also have in nuclear energy trying to get this done.

Okay. So, we put together a list of current challenges with managing the spent nuclear fuel inventory and some potential solutions that are under discussions or consideration. And this is not intended to be a comprehensive list of all the challenges that we’re facing. This is basically just a snapshot of the main challenges that we’re currently facing and how we’re planning to address them.

And the first point will be discussed later today in more detail. But there’s a general understanding that some of the spent fuel inventory at the Savannah River Site will not be processed through H-Canyon and that additional spent nuclear fuel shipments could potentially be received at the site post ABD. So, that’s challenge number one. So, for that we’re identifying potential solutions for the remaining and future inventory of spent fuel. And you’ll hear more about that later today. The department in collaboration with the Savannah River National Lab, we’ve been discussing what capabilities could be utilized at the site to address this inventory of spent fuel. However, we’re still in the preliminary discussions. No decisions have been made.

Another challenge is the sustainability of long-term storage of the spent fuel. As I mentioned on the previous slide, the DOE-managed spent fuel is stored in different configurations. Some of the inventory may need to be conditioned before it’s packaged in a way that it’s ready to be sent to an interim storage facility or a final repository. And for that, we are pursuing some technology development activities to get us there. And I want to highlight the importance of the technology development program because there’s still so many unknowns. And if we ever want to get to the point that we’re ready to send the spent fuel to a repository, there are several questions that we need answers to. And that’s why the technology development program is so crucial.

Next on the list is our ability to packaging the spent fuel that will allow for storage and transportation to an eventual disposal facility. And at this point, Idaho is identifying facilities, modifications to existing facilities, resources, etc. to support a demonstration project for the packaging and staging of the spent fuel.

And as most of you are aware, some of these facilities were built decades ago, therefore, aging infrastructure is a concern for the Office of Environmental Management. We’re very aware of the situation of our facilities. We continue to operate these facilities safely, but there’s an understanding that these facilities are aging. And a good example, and I’m not trying to pick on H-Canyon, but I'm very familiarized with that facility. But a good example is the H-Canyon facility, still operating safely. But it will be over 80 years old by the time the ABD mission is expected to be completed. So, it underscores the necessity of proactive measures for future capabilities. And, like I said before, no official plans have been made post ABD to either repurpose the facility or to build new capabilities.

There was a question from the Board staff or the Board members on our interactions or at least our acknowledgement on the defense board public meeting that was held not long ago on addressing aging safety-related infrastructure. And we're paying attention and we're going to follow and incorporate as appropriate suggestions from that hearing and any upcoming DNFSB [U.S. Defense Nuclear Facilities Safety Board] workshops.

Then we have NEPA. All our activities are covered under NEPA. But some of those NEPA documents were developed decades ago and there has been some supplemental analysis been done recently. So, one of the things that the spent nuclear fuel working group wants to do is they want to initiate a review of the NEPA coverage that we currently have and what we might have to do to ensure that the coverage remains adequate for future activities. And this is a topic that I hope the working group can present in about a year or so. We're starting to look into it.

And then another very well-known challenge is having the adequate resources to do all the things that we want to do. I mean, not only funding but people. Right? So, I think any organization in DOE can relate to this one.

That was the end of my presentation. So, I have… I don't know if this is important right now. These are some of the references that we used. Okay, this is a good one. This is examples of some of the DOE-managed spent fuel types. As you can see, different configurations. HFIR is completely different. Any questions?

SIU: Thank you. Open it up, Lee?

PEDDICORD: Thank you very much. Lee Peddicord with the Board. A comment on your last slide. It might be interesting to also color-code those on age since you've got HFIR cores coming out routinely, brand new, looking good. And some of these are quite historic in terms of how long they've been around. I don't know, that might be informative to see the challenges you're dealing with as well too. I had one question also on your slide, the first one of your challenges and potential solutions, in which it read "for example, e.g., small-scale modular nuclear reactor material processing capabilities." So, small modular reactors says something to some people. Are you referring to these next generation of SMR's that are anticipated?

ROVIRA: No. Let me go back to that. So, there is an effort. It's small-scale modular nuclear material processing capability. So, this is an effort that I'm coordinating, my office is coordinating with DOE Savannah River and the national laboratory on identifying what are the options moving forward if we can't continue using H-Canyon? So, we're in the preliminary phases, just evaluating what those options are.

PEDDICORD: Yep, got it. And then the last thought that comes to mind, you know, in listening to Paul Murray and so on. First of all, the fact that you all EM and he are really talking a lot, I think is excellent. That's a great step. But in terms of finding places, say, for interim storage facilities, you have the kinds of locations with all the infrastructure, security, and so on that would make these places attractive to put commercial interim spent fuel storage facilities as a place. Do your discussions entail that? Again, you've raised all sorts of challenges that might lead to that. But, you know, in Hanford, Savannah River, particularly where they're located geographically and things like that, might this be a convergence for the country to solve one of these issues?

ROVIRA: I mean, that's a good question and good comment. I don't think we've had those conversations. There are agreements with the states that we need to follow, but something to consider.

PEDDICORD: Okay, thank you.

ROVIRA: Thank you.

LESLIE: Bret Leslie, staff. Go ahead and bring Brian on, Woods.

WOODS: Hey, thank you very much, Jomaries. I appreciate the presentation. I did have a question. You know, we just heard

Paul talk a lot about how the liability is a large driver for how they're prioritizing going forward. And I'm just kind of curious. You know, you all had the Settlement Agreement. So, there's a date of 2035. You have other agreements as well. Can you speak a little bit about how does these agreements, these contractual agreements, how do they play into your organization's kind of prioritization process for the different things to put your limited resources and efforts into?

ROVIRA: I will prefer if Idaho answers that question. I know there's going to be a talk on that later today and under management plan. So, I would rather have them discuss that if that's okay.

WOODS: Yeah, no, that's fine. I'll wrap around later on to that. Thank you.

SIU: Nathan Siu, Chair. I have a related question to Brian's. Paul talked about a risk register to help him with his prioritization. Do you have something similar for the EM activities? Are you planning on developing such a register?

ROVIRA: In terms of what specifically?

SIU: To help prioritize. Again, you have limited resources and therefore you have to decide what goes up top and what goes on the bottom.

ROVIRA: Okay. So, we looked at the agreements that we have with the states, and that's obviously a priority for us. We want to make sure we meet those agreements with the states. Or if not, we discuss with them whether we need an extension of those agreements. So, that's going to be in my view priority No. 1. And then in terms of our facilities, we look at how we can prioritize the infrastructure needs and based on our mission, we can then provide funds where needed if that's the priority.

SIU: Yeah, yeah. I wasn't asking you for the solution. I was just wondering programmatically, if you had such an activity to develop such a formal register. It sounds like maybe not.

ROVIRA: I don't think there's nothing formally per se. It's by site. But correct, yes, I don't have something like that.

SIU: Thank you.

LESLIE: Bret Leslie, staff, asking a question on behalf of Dr. Steven Becker, Board member. Jomaries, thank you for a nice overview of EM's work. In Paul Murray's remarks earlier, he called attention to the central importance of communication and establishing trust. Thinking about EM's experiences, since it was created back in 1989, what do you see as the most important lessons learned by EM related to communication with states, communities, and Tribal nations?

ROVIRA: So, EM does a really good job communicating with stakeholders and Tribal nations. So, I think the constant communication, constant visits from senior leadership especially, to all these communities and sites has been key to build strong relationships with all those communities. And I think the communication aspect in EM has been very, very strong for many years, and relationships are really good with the communities.

LESLIE: So, thank you, Jomaries. It’s Bret Leslie, staff again asking a follow-up question by Dr. Steven Becker. What have been EM’s biggest challenges in terms of communications?

ROVIRA: That is a really good question. This is just my opinion, right. I think when you have sites that have many different program offices, that could become a challenge when priorities are not necessarily the same for all the program offices that are in that site within that same state. But, like I said, this is just my personal opinion.

LESLIE: Bret Leslie, Board staff. This is my own question. You had indicated road-ready packaging of DOE’s standard canister requires overpacking at Idaho National Laboratory. And I know that in your road-ready documents you indicated that you are considering the waste acceptance system requirements document. And I’ve looked ahead at kind of some of the figures in the subsequent presentations. Those requirement documents require that individual DOE standard canisters are capable of being lifted at the disposal site. So, can you talk about how the overpacking at a site for storage will allow them to individually lift DOE's spent fuel canisters at a repository one day?

ROVIRA: I don't know the answer for that question.

LESLIE: So, I'll follow up with Idaho folks later today.

ROVIRA: Okay.

SIU: Do we have any other questions?

LESLIE: I'm sorry, I probably was not paying attention when you talked about this, but you had a map of DOE's managed spent fuel and I didn't hear if that inventory there included both NE spent fuel and Naval Reactors.

ROVIRA: No, this is strictly EM-managed spent fuel.

LESLIE: So, when you say DOE-managed, you mean DOE-EM-managed, whereas when the Board talks about DOE-managed, we're talking about DOE.

ROVIRA: Okay. That’s a good distinction.

LESLIE: So, that’s a really important point because that’s how we view things.

ROVIRA: Okay.

LESLIE: Thanks.

ROVIRA: That’s good to know. Anything else?

SIU: Okay. We’re done.

ROVIRA: Well, thank you.

SIU: I guess we’re breaking early. So, we will reconvene. So, we’ll just stay on schedule. So, 10:10 we’ll reconvene. Thank you.

[BREAK]

In the spirit of our hybrid meeting, our next presentation will start with a virtual presentation and then we'll go in-person. And then we'll have a follow-on hybrid, virtual presentation. So. Rod Rimando first.

RIMANDO: Well, good morning. Good morning from Washington, DC. Am I on the stage yet?

SIU: You're on.

RIMANDO: Oh, okay, great. Thank you. Well, good morning again. My name is Rodrigo Rimando. I am the Director for the Office of Technology Operations within DOE's Office of Environmental Management. First of all, thanks to the Board and the organizers of the meeting for having the virtual option to participate. This is fortuitous for me as I'm a bit under the weather and travel would not have been a good option. So, my voice is still hoarse and I may sound a bit nasal as I speak. For that, please pardon me. For my brief presentation to you, I will provide a high-level update of EM's technology program. Next slide please.

So, there are two topics that I'll cover in my brief discussion. First, I will summarize EM's new structure of the Chief Technology Officer and his office. I recall Paul mentioned that this morning already. I'll then provide highlights of the current portfolio of technology projects. Next slide.

Thank you. So, it looks like there are some animations in here. If you could just flip through the animations to get the full screen up. Several months ago, EM Headquarters underwent a realignment that included establishing the Office of the Chief Technology Officer. Too, if you could hit enter or advance, I think the next bullet will show up. I apologize. Thank you. First to provide centralized senior executive leadership at headquarters that is empowered to synergize and drive innovation across the EM enterprise. It is purposeful to house this key leadership position within the Office of Field Operations because with the emphasize on delivering cleanup objectives, complying with our regulatory agreements and adjudicated mandates, meeting the expectations of stakeholders and demonstrating due diligence to the American taxpayer, the operational imperative for technology insertion and mission innovation is best appreciated and realized from an operational, from a field mindset and perspective. A CTO [Chief Technology Officer] is focused on solidifying a program after structure that is defensible and sustainable. This is done by establishing and implementing a governance structure of policies, strategies, management plans, and operating procedures. And this is particularly important because considering the mission, a completion date of somewhere in the 2070's, we're going to need a program structure that will certainly sustain our mission and be enabled to insert these new innovations and also to keep pace with new technologies and emerging technologies. Of course, you all appreciate that. It is just about moving at an incredible rate now where we are very much challenged with keeping up with availability of these new solutions.

And also recognizing that the federal government is also making sizeable investments in innovation and technology. A CTO is particularly charged with promoting increased collaboration with other federal executive departments, independent agencies, as well as the international community. So, while there are a lot of R2A2 roles, responsibilities, authorities, and accountability associated with CTO, these three jump up immediately certainly as we look at how best to structure the program. So, again, it is sustainable and it is transparent.

Just on the organizational structure, within the immediate office of the CTO there are three key direct reports. There’s the Senior Advisor of Laboratory Policy who coordinates and integrates DOE National Laboratory expertise capabilities and activities. A Chief Engineer serves at a corporate engineering level by providing leadership and developing engineering strategies, polices, and guidance specific to EM operations. There’s only one supported office within the CTO and that is the Office of Technology Operations for which I am the director. This office is responsible for the overall integration and coordination of the technology portfolio across the EM enterprise. This officer also manages university engagement, including the EM minority serving institution partnership program. Next slide please.

This should be a familiar figure to many of you and it is one of the more common graphics we use to summarize our budget by mission area for any given fiscal year. For fiscal year ’24, our enacted budget is just shy of $8.5 billion, of which $563 million, about 6% is appropriated for activities in spent nuclear fuel and special nuclear materials.

I use that same graphic to show our current technology portfolio, which totals nearly $103 million. 54% of that budget is focused on our tank waste, radioactive liquid waste mission, for our project supporting spent nuclear fuel research and technology development activities. We're providing funding at a level of around $11 million.

You will also note that there's a technology thrust for mission enablers, which are technologies that are not specific to any single mission area. Instead, these are technologies such as advanced sensors, artificial intelligence and machine learning algorithms, advanced modeling and simulation, digital twinning, virtual reality, mass materials and robotics, all of which have broad and crosscutting application. Next slide.

I'll kind of shift gears now and discuss the portfolio itself. And I'll do so by cross referencing our technology maturation process. As shown, we follow the basic construct of the technology readiness level, TRL, scaled from 1 to 9, and of course 1 being the start of the maturation process and 9 representing the end.

We group the TRL’s in three general phases, the lower TRL’s, 1 through 4, are what we consider the design… discovery and design. The mid TRL’s, 5, 6, and 7, are the demonstration phase. And, 8 and 9 are the deployment phase. I then overlay our current portfolio of 132 technology activities funded, and I add the total of $102.8 million. Of that, 89 projects funded at around 52 million are in the low TRL’s. 39 projects and around 46 million are in the demonstration phase around 4, and around 4.7 million are in the mature and hopefully soon to be deployed phase.

Now let’s take a look at who’s doing that work. That is, who are the lead principal investigators? Of the 89 projects that are in the lower TRL’s, our national labs are leading 21, while our universities are leading 68. As you can see, the effort in investment is somewhat weighted towards our colleges and universities as we actively engage with them in recent development, but also as they serve a key role in filling the workforce pipeline and actually serve as the primary source of the next generation of STEM professionals and leaders.

In the demonstration phase, our national labs are leading 37, while our universities are leading 2. And this makes absolute sense because our national labs are the best equipped and best positioned to coordinate directly with our FINA (sic) contractors to demonstrate the utility and prove out the performance of technologies.

Finally, in the deployment phase, our national labs are leading 3 while new vision engineering is leading a demonstration of technology being transferred from the UK. Specifically, a modular drum assay system that was initially developed to support Sellafield nuclear site in Cumbria, England. And we are, by the way, giving greater emphasis to modular systems and slowly moving away from constructing these huge monolithic waste processing facilities because we're transitioning to a point where we're going to need the mobility, the portability of many of the systems to address some of our challenges that we have, both in spent nuclear fuels, special nuclear materials. Jomaries already mentioned kind of what we're thinking about for H-

Canyon. But also for our liquid waste system. As we continue to make great progress at Savannah River Site and as we begin to make really demonstrable progress at Hanford. There will be a point where these huge facilities from an operational standpoint reach a point of diminishing returns on their operational capability and their efficiency. And that’s where these small modular systems will play a pretty important role.

And if you could go to my last slide. So, yeah, you’re going to have to click through. I apologize for that. There’s some embedded animations here. In summary, EM’s Technology Officer and the entire organizational structure of CTO, positions them to be able to smartly, efficiently, and safely execute our mission in the five, possibly six decades ahead of us. Of course, with the focus on mission innovation and leveraging. We even exploit new and emerging technologies as they become available.

Our current portfolio with technology activities will continue to grow and expand. Our more immediate focus is on applied science, technology demonstration and technology transfer. Our portfolio leverages the broader technology market and we strive to insert commercial off the shelf technologies, that is COTS. I mentioned collaboration with our other federal agencies. We also work to insert government off-the shelf-technologies, that is GOTS. For those folks who may not necessarily be familiar with GOST, these are solutions that are developed by other federal executive departments and independent agencies specific to their missions. While GOTS are again mission specific, there is great applicability for transfer to the EM mission particularly for (unint.) solutions. That is technologies that are designed to address chemical, biological, radiological, nuclear, and explosive hazards.

Lastly, we'll continue to make strategic investments to reduce our technical risk and vulnerabilities and to reduce the federal government's environmental liability associated with not just the Manhattan Project and the Cold War, but also in the early years of nuclear science and technology. Because, again, the government owned that, particularly those that were part of President Eisenhower's Atoms for Peace. Those early initiatives are part of the legacy for which Congress chartered us to address. So, that concludes my presentation, fast and furious. I wanted to make sure there was enough time for other folks during this session. Again, I wanted to give you a quick overview of where we stood within EM and particularly the Chief Technology Officer and what our vision and how we're moving forward with the technology program. Thanks for your attention.

SIU: Thank you, Rod.

EIDELPES: Thanks a lot. Again, my name is Elmar Eidelpes. I'm a Spent Fuel Analyst at the Idaho National Laboratory and together with my colleague Gordon Petersen, I will be speaking to the spent fuel technology development activities at the Idaho National Laboratory. First, before we start, this is just a sort of disclaimer that I'm speaking here as a researcher. Gordon as well. And that nothing that we say is necessarily the opinion of the US Department of Energy or the US government.

All right, before we hop into the actual content, I just want to provide a brief overview of the presentation content. So, I will be discussing the spent fuel technology development activities, including goals and objectives, as well as the research on extended dry storage of aluminum-clad spent fuel. So, it's my understanding that the particular interest of the NWTRB here today is on this part of our research. So, we will be discussing the technical basis, which was a document that was issued in Fiscal Year 2022 and then we'll discuss the status and ongoing work as well as the impact of our work on the US Department of Energy's ability to store aluminum-clad spent fuel. And then Gordon will be briefly talking about advanced neutron absorber work that has been performed for the last couple of years.

All right. So, the program goes… Some of you may know that our program used to be funded by a Congressional mandate. So, there was this piece of language that could be found in the appropriation languages that was along the lines of this text up here. So, to perform technology development for the National Spent Nuclear Fuel Program to address issues related to storing, transporting, processing and disposing of DOE-owned and -managed spent nuclear fuel. So, these are our program goals. You can see here on the right side also one of these images that Jomaries has already presented, kind of like illustrating this variety of different fuel types that we are dealing with here.

Now, in terms of program objectives, these are defined each fiscal year on the consideration of various input sources from

DOE or NWTRB and independent technical reviews. Now overall, we always provide … try to provide support to DOE and the sites and other national laboratories in their spent fuel management responsibilities. And I also want to point out that while this program is led by Idaho National Laboratory, we are working in close collaboration with Savannah River National Laboratory.

So, I mentioned some of the key important sources. I want to highlight one. This is the 2017 Spent Nuclear Fuel Working Group Report which identified five technical gaps on extended dry storage of aluminum-clad spent fuel. Of course, we participate also in meetings at the Spent Nuclear Fuel Working Group or meetings like this one here today. We also address applicable recommendations from the 2017 NWTRB report that was also mentioned today.

This slide here provides a comprehensive overview of our program scope. You can see here three lists of activities. The first one on the left is this earmark program. This includes a range of different activities. All of them with the goal of addressing questions related to spent fuel storage or management. And the ones that are marked here with these red arrows are primarily focused on enabling extended dry storage of aluminum-clad spent fuel.

In addition to that, we have also two additional projects that were funded outside the EM program in FY ’23-’24. So, we are working on innovative technologies to monitor and interrogate spent fuel dry source casks, using, for example, helical guided ultrasonic waves. And then we have also another effort ongoing that is looking at vitrification of sodium-bonded Fermi reactor blanket materials. Now, I would like to say that all of these activities are funded by the Office of Environmental Management Technology Operations and we also enjoy a strong subject matter expert support by the Office of Nuclear Materials.

All right. When we talk about aluminum-clad spent fuel and dry storage, I think we should just take a brief look at the inventory. Nationwide, we have about 13 metric tons in EM, that is in the custody of DOE EM. This doesn’t sound like a lot, but when you look at the volume percentage, that would be 15%… relatively high because of the low-density. Much of the material is either stored wet or dry at Idaho, Hanford, or Savannah River. And also, the aging facilities were mentioned today already. So, we have also agreements in place with states such as Idaho that requires us to repackage and maybe move the fuel at some point and move it to extend dry storage.

Now in terms of technical challenges, you can see here on the right side some images. So, the first one in the upper left corner shows these aluminum oxides that can be found on aluminum-clad fuel. So, the problem with aluminum-clad spent fuel it tends to corrode. These oxides may carry a lot of water and that makes it very hard to dry. We ran some drying experiments. Here’s a setup shown in the center upper image. The problem is with any residual water in dry storage canisters is that it may be subject to a radiolytic gas generation. So, this graph here illustrates the formation of hydrogen as a consequence of this radiolytic gas generation process as a function of absorbed gamma dose. We can model and simulate these work…excuse me…these processes. This is shown here in the lower left image. We can also monitor these processes. Here is the remote canister monitoring system that we are currently working on in the lower center image. And then of course, we have the aluminum-clad nuclear dry storage pilot which, of course, will be discussed in detail today for validation and verification purposes. So, here’s an illustration in the right lower image.

So, summarized, there is a need for the development of the technical basis for extended dry storage of aluminum-clad spent fuel to address these technical challenges and to meet the packaging and extended dry storage needs.

I mentioned the Spent Nuclear Fuel Working Group and the Spent Nuclear Fuel Working Group report on challenges associated with aluminum-clad spent fuel and the extended dry storage of such. So, these five challenges are listed here in this table in the first column. The identification of these challenges completed Step 1 in our flowchart shown here in the left lower corner. We initiated in our laboratory studies… These laboratory studies were initiated in 2017 to address these challenges. So, we initiated the program that consisted out of six tasks. These are listed here in the upper row of the table. And these X marks indicate how these technical tasks should address these technical challenges.

And now we are moving into the Step 3 of the flowchart, which is the validation and verification. Ultimately, we want to move to deployment.

So, I mentioned a technical basis that was issued in Fiscal Year 2022. I just want to go briefly through the main findings of the researchers that led to the issuance of this technical basis. So, the first task here was research on (oxy)hydroxide behavior. The researchers looked here at the water vapor corrosion using this piece of equipment shown in the upper right corner. And what they found is that we don’t expect hydrogen being generated as a consequence of corrosion on the representative dry storage conditions. However, high temperature drying could lead to a lot of phase changes maybe in the fuel cladding.

This task was completed. Our second task, radiolytic gas generation experiments, focused really on the radiolytic gas generation process. You can see here some of the data shown in the lower left image. This is again a graph of the hydrogen as a function of the absorbed gamma dose. This work was also supported by mini-canister testing executed at Savannah River National Laboratory. It allowed to test larger coupons under various drying conditions. It allowed us to define these G values, which are basically a unit that describe the quantity of hydrogen as a function of the unit of the deposited energy. Maybe one of the key findings here is that we have insignificant quantities of oxygen being generated, and we also expect a rollover at higher doses.

We can model and simulate these processes. You can see here a time history in the upper right corner of hydrogen versus storage time. So, we can run complex thermal simulations of various dry storage configurations of aluminum-clad spent fuel and these are coupled with chemical simulations. Again, these models found that we have maybe large hydrogen concentrations. We have insignificant oxygen generation and that generally should prevent the canister flammability. In vented systems oxygen inhibits hydrogen generation. Canister pressurization should not be the main concern here. And the modeling simulations found that we have an insignificant amount of nitric acid being generated.

We also completed aluminum-clad fuel dry storage performance evaluations in which we characterized aluminum-clad spent, fuels specifically Advanced Test Reactor fuel stored wet or dry for multiple years and we didn’t detect any significant changes during this multi-year storage period. Occasionally, we found some oxide plumes, which are large oxide deposits. However, they appeared to remain stable throughout the storage period.

Our drying experiments indicated that drying is a highly effective process for removal of free water. Chemisorbed water, however, requires a very high temperature for being removed, most likely a temperature above 220 C. So, one of these drying experimental setups is shown here in the upper left corner. In the upper right corner, you can see some data on drying mass loss versus drying temperature. And you can see this jump at around 220 C. That indicates this requirement for high temperatures. In any case, we expect significant reduction of hydrogen generation due to drying.

And then our Task 6, which has been completed, was really centered around the preparation of aluminum-clad spent use surrogates to run all this experimental work. And we found that we can use corrosion protocols to reproduce representative (oxy)hydroxide morphologies. And also, we expect a level of passivation protection by existing oxide layers. So, you can see here, scanning electron microscopy image from actual aluminum-clad spent fuel, Missouri University Research Reactor aluminum-clad spent fuel here in specific.

All right, this research work led to the issuance of the technical basis, and the technical basis is actually a summary of three key findings. The first one is that extended sealed dry storage of aluminum-clad spent fuel is both safe and viable. For example, using the DOE standard canister, extended vented dry storage for aluminum-clad spent fuel is both safe and viable. Shown here, for example, for the INL CPP-603 facility and monitoring of extended dry storage of aluminum-clad spent fuel is technically viable. For example, using the remote canister monitoring system architecture. The technical basis was published as a report… as a journal paper as well. And now, throughout the last couple of months, we were working on having an independent technical review [ITR] being completed, and we received some addition research recommendations. Those are preliminary. I want to point that out. The ITR hasn't been completed yet. However, some of them are clearly useful to us and so we picked them up to inform our current research agenda.

So, our current research agenda includes a focus on radiolytic formation of nitric acid. There are still open questions on hydrogen generation. However, nitric acid generation previously has been only simulated, and now we are trying to measure nitric acid generation or the generation of nitrogen oxides in systems that contain aluminum coupons shown here in the lower right corner.

Another research effort here is to investigate breakaway corrosion. So, breakaway corrosion could mean that a corrosion layer is removed either mechanically or through chemical processes and that could lead to additional generation, for example, of nitric acid or other chemical species. And we want to use also this work and the findings to validate and verify our predictive models.

I have a second slide on this work because our PI, Hannah Hlushko, provided me with this slide here. So, these are just some of the initial data points. And, again, the interpretation is still outstanding. However, what it indicates is pretty much… And so, you can see here in this graph the amount of the concentration of nitrogen oxide, such as NO_2 or NO_3 as a function of the absorbed gamma dose. And what these preliminary findings indicate that generally we expect an increase in the concentration of these species with increasing dose. Also, a positive correlation with dose and the availability of water. So, this system here was run with 95% relative humidity in air, and the presence of surrogate aluminum coupons actually lowered the detectable concentration. So, those are the key findings here, and we hope that we can report more on that work in the future.

Also, we have a continuation of our modeling simulation work. The main idea is to help simulate the aluminum-clad spent fuel's dry storage pilot. You can see here a preliminary CFD model, so a thermal model, computational fluid dynamic model in the upper right corner. We need to refine our models. We want to have a good understanding of the gas phase composition and we also want to have an implementation of verified chemical models for gas-phase and surface-mediated radiolysis reactions. And we hope that we can extend the time period of these models. Here is the time history for 200 years of dry storage, but theoretically we believe that we can model even longer periods of time.

Throughout the last year or so we worked on complementing outstanding data from our mini-canister testing setup. So, that was performed at Savannah River. Bottom line is that we wanted to reach higher doses, up to 15 MegaGray. We wanted to complete various conditioning processes and test the impact of these conditioning processes on the yield of hydrogen. By the way, here is another graph of this mini-canister results again hydrogen as a function of the absorbed gamma dose. The mini-canister setup is shown here in the upper right corner. And now we are working on a comprehensive re-evaluation of the available data and all the models. And there were some questions on definition of G value that need to be addressed. So, again, all these visits have been informed by input from technical reviews.

Another effort that I would like to highlight here today is the remote canister monitoring system. So, we need to have the feasibility to monitor extended aluminum-clad spent fuel dry storage configuration during extended periods of time. This is needed to have a good understanding of the safety of the system itself. However, also for repackaging purposes, we also want to understand the conditions of the fuel before we repackage it.

So, you can see here the canister lid system, which is one of the components of the remote canister monitoring system in the upper right corner. This system is called “canister lid system” because it’s low closer to the canister lid. It includes control software and functionalities as well as radiation detection, pressure sensors, hydrogen concentration sensors, and so on. And then we also want to place these in canisters, mechanical assembly at various locations within the canister. This is to collect spatial data on temperature and relative humidity. So, this system is to be deployed in INL CPP-603 facility, which is again a vented dry storage facility. And near-term objectives are wireless transmission testing and the completion of final design.

Okay, again, the aluminum-clad spent fuel dry storage pilot would be discussed in detail by others today. However, since it is an integral part… Sorry, I tried to hurry up here, yes. So, that’s an integral part of our program. So, I just want to highlight that we have this timeline here. We are moving through the planning and design phase. And then ultimately, we want to move to data collection. Just to summarize it, this will be a first of a kind data collection from sealed aluminum-clad spent fuel dry storage using actual aluminum-clad spent fuel.

Okay. I have two more slides left. The first one is just the impact of our current activities on a technical basis. So, we try to address independent technical review feedback. We also want to develop or continue to develop subject matter expertise in this space. We want a deepen our understanding of our one-of-a-kind chemistry models and apply that to a variety of dry storage configurations. We need to validate and verify our technical basis. We have the aluminum-clad spent fuel dry storage pilot, which again would be a one-of-a-kind sealed aluminum-clad spent fuel dry storage data collection. And ultimately, this will provide risk mitigation to DOE. Again, it will inform DOE facility and maintenance and decommissioning efforts for L-Basin, as well as H-Canyon, and CPP-603 of course.

And then before I hand it over to Gordon, I just want to summarize what I discussed today. So, DOE continues to manage 14 metric tons of aluminum-clad spent fuel. There are sources of additional aluminum-clad spent fuel generation, such as Advanced Test Reactor, the High Flux Isotope Reactor or other domestic and foreign research reactors. And a technical basis is needed for extended dry storage of aluminum-clad spent nuclear fuel is needed to enable DOE to package and store aluminum-clad spent fuel for extended periods of time. And, again, our current activities focus really on validation and verification of this basis. And with that, I want to hand it over to Gordon. Gordon, it’s all yours.

PETERSEN: I’m Gordon Petersen, Spent Fuel Analyst from Idaho National Laboratory and I’m going to be taking over from Elmar’s talk and discuss some of the activities related to the neutron absorbers that DOE has been involved with over the past few years. Particularly, neutron absorber activities for DOE-EM managed spent nuclear fuel.

As has been iterated earlier in this meeting, DOE manages many different types of spent nuclear fuel. In evaluations conducted for Yucca Mountain, neutron absorbers were identified to be included in some configurations of DOE-managed spent nuclear fuel packaged in DOE standard canisters. Neutron absorbers, also known as neutron poisons, are materials that absorb neutrons. For the purpose of storage, transportation, and eventual disposal of spent nuclear fuel, neutron absorbers can reduce the reactivity coefficient.

For disposal, the ideal neutron absorber material should have a high thermal neutron absorber coefficient and be resistant to corrosion over long periods of time. For DOE-managed spent nuclear fuel, the National Spent Nuclear Fuel Program developed an alloy known as the advanced neutron absorber. The advanced neutron absorber is a nickel-based alloy system that uses nickel, chromium, molybdenum, and gadolinium. It was in part developed because initial corrosion tests showed poor corrosion results for borated stainless steel. Additionally, if there were corrosion of the neutron absorber, specifically for disposal and disposal environments, gadolinium was determined to be less soluble than boron. So, the American Society of Testing Materials accepted ANA as the ASTM standard and 2005 was approved by the American Society of Mechanical Engineers for ASME Division 3 applications. Next slide.

So, during the time when this material was being looked at and evaluated for disposal in Yucca Mountain, the superiority of the advanced neutron absorber was challenged. So, as I've previously mentioned, the borated stainless steel did not have exceptional results for corrosion resistance. However, other fabrication techniques were developed and they showed better corrosion performance in specific environments. In fact, the transportation aging and disposal canister, used as the canister for disposing of commercial spent nuclear fuel, used the borated stainless steel as its neutron absorbing material instead of the advanced neutron absorber.

In 2011, a study was conducted that determined that borated stainless steel was less corrosive than the advanced neutron absorbers in limited testing environments. In that study, it was inconclusive how well the advanced neutron absorber resisted corrosion, specifically the nickel gadolinium part of that material. Additionally, analyses have been conducted over the last few years that examined the ability of the advanced neutron absorber and borated stainless steel to reduce K-effective, and it was determined that the ability of ANA to control criticality did not exceed that of borated stainless steel. Next slide.

So, additional work has also been performed using borated stainless steel for DOE-managed spent nuclear fuel instead of the advanced neutron absorber, as was originally proposed for Yucca Mountain. Part of this work looked at using the borated stainless steel in different packaging configurations that were originally proposed for Yucca Mountain. You can see, over on the righthand side, is these… kind of the triangle picture shows an ATR4 bucket with Advanced Test Reactor elements inside. So, originally, for the disposal of Advanced Test Reactor elements, these were looked at to have put in a different basket. However, we've reevaluated this and looked at trying to use the ATR4 buckets, which are currently being used for storage and handling mechanisms in dry storage in Idaho in the CPP-603 facility. So, using these buckets increases the handling capability of ATR spent nuclear fuel and also reduces the number of DOE standard canisters because you can actually fit more ATR elements in a single package than you would with the original design using what's called the Type 1A where you can fit 10 ATR elements in a DOE standard canister, an 18-inch diameter DOE standard canister.

So, this work was looked at and a number of different configurations were examined. And it was determined that with the borated stainless steel and additional neutron absorber inserts, all scenarios had a K-effective of less than 0.93. There were additional analyses that have been conducted over the last two years on the susceptibility of the advanced neutron absorber to sea water corrosion. The results of these showed that the nickel gadolinium phase essentially was not as resistant to corrosion as originally thought. So, in the test around

2011, it was inconclusive that there was a large resistance to corrosion for the ANA material. And in more recent tests, they have verified that there were corrosion spots, specifically with the nickel gadolinium phase of that material. So, part of the work looking forward is to isolate that ANA material using an advanced manufacturing technique and then surrounding that material with the nickel-chromium-molybdenum without the gadolinium, which is proven to have exceptional corrosion resistance. Next slide.

So, in summary, the DOE-EM spent nuclear fuel technology development program continues to perform technology development for the national spent nuclear fuel program. It addresses storing, transporting, processing, and disposing of DOE-owned and managed spent nuclear fuel. As Elmar talked about earlier in this presentation, the technical basis for extended dry storage of aluminum spent nuclear fuel was developed. This basis is needed to enable DOE to package and store aluminum spent nuclear fuel for extended periods of time. Currently, efforts focus on strengthening that technical basis, and we will have a talk later today looking at the aluminum spent nuclear fuel dry storage pilot, which will be a part of the V&V [verification & validation] efforts for aluminum-clad spent nuclear fuel. Additionally, DOE and DOE-EM spent nuclear fuel technology development program are continuing to work towards addressing the NWTRB recommendations, such as the research on advanced neutron absorber. With that, I believe that we are done.

SIU: Okay. Thanks a lot. We'll start with questions, Board members.

BALLINGER: This is Ron Ballinger from the Board. When I looked at the first half of your presentation, I was much heartened. Then I read the last half. And then my question is for Tasks 1 through 5, why? Based on the results so far, why do we need the additional work?

EIDELPES: Well, there are still some outstanding questions. I mean, specifically, let's take, for example, our basic radiolytic gas generation work. We still want to have a good understanding of the processes. These are highly complex processes. We have only current experimental data from surrogate materials mostly. So, moving forward, we also want to understand the impact of drying processes, in specific, on the generation of hydrogen. And then, of course, another important issue is the availability of oxygen for flammability. So, those are just the experimental work that needs to be addressed. So, there are open questions on that. And then in the modeling and simulation space, I think it is important for any safety basis for, let’s say, a variety of different configurations, we need to be able to model these processes and that’s a very complex process.

BALLINGER: I understand and I’m much in favor of understanding fundamentally what goes on here. But in the sailing business we have a term called “distance made good.” And that is to say… what do those five tasks do to advance the engineering issues related to long-term dry storage? Does understanding the fundamental processes and generating hydrogen, does that add value to dry storage as a practical matter?

EIDELPES: I do believe so. Because, I mean, the main questions are flammability, pressurization, and corrosion. Those are the main technical questions and for that, I think, we need to have a profound and deep understanding of these processes.

PEDDICORD: Lee Peddicord from the Board. So, the metric for K-effective 0.93 that Dr. Petersen talked about, so that’s a highly subcritical effect the further you get away from one, why the less meaningful the number is. So, interested in how that was picked. But even more so, you’re talking about long-term storage. And are you tracking? You’ve got all these fission products, the fissile materials have long half-lives, so they’re going to be around a long, long time. But as you add the various fission products to K way over long-term, are you tracking how K effective changes? Is it getting more subcritical? Is all this decay of fission products are bringing you back closer to criticality over a very long storage time?

EIDELPES: So, can I… Sorry, yeah, please go ahead, Gordon, because I just wanted to refer it to Gordon.

PETERSEN: So, to answer your question about the 0.93 number that was selected. That's a legacy number that was used for the evaluations for disposal of Yucca Mountain's spent nuclear fuel due to trying to bound the wide variety of different elements that we have. Additionally, to increase conservatism, what was done is they actually looked at specifically… for the Advanced Test Reactor looked at fresh fuel, and also they looked at trying to come up with a distribution that looked at the maximum beginning-of-life U235 fissile material, and then the maximum end-of-life plutonium material for some of the DOE-managed spent nuclear fuel, specifically I can cite what they did for Fort Saint Vrain and there may be some discussion on that later today in the packaging, in the road-ready dry storage packaging demonstration talk for that.

So, for ATR, 0.93 was selected because of some of the uncertainty is surrounding the fuel type itself, and we have not looked at how K effective would change over time because of the large conservatisms that we took initially, or at least that they took initially, the national spent nuclear fuel program, in determining that they're trying to find the most reactive configuration of ATR spent nuclear fuel and its life cycle. So, we believe that we are modeling the most reactive configuration so that we don't have to determine after kind of a time lapse approach of what sort of radioisotopes and how much fissile materials are in the package and in the elements and modeling that.

PEDDICORD: Yeah, I think that makes sense. You know, and I'm thinking, as we say, we're storing this stuff longer, longer, longer than we'd anticipated. So, I say, cesium decays away and stuff like that. But I agree that you have sufficient margin of subcriticality that I don't see that becoming an issue over a long time. I'd like to ask a question, if I may, to Mr. Rimando. Coming from a university, I think your participation in university, 68, 70 of them, is great. I had a question, more of an observation that since you're engaging these universities and lots of students, are you able to take a little broader approach in using them as a pool of individuals that you'll bring to your sites for summer internships? That we find at universities that if you get students coming to your various facilities and do summer internships, it greatly increases the probability that you're going to be able to make them part of the future workforce. So, I don't know if you've had a chance to look at this as kind of a broader, more holistic or integrated approach of how you are working with the universities.

RIMANDO: Yes, sir. Thank you for the question and the observations. Yes, internships is a large component of how we engage with our universities. It’s just not internships. It’s the whole context of experiential learning where they’re able to take what they learned in a classroom and at the university lab and actually apply it or observe it in the field. So, for example, at Savannah River we have this construct called the “Field Station” where they’re able to do so. They essentially get their feet wet, get their feet dirty, hands dirty. And not only do they engage in meaningful studies and activities, but at the same time, we’re actually coordinating with our universities so that the time spent as they go through these activities, they actually earn college credit towards that. So, in many respects, you know, you go to college and get your one credit for a lab. The same approach. Instead of the lab on campus, it’s a lab in the field. So, yeah, there are a number of different features, including post docs and graduate fellows that we engage with the students. And, again, it’s twofold. One, so that the universities have the opportunity to contribute to the EM mission and help us solve the many problems and challenges that we have. But also, again from a workforce pipeline in looking at them in particular as like I mentioned, the next generation of our STEM professionals and leaders, they are a big part of the component of our university engagement. So, I appreciate the question.

PEDDICORD: And just an additional comment to that. Generally, we find that the earlier you can kind of engage and grab the attention of students, I'm talking as even undergraduates, sophomores, juniors, again, the greater the probability that they will become part of your workforce in the longer term. So, I think your approach sounds very good and well done.

SIU: Thank you. Thanks, Lee.

RIMANDO: I absolutely agree if I can comment. It's not just the undergraduate, but we have some of our universities that are actually reaching out to their local high schools. From Texas State University, for example, has partnered with Atkins High School and they developed a partnership there where the students themselves, high school seniors and juniors, are able to do what they call externships within the university. So, all that we can do to kind of pave that pathway and engage as much as our young people as we're able to. We certainly pursue that.

SIU: Okay, I think we have…

WOODS: Nathan, this is Brian Woods. If I could ask a question. Rod, you know, when you were listing your, I think, the budget and of course, just like most programs, there's a line item for crosscutting technologies. So, I was curious, I mean, are these crosscutting technologies that are really developed for the EM TD program or is there an effort to look outside of EM for different types of crosscutting technologies and their development, maybe through another DOE program or maybe outside of DOE or maybe industry. And if so, if you could just talk about that for a moment or two. Thank you.

RIMANDO: Thank you. Yeah, for the enabler, it is not necessarily limited. So, to the extent that we do have these opportunities for technology maturation, technologies transfer, we certainly pursue those. So, that does include, you know, those technologies to develop in-house, meaning within our national laboratories or even to the extent our contractors are doing so. We absolutely do incorporate that. Part of our mission also is to make sure that we collaborate much greater with our other program offices. For example, Paul mentioned the greater collaboration that we're pursuing with the Office of Nuclear Energy. Likewise, with [Office of] Science, ARPA E as well as in an NNSA [National Nuclear Safety Administration] because even within those different program offices there are applications or technologies that are applicable to the EM problem set. And to the extent that we're able to partner and leverage the transfer or even the sharing of information, we will certainly do so. And I mentioned COTS and GOTS, absolutely. We do we need to "reinvent the wheel." If there's a solution that's already commercially available, then we will do what we can to insert that. But of course, the challenges are for us is to make sure that in doing so, 1) that the technology operates as intended, 2) that it doesn't bring or introduce new risks or hazards so that we can demonstrate that it operates safely. And if it fails, that it fails safely too. And then the other component is that, you know, from a waste management perspective, we want to make sure that by introducing these technologies we ourselves don't generate orphan waste, or in other words, waste for which we have no disposal pathway. So, there's a lot that we do from the demonstration phase to include the whole gamut to the extent that we can do so of available technologies and emerging technologies.

SIU: Bret.

BECKER: Yes. Dr. Steven Becker for the Board has a question for Rod. This team presentation covered a lot of very interesting and important technical work. Do you have opportunities to communicate about this work to the general public? What have you learned from these communication efforts?

RIMANDO: I'm sorry. Is that a question directed to me, sir?

LESLIE: Yes, it was.

RIMANDO: Oh, okay, thank you. Yeah, so, of course we want to spread the good news. All right? So, of course we have our normal communique within EM and within the department. Our national laboratories advocate on their technology highlights and how they engage with the department. Certainly, our universities, there we encourage them to even highlight not only the contributions, again, that they're making to the EM mission, but how they're going about curriculum and development and preparing themselves to enter into the workforce. So, there's a number of different avenues that we take to really advertise and even market what we're doing. Of course, we participate on a number of campuses and symposia and engage with the broader community a practice to include many of our professional societies. [SOUND FREEZES AT ABOUT 02:52:11.]

SIU: Looks like we lost the audio… I'll take chairman's prerogative even though we're just a tad over. I'll ask Elmar a question. Let me follow up on Ron's question. In one of your early slides, you indicated that your program was being driven by input from multiple organizations, including us, which is of course is fine. Do you have any metrics or specific factors that you consider when identifying topics that need to be addressed and the priority of addressing those topics?

EIDELPES: Should I?

SIU: Either.

EIDELPES: Rod, I think you were lost and then we moved onto a different question. Okay. I will just address my question and we can complete Rod's. Well, first of all, I mean, our project objectives are to support DOE in their spent fuel management activities. So, that's kind of an overall first evaluation process. Now, in terms of priorities of these individual activities, I would say since we're moving into this validation and verification phase, again, I also want to make it clear we are very confident in our technical basis just to clarify that from what I answered before that. And our current activities are really focused on the validation and verification processes. Now, we receive input from technical reviewers. We respond to them. Partially, we believe they make sense. Now, do we have a quantitative rating of priorities? I don't know, like risk register or something like that as it was discussed today. I mean, our program is relatively small, I would say. So, overall, I mean, our next goal is really to demonstrate aluminum-clad spent fuel transfer using the pilot. So, this is another criterion or another topic that we use when we rate the importance of our activities to enable this pilot. And this is the next step to validation and verification. And then, of course, we need to see what happens in terms of deployment. So, there’s also, of course, the more, I would say, political side of things with the Idaho Settlement Agreement and so on, which is also, of course, on high level impacts our research work as well.

SIU: I will open in case the staff has any burning questions.

LESLIE: Just one that could be answered later. Given what you know about your technology development program, what is the TRL level? And so, we can come back to that this afternoon.

EIDELPES: Thank you very much. I mean, the TRL level, I also want to say, is probably a little bit subjective. So, yeah, we can have a conversation on that depending on how we define the level specifically for this application. So, it’s application dependent. But I’m happy to have a conversation with you.

SIU: Okay, thank you very much. Our next presentation by James Therrell. And, by the way, we’ve taken a couple of your minutes. Feel free to take them back.

THERRELL: I’m James Therrell. I’m the Mission Planning Manager for Savannah River Nuclear Solutions Environmental Management Operations. I think I met most of you all yesterday during the tour. I don’t know about you all, but I was pretty wore out. You guys went to a lot of spaces, a lot of them were hot. I did enjoy tagging along with you all. One thing that I hope you all got in addition to seeing the facilities, which I know the facilities were appreciative of your interest in them, was the amount of integration that's required in order to implement these programs. So, especially the ABD program. So, the integration between L-Basin, K-Area, H-Canyon, and DWPF [Defense Waste Processing Facility], SWPF [Salt Waste Processing Facility], tank farms, integration among the contractors across the site, integration with our customers both locally and at headquarters and also integration with our national labs both SRNL and Sandia when we talk about higher glass fissile loadings.

I'm not going to go into a lot of the background of ABD and how we got to ABD. You all have heard that a couple of times now. Jomaries mentioned it. Nick mentioned it on our tour yesterday. But I want to talk more about the implementation of ABD and how we've implemented it. Next.

So, the purpose of this really is in alignment with your LOI's. So, a synopsis… you asked for a synopsis of the ABD program. We'll go through that. Again, more of the implementation side. Major constraints on L-Basin through H-Canyon. The fuel coming from L-Basin going through H-Canyon. The groups of spent nuclear fuel that we've identified and the projections for those fuels going through be disposition. How we integrate with liquid waste and how we meet their WAC [Waste Acceptance Criteria]. How will the addition of the spent nuclear fuel process through the project impact the expected number of glass canisters? And then what are the groups of spent nuclear fuel that are not expected to be processed during the project?

So, just an overview of the ABD flowsheet. Again, talk about the integration. K-Area, we receive a minor amount, smaller amount of fuel from K-Area, but there are specific attributes to that fuel requiring it come from K-Area, i.e., it’s more plutonium-based, HEU [highly enriched spent nuclear fuel]-based materials, not necessarily spent fuel or irradiated fuel stored in drums. We get that by truck. L-Basin we have aluminum spent nuclear fuel. We have non-aluminum-clad spent nuclear fuel and we have other fuels that are current in L-Basin. We saw those yesterday. I know they all look the same when they’re underwater for the most part except for the HFIR. But they are varied. What was all contained in those bundles. And we continue to receive foreign research reactor fuel and domestic research reactor fuels and that impacts how our planning case is formed. And we receive all that fuel by railcar from L-Basin to H-Canyon.

Once we process it through H-Canyon, we support formation of what the tank farm calls a “sludge batch.” So, they form sludge in batches, qualify to a specific recipe for that batch. We send that material after we dissolve it in H-Canyon that fuel to Tank 51, or in the future we'll have a … another sludge preparation tank, Tank 42. And when that material gets sent down to tank farm, they will do … integrate it in within their existing tank farm flow sheets, and eventually make it over to SWPF or DWPF. The … our major contribution to that will go to the DWPF glass process. So ultimately, the fuel comes from K or L and gets output as glass.

So, when we were reconfiguring the canyon to support ABD, we had to take a look at all of the equipment that was used for the solvent extraction process. So, if you remember, if you recall, we talked about ABD being no recovery of uranium. So, we're no longer needing to use the solvent extraction equipment, and there's a lot of associated vessels that were a part of that solvent extraction unit operation that we could repurpose for storage. We knew storage was going to be a major constraint for the ABD Program because those sludge batches aren't continual. We only have windows in order to be able to discard that material in those sludge batches. So, we knew volume and storage of the solution, the dissolved solution, was going to be very important to us. So, we repurposed as many vessels as we could as part of that pivot from recovering uranium. So, if you look on the far left, we have three dissolvers over … we … each is kind of a little different in that the types of fuels that it will take. You notice that the 6.3 and the 6.1 dissolver, only one of those can run at any given time. So that's one of the constraints that has to do with our off-gas limitations. But that's not impactive to us. We're still doing chemical dissolutions in that … called the 6.4 dissolver, which can do HFIR and MTR. And then we have the 6.3 electrolytic dissolver or the 6.1 chemical dissolver that we can run. We're currently configured to run the 6.3 electrolytic dissolver for the FCA mission, which we'll talk about in a second.

But we established basically two processing lines, one for aluminum and one for the non-aluminum clad materials. So we have kind of where it says storage tanks. That's a multiple array of storage tanks that we've repurposed for storage. And then we … as it moves through the facility, we'll take that dissolved solution and neutralize it. As we mentioned yesterday in our tour, the electrolytic dissolver uses both nitric acid and electricity to break down the non-aluminum clad fuel so that we can get to the fuel meat and dissolve the fuel meat. The other two dissolvers just use nitric … heated nitric acid and mercury to catalyze the process. Once it moves through the accountability tank, the adjustments tank, we do have poisons that we add. We add depleted uranium to lower the enrichment to meet the tank farm criteria. And then we also have gadolinium poison, which also meets the tank farm criteria or another facility within the tank … within the liquid waste system. Once it moves through our storage array, then we have, like I said, the neutralization tanks where we add caustic and drop out the radionuclides or the long-lived radionuclides, plutonium, uranium, into sludge and transfer that to tank farm.

So, I mentioned the integration among the facilities. This is at the facility level and actually is … it involves two contractors. So it's … this is part of my group's major job responsibilities is to integrate with DWPF or the liquid waste facility. And we start, we have the feed that's in L-Area that, you know, we have fuel meat, the types, the varying types of fuel meat, whether it be uranium or plutonium. There's all kinds of enrichment …vary. There's other fuel meats, such as, I'm sorry, other major metals such as cladding. So like I mentioned, we had aluminum metal. We also have stainless steel, zirconium.

There's Hastelloy, Haynes alloy. Those present a flow sheet challenge. And we also have integrity differences with regards to the failed fuel. And I know you all had asked a question about failed fuel yesterday. So, there's differences in burnup and cooling. We have requirements of how long fuel has to be fueled … be cooled before we can receive it in H-Canyon. And then there's storage limits and cask handling ability. So we have to look at all those considerations when we're thinking about the feed coming from L or K. And that determines how much material we'll be able to receive in H-Canyon and at what the time frame is.

H-Canyon, there's a bunch of dissolution characteristics. We know our flow sheets are only compatible with existing proven flow sheets that we have developed either at the laboratory or through past historical operations. How many fuel bundles can we put in per batch? What's the chemicals that we need? What's the processing time? What's the batch volumes? And we also have, like I mentioned, one of our major risks. You guys have honed in on risks today. We know that storage in H-Canyon is one of our major risks. So we have limited storage and we have limited windows to discard that material. But we have to maintain that and manage that storage. Equipment availability, aging facility, over 70 years old. We will … we need to continue to address obsolescence and the overall health of the facility to get through the mission.

And then between that second circle and the third circle really is that WAC. That's the … where we hit. We have to maintain our Waste Acceptance Criteria requirements for the tank farm. It could be tank farm or DWPF requirements or SWPF requirements. It all gets rolled up into, here are the requirements that you need to meet H-Canyon in order to send us a discard of the sludge.

So as you can see, there's also a back loop over here because the tank farm, they’ve got a … and DWPF, they've got the glass characteristics for waste quality, fissile loading limits, processing limits, canister storage limits, the big limit on when they have … when they will be closed, 2037. And then they also have availability risks in addition like we do. So, that back loop really provides us if we see … look at our feed and we know something's coming down in three, four years that we'll need to go address, the higher fissile loading was a good example of that. We knew we couldn't get through the ABD mission if we didn't increase the amount of fissile material that we could put into a canister. We started out, it was at 897 grams per cubic meter. We're now up to 2,500 grams per cubic meter, and we're working additional research in order to go beyond the 2,500, and you'll see in future slides we're going to need that in order to execute ABD.

Poison was another one. We … when we started out ABD, we were using a strategy that used manganese and iron as a poison, and we needed to pivot from that because we would be adding copious amounts of iron to our discards, and so we switched to a more effective poison, gadolinium. So we … that back loop, we work with the tank farm and our national labs to figure out how to optimize the Waste Acceptance Criteria and change them when we can to implement ABD.

So, you asked about the nuclear material inventory. Like I said, when you look down in the basin underwater, they all look like the same can, but it's highly varied. We have aluminum-spent nuclear fuel. We have non-aluminum-clad spent nuclear fuel, and I'll talk a little bit more about that. You can see that's really one of the only groups that has a TBD beside it as far as the disposition on 4 and 5. We are working technologies to address that.

The FCA material, which is the Fast Critical Assembly mission, stainless steel-clad plutonium plates that we're going to process through our … or have started processing through our electrolytic dissolver. We have a portion of the aluminum-clad spent nuclear fuel that have components in them, rollers and bearings that do not dissolve in the chemical flow sheet, so they'll drop to the bottom of the dissolver. That's a little bit of a development tech … need to go and figure out how will we retrieve those items, or do we leave them in the dissolver, can you leave them in the dissolver, what's the volume of those pieces that will build up? That's a technology development effort for us.

Targets, you guys toured the Mark-18 production line yesterday. Most of those targets will be going to the A … Mark-18A mission. However, we have a small portion of non-Mark-18 targets. This … well, I'll talk a little bit about how we are doing our system plan. Part of the benefit of the system plan is we've designated those targets to go through the Canyon. Now there's discussion about should you save those to the end, where should you put them, because there could be potential value in those targets for isotope recovery.

Dry fuel, you saw the dry fuel storage area in L-Basin. You can see the disposition for most of those are through H-Canyon. We have a small number of those items that will go through the lab for disposition. And then there's a host of miscellaneous other materials. Skull oxides, U-233 material that we need to disposition. There's some hot … oversized fuel items that don’t … won't fit into our current inserts in the Canyon. We need to consider how to get those inside the dissolvers. And we have some sources, standards, and samples that are various types and quantities. And it says TBD, but really those are kind of like a repurpose. You advertise those. Who else could use this source? Who else could use this standard? So we've done that across the complex. We'll continue to do that to see where we can move some of those. And we've already done some of that with Oak Ridge being kind of the first one.

So, I mentioned the non-aluminum material. So there's only 400 bundles out of the roughly 3,300 bundles that we have to process through ABD. But I really want to focus on that because that's the bulk of the technology need. So, there's only 400 bundles, but I like this chart. I call it the jawbreaker chart because it really shows the varying nature of those 400 bundles. I wish they were all the same. They are not. This chart shows the two kind of impacts of processing those items, one being the risk to the H-Canyon flow sheet and the other being just the handling in L-Basin. So, if you look on the vertical line, that's the L-Basin risk of contamination. And at some point, you get to where you need some additional controls, i.e. isolation, in the Canyon. So you saw the emergency basin yesterday. That's where the emergency basin isolation would come into play. Anything above that line you'd need because it has failed fuel. It could potentially contaminate the basin. As you go to the left to the right on the H-Canyon flow sheet risk, you get to a point where we're processing materials that we haven't processed before in our system. So we know that there's potential scale-up issues that we need to address so we feel we need a pilot-scale dissolver in order to process anything from the left to right after that pilot scale line.

And then you get to a red line there, and that's actually potentially reactive in our dissolvers and not currently compatible with our dissolvers. And that's that TBD. Look, the … okay. So the numbers there are the number of bundles. So … and the size of the dot represents the number of bundles. It's just a visual, the magnitude of how many you have, the quantity basically. So if you look to the lower left and bottom, that's … that’s what we're calling campaign-1. That's the first campaign in non-aluminum that we are going to target. It's the … it represents the lowest risk for both L-Basin and H-Canyon. We just did a press release in the EM Update. It said we've got our flow sheet for that material now. It was a major accomplishment over several years to develop that flow sheet. That material is going to go through the electrolytic dissolver. As you work up, obviously, up and to the right, we need additional technology. So our strategy with doing the non-aluminum overall program is to implement what we can while we're developing the long-lead technologies and feather those in to the implementation schedule as we get the technologies developed. So we're working technologies, the long-lead technologies for groups 4 and 5, that group over there on the upper right, while we're implementing the strategy to dissolve, disposition the lowest risk items.

So, I mentioned the System Plan. So we put together this past year the first issue of our system plan under the ABD Program. And I actually brought some hard copies for you guys. They're out here, so you can take that with you. But we needed a way to really maximize the remaining value of H-Canyon during its useful life. And so we wanted it to be well thought out, take a rigorous approach to ensuring that we're getting the most bang for what we have left out of the Canyon until both the Canyon, as well as the vitrification disposition flow path, i.e. while the tank farm is still open. So, we made a 10-year plan. We wanted to make sure it was executable. So, we also evaluated risks. We have section in for risks to well … make sure we could well understand our risks, both from a processing standpoint and from a programmatic standpoint and from a technology standpoint. We looked at our hard and soft limits, worked with our customer to understand their desires for what they wanted us to process. We worked with the tank farm on what things would be best to sequence in and when. We integrated in with the tank farm's system plan. They have a … we actually modeled a lot of our system plan after the liquid waste system plan and integrated with that plan. We grouped our inventory by dissolution characteristics. The … that basically set the stage for the technology roadmaps because that was where you could … what flow sheets did … basically, what flow sheets did you need to go develop as part of that roadmap? We categorized the inventory groups by readiness to process. I think most importantly, when you think about the system plan, my job, my group's job, would be very easy if all we needed to do was maximize throughput because we have … we're no … we know, as you'll see later, we have some aluminum bundles that will be remaining at the end of the project, the mission. We could say just process as many aluminum bundles as possible. We know that's not the right answer because we need to balance both throughput and long-term risk or burden to the department, and that's what we worked really hard on. And so we developed a weighting strategy where we looked at special considerations with some of the fuel. We looked at what … how hard will that fuel be to process post-Canyon. We considered that as a big factor, and then also we just looked at what is the … from a storage standpoint, the long-term storage, decades to come, do you have any risks associated with it being underwater? We want it … do we want some things to go to their final resting place more so than others? So we've developed that weighting system. You know, if we did … if we put throughput as the number one priority, we would have a lot of items remaining at the end that would be the hardest items, and that's not right. And if we only focused on the hardest items, then we'd be waiting around for technology to be developed. So you'll see that balance as it's written up in the System Plan, and you'll see kind of how we reduced that burden through our baseline scenario that we landed on. We did a whole slew of scenarios, and we grade … and we ranked those scenarios by various rankings to see how the burden reduced, how many bundles we got out, what technologies and funding we would need, and we analyzed those results and got concurrence from key stakeholders to establish a baseline scenario. And we pull this book out almost daily to reference it. It's been great to have as a reference.

So this is where we ended, and now this chart shows FY24 all the way through the end of when we're going to make our last discard to liquid waste, and you'll see the varying groups, whether it be HFIR, non-aluminum, targets, FCA. You see how those are all planned in there, and that's … we had a mathematical model that told us when we should sequence those in based on our goals. You can see the line going from left to right down. You can see that's the reduction of the inventory. Now, this … since we did this in September of last year, things have changed just a little bit, but for the most part, the dissolution targets, the inventory projections are all holding steady what … to our predictions. The main thing that's changed is we're going to have to add a little DUO earlier in the process, where it's showing the depleted uranium additions in the FY28 timeframe. It looks like we're going to have to do that a lot earlier, but for the most part, everything in the trends are remaining the same. One key here is where it says storage volume limited, and you'll see that on our volume chart coming up, we transitioned … after we get the second sludge batch storage tank, we transitioned from being storage volume limited in H-Canyon to a much more comfortable storage volume situation in the Canyon to where we're dissolution- and process-limited. So right now, we're not processing as fast as we can because we can't discard, but once we get that second sludge batch storage tank in place, we can then discard pretty much as fast as we can, make the material… within those windows. So in summary, we process over 70% of the spent nuclear fuel. We create storage space for 67 HFIR and 2,680 bundles at the end of the program.

I mentioned the storage volume in H-Canyon. So the blue line up top is the limit for the aluminum processing line. The orange line … horizontal line is the non-aluminum storage line, and you can see that transition from where we're storage volume limited to where we become process limited. On the non-aluminum side, it's a little more tricky because we are discarding plutonium in addition to uranium. So it's a little more complex of a story as to why that … the discards happen the way they do.

So, in summary, the chart on the left shows our aluminum, our aluminum with non-aluminum components, our non-aluminum groups, all the different groups and how they … whether they're … the breakdown and then where they ultimately end up. So, 2,700 or so and … go to liquid waste. Bundles will end up in liquid waste. We keep about a thousand bundles in L-Basin, and a small quantity, mostly the Mark-18A, will go to SRNL. If you look at the non-aluminum, the 395 bundles, you can see most … we get most of the groups 1 through 3. So I didn't mention the groups. So SRNL over the last four years has done a great job in organizing the non-aluminum into higher level groups so that we can begin to attack that variety of bundles. Five major groups, and within those we have a lot of subgroups, but if you just think growing complexity going from group 1 through 5 being the harder, that's a general … the general trend. There's failed fuel items among pretty much all the groups, but that's the … that's where we'll end up. Most of the group 4 and 5 or all of group 4 and 5 right now, until we develop a new flow sheet, will be in L-Basin when we're done.

So, the breakdown, the more detailed breakdown, you can see the amount of nuclear fuel items that we leave. I already mentioned that. The total fissile, we reduce it from 4,100 to roughly 1,000 kgs. We have … this is the term that I talked about with the weighting approach that we did. We called it the long-term storage burden because it wasn't all storage risk. There's other factors with these fuel items that make them burdensome for us to hold onto. So we reduce it roughly 62% per our subjective grading system, and then our initial storage positions go from 20 … from … our initial storage positions go from 768 to roughly 27 … roughly 2,750.

So, you guys asked about the number of canisters that ABD is going to incrementally add to this … to DWPF. So you can see by sludge batch the orange increment there of what ABD adds to the canister count. I did get the total. So right now, there's roughly 8,100 planned canisters for the entire life cycle. Ours adds 268 total canisters if … with our baseline scenario. If we got everything out of L-Basin, we'd add another 84 cans, but all of that 8,300 that are planned include all of the ABD canisters. So there's no … basically the canisters that are currently planned in DWPF include all of the ABD canisters. And the glass waste storage buildings, 1 and 2, will hold roughly 9,200 canisters. So, we're not creating another glass waste storage building as part of ABD. And we'd like … as we mentioned yesterday, that would have been a non-compute.

Okay. So I mentioned we're going to have some material left over at the end of ABD. One of the things that we thought was … just as important is this optimizing the ABD system in H-Canyon to maximize the amount of value we're getting and the amount of de-inventory we're getting in L-Basin and the amount of long-term storage burden we're getting in L-Basin was to inform stakeholders about the next step. What do we have left over?

Kind of put some context behind that. And so as the policymakers were considering, do we do a next generation canyon? Do we develop a melt and dilute approach to handling fuel? Do we dry fuel? Whatever that next approach is going to be post-Canyon, here's somewhat of the context of what we will have left and how that might in … play into that decision. So SRNL helped us look at whether the … kind of the impact of … from a dry store capability. You can see the blue, the aluminum spent nuclear fuel. It's not complex, but it will be costly in order to do a dry storage capability at Savannah River. The orange there is the metallic group 4 and 5 non-aluminum spent nuclear fuel. That's going to be highly complex and very costly in order to dry those materials. So you think about some of that material being reactive through the drying process, we'll have to go figure that out with some technology.

So material exchange, there had been the potential and had been discussed in the past to exchange some material with Idaho. If we did that, obviously not … the aluminum wasn't the … what was being considered. So, that's a little misleading because we wouldn't be transferring aluminum fuel there, but that would be highly complex and very costly if we were to do that. But there are some nuggets of material in there that are just moderately complex. And then, again, that metallic non-aluminum group 4 and 5 material would be very complex and costly to do that material exchange. We believe there are some nuggets in there, some candidates that would be applicable to that approach.

The next generation canyon, it looks a lot better. There's not a lot of orange there because you really are going to build a canyon to what you need to process your feed. So that would be kind of the scope would be, hey, process this material.

So in summary, we expedite the processing of spent nuclear fuel, and we are highly coupled with the liquid waste flow sheet. We utilized the processing limits. We considered availability, and we've achieved a reduction of 70% of the spent nuclear fuel, which is more than what we would have done if we were trying to recover the uranium, much more. We're going to establish disposition of the remaining spent nuclear fuel that would be remaining. So two flow sheets that we're looking at with regard to those TBD items, that group 4 and 5 metallic non-aluminum that's so troublesome. Melt dilute, we're going to start looking at some of that as it relates, put it in the context of those fuel items next year. And then also the lab is working on a new chemical flow sheet called Alniflex that has the potential to chemically dissolve through … it's a fluoridic flow sheet, but it has the potential to chemically dissolve those items versus running it through the electrolytic, which we know they're not compatible with the electrolytic. So with that, I'm done. Thank you.

SIU: Let's start with questions from the Board.

PEDDICORD: Lee Peddicord from the Board. So a couple of things along the way here. So the overall bound, if I understand correctly, is availability of H-Canyon.

THERRELL: The overall bound is the closure date for liquid waste. We can only process until …

PEDDICORD: Okay. And that is 2034 budget?

THERRELL: 2034 is when we can make our last discard.

PEDDICORD: Okay.

THERRELL: The Liquid Waste Mission goes out to 2037, but we're constrained to 2034.

PEDDICORD: Then probably in these things, the devil is in the details. Those are the ones you have well-characterized, you know how to fold in, will go well. It's some of these kind of outliers that you're tracking, and particularly in your technology development.

THERRELL: Yes.

PEDDICORD: So just to help me understand a bit better, you talked about the ones where you're going to need some depleted uranium. Is … are those materials all available all here at Savannah River? Do you have to go get some someplace or …

THERRELL: Is the depleted uranium here?

PEDDICORD: Yeah.

THERRELL: Actually, we had an inventory of depleted uranium that we used for our initial discards. We started discarding in March of 2023 with what they call Sludge Batch 11. We used those materials up, and we're currently going through an RFP for additional DUO.

PEDDICORD: Okay. Then on the non-aluminum spent fuel, is that all in the L-Area now, or where is that residing?

THERRELL: It's all in the L-Area. We don't receive any … currently don't receive any new non-aluminum spent nuclear fuel. That material's been there for a while. It's all legacy material from previous test reactors.

PEDDICORD: Then I think it was slide 12 where you were showing this limit at DWPF of, what is it, 350 canisters that you're going to slightly exceed. Is the 350 kind of an arbitrary number?

THERRELL: Okay. So yeah, maybe I should have explained this chart a little bit. That’s … that secondary axis is for the bar chart, and the red line and the green line there are for the primary axes. The red line is referring to the 3,500 gram per cubic meter, and the green line is the fissile loading limit against that red line.

PEDDICORD: Okay.

THERRELL: So, there really is no canister limit. So, yeah.

PEDDICORD: Okay, got it.

THERRELL: It's a little misleading. I should have explained that.

PEDDICORD: And then I guess the next slide, 13, your future recipients' receipts of MTR fuel, 161, where are those coming from?

THERRELL: So, we have agreements for it to continue to receive domestic research reactor fuel and foreign research reactor fuel. We're going to …

PEDDICORD: So, this is old stuff then, too, I assume.

THERRELL: Is it old stuff?

PEDDICORD: Yeah, in terms of when it was, you know, when it operated, particularly the foreign return fuel.

THERRELL: Well, domestic research reactor fuel is an ongoing program, so we just need to let that fuel cool long enough before we can receive it. The foreign research reactor fuels, if you want to speak to that, Kiran.(inaud.)

KARANTH: Hello, my name is Kiran Karanth, and I'm the fuel receipts program manager. So for the domestic reactors, they are producing these fuels as we speak. So the spent fuel is being produced. For the foreign, some fuel has been already (inaud.). So those we are receiving as part of the plan, but there are some still being operated.

PEDDICORD: Really? I didn't know that. Okay. Thank you.

WOODS: Mr. Chairman, this is … I have a question. This is Brian Woods from the Board. James, I have a … I do have a question about the H-Canyon dissolution targets, and also your … you discussed about having different scenarios as well that you developed, you know, looking at processing the different groups. Is there any … are there any kind of assumptions embedded in these scenarios or in this dissolution target graph about technology development, or do you just assume that the technology we have in place is … will get us here, or are there some assumptions, hey, we'll have a certain technology developed at a certain date, and if so, I'm just kind of curious how those will get kind of quantified by your model.

THERRELL: Yeah, so we have a roadmap contained in our system plan. I can … We can get you this electronically. You know, we have hard copies for the Board, but in that system plan, there are … there is a detailed roadmap that shows where those technologies feather in, and we … so that is informed by where it's needed in the model, where they need to be … where those groups need to be run. The bulk of the technology is flow sheets. Most of the aluminum flow sheet work … aluminum-clad flow sheet works are tweaks to existing flow sheets to go validate those parameters and assumptions within the process holds true. The non-aluminum is, again, the harder of the technology development piece, and we have a strategy for developing all of those items, and the 4 and 5, again, aren't in the current baseline, but … and we have plans to develop the groups 2 and 3. We actually just kicked off the flow sheet work for category … or group 2, campaign 2, this year, so we're going to look … we actually have … because within the groups there are so many categories, and subgroups, we've actually had to break it down to campaigns, so we actually have about eight campaigns that we're going to work through as part of handling groups 1 through 3, but those … all of those technology development efforts are planned.

WOODS: Okay. Thank you.

SIU: Nathan Siu, Board. Yeah, you've got the slide right there. When do you anticipate making the decision as to how you're going to address these remaining materials? I mean, you have alternatives right now that you're looking at.

THERRELL: Somebody got … this would be.

BUNYAN: I'm Mike Bunyan, the site manager down at the Savannah River. You said the decisions on whether we do dry storage or material exchange, or the … is that the one decision you're talking about?

SIU: Yeah. As I understand, there are alternatives for dealing with the remaining materials, and you're thinking about different ways, whether this is the right set of pie charts or not, I don't know, but at what point would …

BUNYAN: Those are the options they're looking at, but the decision on which way we go is actually above all our pay grades in this room. It's a department-wide … it's not an EM decision, it's a department-wide decision, because the material comes from all these different organizations. We have the H-Canyon, we're operators, so we're operating it the best we can with what we have, but there's a whole other group at headquarters that's looking to try to figure out what happens at 2034 when we can't operate the canyon anymore, what is the next … and so that's probably why we created ABD, is to get the volume at L-Basin low enough to get us time to make the decision and get something in place for a follow-on. Because we'll have L-Basin inventory way down, we can continue to receive for many years material while we sort out the follow-on environment. So, I can't give you a timeframe on that decision at this point.

SIU: Well, okay, not when it's going to be made, but when would it be brought forth to the higher-level decision makers, or is it already being considered now as just in process?

BUNYAN: Yeah, Jomaries was … has been involved in that up at headquarters.

SIU: Thank you.

ROVIRA: I'm Jomaries Rovira again. So there has been efforts involving multiple DOE programs that have spent fuel in their portfolio and other nuclear materials, so we've been working with them. There has been proposals presented to senior management. However, they're not meeting the expectations, so we're now trying to look back and see what are the things that we can start working on, and one of the things that I listed on my presentation was the small modular nuclear material processing capability. So, under the scope of that effort that we're starting to initiate, and when I say starting to initiate, it's just putting some words on a paper and just brainstorming on what those options could be. The next goal will be to present this to senior management and see if this is meeting their criteria, and then moving forward we're going to know when and how and what we're going to be doing, but at this point we're just still trying to figure out what is that capability that we're going to need in the future that meets everybody's criteria.

SIU: Okay, thank you. We're just fact-finding.

THERRELL: So is … so our part in that is we're intimate with this knowledge of this material. We want to inform the stakeholders and decision makers on what that material … what potential options are out there, so we have ideas that we want to investigate and develop to provide a whole suite of options when the time comes to make that decision. So that was the main point of this slide and part of why we included it in the system plan.

OGG: Hi, this is Dan Ogg with the NWTRB staff. James, thank you for the presentation. Great detail there, and thanks again for the tours yesterday. We appreciated that. On slide 12, just wanted to go back to your discussion on the fissile loading limit, on this graph here, you show the limit at 3,500 grams per cubic meters. Is that limit in place now, or is that something you're still working on? What's the limit now? And when do you expect a new limit to be in place?

THERRELL: Yeah, our current limit is 2,500, and there … Sandia is currently evaluating increasing that to a number beyond the 2,500. So that … we need it for the next sludge batch, and our schedule currently shows us getting that. Right now, there have been … the feedback that we're working with our national lab, the feedback we've been getting at the working level is that no major roadblocks. It looks like the repository evaluation and everything is going to support going to a higher number.

OGG: Just roughly, what's the time frame for Sludge Batch 12?

THERRELL: Sludge Batch 12 is currently … I've got it.

OGG: I'm just trying to figure out, is this six weeks, six months, six years?

THERRELL: Yeah, no, no. It's … We're in the … Oh, goodness. One second. I anticipated these questions. So, March 2026 would be our first discard to Sludge Batch 12, and our schedule shows us meeting that before in the 2025 time frame.

OGG: Okay, great. Thank you.

THERRELL: Yes.

SIU: Any other questions? Okay. Thank you very much. With that, we're on schedule. So, we'll break for lunch, and we'll reconvene at 1:00. Thank you.

[BREAK]

SIU: Okay. I think we're ready to start. Kiran Karanth. I hopefully got it right.

KARANTH: Yes. Good afternoon, everybody. My name is Kiran Karanth, and I am the fuel receipts program manager at L-Area, and I also support James and his team in H-Canyon planning ABD from L-Area perspective. So, let's get into the L-Area overview.

L-Area is one of the only two operating facilities in the nation which can receive spent nuclear fuel from research reactors. So, our core mission is threefold. One is off-site fuel receipt, which is from both domestic and foreign research reactors. The second one is safe storage. And the third one is transfer to H-Canyon for processing. It's a transfer to H-Canyon for processing, but as this ABD realm is becoming … we're getting into the ABD realm, we're also looking at, like James talked about, transfer of Mark-18A targets to SRNL for isotope recovery program, as well as we are currently working on projects where we can transfer two of the dry stored INL drums for SRNL for processing. Okay.

So we'll get additional details in it. So as far as safe storage is concerned, a brief overview of the L-Area material storage facility. Some of you toured this yesterday, and it is a large swimming pool, 3.4 million gallon basin, with depths varying from 17 feet to 30 feet. These are all interconnected basin, and we call it as disassembly basin, but there are machine basin, VTS basin, emergency basin, dry cave basin, and many more, transfer bay basins. So these are all interconnected.

So we have the capability to handle a variety of fuel sizes, like HFIR being the largest and we do MTRs and sort of various sizes, enrichments, and fuel conditions. The … we also have a limited dry storage capability where we store dry fuel, and the access for rail as well as trailer inside the facility, which enables us to bring the casks containing fuel packages, the cask packages, either by rail car in case of the … some of the foreign receipts we are receiving from Japan. They come from Joint Base Charleston on rail car into SRS, and our transfer of these cask cars, the 70-ton cask to H-Canyon is also by rail. And many other packages for domestic receipts, like NAC-LWT or G2000, and BRR, they all come in trailers. And the Mark-18A cask, which we will be starting transfer of Mark-18A targets, will happen through the trailer as well.

So a brief snapshot of the inventory of L-Basin. James kind of covered that a little bit, but aluminum clad, if you look at the total number of containers, it's approximately 3,000. The fuel assemblies is about 13,000. In terms of metric tons of heavy metal, anticipated projected for the ABD baseline is 9.2 metric ton. Most of it is already here, and some of it is projected to be received. So we will … we'll cover that a little bit about the receipts. And the dissolution pathway for this is chemical dissolution for aluminum clad. Mostly we don't need any additional handling for the aluminum clad fuel.

Whereas non-aluminum clad, we currently have about 395, that’s 400 … less than 400 containers, constitutes to about 2,000 fuel assemblies. But it is 20 metric tons of heavy metal. The pathway is dissolution through electrolytic dissolver, and some of them require repackaging. So in essence, storage capability right … capacity right now is about 84% for MTR, and then about 56% for HFIR. So, when we started the ABD a couple of years ago, we were at 90-plus percent full on HFIR. Since the years past, this has come down because of accelerated processing of HFIR fuel in H-Canyon.

So I also want to briefly touch base on the heavy water stored. These are from the production reactors which ran at SRS. They're stored in stainless steel drums. And some of you took … you saw a sample of that in the process room in L-Area. You see the picture of the dry stored fuel. You saw the building where these drums are housed. But the inside picture shows, you can see how the drums are stored. The next slide talks about a brief overview of the inventory.

I just want to cover a couple of items here. The slug vault is a dry store facility where 16 positions are 100%, and the dry fuel storage area, which you saw yesterday, is 23. It's inside the disassembly basin, which is 100% full. And there are some cats and dogs. At the bottom, you see the dry cave and VTS area. That's the 3,650 storage positions for the bundles, and the HFIR core where you see is about 120 storage positions. So with that said, I'll invite Ms. Alexis to talk about basin chemistry and microbial growth.

SCHUCHMANN: As Kiran said, my name is Alexis Schuchmann. I am part of the Spent Fuel Project process engineering group as the basin water chemistry engineer. I'm going to talk a little bit about some of the programs we use to ensure safe storage in the basin. So the L-Area facility has a technical safety requirements administrative program that is established … it was established based on the maturity of the program. It's about a 30-year program, so the history of the program allows us to create this sampling schedule.

So this is part of the corrosion effort of the basin. So as part of that effort, we also monitor for metal concentration in the water, which would be an indicator for the fuel racks, because one of those is an aluminum, which is what the majority of your fuel racks are composed of. This will also include a microbial analysis, which is done in basin water on a biannual basis. And then we … so we do have some microbial growth in the basin. The primary area that we've seen it is on top of the fuel racks. It is vacuumed periodically, determined on an as-needed basis, and so we do do periodic sampling of that when needed.

Through the Corrosion Monitoring Program, there is corrosion coupons. I believe I talked about that a little bit earlier. So, we do have some corrosion coupons that are made of aluminum and stainless steel to help … to allow us to monitor the potential corrosion in the basin. We use these corrosion coupons. They are sent to SRNL periodically to determine microbial activity, and through the corrosion monitoring with the coupons and the sampling, we have shown that corrosion is kept to a minimum in the basin. So, I'm going to turn it over to Kiran to talk a little bit about how we … more of that corrosion monitoring.

KARANTH: So the AMCAP, you may have heard of this term as part of corrosion monitoring, the AMCAP is … the acronym stands for Augmented Monitoring and Condition Assessment Program. So what it does is monitors and verifies the condition of materials required for successful long-term storage. So, basically, in essence, this was around in 2011 when they realized that the storage is going to go beyond 2020. They kind of came up with this program to kind of assess the overall condition of the fuel management program. So, basically, as the name suggests, it is an augmentation to the existing programs. Like we talked about, like Alexis mentioned about the Basin Chemistry Program and the Corrosion Monitoring Program, and also, the other thing is about the Structural Integrity Program, where we look at structure systems and components for various cracks and structural integrity issues.

So as part of that analysis, what we did is L-basin concrete structure of the disassembly basin itself to see how it is holding up. So as part of that exercise, when we were grouting the C-basin, so what they did is the area closure project took a grouting sample of the C-basin to kind of see what it tells us. And then the sample was sent to SRNL for chemical and crushing test analysis. And what they found out from that testing is that the whole concrete is as good as new. So they did not find any issues at all in that. So on the other hand, from the AMCAP realm, we look at the structure.

The second thing we are looking at is the aluminum clad bundles. So if you … so from the tool from yesterday, you notice that these fuel assemblies are stored in an aluminum bundle, 5-inch aluminum bundle. So aluminum clad is similar material. So what we did is we took out the … took out these fuel assemblies stored in aluminum bundle in machine basin. We have an inspection table set up, and we did a detailed inspection of those. And we also have a data point from … before receiving these fuels from the research reactors where they came from. You got two data points to compare. And with respect to non-aluminum clad fuel, so that is going to be stored in an aluminum container and then predominantly, like James talked about, stainless steel clad or zirconium clad or Hastelloy clad. So there is going to be dissimilar materials in contact, which is going to enable some sort of a galvanic coupling going, and this is going to accelerate the corrosion process. So we were kind of looking at that as … from a perspective of container integrity itself. The way they are stored today is the container is in good shape. So we started looking at that.

So the basic inspection criteria there was visual inspection of the container from outside, from the top, from the bottom. You see some of the pictures there. And then also, you saw the bundles have these holes at the top, and we did a boroscopic inspection of … through the through hole to see what activity is going on in the inside wall of the container. Okay? This inspection was done, I think, in 2022, '23. So what we learned … we did … when we did the inspection, we did some of the canned fuel as well as direct-bundled fuel. So this … the pictures that you see here is the … is an example of the ERR, Elk River Reactor fuel stored in a GP tube as a general purpose tube bundle. So what do you see there? There is some general corrosion which we see, some microbial growth in the picture in the middle from the left, second picture in the middle. But other than that, we don't see a whole lot of, like, striking issues from the whole thing. So in essence, and also what we are doing with this is, this is not one and done. So we continue to monitor this AMCAP program. The way we operate this is, one year we look at the corrosion coupon, the next year we look at the AMCAP inspection. So for the next follow-up for the AMCAP is going to be oversize cans and look at the oversize can containers and its integrity and look at the … and do the internals of the EBWR fuel assembly. So what I want to kind of like state in conclusion, and before we get to the conclusion of the AMCAP, so these fuel assemblies, we have chosen for inspection. They're not … they were chosen based on a risk grading process. So they're not like the … we already have an indication that they are not in their best state to begin with. So we are attacking or looking at those containers which we suspect that there could be some potential issues. So we are looking at those to make sure that … and so these, so far we have not found anything problematic. So looking at the corrosion coupons and so far what we have done on AMCAP, so I think we are comfortable to come out and say that the safe storage in L-Basin can go on for a couple of decades. Okay?

With that said, let me move on to the other mission in L-Area, which is the offsite fuel receipts. So the offsite fuel receipts has two components. One is from the foreign research reactors and the other one is from the domestic. So at the foreign research reactor, all fuels which we receive are aluminum clad only. There is no non-aluminum clad fuel that can be brought into SRS. So initially, the FRR program, this is a NNSA NA-23 mission. So, their mission was supposed to end in 2019. A 10-year extension was given because of the earthquake in Japan. And there were certain countries, Israel and Italy, they did not return the material in time to comply, so they were given an extension.

So to address one of the earlier questions, we predominantly receive from Japan. Japan has two reactor facilities, JMTR, Japan Material Testing Reactor, and JRR3, Japan Research Reactor Number 3. So Japan Research Reactor Number 3 is still operating. JMTR has been shut down, and we continue to receive the fuel until 2029. Israel is still operating. We expect to receive it next year if the war situation becomes better. Again, I don't want to go into the detail, but this is what you see here, and these are all subject to change because of various things … geopolitics in play. So basically what we have done is the … for the ABD baseline, all this material has already been incorporated in the systems plan. Okay?

The next one we talk about is the domestic research reactors. So there are four or five of the predominant players here. We support the life cycle of nation's neutron production. That's the fundamental science, and neutron production is what's going on here. So HFIR is the Office of Science mission, whereas MIT, MURR, and Rhode Island, they're all NE projects, and NIST is a Department of Commerce mission. So if you look at this, it just gives you a 10-year snapshot of our receipts. Typically we receive about 12 HFIR cores, and then three MURR shipments, one or two depending upon how MIT is being run, and then we receive from Rhode Island once in six to eight years, depending upon the burn-up. So for the Systems Plan, which James earlier talked about, we have considered receipts until 2032, okay? And then there is a LEU conversion going on, and there are certain unknowns about where those fuel will go, but for the ABD baseline planning, we have considered receipts until 2032.

So the next slide shows you a general overview of, at the top, talks about cores and fuel assemblies. So if you look at the HFIR, we have been continuously receiving from Oak Ridge since 2018 at a rate of 12 a year. So we have removed so much already that they are not producing at a faster rate for us to receive. And James talked about it, there is a two-year cooling required before that spent fuel can go into the cask, so before it can come to SRS. Whereas MIT and MURR, they are continuously running reactors, they have a six-month cooling period before it can go on a cask and come to SRS. So the problem … one of the key issue here is with MIT and MURR, they will get to a MAR limit on their NRC license if we don't receive it. That's an underlining factor, because we have … that's how we are helping them to keep the production of neutrons going. At the bottom, you see all the foreign research reactor assemblies, predominantly from JMTR and JRR, and if you come further down, you see the number of bundles we are creating from the assemblies we are receiving.

And the next slide talks about the casks that we are receiving, the total inbound casks in L-Area. Just to give you a snapshot about that in the planning of ABD, so you saw the slide from James's presentation on how the … how the H-Canyon material processing going on, and it kind of transposes back to how many casks do we expect to see in L-Area? So in order for ABD transition, we will be looking at higher fuel handling, and we will have to do some repackaging for non-aluminum campaigns, as well as an increased level of crane operations. And one of the questions from yesterday is, what is your single point failure? When we are doing these operations at a higher pace, there are some bottlenecks we will hit. And the 70-ton cask loading to … loading for H-Canyon shipment, along with Mark-18 for SRNL, that kind of becomes at, like, at an increased rate.

So if you look at this, after 2028, we ramp up to, like, close to 50 casks a year, more than 50 casks a year. That's like every week we are rolling out casks. It becomes like, it's an increased level of ramp up on cask handling.

So what are we doing? What additional capabilities we are adding to support ABD mission? So some of you, as we pointed out yesterday, emergency basin and the way emergency basin is structured, it has a 17-foot ledge and a 30-foot ledge. So we have identified this area for the installation of the rebundling capability in L-Basin. So the plan is to use 17-foot ledge for rebundling activities and the 30-foot ledge for storage of the fuel after or before rebundling. So I want to kind of take a minute and talk about a little bit here is, we are going with a graded approach here, is that we are going to start with basic rebundling with a criticality level isolation in the sense that we are going to isolate the emergency basin with criticality controls while the fuel receipts in L-Basin can continue to happen. And you create an island inside an island, right? So that way the activity can go on without affecting the fuel handling activities that is taking place. As we go along on the non-aluminum campaigns, we will need basin isolation because the risk of contamination when we open failed fuel, those things will happen. So we'll have to come up with those designs as we go along into out years of ABD. Okay?

So a little more details about the emergency basin capability we have designed so far and yet to be installed. You see on the left, there is like rebundling tables, which is going to come with a tilt table in order to horizontalize and verticalize the fuel containers and there is a bandsaw. So I'll talk a little more detail about that as well as the racks which you see on this view for fuel storage. Okay?

So again, this is the snapshot or a view graph of the tilt table. So the tilt table design is … has the … so we have various types of containers, heights like GP tube or expanded basin storage bundle, L bundle and then oversize can. So this tilt table can handle all those various sizes. So the fundamental function is to horizontalize and verticalize the bundle for unloading or reloading into the bundle. Okay?

And next one is a bandsaw. So the reason for this bandsaw is not to resize the fuel. It is only in case when we are trying to take the bundle lid out from the current configuration, if you are not able to open it, then we are going to use the saw to cut it open. So it has clamps and we have like the rulers there so that in order … to make sure that we are not cutting into the fuel assembly.

The next item is the storage capability in the emergency basin where we are introducing storage. That way we can bring all the fuel that requires rebundling into one place and then isolate from the rest of the basin and continue to package/repackage while the concurrent operations is going on in the rest of the basin. So this is where we are and … excuse me. So criticality analysis and DSA work needs to be done for this to be used.

So in essence, if we go through with ABD, I think James talked about this slide. So I want to kind of just touch base on the storage capacity towards the bottom. So, what … where we will be after ABD. We'll be left with about 968 bundles. Our total capacity is 3,650 and HFIR will be at 53 cores, which is going to be like our maximum storage position is 120. Also keep in mind that Oak Ridge has 105 … they can store 105 at their location as well. So this is where we are going to end up.

In summary, we continue to receive and safely store fuel from offsite. And then we are ramping up for increased transfer to H-Canyon in support of ABD. We're getting ready to do non-aluminum campaign-1. And also we are fabricating these rebundling capability to be installed in emergency basin in order to begin work on rebundling for campaigns-2, 3 and beyond.

So infrastructure upgrade. Some of you kind of like when you walked into L-Basin yesterday, you kind of felt the air conditioning and all that, so that is part of our critical, long-term critical infrastructure plan. We are going through all that and making sure like you heard the 70-year old infrastructure, we are diligently working on keeping the infrastructure going.

And also adaptability is one of the things that I want to touch upon. Supporting Mark-18A isotope recovery, we are supporting SRNL in this. We are shipping Mark-18A targets. We have 65 of them in the basin. It is also helping us ABD, the de-inventory, the basin out of the 65 targets. And also SRNL is kind of leading the effort on a demo to do the HFIR drying. So we are kind of in the beginning stages of the … our involvement with this. And I also want to mention one thing about SRNL's effort is the design of emergency basin rebundling capability is being designed by SRNL and they're fabricating this infrastructure as well. So future mission also is to kind of like look at plans to stabilize the heavy water, the moderator which we store in L-Basin and also the availability of infrastructure for new missions. That's it.

SIU: Okay. Thank you for a lightning presentation. We're open for questions now.

PEDDICORD: Lee Peddicord from the Board. Just a couple of things on the microbial growth. If I remember correctly, the … it was observed as taking place on the … mostly on the racks and not the containers. Do you have any idea why that was? It was because of the different materials or why preferential to the racks?

SCHUCHMANN: As far as why they were formed, we're not sure why. Really what we can confirm is that they're not causing corrosion damage. It would be … the biggest indicator would be through our metals analysis, if we had an increased concentration of something like aluminum in the basin, then that would mean like a breakdown of potential fuel racks and stuff like that. And we really haven't seen anything like that. The corrosion coupons is coming back with minimal corrosion. So to answer your question as to why they're forming there, we don't have a solid answer as to why they're there. We just know that they're not causing any significant issues.

PEDDICORD: Okay, thank you. Then another question relating to the EBWR fuel, which is getting on to 60 years old now. And what

I was wondering about, has that, over its entire lifetime, been stored underwater or were there periods when it was in dry storage? I'm trying to help out Paul Murray over here with the idea that he's doing the high burnup demonstration, looking at, you know, the higher burnup in fuel. But here you got something … boiling water reactor fuel, Zircaloy 2 probably clad, I'm guessing. And again, now some of the oldest fuel we have in the country in some ways.

SCHUCHMANN: Yeah.

PEDDICORD: And if any of that was in dry storage for a while before it came to L-Basin, anything you can learn from that in terms of the viability of this very long-term storage of more characteristic normal fuel or more characteristic fuel that makes up a lot of the inventory?

KARANTH: So to be very quick on the answer, I'll let Dave Rose or somebody else comment on this, but I think as long as I've seen … so this EBWR fuel initially stored in a place called RBOF. So RBOF was our initial primary storage basin. And in

2002, they closed RBOF and moved everything to L-Basin. So RBOF was all wet storage.

PEDDICORD: Wet storage.

KARANTH: And L-Area is all wet storage. So I'm very certain that these fuel, when it came out of … it always stayed wet storage.

PEDDICORD: Okay. Okay. Okay. I'm afraid we are unable to help out Mr. Murray then with this exercise. Thank you.

WOODS: This is Brian Woods with the Board. I do have a question. So, you know, thank you for the update on the augmented monitoring program. I'm … I am curious though, as you think about infrastructure upgrades, as you can think about this ABD ramping up. And of course, some of the items you mentioned at the end about adaptability, do you foresee any changes at all to your augmented monitoring program or do you have a pretty good handle that the current program as it is, should probably take care of when you would anticipate any changes going forward for this?

KARANTH: So it's a great question. And the timing of this question is also extremely well-timed, I would say that, because … so we talked about this like two weeks back and see, okay, we need to meet as a group and come up with a strategy for future years. What is our future plan for AMCAP? And what are we going to look at? So initially we have at least a near time horizon of looking at oversize cans and the EBWR fuel. Other than that, like we need to come up with a roadmap as to … as this program goes on and we are going to leave bundles at the end of ABD. So we need to kind of modify our plan or plan of AMCAP to kind of suit that, okay, what are we going to leave? And can we look at that and see … get data points as we go along? So that meeting is going to happen sometime within the next two weeks. And then we're going to come up with a plan as to how do we go about implementing that plan.

WOODS: Okay, thank you.

LESLIE: Bret Leslie, Board staff. Thank you for a very nice presentation, but I'll ask one acronym question. What's RBOF?

KARANTH: RBOF is Receiving Basin for Offsite Fuel.

LESLIE: Thank you. Now for the real question, and it might require both James and you to answer. It's because I'm seeing his figure of risk and the grouping of fuel and you were talking about the … getting all the fuel in isolation. That's like 200 assemblies? Did I miss that? Or …

KARANTH: So the way we are doing it is in a very … if you saw those circles in James's presentation, all right? So we are going to attack it at one … at a point, like if we are going to take it like one slice, one slice at a time. So there are certain … so one of the major … so you might ask the question, why rebundle, right? The question is like, why do we do all this? So the … one of the factors driving us is efficient dissolution of the Canyon. The Canyon is the scarce resource which we have. So we got to get the … get to Canyon at a stage that they can dissolve it efficiently. And some of these non-aluminum clad fuel, they were … so the MTR aluminum clad material testing reactor fuel which we receive, they are really like run the proper way. But these non-aluminum clad fuel, they were tested for failure, and they were cut, and there is all kinds of various testing that was done in the '60s, '70s, '80s.

So it is … to be very honest with you, that the thing is, every fuel type is a challenge, like Zr-2 or stainless steel clad or the container inside container. So we had to like do that in a very graded approach where I said graded approach, is that so we're going to bring in next, so campaign-2. So we look at campaign-2 and what is the 35 container? I'm just going to focus on 35 containers, come up with a plan, implement the plan. While the plan is being implemented, we look at the next set of 35 containers for campaign-3. So that's our kind of approach. And then what we are trying to do, James, correct me if I'm wrong, so where we are going with this, complicated fuel assemblies like the canned and failed fuel which is inside cans, we're just going to park it aside, not worry about it. We go, what is the … you saw a slide chart about L-Area complexity, H-area complexity. We're going to try to see the easy wins, as we say, so that way we can get those out of the basin while we have canyon available.

LESLIE: Thank you.

THERRELL: Can we just to expand on that? Is it going? James Therrell again, EMO. Just to expand on that, we're also working a few opportunities to try to minimize the amount of cans that would need to run through isolation. So, for instance, again, too much detail, but we've done a … I call a surgical modification of our dissolver, our electrolytic dissolver to accept a little larger can. The cans were just slightly oversized for our dissolver, so if we had to pop into those cans and remove inner containers, we knew that was a little bit risky to do outside of isolation. If we can fit … now fit those cans in with some of the late innovation that has just occurred within the last few months, we potentially could put that whole can in the dissolver and not have to go into it. So, we're working efforts to try to minimize the amount of handling in L-Basin. And so, there's actually … it's very … things would have to fall very much so butter side up, but we have another potential with that chemical flow sheet that I had mentioned for groups 4 and 5. That could potentially take the bundles as is, because it's a chemical dissolution flow sheet and our chemical dissolvers can accept a larger bundle. So, it's very low probability, but we have our eye on, can we get out of isolation altogether potentially? I don't think that … I don’t think we'll get there, but that's our aim.

LESLIE: Bret Leslie, Board staff, follow up question. So, we heard about the flow sheets for the actual processing and my original question is, I'm trying to see how handling in the L-Basin is really integrated with going down. So, you kind of have something similar to what James has, like in each of the years out, we'll have to do this. We'll need to do that.

KARANTH: Right. So, to kind of expand upon that a little bit is that the System Plan is kind of the Holy Grail for us, right? So, from there, we are coming back. Okay, if he wants to process 2029, this material A, so what do I do in 2024? So, that's what our schedules and our effort is lined up with that. That's what we are working towards. It's not only the designing of new containers, designing of new processes, procedures, cask … even though if we have a cask, the paperwork that is needed to authorize moving that material in the new … in the cask, in that configuration, that has to be analyzed and authorized as well. So, there is all this work which is happening in the back end for some work which is happening in out years. So, that's all in the schedule based on the System Plan.

THERRELL: James Therrell, EMO. We're … as Kiran talked about, we were putting in the initial capability, the rebundling, knowing that we could bolt on capabilities as we go further into the System Plan and actually learn more about how we'll disposition some of the materials, because we might modify our approach a little bit. So, stepping into it, we know we need re-bundling capability. Some of these items need to be re-bundled just because the volume of the fuel inside is too much. Once you dissolve the cladding, the fuel would overflow the basket that's in the dissolver. So, we just need to basically separate out some of the fuel pins, and that's a lower risk operation that's not going to contaminate the basin, but it's handling that we don't want to do outside isolation. So, do you necessarily need deionizing capability? So, as we get into the system plan and we learn more about the flow sheets that we're going to have in the out years, we can bolt on those capabilities and tailor it. But that first step that we're doing with the rebundling, we definitely need that part.

SIU: Any other questions for our speaker? Hearing none, thank you very much.

KARANTH: Thank you so much.

[Applause]

SIU: Okay. We're nicely ahead of schedule. Next talk, Steve Vitto, Anna d'Entremont, and Xian-kui Zhu.

VITTO: Okay, good afternoon. My name is Steve Vitto. I am a … currently a spent nuclear fuel program manager with DOE-EM headquarters, and also with the Office of Nuclear Materials. So, today I'm going to talk about the management alternatives at Savannah River Site.

So, you just heard our current mission and status regarding ABD and L-Basin. So, my job today is just to tie those together, right? So, we heard about what we're currently doing, what we envision in the future, near term, and then post-ABD is what I'm going to try and paint a picture for you. As you heard earlier with the question, a lot of this information is pre-decisional. We haven't made decisions on it. So, just trying to give you a flavor for what we're currently in process of doing, and a lot is still needed to be worked on and done in order to finalize these decisions. So, yeah, so I'm just going to give a high-level overview of our current strategy and work to assist us to make that eventual decision, and then afterwards, my colleagues at Savannah River National Lab will go into ongoing research associated with the dry storage project and the flaw tolerance of DOE standard canister work, which is going to help us to help our perspectives in disposition pathways going forward.

So, some of this information is more higher level than what you just received, so I'll go through it pretty quickly, but just want to stress a couple points here. L-Basin does provide safe and secure storage until future disposition strategies are identified, and then what's been said before is additional capabilities will be needed, and we understand that at Savannah River Site, depending on the future decisions, by the department as it relates to packaging and/or processing any of the spent nuclear fuel.

So, I'm not going to spend too much time here. You got more detail than I have here with Kiran and James. Just reiterate what we expect post-ABD, right? We talked about current generation and what's legacy. Post-ABD, we expect, you know, anything that's left over, especially focusing on the non-aluminum that you just heard about, and then also what Kiran just mentioned as well, foreign research reactor returns, anything that comes post-ABD that's not currently in the baseline, and then domestic research reactor returns that we do expect to continually generate since their missions will go further than 2035 timeframe, things like that. So, that's what we expect, and those are our current main generators anyways, so we currently receive that fuel on a regular.

So, futures … efforts that we have been … our ongoing efforts that we've recently done in … last year. We put together a multi-program DOE working group that was focused on initial assessment of DOE capabilities to manage future spent nuclear fuel. So, the goal was to provide assessment on the needs related to receipt, packaging, interim storage of future spent nuclear fuel. We were also tasked with laying the framework for describing this integrated approach to management of the projected inventories. So, the report … internal report was laid out into some key observations and recommendations. These are just some of those, and they're tailored towards Savannah River

Site, but there are some other recommendations and observations that went into this.

So, I just want to highlight a couple here, and they're not going to be surprising, a lot you've already heard. So, the team main observation was that there is adequate storage capacity to manage that spent nuclear fuel inventories for the next 25 to 30 years. So, with that being said, there are some programmatic policies and agreements that do constrain our use … efficient use of the facilities. They've been mentioned today, the ISA, things like that, Idaho. The … So, using or weaving our way and finding a path forward with those agreements is what we need to do when we plan our path forward. And then again, you've heard this as well. You know, however, we do have adequate interim storage, our facilities are aging, so how long are they going to last, things like that. What is our viable storage infrastructure and how long do we expect that to be in existence? So, another item, so a need currently exists to adequately and consistently fund focused research to management of the challenging spent nuclear fuel that you've been hearing about. For example, the dry storage of aluminum and then conditioning heavily degraded spent nuclear fuel and other technology needs as well.

And then just hitting on some of the recommendations from the group. So, one of them was to determine a path forward for addressing the near-term storage needs for spent nuclear fuel that would go to Savannah River Site post-accelerated basin de-inventory. And that's directly related to this presentation. So, we're currently trying to develop that framework and develop that path forward as we speak. So, that's why a lot of this information is very high-level since we have not decided on the correct path yet. And then the other ones are also related to the key observations. They're a recommendation associated with each key observation. Support identified technology development requirements. And then also develop a long-term infrastructure management plan. So, this was more of a … the recommendations were divided up into near-term recommendations which was one to five years and then longer term recommendations five to 10 years and out. So, that was more of the start implementing the plan for the infrastructure management and then develop more of the strategy and everything like that up front. And then the plan will come later. So, that was more of a five to 10-year recommendation from the group. And that will help to further develop the integrated strategy associated with the handling of the spent nuclear fuel. And then also including any NEPA updates or anything like that that we may need more time to implement as we develop that path forward.

So, here I just want to talk about some main considerations that are driving our alternatives. So, there was a recognition that disposition strategies associated with some of the more challenging spent nuclear fuel would have to be developed. And we're currently working on those solutions. So for example the establishment of the non-aluminum electrolytic dissolution capability is an example of what we're currently planning to implement in the campaign. So where do we go from that? You know, how do we implement … or after that first initial campaign and follow-on activities? So as you know, the remaining … resulting remaining inventories post-ABD and facility age will have a large impact on our preferred technologies going forward as well. So that depends on if we can implement something that may use our existing facilities or if we need to develop a new capability that would be separate from any facilities that we currently have. So that time frame is very important when we consider a path forward. Okay.

So there's only a couple main options that we have, right? So there's … we process the material, we wet store it like in its current configuration, or we can package and dry store it, right? So the next slide after this one I'll talk more about the technologies that will be more in the processing. So you only have a couple of high-level options and then how you implement that option is through that technology, right? So that's where the details … some details of how you're actually going to achieve that end goal. So we do have plans for a feasibility assessment using melt and dilute technology to disposition some of the non-aluminum spent nuclear fuel. So melt and dilute was a disposition method for aluminum spent nuclear fuel that was explored in the 2000 time frames. And the L-Area experimental facility was actually set up prior to discontinuing the project. So the plans for assessing the viability of that approach are in the works for next year. And then so the theory behind the melt and dilute was that it was … you would melt the aluminum-based fuel and then put them into DOE standard canisters was the eventual disposal mechanism. So trying to understand, you know, how that would be applied for non-aluminum or the more challenging materials is what that is going to accomplish. And then the other options which we already mentioned, you know, continuous storage in L-Basin and then dry storage is always an option as it comes to it.

So here I just want to highlight some of the alternatives that have been considered in the past and that will be considered in our eventual evaluations. Just want to highlight really one item here. It's the one in the center, the mobile melt and consolidate work. So SRNL is supporting NNSA by leading a collaboration with Norway to eliminate highly-enriched uranium using SRNL developed mobile melt and consolidate technology. So that's a good example of something that maybe we could have as an option for our post-ABD activities. If we already have some in-house knowledge of setting up a, you know, modular capability like that, can we apply that to our existing facilities or somewhere in our facilities to accomplish what we need? And then just some examples of other technologies that have been considered in the past and that we will evaluate and use all the information we have. I'm not going to go into too much detail here, though.

So some paths forward. So we have an opportunity to pursue and conduct a pilot scale, a demonstration that would leverage Savannah River Site infrastructure if, you know, if we're able to do that and apply a modular concept to address these inventories. So in order to do that, we have to prioritize the expected inventories moving forward because that's going to be the basis for the technology. If we know what we’re going to … the priority for the items that are post-ABD, those are the items that we're going to apply the technology to go and handle. So we're going to apply similar criteria that's been in the past. You know, the current mission need at the time, regulatory compliance, safeguards and security. You know, can we make this material less attractive in a different form for long-term storage based on the final form, things like that. Maturity of technology is always important. Ability to execute, right? So … and then ability to meet production rates and stakeholder considerations are just a couple items that we consider for criteria for technology decisions. And then also we go through our normal analysis of alternatives approach as well.

So some near-term efforts. So, yeah, we're not going to reinvent the wheel. We're going to use past efforts that we've already done and inform our road mapping approach. So we're going to try and use a road mapping approach and then also an options analysis that will help us to set stops where we can make decisions along the way so we have a set path of handling these materials. So we're going to lay out the scope and end state in the coming months and then assess the feasibility of a pilot-scale demonstration to address this material. And then also lay out what to expect and additional actions for implementing such as NEPA or anything like that. So we'll lay out that path forward for eventual investigation later on.

And then we hope to have some follow-on actions where hopefully this pilot study is eventually, you know, successful. You know, it might go into a formal mission needs statement where we continue down the path of addressing either EM needs or departmental needs to complete the ABD scope of the material.

We're also going to explore if we could develop a strategy for a suite of modular technologies as well. So can we use one modular that would be specific for a certain type of material and then expand upon that in an, you know, an effective approach that allows us to address multiple mission needs over, you know, the course of many years and trying to make sure that we're focused on EM's needs but also other DOE program needs as well. Oh, so one other thing I wanted to mention here as well. So we envision a collaboration with the Spent Nuclear Fuel Working Group where we have a bunch of tasks that we would be implementing. So Jomaries mentioned NEPA compliance tasking. Also in the infrastructure planning would be an example of things that we're currently doing that would eventually, you know, fall in line with our planning for this pilot-scale modular capability. I'm sorry. I want to go back. There we go.

So, we wanted to hit on the infrastructure strategy. You know, this is important and a long-term goal of ours. We want to be proactively invested in infrastructure to meet the mission and it directly applies to, you know, pilot scale technology and what infrastructure we would need to implement that as well. So it's a phased approach for … to be proactive moving forward. So we want to lay out the best way to accomplish the evolving technologies as well and maintain alignment with our strategic framework to placing the material into a road-ready dry storage configuration …if need be.

So some future considerations. So we anticipate the need for future technology and infrastructure development. We're at the verification and validation step of a lot of tech development that you heard earlier today. So … and that's an essential step to lay the way for the path forward. And then additionally, you know, to maintain and enhance the safety and efficiency of spent fuel management and then implement capabilities and technology at Idaho National Lab and Savannah River National Lab for long-term storage solutions. And then the next presentations will focus on work led by Savannah River National Lab, which include a focus on aluminum dry storage pilot and then also DOE standard canister packaging and storage implementation. So thank you and I'll give it to Anna.

D’ENTREMONT: Hi, I'm Anna d’Entremont from Savannah River National Lab. I'll be talking about our aluminum-clad spent nuclear fuel dry storage pilot. This is part of the collaboration with INL that Elmar spoke about earlier today.

So that is development of a technical basis for dry storage of aluminum-clad spent nuclear fuel. And one of the key challenges we are facing is making sure that we are adequately dealing with the chemically bound water in the form of aluminum oxyhydroxide on the cladding surface. And with the … those being prone to release hydrogen gas through radiolysis. So as Elmar briefly covered, both INL and SRNL have conducted a variety of experiments to investigate that. INL has also conducted modeling. And so far, our results point to this being safe for extended dry storage in both the sealed and vented configurations.

The pilot is for our next step of a full-scale monitored pilot canister for verification and validation purposes. So this pilot will allow us to demonstrate the canister loading, handling and drying processes at full canister scale with actual spent nuclear fuel. And to monitor the internal conditions over a storage period in order to validate our models and understanding of the behavior.

So the basic concept for the pilot is that we will have two DOE standard canisters of the 18-inch outer diameter and 10-foot long configuration. Each canister will be loaded with three HFIR inner fuel elements. So this will be actual spent nuclear fuel. And we will be using the basket geometry that has been proposed for the HFIR cores, which you can see a simple schematic in the top right here. It basically just keeps the fuel centered in the canister. But this will not … we will not be incorporating any sort of neutron absorbers in the pilot basket. We will be using an instrumented lid approach to monitor the internal conditions. We'll be monitoring some temperatures at inner … internal locations to the canister and also sampling the gas space. And we will also be using a bolted flange lid that will allow us to retrieve the fuel after the pilot. The plan is to do a dry-to-dry transfer from a transport cask. So this fuel will be coming to us directly from Oak Ridge National Lab. And it will be … the plan is to transfer it directly from the GE2000 transport cask into the pilot canisters without ever immersing it in the basin in between. We intend to apply two … oh, sorry. We intend to apply two commercial drying processes, one to each canister. Those being vacuum drying and forced helium dehydration, which involves flowing heated helium through the canister. Our initial planning for this, we said we would design this for monitoring for up to five years. The current hope is that we will be able to collect sufficient data within the first couple … first year or two. But we will be temper … measuring the temperature and the gas composition, as I mentioned. And this pilot will be sited in Savannah River Site L-Area. A location has already been selected there.

So I want to briefly go over the motivations behind those … looking at those two different drying processes. So earlier in our laboratory scale testing, we did some small scale drying tests using thermogravimetric analysis on coupons. And we were seeing that to dehydrate bayerite, which is the … one of the aluminum trihydroxides, we needed to get it up to about 220 degrees Celsius. So this is the lower threshold that we expect to need to reach to remove any of that chemically bound water from the oxyhydroxides.

INL led some engineering-scale drying tests, which Elmar mentioned briefly earlier. And they tested both vacuum drying and forced helium dehydration on a roughly one-third height canister mockup that was loaded with mockup fuel elements. And so they found that both methods removed free water successfully, which was not surprising for established drying methods. But interestingly for our purposes, they found that the forced helium drying could bring the fuel up to … the mockup fuel to at least 220 degrees Celsius, while the vacuum drying did not.

So in this plot on the right, the x-axis is the maximum temperature reached by that mockup fuel. And the y-axis is a metric for the amount of water removed during drying relative to what could be removed from a control sample during TGA up to 600 degrees Celsius. So on the x-axis, you can see that the forced helium drying results are all clustered near the high temperature range, about 200 degrees and up. The vacuum drying topped out at about 120 degrees Celsius, well below that threshold for decomposing the oxyhydroxides. This test did include a internal heater in one of the mockup fuel assemblies to simulate the decay heat. And even with that simulated decay heat, they still weren't seeing high temp … really high temperatures during the vacuum drying.

They also saw a very sharp increase in the amount of water removed during the drying process at the 220 degree threshold. You can see I've got the line marked on the plot, and there is a very sharp jump in that drying mass loss. And so that it …

that's why we want to see both the forced helium drying and the vacuum drying, to see how much impact that has on the hydrogen observed during the pilot.

For context, the estimated water, we did some estimates of the residual water we'd expect to see in the pilot canister after a drying process. I … We estimated that the undried oxyhydroxide, based on the oxide seen on an actual HFIR inner fuel element during post-irradiation examination, would correspond to about 35 moles of chemically bound water on the surface of the fuel. If that was completely dehydrated to boehmite, removing two-thirds of the water from any trihydroxides, that was estimated to be reduced to about 20 moles of water. For comparison, the other estimated water in the canister for physisorbed water and for water vapor at the … based on the dryness criteria for the drying methods, that was estimated to be about … less than about a tenth of a mole. So it is overwhelmingly dominated by the oxyhydroxides.

The other thing I want to go over is the sort of lab-scale precursor to our pilot testing, which is our mini-canister radiolysis testing. The idea here was we took small stainless steel vacuum vessels. So these are about three inches in diameter and seven inches tall. The lid has a valve sampling line through it so that we can pull small samples of the gas from this canister. This is loaded with a sample subjected to any drying processes we want to apply before irradiation, backfilled with helium, and then the entire canister goes into a cobalt-60 gamma irradiator.

So we've tested these using both high surface area aluminum surrogate assemblies, which you can see on the bottom left. And we also have done one test with an actual cropping from a spent fuel element. This does not contain any fuel meat itself, but does have the oxyhydroxides formed during its surface life.

So, on the right you can see the kind of data we get from this. This is essentially the same approach we want to use for sampling the gas in the pilot. So we get a nice yield curve of the hydrogen … cumulative hydrogen generation as a function of the dose. We have tried several different drying approaches to these mini-canisters. And so one of the things to note here is the very large impact of the heated drying processes, the blue squares are for a canister that was nominally undried. The sample was air dried, but there were no extended vacuum steps and no heated drying.

By contrast, the red and yellow data points are for a heated drying step applied at either 150 or 220 degrees Celsius. And you can see there was a dramatic drop in the hydrogen generation as a result of that drying. Early on at the low dose end of this plot, you can also see some green data points that were for only an extended vacuum step with no heating. And you can see that was tracking pretty much with the air dried sample with much higher generation rate than the heated drying.

So for the pilot implementation, we're currently in the process of doing various safety planning and documentation steps. That includes evaluations of potential flammability, shielding requirements, et cetera, as well as plans for things like the specifics of the drying procedure and plans for emergency retrieval. The component designs for our equipment are going to be finalized with the help of a commercial vendor. That would include details of the dry-to-dry transfer system to go from the transport cask to the DOE standard canister. The overpacks to be used for shielding during the pilot and spacers to go between the fuel elements and the standard canister modifications, specifically the bolted flange and the instrumented lid to allow us to monitor the interior conditions. That has been developed conceptually, but we need to refine the details.

We plan to do pre- and post-storage visual examination with the help of a camera in the transfer system to see if there are any visual impacts on the oxyhydroxide. And it has been proposed that we use a horizontal storage configuration which will be very helpful for particularly the forced helium drying, since that requires both an inlet and an outlet for the gas to flow through the canister. And the DOE standard canister has its inlet port in the center of the lid and an optional second port on the center of the base. We are planning to do two sets of dry runs that will use dummy fuel elements and these will allow us to verify the function of all of the equipment and also do training of SRS personnel prior to handling the actual fuel.

So, this is a basic road map for various steps in this pilot process. We have already completed the pre-conceptual and conceptual design stages that are over at the … on the far left. Those were documented in reports. This year we have been coordinating with facilities and operations. And we have been also working towards getting a contract with a vendor to complete those detailed designs and eventual fabrication. Once that is in place, we can move on to finalizing the component designs. And the current timeline has the actual loading process happening somewhere in the fiscal year 27 timeframe.

So in conclusion, dry storage is a potential path for future ASNF receipts or potentially for SNF remaining in L-Basin after the closure of H-Canyon. The pilot will provide verification and validation of drying and dry storage performance and of the models that were developed using the laboratory scale data. This pilot will establish SRS capability in dry-to-dry transfers which are potentially applicable to future SNF receipts so that we don't have to put fuel in the basin if it is destined for dry storage. And it will also establish capability in use of the vacuum drying and forced helium drying processes at SRS which would be applicable to either dry-to-dry transfers or to wet stored fuel that is moving to dry storage. And that is all that I have. So Xian-kui will be up next.

ZHU: Good afternoon. My name is … Okay. Okay. My name is Xian-kui Zhu of Savannah River National Laboratory. The co-author of this work is Bob Sindelar. He is here. Bob is my technical supervisor at Savannah River. I'm going to talk about flaw tolerance of DOE spent nuclear fuel storage canister. This is a current EMDT project.

And as you may know, the DOE standard SNF storage canister is designed especially for DOE spent nuclear fuel storage for a wide range of DOE spent nuclear fuel in different design and conditions. DOE canisters are significantly different from the commercial multipurpose canisters or MPC in size. Specifically, the MPC canisters are very large. Typically, the diameter is 68-inch, wall thickness of 0.5 [inches] and the height is about 16 feet.

Compared to that, the DOE canisters are small with a diameter of only 18 or 24-inch. And the wall thickness for OD 18-inch is 0.375 inch. For the larger diameter, 24-inch, the wall thickness is 0.5 inches. And then the length, 10 feet or 15 feet. So, compilation result is four standard design.

The figure on the left is a schematic illustration of DOE standard canister. And then the structure evaluation of the DOE canister, we compare to the commercial MPC canisters. The structure evaluation, of course, include the flaw tolerance have been performed extensively for the MPC or commercial canisters. The commercial canisters typically have four axial welds and one central cross weld or circumferential weld and the two closing welds. And this weld is susceptible to chloride-induced stress corrosion, that’s the CISCC or simply called SCC problems. And then the flaw instability and the result have been extensively published in the literature. You can find the result easily in the public domain.

And the structure evaluation was also performed for DOE standard canister. And the DOE has sponsored the structure integrity study to evaluate specifically the weld integrity using the drop test or the finite element analysis called FEA simulations. And most of the studies was done at the Idaho National Laboratory. And then the figure at the right is one of the real canisters at the Idaho National Laboratory, maybe made for drop test.

So, the DOE canister typically has one axial weld and two closing cross weld possible. And there are no rigorous flaw tolerance analysis for the DOE standard canister so far. And the flaw tolerance analysis will ensure the robust DOE standard canister for handling, storage, disposal of the spent nuclear fuels.

So, the proposed technology is using the fracture mechanics technology. We will adopt the API 579. API means American Petroleum Institute. There's a standard especially for oil gas pipeline industry and the pressure vessel as well. So, to estimate the residual stress distribution for longitudinal or circumferential welds and use [API] 579, the called … so-called failure assessment diagram, called FAD, the approach to determine the flaw acceptance criteria and also the critical flaw size at the flaw instability. The FAD assessment approach are similar for both commercial and DOE standard canisters.

The scope of the work is to do a literature study and to develop the technology used for the tolerance assessment. So, we developed a fracture mechanical method to evaluate the flaw tolerance for the DOE canisters and we've developed FAD, the framework, and the flaw acceptance criteria for the work year 1, FY24.

And for the following and next year's work, we will focus on evaluating the crack opening displacement, COD, for a postulated crack in the DOE canister for the safety and the risk evaluations, and that's a typical plan for next year's work.

And the benefits to DOE is to provide advanced technology for reducing risk of the DOE standard canister storage and also provide advanced model for evaluating structure integrity for the DOE standard canisters.

Okay. Let's talk about what the FAD assessment. The assessment we used is from the API 579. This is the figure. You can see there's a curve from the top and the drop down. Typically, they have three zone or region we call using this method. The zone 1 start from the vertical axis of K_r. They're relatively flat top on the assessing the curve. This is called the zone 1. Zone 1 is elastic fracture mechanical control L-Area and then go back to the down zone three. That's the bottom one near the horizontal L_r. That's called plastic control L-Area. Between they are typically called room two is fracture, elastic plastic control fracture mechanics and gradually go to the collapse control.

So within this curve, we can assess any defect in the canister to evaluate if the crack or flaw is stable or not stable. If stable, we may accept. If not, we will not. Typically, if the flaw assessment fall into the inside of the curve, this acceptable region, I will show you in the green word and the outside on several as the red words.

So let's give an example using the FAD assessment. We assume axial outside the surface crack in the axial weld with the hoop region stress and axial crack size, initial is in the 10 millimeter, typically this is because the wall thickness is 12.7, so about 70% of the wall thickness. It's a very critical, very deep crack. And the initial crack length about 30 millimeter per short after, for example, if SCC or other reason the crack grows, they have inside called with the circle from the initial point to the final crack length, the C … of course, this is a half crack length. C equal to 30 millimeter, the assessment point from initial to the last, or we see in the failure assessment curve, so that's mean this curve is stable and reliable, is acceptable. This only for normal loading condition.

If we combine the normal operation condition and the loading condition with residual stress, you can see the final point can actually exit within the failure curve, that point. That point, this half thickness can be 216 millimeters. That's mean in that case, the crack can be failed or instable. However, the API standard permit a crack length maximum is the total is 80 inch or 200 millimeter, half inch, it could be just 100 millimeter. So in this case, the both normal or normal loading or normal loading plus the residual stress are stable. This mean in play … in plan, they will indicate that the flaw is stable and acceptable for both cases conditions. So this work typically shows the current … the DOE standard canisters are safe and reliable for long-term storage. Thank you, thank you for your attention. That's my presentation.

SIU: Okay. We are now open for questions. Question… mic.

BALLINGER: These back … let's go … what did I … an echo here or something? These canisters are designed according to code anyway. That includes dropping on an unyielding surface and all that kind of stuff. And there's an inspection requirement. And so there's no way there's a crack that's initial … that initial flaw size is going to be there. Is that correct?

ZHU: Yeah, this is the design, the condition or objective. But for … and … okay. So, of course, this is the design objectives. We want the canister perfect.

BALLINGER: I mean, it's not an objective, it's a code requirement.

ZHU: Yeah, that's a code requirement. But even for the manufacturer, for weld point site, they're possible for chloride … the stress chloride SCC, and also for the possible existing, the weld defect in somehow include inside the inclusion or some, if we assume such a crack existing, we do some follow standard method to evaluate if this is possible crack failure or not. For our current study show, this is not a concern.

BALLINGER: Okay, so you're thinking that we could get chloride stress corrosion cracking?

ZHU: And not only that, it's possible for weld assembly, weld always have some micro corrosion, defect or inclusion inside. So we just pushed that, this is kind of assumption. To the research, to show the mechanism, how the crack can be stable if gross or not stable. In our case, in this case, all our crack are stable. So don't worry the possible crack failure mechanism. Thank you.

BALLINGER: Okay, I guess back to slide, your slide number, where am I at? Four. On the drying. The drying. Excuse me. Not that one. I don't know what … I'm looking at four on my … yeah, wait a minute, no, no, no, yeah.

D'ENTREMONT: That's too far.

BALLINGER: Drying test, the title of the slide is drying test.

D'ENTREMONT: There we go.

BALLINGER: Okay, if you don't dry it at all, and one of your backup slides shows the amount of water that could be there. If that was all converted to hydrogen and oxygen, what would the pressure be?

D'ENTREMONT: I don't have that number in my head right now. We did … there was a bounding pressure analysis done by INL. That the HFIR was not the configuration they looked at. They looked at an ATR configuration that was deemed to be bounding in terms of the amount of surface area and oxide relative to the gas volume. I don't have the specific pressure in … I'd have to go check it, but they found it was within the limits of … that … for a thick layer of boehmite, full release of that would be within the pressure capabilities of the canister.

BALLINGER: Yeah, that's what I was after. So, no matter what happens …

D'ENTREMONT: Well, that was for boehmite. If it was a layer of bayerite, it would still be within the pressure up to, I think, was it 300 degree … 300 something degrees Celsius. So it appeared that the only risky condition was if you had a very … a thick layer of completely trihydroxide that completely decomposed in order to exceed the pressure rating of the canister.

BALLINGER: Okay, now on the next slide, the next slide. I guess I have a question about whether or not using cobalt-60 is the correct … is the appropriate. Maybe the only one you can use. But that G value is different than it was … if it was for electrons, which is likely to be the dose source from the surface of a cladding to the oxide. So is that non-conservative in some way using cobalt-60?

D’ENTREMONT: That is something I would have to check with my colleagues.

BALLINGER: That's what I'm saying. The dose that we're talking about that generates the gas is right at that interface between the metal and the oxide, right?

D’ENTREMONT: My understanding from the rest of my team was that they expected the radiation at the outer surface of the cladding to be primarily the gamma radiation.

BALLINGER: Okay, I'm just …

D’ENTREMONT: Like I said, I'd have to verify that with someone else, because that's not my area specifically.

BALLINGER: And then on the graph, I was a little slow to pick that up. The hydrogen generated didn't depend on the drying temperature, did it?

D’ENTREMONT: That is what we are seeing for these samples. And that did surprise us because we anticipated … we targeted the 220 degrees intending to dehydrate some of that oxyhydroxide. And we had a characterization sample that was dried alongside the canister that did show some conversion to boehmite. I'm not sure why this keeps jumping around. But yes, in this test, what we were seeing is that it did not seem to be sensitive to the drying temperature between those two, just to the presence of a heated drying step.

BALLINGER: And then another question is, you've done the modeling on this, right?

D’ENTREMONT: INL has done the modeling.

BALLINGER: Well, okay, you meaning the generic you, okay?

D’ENTREMONT: Yes.

BALLINGER: And is there a point … if you were to take the time out, like in your test that you're going to do, by the way, I'm a big fan of heat it and beat it and these kind of tests are good tests. But is there some point at which the production of gas and everything would level off and the pressure would be constant? In theory, there has to be …

D’ENTREMONT: Yes.

BALLINGER: Because in theory, you get rid of all the water.

D’ENTREMONT: Yes, in theory … so we do see, first of all, in our experiments, we consistently see that the highest generation rates are at the very beginning of the test. And over time, it … the generation rate slows to at least some degree. So there's …

BALLINGER: But you also have a consumption side, right? Because hydrogen diffuses through that stuff, right?

D’ENTREMONT: There will also be a consumption of the available hydrogen.

BALLINGER: Well, I mean a loss, not a consumption.

D’ENTREMONT: Okay. That is not something I think that we factored … I … that is not factored into the models, I'm fairly certain. Diffusion of hydrogen through the canister. But what we … what does definitely show up in the models is over time, your dose rate will be decreasing continually due to the decay of the fuel. So both the rollover we see in the experimental radiolysis rates and also the decay of the fuel as the radiation source term will both tend to drive it to much slower generation over time.

BALLINGER: Because I still needed to think about the lower two curves. Because it really says it's not … the hydrogen generator is not dependent on the drying technique, the drying temperature.

D’ENTREMONT: So …

BALLINGER: which means it comes from …where?

D’ENTREMONT: When we saw the relative insensitivity to the temperature here, what we think may be happening is that we think we may be getting a significant contribution from the physisorbed water, which is a much smaller amount … as much smaller contribution to the water available. But we … our data seems to indicate that it breaks down faster when you start irradiating this. So what we think is going on here is that unheated vacuum drying, at least at the durations that we've used, is just less effective at pulling that physisorbed water off than if you heat it up. But for example, in addition to these results, there's also been some work done where they irradiated … where we irradiated coupons that did not have an oxyhydroxide film grown on them. So they would only have the very thin passivation film of alumina.

BALLINGER: Yeah.

D’ENTREMONT: And we still do see hydrogen generation from those, which we think has to be attributable to the physisorbed water.

BALLINGER: Last question, then I'll stop beating a dead horse. The HFIR fuel, is that the right fuel to start with? Because that's going to be very uniform oxide. It's coming right out of a … everybody knows what the pH was. It's been at a uniform temperature. Is that way different than the stuff that's in the basin?

D’ENTREMONT: So, we have looked at some oxides from fuel that came out of L-Basin. INL has also looked at some from ATR fuel. The items we've looked at in terms of the oxide thickness, I don't …I think were on par or lower than the oxides that have been reported for oxide thicknesses from HFIR fuel elements.

BALLINGER: I'm searching for something that would make your experiment invalid.

D’ENTREMONT: Yeah, I can see you're trying very hard.

BALLINGER: And I haven't found it. I mean, these experiments are really fantastic, but sometimes they cover.

D'ENTREMONT: So the … part of the difficulty is the oxides we have characterized are primarily taken from things like this MURR cropping, because that is what is …has been feasible to pull out of the basin and do characterization on for us. Stuff like this cropping is from the end of the fuel, and so it may not represent the highest oxide loadings. We did go back to …We did a report doing a literature review looking specifically for oxide thickness data. And I tried to look for any data I could find that did basically profiles of the oxide thicknesses along elements to try and get better data for the distribution and the average. That is where the HFIR data that I'm working with came from. They do find that the oxide thicknesses tend to peak near the middle of the plates. From the data I found, it seemed like the HFIR was reasonably representative and one of the reasons we are interested in HFIR is fuel like … like ATR fuel from INL is pre-filmed. They specifically target the boehmite. And we want to make sure we're testing with a fuel that has a significant trihydroxide loading, which HFIR seems to fit the bill for.

Because we want to see the impact of things like this drying method on something that has significant trihydroxides.

BALLINGER: HFIR fuel is going to be shipped dry, right?

D’ENTREMONT: It is. It's a vacuum drying.

BALLINGER: And so it wouldn’t … vacuum dried, and so it would stay dry all the time. If you were going to put this in dry storage, you wouldn't go into the pool. You'd just go directly to dry storage.

D’ENTREMONT: Yeah, that's the intent here. So we do not expect the vacuum drying for the pilot. We expect to be … we're eliminating any moisture that the canister was exposed in the … to the … the canister was exposed to during the loading process. We don't expect there to be a huge impact from the second round of vacuum drying. Where we do potentially expect to see impact is the forced helium dehydration.

BALLINGER: Okay. Thank you. By the way, you used API 579?

ZHU: Yes.

BALLINGER: Not FS1?

ZHU: No, this is same thing, 579 combined with ASME.

BALLINGER: Okay. So, it is the ASME code you're looking at. You're using the ASME code version.

ZHU: ASME.

BALLINGER: Okay.

ZHU: Yeah, API 579 and combined with the ASME FFS-1, you are right.

BALLINGER: I got you.

ZHU: Yeah, the same thing, one code combined.

BALLINGER: Thank you. Thank you.

SIU: Lee?

PEDDICORD: Lee Peddicord for the … from the Board. Question to Steve Vitto. So first of all, I think what you're doing is really important in terms of looking out. You're looking a decade and beyond, and that's really good and something we probably don't do enough of. So what I wanted to ask, though, and you're looking at capabilities we might need in the US government and DOE after this nominal 2034 time frame. So as a background, we're … we seem to be looking at this inflection point for nuclear in the United States, all the things that are coming along. When Paul Murray was here, we talked about the idea of SMRs coming along and stuff like that, a whole bunch of new applications, data centers, non-electric, and so on. You're, of course, looking at the government programs, DOE specifically. But what I want to do is encourage you to kind of open the aperture of the things you're thinking about for the following reason. Not all these utilizations are going to be in the private sector. So we have, for example, the Department of Defense looking at deploying micro-reactors, which are different kind of beasts. They're the heat pipe, cool reactors, and so on. And the Navy knows what to do with spent fuel. The Army and the

Air Force, I think, doesn't. And I'm guessing they aren't thinking about it. So you, although you're leaving the job and going to NE, as I understand, and so your successor in the group, I think this would be a good time to think about how the government, DOE, or maybe in conjunction with DOD, because as I say, I don't think they probably have this capability. Certainly, Savannah River is well positioned. And I don't think it'd be worthwhile to task them to develop the ideas. And I would further speculate they aren't thinking about it yet. So in your group that you're doing this, this is why I would like to encourage you to take this wider look at things down the road, 10 years, 20 years, and so on, and look at a whole variety of different kinds of technology that seems to be … seem to be on the horizons. And how we're collectively, and collectively, I'm thinking US government, not the private sector, are going to deal with these. And it looks to me like your group is probably the only one that might be in a position to think about it. So think more broadly. Think more creatively, innovatively, and … because I think we're going to need your thoughts in laying out a plan in a decade, in two decades, to respond to this. So I guess it's not a question, I'm a professor. I like to give homework assignments. And so your homework assignment, or your successor in your group, is to get busy on this now, because now is the time to start thinking about it.

VITTO: So just to address that, thank you for that comment. One of the recommendations of the Future Receipts Working Group was to directly towards what you're talking about. Right? It was a … later on, it was more of the later stage, right? Implement something five to 10 years when we know what the outlook looks a little bit better, right? There's all these encouraging development of different technologies and things, but nothing's been licensed, nothing's been … so once we hit that stage of, okay, now we see different things coming down the road, I know that might be not too late, but one of the recommendations was to look into advanced reactor fuel types and things like that, in addition to working with NE on the BEMAR group and things like that.

PEDDICORD: OK, wrong answer, because DOD has placed contracts with these vendors, BWXT and Oklo and so on. So it's not waiting for these things to get licensed. Let's get ahead of the game one time in our collective 70 years of using nuclear and think about it beforehand. So that's my admonition.

VITTO: Thank you.

SIU: Thank you, Lee. Bret.

LESLIE: I think we'll be bringing Brian Woods on.

WOODS: All right, thanks, Bret. Brian Woods, Board. My question is for Steve. Steve, you mentioned, you know, the future receipts working group. I guess one of the observations was that there's 25 to 30 year capacity for storage, I believe is what the number was. But you also discussed considering the needs of other DOE programs. When you're going to put your roadmap together, there's been discussion off and on. And I think even in your slides about potential state and local agreements when it comes to storage. So my question is, are there any external drivers? You have this long period of time where you have the storage capacity, but are there any external drivers setting maybe an earlier date for you all to kind of start, you know, the post-ABD processing or finishing the post-ABD process or is it truly really just limited by the ability to store going forward?

VITTO: So currently, I would say that for Savannah River Site, no, there's not any external drivers. We do … we are confident in L-Basin's ability to maintain safe and secure storage. If you're looking at DOE-wide as a whole, there are some drivers with, let's say, Idaho with the current restriction on sending fuel. So the working group was a DOE program-wide effort. So NE had a recommendation for addressing some university reactor fuel needs that are destined to go to Idaho. So they're running into, I think it was mentioned earlier today, some NRC fissile content limits at certain TRIGA reactor sites that are destined to go to Idaho eventually if that, you know, pathway would open up. So we're trying to figure out as a whole, as a department, other avenues to address those issues at the specific universities. So that would be one driver that may not associate with Savannah River, but with Idaho.

WOODS: Okay. Thanks.

SIU: Nathan Siu, Board. this is also for you, Steve. And it's very prosaic. You mentioned the aging infrastructure. Could you just mention some of your top challenges there?

VITTO: So some top challenges. So when I'm talking about that, I'm not talking about maybe at the site level of, you know, specific day-to-day operations on more long-term efforts, right? So our plan for at least in the near-term is to have a tasking with the Savannah Fuel Working Group in order to establish a strategy for how we're going to DOE-wide take this on, a strategy for a plan, and then we're going to try and implement that plan at the sites going forward. So that would influence, you know, any potential … if we have a need for any potential processing needs or anything like larger term projects, things like that, that holistically we can look at. And then we'd also go down to the site level on priorities in certain timeframes is the idea. So no, yeah, don't want to, you know, shortchange the site needs for addressing, you know, infrastructure needs and maintenance on a day-to-day basis, but it'd be a more long-term effort associated with that strategy planning for future.

SIU: Great, thank you. Dan.

OGG: Dan Ogg with the Board staff. Can we go to Steve's slide on mine it says 12, but the title is infrastructure strategy. Yeah.

And Steve, I don't think you spent a lot of time on this, but the last main bullet and the sub-bullet underneath there is where the source of my question comes from.

VITTO: Okay.

OGG: And I'll summarize or even read the bottom sub-bullet just to get the context here. So this is your long-term strategic plan, if you will, for spent fuel. Applies to the spent fuel being packaged at Savannah River Site, at Idaho, at Hanford. And your goal or your strategy here is that the material is packaged in a form that can be readily be placed in configuration that's applicable for transportation requirements and applicable disposal requirements without the need to reopen or repackage. Can you talk about this a little bit more, especially the phrase applicable disposal requirements? Are you or the DOE headquarters, other DOE headquarters folks, looking at those requirements now and applying those to the Idaho packaging project and are you applying the Yucca Mountain disposal waste acceptance criteria or some other criteria or is there something new to be determined?

VITTO: Yeah, I'll do high level and then I think you're going to get it definitely in the next presentation they're going to talk about that, too. So if I don't answer it, or if they want to speak as well. But yeah, what we're referring to is applicable transportation requirements and things like that part 71, 10 CFR 71, 72 for storage and transportation requirements. And then our current planning is we have to plan to something so we plan to what we currently have with the Yucca Mountain waste acceptance system requirements documentation for disposal requirements. And we have a MOU that was with … that's currently with EM and NE when Office of Civilian Radioactive Waste was active, and they have since transitioned over so we have a planning document MOU that establishes that, that's what we will plan to until we have a different requirement too.

OGG: Okay. Maybe I'll save follow-up questions for the next presentation.

VITTO: Yeah, they'll go into it for the … specific for the dry storage project.

OGG: Okay. Thank you.

VITTO: Or excuse me, the packaging demonstration project.

LESLIE: Bret Leslie, Board staff. And I've got two questions. I'll …first one is for Steve and kind of having worked at NRC and kind of know how they license things that get older and older, you know, on the reactor side they have the license renewal and their aging management requirements and they license for a specific time window and then there's a subsequent renewal and then there are additional aging management requirements. Can you describe the process that DOE uses? Is it formalized as, you know, we’re we think this facility is good for another 40 years because we've done the aging management and this is everything we'll need to do?

VITTO: Yes, that might be out of my wheelhouse but I know there are … so specifically what I could talk to is I know there's been studies associated with structural integrity at L-Basin for the life, so we have estimates of when that's been deemed, you know, a safe environment for the structural elements of that, so we use that as a planning basis, things like that, but I'm not sure exactly.

LESLIE: So let me expand it a little bit more. I felt the uncomfortableness with talking about alternatives earlier on, you know, what's moving forward, but you also have to have it in terms of a timeline, okay? If we need the capability for 40 years, you need to compare the technology development, the aging management, the actual facility cost for those and so that's kind of why I was asking this question is unless you guys at the staff level kind of know what am I supposed to be assessing to, right? As a geologist, we hear bring us another rock, right? You know, well, tell me what kind of rock you want and I'll bring it to you. So anyway, that's kind of what this question's about and I don't know whether the Spent Fuel Working Group has the necessary information, constraints to do the analysis to evaluate the alternatives. Maybe it's not a question, but it's an observation.

VITTO: Okay, thank you.

LESLIE: So I'll go back to Ron's question, which I'll make it a little broader and it's probably for Anna, which is he focused on the aluminum fuel. So if you look at our lovely report, it has some really nice stuff in it and in the sense that it describes all the fuel and these are grouped by how they were going to be disposed of at Yucca Mountain. They did all the criticality analysis. So if you look at their SRS heavy water components test reactor, which I think is non-aluminum spent fuel that's going to be hard to process, that's going to be if you were to package. It's not just that that goes into the package. It would also be the advanced neutron absorber plus supplemental shot. So that's what would be packaging. So kind of big picture, have you identified the technology development for all the fuel that would need to be packaged for … if packaging was your strategy? Do you have the roadmap and identify for all the fuel? This is all the technology we would do. In a way, it's similar to what they have to do for the ABD.

D’ENTREMONT: That is not something that the work I'm involved with has looked at. The … we've been focused on the aluminum clad. There has been some … I mentioned in my talk that we're not planning to … we're planning to match the geometry of the HFIR basket but not incorporating neutron absorbers. So in terms of like the develop … the model development, incorporating something like a specific neutron absorber, we would need to know what neutron absorber we need to focus on. You heard earlier that they're still looking at neutron absorbers. And then the question from my perspective would be, we need to look at, what is that material? Do we have a reason to expect that it would affect the radiolysis of physisorbed water differently than the other components? So that we can know, do we need to run a test for that material in order to incorporate the model? Or do we just … can we account for it using the data we already have? So from my perspective, that's how you would go about adding those materials. But I have not looked at stuff related to other fuels.

LESLIE: Okay.

VITTO: So we, I believe in 2012 there was also a dry packaging study that was done at Savannah River Site. So I'm not sure if the … did it … if it had that amount of detail because I'm not as familiar with it. But we definitely have to use that or that type of methodology to investigate if that's a viable path going forward, right? So addressing the failed fuel, how are you going to go down that path? Similar to what you just mentioned with ABD, what they're doing with having to isolate and things like that. If that's the decision made, yes, of course, that has to be done.

LESLIE: Well, let me test you on that. You said once a decision is made, and what … did I hear that right? You would have to go down that path and figure things out after a decision is made?

VITTO: Well, I mean, if you're going to … so right now we're in the process of determining the path forward. So yes, if that's a decision that's made that we're going to just dry store, then of course, yes, that's what we're going to do. But there's been analyses that have been done in order that we'd use to help our decisions.

LESLIE: We'll make sure we have that 2012 report. Thanks, Steve.

SIU: Do I have any other questions from the Board or staff?

JUNG: Well, I have two questions. The first one …

SIU: Andy, could you introduce yourself, your name?

JUNG: Oh, I'm Andy Jung… Hundal Jung, the NWTRB staff. I have two questions. The first one is for drying. I think your experimental plan and also the pilot test concept could be very useful for the commercial spent nuclear fuel cladding to evaluate residual water, to estimate, also, the potential impact. Is it … have you been collaborating with NE-8 or Zircaloy Cladding Group?

D’ENTREMONT: We do have some work that has been done for NE-8, a different project. We … that started with … we did in … a theoretical evaluation for the high burnup demo cask, which they only had a few gas sample measurements very early on. But we were doing an analysis to figure out whether we thought radiolysis was a potential explanation for the hydrogen results they saw. And as a follow on from that, we have had a small scale project to test some zirconium samples in the mini-canister setup that I showed for the aluminum, or a very similar setup.

JUNG: So your pilot, the test facility or so can be utilized for the commercial, the Zircaloy cladding, too?

D’ENTREMONT: A similar monitored canister could potentially be done. I … that's not something that I've been involved in any discussions for. But there's no reason that the same concept couldn't be applied. The high burnup demo cask already did temperature measurements for storage of a canister of fuel for the zirconium clad. So I don't know if there is an intent to carry out any future work with the gas sampling over the monitoring period.

JUNG: Yeah, it'll be very useful, very helpful, valuable data for the Zircaloy cladding, utilizing your … the pilot test concept.

D’ENTREMONT: I think the concept would be equally applicable.

JUNG: Yeah.

D’ENTREMONT: I'm not aware of plans to do that at this point.

JUNG: For the fracture mechanics, do you also consider for dynamic the mechanical structural integrity during transportation can be experienced for some shock and vibration can be an effect to the spent fuel … the canister, for standard canister, too? So not only for the storage condition, it's a transportation. It's also considered for future study.

ZHU: Thank you for this question. I could join in the … do you support an integral assessment specific for the drop test company, the Idaho. They have done many different tests that show this integrity concern. It's not a problem for that dynamical impact. For our study, I did not show yet. I just show the normal loading condition and the combined with residual stress. I also have called accident, as you mentioned, potential drop or vibration caused the accident loading, and accident loading combined with residual stress. So both … that's total cost of four situation, the loading condition. So all loading conditions, the postulated crack are stable, and the safety condition is not a problem for DOE standard canister. Thank you.

JUNG: Okay, thank you.

LESLIE: Bret Leslie, Board staff. One more for Anna. It's … enjoyed and learned from the tour yesterday, but it's kind of a follow up question. And I know the Spent Fuel Working Group has done a really good job in terms of integrating across the complex, but I think maybe I'm not familiar enough with it. But is the condition of the non-aluminum SRS spent fuel, like the Hanford K Basin spent fuel, in a sense that they went through this drying process? And what lessons did they learn? And how can they be translated or transported, so to speak, to Savannah River? And inform … and maybe it's to Steve too, inform kind of the decisions for packaging.

D'ENTREMONT: I think some of my colleagues are more familiar with the … with that work than I am.

LESLIE: Please make sure you identify yourself.

CHUNG: Yes, this is Tam Chung, Savannah River National Laboratory. We are definitely utilizing that. So right now we are leveraging the Hanford characterization data for our grading scale model. So we're trying to use SRS records and the characterization of the K Basin uranium metal to be applied to our metallic uranium zirconium alloy. That is very relevant to us so that we can be able to develop models for the reactive surface areas and then project estimates for radiolysis, hydrogen generation for transportation, processing, and potential disposal through dry storage. Yes, definitely leveraging existing literature.

THERRELL: I just want to add from a … James Therrell, EMO. Just want to add from a program standpoint, that technology is proven. We, you know, Hanford executed it. We know it's very costly. So we want to have alternatives, but we want to lean on that information like Tam just mentioned. But …we could go out and spend a bunch of money and get that capability and do exactly what Hanford did. That technology is a high TRL. But we obviously want to optimize and maybe do it cheaper.

LESLIE: Here I thought we were going to have an early break. This is Bret Leslie, Board Staff. So also in Hanford there was one multi-canister over pack that was packed with aluminum clad metallic uranium. Is that information playing into your drying stuff?

D’ENTREMONT: I believe that is part of the information set that I’ve reviewed in the past. I don’t recall any specifics that have been utilized in our current work, but I'd have to go back and look more at that.

SIU: Okay. Thanks for your patience. Despite our best efforts we didn't fill up all the time. Thanks to Kiran again for giving us the huge margin. So, we will break and reconvene at 3:15. Thank you.

[Break]

SIU: I have 3:15. So our next presentation is by Steve Wahnschaffe, Idaho.

WAHNSCHAFFE: Good morning, Board. I'm Steve Wahnschaffe. I'm the Spent Nuclear Fuel Manager for INTEC for Environmental Management Office. Nick Balsmeier, my boss, was supposed to be here with me, but he unfortunately had a family emergency, wasn't able to make it today.

So, I'm going to give a quick overview of the Idaho Spent Fuel. Basically, Idaho consists of three offices that manage fuel. The first one, the one I work for, the Office of Environmental

Management, the manager for that is Mark Brown. The manager for the Idaho Cleanup Project. The next, Office of Nuclear Energy. I should say EM basically covers the Idaho Nuclear Technology and Engineering Center, which we call INTEC and which I will be calling INTEC because basically I'm used to it. So, the Office of Nuclear Energy, their main facility is the Materials and Fuel Complex. That's where they store fuel. And the last one is the Naval Nuclear Propulsion Program. And basically, their facility is in NRF.

So basically, what Idaho, this is basically a grouping of the fuels we store. Basically, we have about 287.4 metric tons heavy metal. Various categories that we store, 1 through 6. And I'm saying that the number does not include the amount at the Naval Nuclear Propulsion Program. They have about 41 metric tons heavy metal at this time. And, of course, they're always receiving more.

If we break up the non-Navy fuel this would be the number of canisters we have. Basically, we have various sizes. The sizes were when the repository first came along, we were going to comingle Department of Energy’s fuel with the high-level waste glass. And that’s where the different sizes came from.

So, the Office of Environmental Management, we basically have six facilities that we can talk about. The first one, CPP-603 – it’s the one everyone shows. It’s the second one from the left. That’s the storage area for 603. So, it’s dry storage. The next one’s 2707. That’s our cask pad. 749 would be the third one from the left. That’s underground storage. Fort St. Vrain, the one at the top, that’s where we’re storing the fuel at the reactor area. The final one is TMI-2 where we’re storing the core debris.

The Department of Nuclear Energy. They basically have three facilities that we’re talking about: MFC-771, which is the Radioactive Scrap Waste Facility; MFC-785, which is the Hot Fuel Examination Facility; MFC-765, which is the Fuel Conditioning Facility.

Naval Nuclear Propulsion Facility has four facilities: the Expended Core Facility; Spent Fuel Packaging Facility; Overpack Storage Building; and Cask Shipping and Receiving Facility.

We're in the – we call it the Spent Fuel Staging Facility. It's a new DOE 413 project. We had Critical Decision 0 approved May 20, 2021. We're still working on Critical Decision 1. We're hoping to have that approved second quarter of fiscal year 25. Basically, this is where we want to place our fuel in road ready storage.

When we were doing CD-0 for the Idaho Staging Facility we were directed from both Congress and EM1 that we needed to have an integration spent fuel management plan that covered all the offices at Idaho, which I think that just makes sense, you know. So basically, the plan, I'll go to the second bullet is to strategize and establish a road-ready dry storage packaging configuration capability, integrate with expertise of federal and contract personnel from the three distinct SNF program offices. And the fourth one's the one that I think this makes sense, it says effectively use existing resources and facilities. So that's what we've been directed to do and that's what we're going forward with.

So, here’s some of our big assumptions. People might disagree with these, but the first one is, you know, a repository. We don’t foresee that within - probably not my lifetime. So, we have to look at decades from today’s date. Now, Road Ready Packaging Strategy is being established. Our SNF can be packaged into DOE standard canisters. And then it says an over-canister using various basket designs. DOE SNF are assumed to not – so we’re assuming not to begin shipping for 2055.

We’re saying when DOE order 435 gets issued we’re assuming that we can decrease our volume, may decrease our volume by about 53 metric tons heavy metal. Most of that is the blanket material that we’re storing as spent nuclear fuel. And basically, we have a small volume that we think will require conditioning. Most of that is epoxy, fuel that has epoxy and sodium fuel. And then the big one for TMI-2. We think that TMI-2 is in road-ready condition already so we will not be repackaging that.

Our proposed path forward. Identify potential funding needs and sources. Identify facilities and infrastructure upgrades and modifications needed to support the SNF packaging demonstration effort. Further assist integration opportunities among the three programs. Define what road-ready means. We all have our … we all know what we think it means, but we want to put it out there. We want to actually define it. Develop proposed regulation compliance frameworks. Create disposition strategies for non-SNF materials. And evaluate staging facility to progress from CD-1 for DOE-owned fuels.

Here’s basically our ongoing activities. Routine maintenance, surveillance and materials of facilities at INTEC and at Fort St, Frain. Continue ATR receipt. We still receive the spent fuel from ATR and we’re transferring some fuel from first generation to second generation vaults in CPP-749. It’s Peach Bottom fuel. We’ve had it for about 50 years. We think it’s time to move it to a better storage condition. Naval Nuclear Propulsion Program continues to package and store Navy SNF in its road-ready condition. And then DOE, EM and NE are on a road-ready demonstration program. Facility upgrades to CPP-603 to support the road ready demonstration. And then EM as I said has approved a capital storage at our staging facility. So, we want to progress on that.

And I'm saying this slide … this slide is what the next presentation’s basically going to talk about is a road-ready dry demonstration, packaging and storage. Basically, we’re using the DOE standard canister. It’s going to be done in CPP-603. The first fuel that we plan on packaging is the Fort St. Vrain fuel in CPP-603. A number of reasons for that. There’s a bunch of it. It should keep us busy for at least 10 years after we demonstrate we can do that.

So, we’re working with NE on basically fuel loading, fuel baskets and equipment. NE is working on the remote welding development for the canisters, and fuel conditioning to support the interim storage. And with that … I'm quick, so ask me a lot of questions, please.

SIU: Thanks, Steve. Okay. Do we have questions? No?

WAHNSCHAFFE: I knew Bret had one.

LESLIE: Yes, Brian doesn’t have any questions for this presentation. Bret Leslie, Board Staff, by the way. Thank you, Dean. So, if you back up to two slides, I guess. Right there.

So, I don't think Steve Kamas joined us today. I thought he was going to. Talking about naval spent nuclear fuel. And I'm not sure I appreciate …

WAHNSCHAFFE: I'm not going to answer any of those questions.

LESLIE: I know. But this goes to the heart of it. It’s road ready or disposal ready? And so, the Navy has continued to package its fuel, according to the waste system acceptance criteria, so that it’s disposal ready, in addition to being road ready for transportation off site. So, in your “road-ready” for the DOE-EM is it going to be disposal ready?

WAHNSCHAFFE: I would think that’s what the definition is going to end up going to – disposal ready.

LESLIE: So, there are two aspects of the disposal-ready. One is how does it get transported from the site to a repository, because a repository had a certain design and assumed certain things.

WAHNSCHAFFE: Correct.

LESLIE: For instance, that DOE standard canisters would not be in welded canisters for storage or for transportation.

WAHNSCHAFFE: Correct.

LESLIE: Okay. So that’s …

WAHNSCHAFFE: So, yes. And I should say, you know, we have great Congressional people in Idaho and one of the first things they did is they said we want you to do what the Navy’s doing. And we said, okay, we can do that. And then we have Congressional language that told us to go that direction too. So, we’re supposed to use a multi-purpose canister, which we call the over pack for the DOE standard canisters. So that’s what started this off. What we understand you know we were going to comingle with the high-level glass, there’s going to be a packing facility at the repository. Right now there’s not going to be a repository. From what NE-8 said today that they’re looking at an interim storage facility. I don't think that’s going to have a packaging - the ones that are trying to be licensed now they don’t have a packaging capability there. So, we’d have to go someplace where there’s not a packaging capability.

LESLIE: A follow up. Bret Leslie, Board staff. Do you recall where that guidance was? Was that in appropriation language?

WAHNSCHAFFE: Yes, it was.

LESLIE: Do you remember which year?

WAHNSCHAFFE: Yeah, it was 21.

LESLIE: Okay.

WAHNSCHAFFE: 2021.

Bret Leslie: And it was specific to package in an MPC?

WAHNSCHAFFE: Yes, it was. I can get that to you if you want?

LESLIE: Right. So, the DOE standard canister is an MPC.

WAHNSCHAFFE: No. The DOE standard canister is the DOE standard canister. A multi-purpose canister has things packaged inside. So, we’d say … so that’s where we’re going with. A multi-purpose canister is basically what the commercial fuel does, is using, or what the Navy is using to package their fuel in. So, our multi-purpose canister will have … right now in the next presentation we’re planning on putting seven DOE standard canisters in a multi-purpose canister.

LESLIE: Nathan? Board question, online. Bret Leslie now asking a question on behalf of Board member Steven Becker. Thanks for a nice presentation. A lot of activities that you spoke about could be of interest to members of the public. What role do you see for public communication in relation to your activities? Who will be doing it and what challenges do you anticipate?

WAHNSCHAFFE: I'm not the person to answer that question. I'm more of a technical person. So, I mean, right now we do have a communications specialist, and we do keep our stakeholders involved in this. Outreach, we would go to Jomaries or Paul Murray for communicating what we’re doing. I don't know if Jomaries wants to answer that for me.

OGG: Dan Ogg with the NWTRB staff. You mentioned the Idaho integrated spent nuclear fuel strategic plan or management plan.

WAHNSCHAFFE: Correct.

OGG: And that ties very much to the road-ready dry storage project. I assume it also needs to interface with or line up with the Idaho Settlement Agreement.

WAHNSCHAFFE: Correct.

OGG: So of course you have many, many stakeholders very interested in that plan. When do you expect that will be available for the stakeholders to see? When do you think it may be released?

WAHNSCHAFFE: I'm not going to go there. It’s a long drawn-out process. So not only does my office have to concur, we have two other offices to concur on the plan. And then we have the lawyers involved. So, it’s been a drawn out process.

OGG: Okay. Thank you.

LESLIE: Mike, can you bring Nick Balsmeier onto the stage? I think he wanted to help answer.

WAHNSCHAFFE: I'm glad he’s there.

LESLIE: That was Bret Leslie, Board staff. We’re bringing, Nick we’re bringing you to the stage.

BALSMEIER: Alright. Good afternoon. Can you hear me now?

LESLIE: Yes, we can.

BALSMEIER: Okay. Yeah, to give Steve some assist. Again, like he said, sorry, I can’t be there. My son had quite the dislocation of his shoulder Friday night in a football game. So, we’ve been spending the weekend, MRI booths and other doctors’ appointments. But in regards to the spent fuel management plan EM and NR have both concurred on that. We’re working through the process to get it released. And if Mr. Murray’s there I’ll let him speak on behalf of NE on the status for NE’s concurrence.

LESLIE: Unfortunately, Paul’s not here. Bret Leslie, Board staff.

BALSMEIER: Okay. So as of this time NE is non-concurred on that plan. We’re working with them to get through some of the technical issues and get that released out to the public as soon as possible.

LESLIE: Thank you, Nick. That was very helpful.

LESLIE: Bret Leslie, Board staff. And again, too bad Paul’s not here. But Bill Boyle is from his staff. Okay, you’ll be in the record. So, under the generic repository R&D program basically they evaluated commercial spent nuclear fuel and the potential for post-closure disposal criticality. And so, there are three kind of main rock types. You could have a repository in salt, you could have a repository in argillite or shale, or you could have a repository in crystalline rock. And that could even be something like Yucca Mountain, because tuff is a crystalline rock. What Oak Ridge found was that the most limiting, in other words, the one that had the highest probability for criticality was Yucca Mountain, basically. And that’s because it was unsaturated, low chloride content.

So, from a disposal standpoint if you package to meet what was in the waste system acceptance requirements document for Yucca Mountain. Then DOE spent fuel in its individual DOE standard canister would be from a criticality case standpoint okay for the other ones. If it met for Yucca Mountain, it would be okay for the other ones. So, I'm going to come back to you indicated that the DOE standard canister would be packaged with whatever is required for disposal. Is that correct, in terms of neutron, advanced neutron materials, gadolinium shot, lead shot or iron shot? Because there are like 214 canisters or DOE standard canisters at Idaho that would need that supplemental material. I guess my question is, is that still the plan?

WAHNSCHAFFE: Could be the plan. So basically, what the plan is is we’re going to address each fuel type as they come up. So right now we have study packaging Fort St. Vrain fuel. And that’s the only one I would even care to go further on.

LESLIE: Thanks.

BALSMEIER: So this is about … the Fort Saint Vrain fuel that we have analyzed will allow us to package for about 10 years, maybe a little longer. So that will give us the time to further evaluate the additional fuels as we go forward.

LESLIE: So … this is Bret Leslie, Board staff. Nick, you’re the one who’s probably going to have to answer this. So how long would it take … well, two part question. How many canisters of the 2,000 that Steve showed would be the Fort Saint Vrain fuel? And then how long in total would it take you to package all 2,000 packages that Steve showed? Uh oh, he’s frozen.

BALSMEIER: I'm back.

LESLIE: Did you hear the question?

BALSMEIER: I think so. So, the first question was how many of the standard canisters would be for Fort Saint Vrain.

LESLIE: Correct.

BALSMEIER: I don’t have that off the top of my head. Will, who’s probably in the audience, or Bill Kirby may be able to give you an answer on that. But for the second part of the question how long would it take us to package all of the fuel in Idaho? I would say into my grandkids’ lives. I think you’re looking 50 plus years minimum to package all of the fuel.

KIRBY: So I’ll give a little bit more context for Fort Saint Vrain. Bill Kirby, Senior Director of Liquid Waste and Fuels for IEC at Idaho. We have about eight and a half metric tons of Fort Saint Vrain fuel in Building 603, so seven times eight, 25 or so DOE standard canisters. You know, what we’ve discussed, you know, based on budgets and where we think we’ll be going is if we could do a few packages a year that would be, you know, something we could manage. We believe we could get it through the facility. Remember this is coming out of 603’s the dry, dry storage area that you saw in some of the pictures, and Will will cover this and go through the whole process.

So there is a series of weldings that have to happen between the DOE SC’s [standard canisters] and transfers of the cask and canister assemblies in and out of the fuel storage area or the fuel handling area. So, say something around there, about 25 DOE SC’s and, you know, a few, a handful, towards 10 years. Like six, seven, probably seven to 10 years.

LESLIE: Thank you. Bret Leslie, Board staff.

SIU: Okay. I think we don’t have any more questions. Thank you very much, Steve.

WAHNSCHAFFE: You’re welcome.

SIU: And thanks also, Nick.

BALSMEIER: Thank you. And next time I’ll try to be there in person. Appreciate you guys accommodating us.

SIU: Can’t predict everything. Okay, last speaker today is Will Anderton, Idaho.

ANDERTON: Thank you. Yeah, as you just mentioned, my name’s William Anderton. I work for the Idaho Environmental Coalition. I’ll just start giving a brief introduction. Today on the agenda

I’m going to be primarily focusing on infrastructure upgrades on our existing facility, and I can maybe briefly talk about other infrastructure needs and then I’ll be providing some more detail on the packaging process and any other residual questions that haven’t been answered thus far for this road-ready demonstration project.

So just for those of you who are not familiar who are participating in the meeting today, the INL site is located in eastern Idaho. Currently the site is divided into three different contracts. One of those is the Idaho Cleanup Project, which is managed by the Office of Environmental Management and Idaho Environmental Coalition is the contractor for that contract. And in the red box on the map, you’ll see highlighted the Idaho Nuclear Technology and Engineering Center. Steve Wahnschaffe referred to that as INTEC. That is where the packaging demonstration will be taking place.

Specifically at INTEC there’s a facility called CPP-603. I think I’ve failed to put this acronym in the acronym’s list in the supplemental slides. So CPP stands for Chemical Processing Plant in the old times – I shouldn’t call them the old times – but formerly it was called the Chem Plant. The purpose of INTEC was to recover uranium from aluminum clad spent fuel from all the various test reactors that were on the site. So, this building was built to be a storage facility, a wet storage facility in the 50s. There were three storage basins. They're no longer in use. They've been grouted over. And then a dry storage facility, known as the Irradiated Fuel Storage Facility, IFSF, was added between 1972 and 1974.

I don't have a laser pointer, but I'll just kind of describe. You can see the long truck bay going right in the middle of the picture. Everything to the left of that is the old facility for wet storage. And then the large white concrete structure to the right is the IFSF. And that was primarily built to facilitate storage of Fort Saint Vrain fuel and Peach Bottom fuels, which are high temperature gas reactor type fuels. And so this is where we're planning to do the packaging demonstration.

I know we've had a lot of discussions thus far about what does road-ready mean and is it disposal-ready? This is what the exact definition of that is still being determined and discussed between the Office of Environmental Management and NE. But this is where we conceptually would like this project to go and what we would like it to achieve. So, we'd have four Fort Saint Vrain elements per standard canister. Several of those packaged inside of the commercial multi-purpose canister. And then conceivably that will use a commercial transport cask in existence with some modification of course.

And then on the far right of the diagram is well beyond the scope of the demonstration project, but eventually that transportation package could be utilized for transporting the spent fuel to a consolidated staging facility or a repository when one opens up. So, the point of this slide is we want transportable and disposal ready. That's what we want.

So, the exact scope of the project. We're going to make our needed infrastructure and facility modifications to 603. We're going to develop, we're going to work with a commercial vendor to develop the transportation package. The INL, Battelle Energy Alliance is helping us out with the standard canister closure technology. So, they're developing the weld machines, the apparatuses for leak testing and conditioning and so forth. And then we will also be working on the development of a data package, which would support disposal efforts in the future. That data package will be based off of the Yucca Mountain WASRD requirements. And then physically at the end of the demonstration project we will have a single cask, a transportation cask with one MPC and seven DOE standard canisters. So that’s the physical outcome of the project.

Then we move into a little bit of the facility modifications. I will have some pictures here in a minute. I apologize for all the bullet points. We have a new cask insert that we need to install. I’ll explain what that is here in a minute. We have a west truck ramp in the facility that a few years back we did a project with BEA on a large cask adaptation capability to bring in large casks into the hot cell area of the facility. And that project determined that this truck ramp needed to be filled in to avoid some of the accident scenario for cask drops and so forth. So, we’re working on that. We have a permanent containment structure, re-build to do. I’ll have pictures of that here in a minute. We have a variety of different engineering analysis work in order to update our safety basis, to show that we are able to do these operations safely. We’ll be upgrading our hot cell camera system to rad-hardened cameras.

We've made it all this time without rad-hardened cameras. But I don't know if we'll be able to continue that for moving into these operations. And then there will be a development of other miscellaneous pieces of equipment to support the process, which I will not get into today. But that's kind of the overview.

So just a little more detail on some of the things we're working on right now. On the left here you're going to see a black and white depiction of the CPP-603 transfer car. The transfer car's purpose is to move large casks of fuel, shielded casks in and out of a hot cell. And so, what you're seeing on the right we call that the large cask insert. This is something that we're going to bolt on to the bottom of this transfer car that will be able to hold up to 128 tons. So, 128-ton capable cask. And it will be able to not interrupt the other missions that we have in the facility. So, we do have other FRR/DRR shipments. We still receive ATR direct shipments from ATR. And we want to make sure that this doesn't interrupt our ability to do that. So, we'll bolt onto the bottom and be able to allow us to bring those larger casks into the facility.

The permanent containment structure. On the left is a walk in type containment. It’s hard walled. We’ve had this in the facility since about 1990. It provides contamination control when we bring the transfer car in and out of the cave. It has its own negative ventilation system in order to maintain contamination in those confines. So, it doesn’t spread all over the building. Something we learned on that large cask adaptation project several years ago was that the hinges of the doors are located in a poor position. So, the picture on the right you’re seeing they actually had to disassemble the panels, the roof panels, the doors on top that open up. We had to disassemble those in order to put a mockup of a large cask into this transfer car. And so, for ongoing operations we don’t want to disassemble the entire permanent containment structure every time we move a cask in and out, so … Do you want me to pause? I'm just going to keep going. Okay.

SIU: We’re well ahead of time.

ANDERTON: I'm about to start dancing up here. So …

SIU: Hang on a sec.

ANDERTON: Yeah.

SIU: But you may have to just speak loudly. I'm sorry.

ANDERTON: I’ll move closer to the microphone. How about that?

SIU: Hang on, just a minute.

ANDERTON: Sure.

SIU: We’re cheering for you.

ANDERTON: I like it.

SIU: They’re extremely excited.

ANDERTON: I can’t think of any better way to make this more exciting today. So …

SIU: Finally.

ANDERTON: Do you want me to keep going?

SIU: Let's try.

ANDERTON: Okay.

SIU: Lift the mike just a little bit. Maybe that will help also.

ANDERTON: Sure. I'll lean in real close here. So, what we're going to do with this containment is we are going to redesign where the doors are located and then there's various utilities we need to add that will support closure activities of the standard canister. So, we need knife switches, disconnect switches for the welding machine so that we have adequate voltage. We may have to upgrade the ventilation systems to support the fumes and the safety of the welding operations. And then we may want to reevaluate the floor space to make it a more efficient process. So, this is something that we'll be moving into here in the next fiscal year is doing the upgrades to this.

Then we'll move on a little bit from the facility modifications to transportation. So far there hasn't been a transportation capability for the standard canister developed. And so our plan is to partner with a commercial vendor to hopefully minimally modify a multi-purpose canister and a transportation cask that is compliant with 10 CFR 71, 72.

And this is still up in the air a little bit, because of the definition of road-ready is still being finalized. But I can see it being amended to an existing certificate of compliance. Whatever the department decides is best, we'll go with it. But that would be one option. The timing of that I don't have an answer to yet when that engagement with the NRC would happen. Obviously, it would happen before we tried to ship anything. But …

Let me give you now a little bit more detail on the facility. I'm going to show you the conceptual packaging process. So, this is a section view of the hot cell of CPP-603. On the left is the fuel storage area. This is where we have 636 positions for storage canisters in a rack. That is where all of the spent fuel is currently stored, including Fort Saint Vrain, Peach Bottom, ATR and numerous other types of miscellaneous DOE-owned spent fuel.

In the center on the right is the fuel handling cave. This is a hot cell where the transfer car moves in and out of and brings fuel into the cave. In this part of the facility is where we do our repackaging operation. So, if we need to take the fuel and put it in a storage canister or the reverse of that if we're going to put spent fuel into a standard canister it will happen in this cave. We also have a fuel conditioning station in this cave where, for example, ATR direct shipments coming in wet from ATR are vacuum dried before they're placed into the dry storage facility on the other side of the wall.

There's two different racks in the cave, north and a south rack that can hold various types of buckets, canisters. And then on the far right is a crane maintenance area where we can take the facility bridge cranes back into a more shielded secluded area from all the radiation where we can do maintenance. So, we'll see if this works. Sometimes it does, sometimes it doesn't. This is an animation. It's conceptual at this point. And it's going to show you the general process for how we're going to load the standard canisters and close them.

So, I press the play button. Here we go. Seems to be working. So, moving into the facility is conceptually the transportable cask. We have a couple of bridge cranes that can tandem up to perform the lift. So, we have a tandem lift bar that will come over and grab the cask. We'll go ahead and fly that over to the large cask insert, which is bolted to the bottom of the transfer car. And once we install that we'll go ahead and put in some internal components for that. The next thing to be installed is going to be the multi-purpose canister shell, just the lower part. It's not closed yet. It's still open.

And then after that we're going to have the commercial vendor help us develop a basket for the standard canisters. This is just a conceptual model. It has nothing to do with what's actually going to be developed. And then we'll go ahead and put seven lower assemblies. So, these are the standard canisters before they're welded shut. Just the lower assembly. And then, of course, we'll put the MPC lid on top, before we start moving into the process further. So the transfer car is going to go north into the fuel handling cave. Make the wall disappear really quickly. And we will stage that MPC lid in the cave until we're done with it. And I can explain this later if there's time. We have some limitations with the racks in our facility. We can't put seven standard canisters in the rack. So, we have to do some swapping around.

So right now what we're doing is we are putting a spacer into the bottom of the center port of the basket for the standard canisters. Its purpose you'll see here in a minute. We're going to put on a temporary MPC shield cover we call it. And now that that spacer's in there when we reinstall the lower assembly the closure weld is now up where you can access it, but the majority of the … the fuel is down in the shielded portion of the cask. So we'll go ahead.

I don't really have a way to pause this, but just take my word for it, we're considering that we already have all the other internal devices for the standard canister already installed previously in the truck base, so we're just showing that we're going to put the internals and the fuel in there. And then just for the demonstration, not for future operations, we have a shield plug that goes on top. And the purpose of that shield plug is to give us the ability to have hands on access during closure operations. We did that to buy down some of the technical risks with this project.

So now we have the upper lid assembly on there that will bring it out into the PCS, which is not shown in the animation, but it’s there. And now we perform the DOE SC closure. So that includes vacuum drying, backfilling, welding and leak testing. Backfilled with helium of course. And so these machines that are flying back and forth right now are being developed by the INL. They are pretty well, the designs are pretty well finalized. They’re just working on some testing and coming up with some weld procedures for those. And once we have fully closed the standard canister we’re ready to move on and grab the next one.

And so now we have to do another swap. So we’ll take that loaded canister and put it back in the rack. We’ll remove the MPC shield cover. And then we will swap out the next empty lower assembly with the loaded one. And again this is happening because our racks structurally were designed for 2,000 pound canisters and the standard canisters. I know there’s a lot of canisters in that sentence, but the new ones, the standard canisters can weigh more than 2,000 pounds. And so we have some structural seismic limitations there. So that’s why we have to do the swap out.

So now we’ll put that MPC shield cover back on. The next lower assembly comes and the process repeats. I'm not going to make us watch all seven of these. We’d be here for a long time. So in just a second here you’ll see that we’re just going to magically wave our hand and say, okay, they’re all loaded now. So, this is the last, this is the seventh standard canister now. So we’ll take it back out, put it in the rack. And here in a minute you’ll see all the lids will magically appear.

And then for the last one, that space we put in, we’re not going to leave it in there. It comes out. And we’ll go ahead and put the last seventh canister in the center port. And that’s our full complement for the demonstration. We’re not going to do another package. Just one seven DOE SCs with Fort Saint Vrain.

Now the MPC lid goes on and I don’t have any models of all the closure equipment for that, but we are anticipating we’re going to do the full closure process for a commercial MPC. So, it will be vacuum dried according to whatever vendor’s process we select, backfilled with helium and leak tested with the redundant sealing that you typically would find on a commercial package like this.

And so now, this is the physical package for the project. We have a transportation cask with an MPC that’s fully closed. The DOE standard of canisters are fully closed. And we will stage this somewhere at INTEC. That’s to be determined. So that’s the animation.

I think Mr. Wahnschaffe mentioned this just for a moment there is a staging facility project. It’s a capital project. Currently it’s CD-0. This is not a picture of it. This is a picture of some other ISFSI [independent spent fuel storage installation). But we envision this facility is going to be very similar to this in concept where we can continue to take spent nuclear fuel out of 603 and stage it until there is either a consolidated facility or a repository that we can ship it to.

And so, this is an advantage in several ways for the environment. I do want to throw that out there that conditioning the fuel for disposal is an improvement to its current condition. Not that the current condition is unsafe or unacceptable. But it is an improvement. And then it reduces the amount of inventory we have to maintain in our legacy facilities. We do have aging management programs at INTEC. But it’s a little staggering to think that you have to maintain the facility for another, I don’t even want to say 100 years, however long it ends up being.

And then it does speed up the process of disposal because we have a head start with, we call it the low hanging fruit for spent fuel. So, by getting a head start on the fuel that is well characterized gives us more time to finish the research, finish the work to prepare the load, you know, aluminum, spent fuel which we’ve been talking about today.

And then in the future. Additional infrastructure needed. If it hasn’t been done yet we will need a rail spur, rail shipping capability. I don't know what that looks like, if it’s provided by a commercial vendor or if it’s provided by DOE in the Atlas car. Whatever that ends up being. And then if it hasn’t happened yet, the NRC will have to license someone on this package. And so with that I'll be happy to start answering any questions you may have. Thank you.

SIU: Thanks, Will. And thanks for enduring the cheering next door. Okay. Do we have any Board questions? Bret?

LESLIE: Can you bring Brian on, please?

LESLIE: Brian Woods.

ANDERTON: He is in the room, sorry.

LESLIE: I am going to go ahead and ask Steve Becker's question. This is Bret Leslie, Board staff. Pretending to be Dr. Steven Becker. Thank you, Will, for a nice presentation. The road-ready demonstration project could eventually be important in terms of public trust and confidence. To what extent do engineers and other technical experts involved with this work, interface with or interact with staff who are involved in public communication and information efforts? Do you anticipate greater coordination in the future?

ANDERTON: So, thank you. That’s a great question. Currently as an engineer we provide support to the Office of Environmental Management and their efforts for public communication. We currently work to DOE orders in 10 CFR 830 to ensure nuclear safety. So, I can see the involvement increasing with this project and going forward if we start to branch beyond what we’re used to in terms of working with the NRC and preparing the fuel for disposal. But really I think the leadership for that would come from the Office of Environmental Management and we would support as needed. Someone’s cheering for me out there.

SIU: You must be saying the right thing every time.

LESLIE: Go ahead.

OGG: Hi, Dan Ogg with the Board staff. So, I'm going to put Paul Murray on the spot. You talked, well, we heard in the previous presentation discussions about the Idaho Spent Fuel Management Plan and then it was … and then the road ready dry storage was talked about here as well as some discussion about disposal. In the previous discussion regarding the Idaho Spent Fuel Management Plan they mentioned that there’s some discussion between EM and NR and NE and I just wanted to know if there’s anything you would like to say or are able to say about the NE review of the Idaho Spent Fuel Management Plan?

MURRAY: Paul Murray, DOE-NE. So, we’re intimately involved with this package performance demonstration. I think we primarily funded most of it to date. I think we plan to put another four million dollars into it in 2025. So, we are having detailed discussions with DOE Idaho and have a plan of making sure we’re integrated. As Idaho gets ready to, you know, package all its fuel by 2035 and we build an interim storage facility by 2038. We’ve got to be connected and really close to each other. I'm not saying the fuels go in there, but we’ve got to be coordinated and integrated.

Also R&D, just like our R&D program, has to be carefully … DOE is in litigation. Anything to do with storage, R&D, transportation has to be carefully considered as we do that litigation. So, we are starting to talk more and more about that. And then things that other parts of EM are doing at other sites also will start to impact Idaho road-ready demonstration and work we potentially do on the commercial spent nuclear fuel as well. Remember here less than a year, we're trying to coordinate. We have a series of meetings set up. Had a meeting earlier this week. I'll be in Idaho the week of the 16th of September. I think I'm touring the facilities on the Tuesday. So, we are getting more. We are getting much, much closer together as an organization.

OGG: So thanks. A related question. They mentioned that they're still working, if you will, to define exactly what are the requirements for road ready dry storage, as well as what are the requirements for disposal. And what we understand is that their working assumption right now is to use the Yucca Mountain Waste Acceptance Criteria as a starting point for disposal criteria. So, my question for you on the NE side is, is that align with your expectations now or do you expect there may be some different kind of disposal requirements?

MURRAY: The Yucca Mountain is, the Nuclear Waste Policy Act is still the law of the land. And the nuclear waste acceptance criteria for Yucca Mountain is a very good basis for which to plan against.

OGG: Thank you.

LESLIE: Can we bring Brian Woods? Bret Leslie, staff.

WOODS: Yeah, this is Brian Woods, Board member. So, my question is for Will, the previous presentation we just had. I was curious, so when you go to the facility mods to 603, CPP-603, and then developing the road-ready kind of demonstration package. Are these going to be sequential in any or are they concurrently … In other words, will you exercise the mods in CPP-603 when you basically develop the demonstration, the road-ready demonstration package? Or are they going to happen kind of separately?

ANDERTON: Good. Yeah, thank you. If I understand your question, I think you're asking if the facility modifications are going to wait?

WOODS: Yeah. Will they be done or are you going to wait on those until the demonstration's done?

ANDERTON: No. So, we are starting on those now. The facility modifications do not have a direct impact on the process itself, because we have a pretty well-founded understanding of what we need in terms of the size of the casks, the welding operations, closure operations that are going to be needed. So, we, in fact, we've already started on some of our facility modifications and we'll pursue those as quickly as we have funding and schedule to do.

WOODS: Okay. And just another question regarding then the facility modifications. I looked at the animation and I was … and you talked about there's the welding technology that I know is developing. Is there any other technology that kind of needs to be developed? I think you may have already answered this in your previous answer where you said you kind of had a pretty good handle on how, you know, it works. But is there any other technology other than welding that still has to be developed to kind of get this process up and running?

ANDERTON: No. The only two that I didn't really talk about in my presentation, the INL is also working on internal devices. They're working on a spent fuel basket for Fort Saint Vrain. So that’s being developed. But so far what we’ve seen in the conceptual design there’s no real significant risks or challenging technologies there. And then we have not selected a commercial vendor. But we’re planning to adopt their closure capabilities for their MPCs. So again, I don't know the answer for you in terms of that technology. But I assume that it’s not going to be a new rodeo for them, if that makes any sense.

WOODS: Thank you.

LESLIE: Bret Leslie, Board staff. I’ll ask an easy one first and then the next one we’ll have to have Paul and you kind of coordinate. So, the easy one is I think Steve had a slide up of 2000 DOE standardized canisters that Idaho would be packaged. When we did this back in 2017 we pulsed the existing spent fuel inventory database. So, at about 1,700. So, I'm wondering what’s changed or is it a function of the database? Is it a function of different size baskets? I mean, I would have thought it actually would have gone down now that you’re putting more ATR in the baskets and redesigning the baskets. So, I guess my question is what’s the basis for the 2000 DOE standardized canisters?

ANDERTON: That’s a really good question. Unfortunately, I am not privy to the details of why that number changed. I don't know if Mr. Wahnschaffe or Nick if you guys want to try and answer that. It’s before my time. Sorry.

LESLIE: And it’s okay if you don’t have an answer.

ANDERTON: We can get you the answer. Yes, Steve.

WAHNSCHAFFE: This is Steve Wahnschaffe. Basically, that number has changed depending on which study has occurred and as we updated. I mean, I believe one of the studies we had nine standard canisters would go into package. Now with Fort Saint Vrain right now we would packaging or putting that spacer in it to lift it up. That takes I guess a sub assembly spot. Well, that’s going to increase the number because now we can pack one less. So, it all depends on packaging. Basically, we have used the national program packaging capability. NE has done one recently too. So, we picked the slide and we said kind of like …

LESLIE: Thank you. Bret Leslie, Board staff again. So, we’ll go back to this question of road-ready and this is where the sensitivity is, you know, as Paul indicated that from a commercial standpoint there’s a standard contract. I envision kind of the parallel of putting seven DOE standardized canisters in a welded MPC is the same thing as putting it in a DPC and shipping it to the repository and assuming Paul will accept it. And so, I guess the question is that’s not really what was identified in the Yucca Mountain license application. So how does NE/EM, is this part of the definition of road-ready?

ANDERTON: Did you want to respond first, Paul? Or I’ll see … So I mean it’s still an issue to be solved, the future repository, whatever that looks like. In terms of the demonstration trying to meet future requirements that are unknown, I think it actually gives the department more options. You can still have the capability to cut open an MPC and pull out the standard canisters if you want to, because we are closing them in the way that they were originally intended to be closed. They are vacuum dried. They are back filled and leak tested. They are fabricated and closed per code requirements.

So, you would still be able to do what you want to do at Yucca Mountain in terms of handling them individually and pursuing co-disposal. But if it was efficient and acceptable, if they are all in one MPC you could save a lot of handling operations at the future repository and find an efficiency gain if you just put the whole thing in the ground so to speak. But I'll … that's my two cents.

MURRAY: It's a difficult question. It's a good question, but it's a difficult question to answer at this time. We don't have a repository at this moment in time. So, we don't know if any of the packages we're loading currently would actually fit into a future repository. So, we have to be … we have to do the best we can recognizing that in the future if and when we do start a repository program going again there may be some rework. But that's a function of where we are, you know, 70 years, 60 years into a nuclear program. We're going to have issues when we do start a repository program again.

LESLIE: Thank you. And I think Nick wanted to come on and try to address it. So, can we bring him on, please?

BALSMEIER: I was actually just going to give you a response to the question on public outreach and engagement that Will referred to earlier. So, we do have a citizens advisory board in Idaho that meets quarterly for the Idaho cleanup project. Just like this we continually keep them updated, outreach to the public on all of the activities that are going on the Office of Environmental Management side of the house, the Idaho cleanup project. So, we are doing that. We are also working with the other laboratories on what they're doing and how we can use best practices as we go forward with spent fuel operations across the complex.

LESLIE: Thank you for that follow up answer.

KIRBY: So, Bret, Bill Kirby again. Like to add just a little bit more context to the packaging. The package that we will choose for an MPC would be very consistent with what commercial nuke has out there on ISFSIs all over the country, packages that exist all over the world, which almost all of them have some sort of a transport package design or shielded cask transport package design with impact limiter is to go railcar or I believe in some cases vehicle.

And we look at this package with a welded DOE, set of DOE standard canisters inside an MPC that's welded closed. It's one hell of a robust package. So, in terms of it qualifying to be transported we're minimizing our risk by the approach that're taking. And at some point, in time these very similar sized packages to what's up at NRF and at all of the nuclear power plants in the country are going to have to be dispositioned, so we think we're minimizing our risk of that type of package not being accepted.

SIU: Any more questions? Okay. Thank you very much. Okay. Just in-house. Okay, we have … this is a public comment period. We have requests to make public comments from three people. And I guess even though we're ahead of schedule, I'll ask each person to limit their comment to five minutes if they could, please. So, we'll start with Ken Baer from Metatomic.

BAER: Ken Baer, Metatomic. I want to say thank you to the Nuclear Waste Technical Review Board for hosting this event and for allowing us to hear all of their discussions. It's been very interesting. And I want to tell you about the Metatomic. We were established eight to ten years ago. We are a basic fledgling start-up group. We have an idea about what we want to do with spent nuclear fuel; that is, commercial light water reactor spent fuel that would be pressurized water reactors and boiling water reactors.

Basically I have three patents so we’re pursuing a fourth one at this time to convert uranium dioxide spent nuclear fuel to uranium chloride for a fast reactor, fast reactor fuel. That takes care of the spent fuel in a methodical way and allows us to provide it to reactor developers who would be interested in building a fast spectrum molten salt reactor. So Metatomic’s job is to … what we want to do is make the fuel for the reactor developers. We don’t want to build a reactor ourselves. We’ll provide the fuel.

So a little bit about spent fuel. I don't know how much all of you have, the people in the audience or on the Board even might understand about spent nuclear fuel light water reactor spent fuel. Of course, the industry has had various kinds of spent nuclear fuel from its, throughout its history, the commercial industry. And the earlier kinds were very different. Now spent nuclear fuel assemblies are expensive, as everything else is.

So, a typical plant will take a spent nuclear fuel assembly, put it in a spent fuel pool and wait on a different arrangement for the next core load. And typically they'll put it in, back into the reactor again and run it in a second cycle in a different arrangement in order to get more burnup out of that spent nuclear fuel assembly.

This may occur five, six - I haven't heard of it going seven cycles, but I've heard it going six – until it gets so loaded up with poisons, fission products and actinides, it no longer wants to support criticality. But this is done in large part for several reasons. One of them is the fact that spent nuclear fuel that is depleted to a great extent performs a great service of depleting the flux in high flux areas and levelizes the flux across the core of a reactor. So, it's very beneficial.

Spent nuclear fuel can be processed. We're pretty sure it is. It can be done. And to chloride salt fuel. Right now we have the Savannah River National Lab is testing for us. We finished phase one tests wherein they used a little tube furnace, quartz tube furnace and passed anhydrous hydrogen chloride over uranium dioxide. It changed from the white color that it was to a dark green, which indicates a chloride salt production. So we’re really pleased with that.

The next test that’s coming up involves our test vessel, which we had custom made of stainless steel with C276 Hastelloy inserts. That will be our next phase and that’s going to be starting in a couple weeks at the Savannah River. I’ll be out there to observe some of it, I hope. No problem. And that way we’ll be able to pull off some off gas off of this as well as insert the gases and stir the components as they’re melted. So we’re looking forward to phase two.

Phase three should be we get funded for it would involve actual using of vessels. As I described it’s pretty much like an intermediate size of a thermos bottle, you know, thermos with the liner in there so the C276 liner. So, we’re really looking forward to this. I can speak about it more, but I think I'm reaching my time limit. Thank you.

SIU: Thank you. Next is Mike Stake, also Metatomic.

STAKE: Mike Stake from Metatomic. And Ken did a really great job as far as describing the process. Thank you for the opportunity to speak to this Board. It's a very important topic for the United States. My name is Mike Stake, as I said, co-founder and Chairman of Metatomic. I'd like to speak on a perspective and paradigm shift regarding spent nuclear fuel or SNF. I also would like to refer to it as unused lightwater fuel or ULF. The focus is not on the approximately five percent spent, but the 95 percent of unused energy, the fuel that currently resides in all nuclear facilities in the United States.

Changes in Federal policies and in reactor design and construction have evolved in two new important ways that are game changers. First, standard designs are now available to allow nuclear plants to be built more safely, more quickly and less expensively than even in the recent years. Second, the processing techniques and the use of molten salt reactors make it possible to recycle the spent fuel rods now stored at nuclear power plant sites. Spent uranium fuel rods previously considered to be radioactive waste have 95 percent of the uranium's nuclear energy still in them. It is now possible to process the spent fuel rods and use them as fuel for a molten salt reactor to extract the remaining energy.

The molten salt reactor is not a new technology. Oak Ridge ran a molten salt reactor from 1965 to 1969 for 13,000 hours. This breakthrough does two great things. First, an improved version essentially burns off the radioactive waste. Second, it extracts a tremendous amount of additional energy from the spent fuel. Furthermore, it manages the radioactive waste without having to transport it to a place like Yucca Mountain.

As Ken referred, Metatomic is engaged in confirmatory research for this process, converting unused light water fuel to a molten salt fuel currently underway at the Savannah River Site. The Metatomic solution is to co-locate to existing sites to create molten salt fuel for fast molten salt reactors. By doing this it requires no new land acquisition, no new security or safety measures, no transportation through communities, thus, has a lower cost for energy creation.

The 100 years of power that exists untapped should be motivation to continue searching for better, more responsible ways to reduce and use the approximate 92,000 metric tons of unused light water fuel. Metatomic would like to work with DOE to address the liability that you had talked about this morning and produce future revenue. I would enjoy a greater conversation on this paradigm shift and creating energy from a national resource such as unused light water fuel. Thank you. Thank you for your time.

SIU: Thank you. Our last commenter is Peter Briger.

BRIGER: Pleased to be here. And pleased to hear what drove me here was the announcement about a week ago by the Department of Energy that it was going to set up a new program for what to do with waste. And I'm pleased to hear all the good work that’s been done by this group and by the DOE and the folks that are here. In listening to the programs it’s clear to me that the key point was the question of storage. And just as some of the other speakers said there are fundamental ways of dealing with and transformation of nuclear fuel in a safe and efficient way that puts the plutonium under the full control of the government and that permits the work that can be done with these huge deposits not only in the U.S. but the 30, what is it, million tons of plutonium sitting in the U.K.

Our company, Hydromine Energy is going into a project with a Korean company that has developed these ideas and we’re at a point that we can put them into demonstration. And some of the key points are really in terms of what to do about the future there’s been so much interest in using yellow cake to produce uranium 250. And under the technologies that our group has put together we don’t need to do that. We can go to uranium 280 and come up with 100 times more power than using this traditional.

So, we’re confident that there are a series of things that can be done to make the SMR program safer, not only from the standpoint of delivering energy, but in almost every sector of climate control. So, I'm optimistic that we can make the world cleaner, safer and we have some interesting things to do. And it was a pleasure to be here. Thank you very much.

SIU: Okay. Thank you. I understand that we have some comments on the web, and we will post those on our meeting record. And with that, I think we'll call it a day. Thank you again. We really appreciate your time folks in the audience and our presenters.