UNITED STATES

NUCLEAR WASTE TECHNICAL REVIEW BOARD

FALL 2012 BOARD MEETING

Wednesday

October 17, 2012

Hilton Garden Inn
700 Lindsay Boulevard
Idaho Falls, Idaho 83402

NWTRB BOARD MEMBERS PRESENT

Rodney C. Ewing, Ph.D., Chairman, NWTRB
Steven M. Becker, Ph.D.
Sue Clark, Ph.D.
Efi Foufoula-Georgiou, Ph.D.
Linda Nozick, Ph.D.
K. L. Peddicord, Ph.D.
Paul Turinsky, Ph.D.
Mary Lou Zoback, Ph.D.

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P R O C E E D I N G S

8:00 a.m.

EWING: Welcome to today's meeting of the Nuclear Waste Technical Review Board. My name is Rod Ewing. On September 26 I was designated as Chair of the Nuclear Waste Technical Review Board, and prior to that I had only served on the Board for a little more than a year, so I'm very new to this job, but I'm not new to Board activities. I looked back at my records and discovered that my first presentation to this Board was made in 1991, and at that time I had every expectation that we would have a repository and be disposing of waste, so I didn't expect over time to be standing at this podium. Nonetheless, I am very pleased and honored to be here, and I look forward to guiding us through today's agenda and particularly to interacting with the members of the public.

Also, on September 26 of this year eight new members were appointed to the Board, and most are here today with three of us who are ongoing members. We are all glad to be in Idaho Falls. Previous Boards have met here on several occasions, but this is the first visit for a number of the new members to the Board.

Yesterday we had a tour of INL, and I want to thank everyone who was involved in planning the tour and guiding us through the facilities. I've been to Idaho, or

INL, many times, and this was really an exceptional tour that we received; lots of exciting science and possibilities. I was really pleased to see some of the new analytical facilities and modeling capabilities that we were exposed to. So thank you very much.

I'll introduce the new members--in fact, all of the members of the Board--in just a moment; but, first, just a word about the Board and how I see our mission as we go forward. As I said, I'm new to the chairmanship of the Board, but I've been involved in nuclear waste issues for a long time; and I'm especially honored to be chairing the Board at a time when new options for managing spent nuclear fuel and high-level waste are under consideration.

Of course, during this time there are challenges to changing gears and going in new directions, considering new ideas; but along with those challenges come, I think, important new opportunities. The challenges are clear. Just by a quick recitation of our history, after characterizing the Yucca Mountain site for almost 20 years, the Department of Energy submitted a license application for a Yucca Mountain repository to the Nuclear Regulatory Commission in mid-June of 2008; and then DOE requested that the license be withdrawn in early 2010. Final court action on whether the NRC must reopen the licensing process is still pending.

A Blue Ribbon Commission set up by the administration to look at options for managing the back end of the nuclear fuel cycle submitted its report in January of this year, 2012. We are still waiting for the administration to respond to the recommendations of the BRC, and in Congress the Senate is considering legislation that would implement some of the Blue Ribbon Commission recommendations. The House of Representatives has reviewed the recommendations but has not decided what action to take.

So, in summary, for all parts of the system, action is pending, and it’s not clear which direction we’ll be going. So what are the opportunities in such a situation? From the Board’s perspective, I would say that we will continue to cast an independent eye on the technical validity of what DOE is doing to respond to the challenges that I’ve outlined just a moment ago. We can provide decision makers in the Department of Energy and Congress with unbiased technical information to inform the policy debate.

In my opinion, independent technical oversight and information has never been more important than during this period of transition in nuclear waste policies and programs. For DOE or whatever organization finally has the responsibility for waste management, there are plenty of opportunities to gain insight from the Blue Ribbon Commission deliberations, from the experience of the nuclear waste program in this country and from the experience of other countries with their own nuclear waste programs, and, finally, from the ongoing technical oversight that the Board provides. We will be establishing the basis for some of the Board’s technical findings and recommendations during our meeting today. And, in fact, that’s the purpose of these public meetings is to air important issues and obtain the information we need to frame our reports and recommendations.

Concerning the history of the Board, it was created in the 1987 amendments to the Nuclear Waste Policy Act. We know from the statute and legislative history that Congress expected the Board to evaluate DOE activities, provide ongoing technical advice, and report Board findings and recommendations at least twice each year to Congress and the Secretary. An important thing to know about the Board is that it is an independent federal agency. We are not part of the Department of Energy. We are not part of any other agency. We are in the Executive Branch. And if you’re interested in more detail, you can find additional information on our website, and there are Board reports and a brief fact sheet on the table at the back of the room.

Board members are appointed by the President to staggered four-year terms. The National Academy of Sciences nominates individuals to serve on the Board, and then the decision is made by the White House.

Let me now introduce the Board members who are here today. As mentioned earlier, this will be the first Board meeting for many of the members; and even the three of us who are ongoing members are relatively new to the Board, having been appointed just a little over a year ago. So, as a group, we'll certainly be approaching these issues with new perspective, new eyes, but we'll also rely strongly on the previous technical work of the previous Boards.

First I'll introduce myself. I'm Rod Ewing, say it again. I'm a professor at the University of Michigan. I hold appointments in three departments, the Earth and Environmental Sciences Department; in fact, I'm a geologist. The other two appointments are in Nuclear Engineering and Radiological Sciences, and the third appointment is in Material Science and Engineering. As I introduce the other members of the Board, I'd like them to raise their hand when I call their name, and then I'll give you just a little bit of information about them.

So Steve Becker. Steve is a Professor of Community and Environmental Health in the College of Health Sciences at Old Dominion University in Norfolk, Virginia. He was a member of an assistance team that was invited to Japan after the earthquake tsunami at Fukushima Daiichi in 2011, and Steve is a new appointee to the Board.

Sue Clark is a Regents' Distinguished Professor of Chemistry at Washington State University. She has served on numerous advisory committees. Sue is one of the veterans. She has been on the Board for more than a year, just a little more than a year.

Efi Foufoula-Georgiou. Efi is a Distinguished McKnight University Professor of Civil Engineering and the Joseph T. and Rose S. Ling Professor of Environmental Engineering and Director of the National Center of Earth Surface Dynamics at the University of Minnesota. She is a new member.

Linda Nozick. Linda is a Professor in the School of Civil and Environmental Engineering and Director of the College Program in Systems Engineering at Cornell University in New York. Linda is another Board veteran of a little more than a year.

The next three members are all new to the Board. Lee Peddicord. Lee has served as Director of the Nuclear Power Institute at Texas A&M since 2007. He has been a Professor of Nuclear Engineering at the university since 1983.

Paul Turinsky. Paul is a Professor of Nuclear Engineering at North Carolina State University. Since 2010 he has served as Chief Scientist for DOE's Innovation Hub for Modeling and Simulation of Nuclear Reactors.

Mary Lou Zoback. Mary Lou is a Consulting Professor in the Geophysics Department at Stanford University. She is a seismologist and a member of the National Academy of Sciences.

The new Board appointments were made so recently that it has been difficult for several of our members to change their schedules to attend this first meeting, and at least one member will leave a little early today. That’s Sue Clark. So if you want to bend her ear, grab her at the next break.

For two of our new members, Susan Brantley and Gerald Frankel, it was impossible to overcome previous scheduling conflicts, and that prevents them from being here today.

And another new member, Jean Bahr, who had planned to be here, has had a small accident, and she’s at home recovering. Jean is a Professor of Geoscience at the University of Wisconsin in Madison. She is also a member of the Geological Engineering Program and is a faculty affiliate of the Nelson Institute of Environmental Studies.

Susan Brantley is a Distinguished Professor of Geosciences at Penn State University. She also serves as the Director of the Earth and Environmental Systems Institute, and she was recently appointed to the National Academy of Sciences.

And Jerry Frankel is a Professor of Material Science and Engineering and Director of the Fontana Corrosion Center at Ohio State University.

We look forward to seeing all three of these members at our next Board meeting.

All of the Board members serve part-time, but the staff is full-time, so they provide important continuity and technical support to the Board. The technical staff are seated in the row against the wall to my left.

Now that we've finished the introductions, let me say a few words about today's agenda. The meeting has two distinct but complementary parts. In the morning we will discuss transportation and packaging of spent nuclear fuel, and in the afternoon we will focus on DOE's work related to the thermal effects of storing and disposing of the waste, as well as the classification and treatment of some of the defense wastes that are destined for disposal in a deep geologic repository.

To give you a little more detail on the morning session and then the afternoon session, the first thing to say is that the panel discussion that was so carefully arranged by Dan Metlay has suffered from a continued loss of panel participants. And so at the appropriate time I'll rely on Dan to give us the current state of play in terms of participants. That panel, which will be presented successfully, I’m sure, will be followed by an update of activities and plans of the DOE Office of Used Fuel Disposition. This has always been an important part of our meetings. We will then hear about the Used Fuel Disposition architecture structure that is being conducted at Argonne National Laboratory, and the last presentation before lunch will be on issues associated with transporting orphaned spent fuel from a shutdown facility to a consolidated storage facility. This, of course, is of great interest to the Board and quite timely.

After lunch we will hear two presentations on thermal issues related to storage and disposal of spent fuel. Of particular interest to the Board is the evaluation of the disposal waste package designs. In January of this year at a Board meeting in Arlington, Virginia, we heard from DOE about generic work being undertaken to model the disposal of spent fuel in repositories situated in clay, crystalline rock, and salt. Those designs involved closed repositories, which seem to necessitate the use of smaller waste disposal canisters, at least with clays and crystalline formations as host rocks. Today we will hear about DOE’s generic design work for open repositories, which may permit disposal of larger waste packages.

Following these presentations we will hear about two INL projects to treat defense waste for disposal. We have asked DOE to focus particularly on the classification of the sodium-bearing waste so that we can determine whether this falls within the Board's mandate for review.

We have scheduled time for public comments at the end of the day. This session is an important part of the Board meetings. If you would like to make statements or make a comment, please enter your name on the sign-up sheet at the table near the entrance to the room. If you prefer, written remarks and other materials can be submitted and will be made part of the meeting record. Oral comments will appear in the transcripts of the meeting. All of the Board transcripts and other meeting materials, including written comments or statements, are posted in the Board's website.

At this point I need to remind you that the Board members in our discussions and with our questions will freely express their personal views and opinions. We want to continue this practice--it's been the practice of earlier Boards--but we also want you to know that our comments during the meetings are not official Board statements. When a Board position is articulated, we will make that clear. And, in fact, we make it clear by making those statements through our reports and letter reports.

As usual, to minimize interruptions, I ask you to turn off your cell phones or at least put them on silent mode. I also want to remind you that it's very important that when you stand to speak that you identify yourself and your affiliation, because this is critical to the proper transcription of what’s said. And please speak to the microphone so that we have a well-recorded and complete transcript of the meeting proceedings.

With these preliminaries out of the way, I think we’ll move directly to the panel discussion. But, as I said, before we start the panel discussion, I’d like Dan to give us the present state of play. Okay. So thank you very much.

METLAY: As I’m sure everybody in the room recognizes, the four State Regional Groups reflecting the Northeast, the South, the Midwest, and the West have played an extremely important role for more than 20 years in interacting with DOE to reflect upon an appropriate way to transport radioactive materials, both in the case of WIPP and in the case of Yucca Mountain. We thought it was appropriate, given the recommendation of the BRC, to develop in the near term a full transportation system to get representatives from these four Regional Groups to talk about their views of the BRC recommendations and how those recommendations might be implemented.

Three out of the four groups accepted. Unfortunately, within the last ten days, two out of the three, for very good and important reasons, were unable to attend; and so our panel of three had dwindled to a single presenter of one, Jim Williams representing the Western Interstate Energy Board. We were very fortunate that both Jeff Williams from the Department of Energy and Earl Easton from the Nuclear Regulatory Commission have agreed to step in and give some impromptu comments on the role their agencies have had with the State Regional Groups.

So I guess with that introduction, perhaps Jim Williams could come forward.

JIM WILLIAMS: I'm Jim Williams. I'm with the Western Interstate Energy Board. That's what WIEB stands for. You know, all of us really appreciate the invitation to the so-called State Regional Groups, and I regret that I'm the only one that was able to show up.

I want to discuss three items. Our response to the question implicit in the title for this session, the State Regional Groups' Views on the BRC Recommendations on Transportation, is one. Another is that I'd like to go through the meeting that we had just last week and its purpose and its topics and give you a sense of what we discussed there. And then I want to spend a few minutes on a notion that came out of our meeting the previous week with the DOE in D.C. on how states and a federal agency should proceed with transportation system design.

Before I do that and since the others are not here, I wanted to report briefly on the meeting that we had with the Department of Energy on October 3rd and 4th. Jeff Williams ran the meeting with the help of Corinne Macaluso and Alex Thrower, who is on the BRC staff, and Judith Holm, who has masses of experience in certain aspects of this program; Elizabeth Helvey, who has chaired a lot of the Section 180(c) work. Monica Regalbuto was there, and we appreciated that very much. And Pete Lyons stopped in for 45 minutes and had a good discussion, emphasized the uncertainty that the DOE is in at the moment, but also expressed a lot of knowledge of our process and support for our process, I thought. So I thought--it was a two-day or day-and-a-half meeting. I thought it was an excellent start to a partnership process, and we hope to repeat that in some way on some regular basis.

Okay, now--the next one, please.

As to the WIEB views on the transportation recommendations adopted by the BRC, here are, I think, a summary of what our views are. We're for them, and we're for the BRC recommendations generally. We advocated for them, both in several presentations to the BRC and in our comments on the draft report and in a special regional meeting in Denver that the BRC had to discuss their draft report. So we want to work with DOE-NE and any successor agency to implement these recommendations. And that is the subject of my third topic, and I'll get back to it in a little bit.

We have lots of thoughts on particulars and linkages. These come from people on our committee, some of whom helped create the WIPP transportation model, a key model of success, and others who have 15 or 20 or 25 years' experience dealing with transportation issues from state points of view and from the perspective of effective states and communities.

We have a broad view of transportation, not just routing and operations, but it includes cask design, modal choice, acceptance order, even storage policy, and we are trying to think through with everybody else kind of an integrated approach among these things that addresses this issue. As I mentioned, we had a pretty fully-loaded meeting last week, and I'll get to that in the next slide. And we are expecting our inquiries to proceed on two paths that we will, I think, definitely consider related to each other, not separate and distinct from each other, one regarding the orphan sites and removal from them and the other regarding removal from still-operating sites. Okay, next.

Quickly about the meeting that we had last week, it was a day and a half, plenty of discussion. Corinne Macaluso attended and contributed. The first part of it had to do with the status of the nuclear waste program in reformulation. For the BRC findings and recommendations, we had a review--a good review, I thought, from Alex Thrower, who was on the BRC staff. On the litigation on the waste confidence, the fee, the mandamus suit, we had Mike McBride, who is with Van Ness Feldman, who was the BRC’s, kind of, go-to law firm on legal issues. On legislation we had Sam Fowler, who is chief counsel for the Senate Energy Committee discuss some of the background and the choices made during the development of S.3469. On regulation we had the estimable Earl Easton, who pulled out a flip chart and began explaining to us first principles of various issues, and I thought it was great, but we need more of it. And on the DOE-NE initiatives we had Corinne Macaluso, who also contributed in other parts of the meeting and on topics, some of which, I think, Monica will talk to you after this session.

The second part of the meeting or the rest of the meeting was a--we organized around the National Academy’s recommendations from 2006. Why did we do this? It provides a comprehensive list of basic issues, and I’ll show you how we worked our way through them. And so it establishes, we thought--we still think--a pretty good framework for looking at the total issue rather than pieces of it and also because the BRC generally adopted these recommendations, although they did not get into detail. Transportation came up rather late in their process, possibly to some degree at our insistence, and so they did not elaborate on that in the way that they did on consolidated storage facilities and consent-based siting. We approve. So we understand that.

At the bottom here, the way we worked through those issues is sort of asking ourselves three questions. Should these recommendations from the National Academy be a part of spent fuel/high-level waste transportation system design at this point? Our answer is generally yes. Next, what questions and issues must be addressed in implementation? And there are lots of those, and the discussion brought up more topics for us to get to a comfortable understanding of than we will be able to address, and we are trying to digest and assess that now. And then, what directions and priorities does all this suggest for us in our efforts over the next couple years? Okay, next one, please.

And so this is the way we worked through the recommendations. On each of these categories we had a committee member lead the discussion. First was--well, we had to have Bob Halstead on two of them, cask design and testing, Bob Halstead. Same with modal choice and acceptance order. On route assessment and selection we had Fred Dilger. On transportation operations, including 180(c), we had Anne deLain Clark, who is from New Mexico and has been dealing with those types of issues from a WIPP perspective for a long time; transportation security, Rich Baker from Arizona; and organizational structure, Connie Nakahara, from Utah. And so laying that list down the top row we are thinking that we might organize or at least consider in our organization how these issues relate to removal from shutdown sites, number one, and later from operating sites.

Okay. I want to now go to the next slide and touch on one topic that came up in our October 3rd and 4th meeting with DOE-NE, which involves not just what choices we make with regard to transportation, but how these choices are made, by what process, and based on what values. This, in my mind, stems from the key principal finding from the National Academy report in 2006, which reads, “There are no”--well, my assembly of it for this purpose, “There are no fundamental technical barriers to the safe transportation of spent fuel and high-level waste; however, there are a number of social and institutional challenges, and challenges of sustained implementation should not be underestimated.” We agree with that statement and think it has pretty many implications.

And so in our meeting on October 3rd and 4th we raised the idea of what this implies for the federal-state transportation process now underway. And our, sort of, question to ourselves is: What happens in hundreds of corridor communities potentially that are facing perhaps 50 years of spent fuel/high-level waste transportation? Well, at that point, when that goes down to the community level, will the federal agency be on its own on the stage, or might states and localities be willing to join the federal agency on the stage? And if the ambition is to do the second, then we should consider that right now; and we have tossed out a few ideas about how to formalize that idea. One has to do with the partnership purpose, the idea that the federal agency and states begin and continue in partnership in this and hopefully wind up in partnership on transportation system design.

Another has to do with the potential Achilles heel that the transportation component poses to the entire program. And when I think about it, I think that certainly origin sites and the few consent-based destination sites will understand the role of transportation and the need for it even if they are uncomfortable with it. Not true for hundreds of communities along corridors. So those communities are going to have to weigh a somewhat abstract national need against a threat impositioned on them personally, and so we should understand that at the outset.

Another has to do with risk perception and the response to risk perception. We think and agree with the National Academy that there are no fundamental technical barriers, but that does not mean that perceptual issues can be washed away. And it also suggests to me some kind of key thoughts about how we should communicate all this, not by trying to convince people of the risk of zero, but acknowledging the residual risks, discussing ways that we have addressed them, and not by trying to convince people that these risks are somehow less than some other risks that they currently bear.

Then we get to the list of best business practices that might be considered to ensure safe and uneventful transportation, and it is a--well, you see the list: full-scale cask testing possibly as part of a comprehensive program, comes right out of the National Academy; shipment of older fuel, which the National Academy recommended, while maximizing transportation efficiency, and we'll need to be thinking and getting input on that; shipment sequencing from individual and sub-regional reactor sites; full implementation of the dedicated train decision, we had considerable discussion about what that exactly should mean; use of advanced monitoring and tracking tools and advanced route assessment tools, this may suggest some break from the--or some new thoughts about how DOE should procure technology for transportation purposes; and communication processes, at the moment I've forgotten exactly what the heck that meant.

Anyway, the whole thing arrives at an understanding about the somewhat complicated cost component of the transportation program, in which best business practice means a lot of things that may or may not go beyond regulations;

and some of those things will involve what may be interpreted as additional costs but that very likely those additional costs are minor, even trivial, compared to the costs of contention and delay and, you know, not just in the transportation program but in linked aspects of the program such as DOE’s ability to accept this fuel and get over the breach of contract judgment.

And so that leads to an idea about what DOE or its successor agency needs to be able to carry out this mission, hopefully in partnership with states; and they will need consistent and adequate funding over long lead-time. They will need reliable agency support for key things necessary to implement a best practice transportation program. That means support of the Department and the administration in Congress, and it may--and that’s not necessarily an easy one, but I would argue that the Agency responsible for this needs to not be at the whim of politics of the process, and they need to recruit and retain top-flight people. So the status of this is very preliminary, and it’s going to be reviewed by us over the next months.

So the next one is questions.

EWING: Thank you very much. We’ll follow our normal procedure where I’ll first ask whether members of the Board have questions. Any questions from a Board member? Yes, Mary Lou.

ZOBACK: Mary Lou Zoback, Board member. Thank you. That was a very insightful, thoughtful presentation, and my only question is: The “we” that you use, were you specifically referring to WIEB, or do all the State Regional Groups get together and discuss this among themselves? And the meeting with DOE, was it just WIEB or was it all the groups?

JIM WILLIAMS: It is all the groups, and this one stemmed out of the October 3rd/4th meeting with DOE-NE in D.C. And at that meeting all four groups were represented, me and my counterparts in the other regions, and each of us brought a couple of our key committee members to the meeting. And, as I say, I thought it was a great meeting. I mean, if you’re talking about the particular vision or charter or the ideas for that, that came up, and it’s very much in its preliminary stages. But a lot of these things, the states generally agree. They, I think, strongly agree about working towards a partnership process; but there are, of course, regional politics that intrude on all this, and we don’t agree on everything. But we, I think, do agree--you know, I may be out of turn, but we do agree that we need to work among ourselves and with DOE and thrash those things out. And to do that we need to bring along our members, so at the moment we have--let’s say, among our eleven states we have five that are representative by people that are steeped in this stuff, steeped in it.

Others have other day jobs and are trying to get on board. Well, you know, that's where I am supposed to be of some help. Frankly, they need to be active in decisions that we make within WIEB and in interactions with other State Regional Groups, but I think that we can get there. But I personally think we sort of need a charter for the process, and that's why I brought this thing up at the end even though it's a preliminary set of ideas.

ZOBACK: I appreciate that. So do you think in the end that this sort of vision that you outlined on the final slide would be adopted by all the different State Regional Groups?

JIM WILLIAMS: Including DOE-NE.

ZOBACK: Yeah.

JIM WILLIAMS: I mean, they are--

ZOBACK: Oh, no, right, they're the partnership; right?

WILLIAMS: Yeah, right, right. That's where we're all heading.

ZOBACK: Okay, fantastic. Thank you.

EWING: Linda.

NOZICK: Nozick, Board.

JIM WILLIAMS: Hi.

NOZICK: Hi. I was wondering if there's any particular actions you think that would be effective beyond those categories in bringing these corridor communities along? Is there anything particularly that you’ve seen over the years that’s been left out?

JIM WILLIAMS: I sort of have to go back to first principles on that. One of the things that the State Regional Groups bring to the process is that we have members from each state or in many cases a couple of members from each state. So I think that we need to conduct this process--I mean, actually, I think that’s sort of a metaphor of the idea of when this hits the fan in Chicago or Omaha or some other community, is the federal agency going to trot out there on their own? You know, this is a disaster, a potential disaster to the program.

And so I think that the way to get around that is to have a sort of partnership purpose starting now and build towards that and not pretend that there are any quick fixes in these communities. But to really understand--and I mention this--that in dealing with these communities, it’s not going to--in my view, I would start by not assuming that we can convince a community that this has no risk. Don’t even go down that path. Say that there are these risks, here they are, and then say here are some things that we are considering doing to limit that risk to the appropriate minimum. I mean, I fully believe myself that the health and safety risks of a gasoline truck are probably considerably higher than that of a nuclear waste cask on a technical basis.

But the risk perception component of this cannot be washed away, and we shouldn't assume that it--it would be at our peril if we assumed it could be. And oftentimes in the technical process, you know, I mean, I think the NRC is subject to this, because they do, as an agency, make their decisions on a technical basis. They need to. But in dealing with communities on this, we shouldn't do it. We should be much more careful about how we approach them, engage them. You know, it's not a small task that we're talking about here. That was only partly responsive, but I think basically so.

NOZICK: I was wondering, any discussion of fairness or why my community versus your community? Any ideas along that--

JIM WILLIAMS: I don't have a solution for--well, I do have some ideas.

EWING: Before we go further, I'd like to get the other two presenters in. Do you have a question?

BECKER: Yes.

EWING: All right.

BECKER: Steven Becker, Board member. I too have very much enjoyed the presentation. There is now a pretty large body of research that suggests, not surprisingly, that from the public there are concerns around these issues--all-around issues of health and safety. And that same body of research also suggests that they tend to look to local and state health departments to provide information to them that can be trusted. What role do you see in this partnership for the local and state health departments?

JIM WILLIAMS: That they are brought in and--well, the anticipation of bringing them in is there right now, and they are brought in via states, and that it is true--or I agree with the results of the research that we need the fire chief and the police chief up there saying that they think they understand this pretty doggone well, they understand how they would deal with the contingencies, and be willing to say that, okay, that's how I back up to partnership process beginning now.

EWING: Right. Another last question, Lee.

PEDDICORD: Yes. Lee Peddicord, Board member. You had mentioned the past experience with the WIPP transportation model, which you characterize, you felt, as being successful. With regard to your last slide and those issues you laid out--that's the one before--are you all going to get a chance either within WIEB or your colleagues, your peer organizations, to go through and assess these issues against the WIPP transportation model, see where these were met, where there might be actions taken, and so on, and meet these objectives?

JIM WILLIAMS: Yeah, and the answer is, it’s engrained in our members who were there at the design of this and have been part of the implementation of it. What we do have on our agenda is a sort of a careful review of how the so-called WIPP transportation model adapts to spent fuel and high-level waste, which has a lot more radioactivity, more rail transport, other key differences.

PEDDICORD: And that seemed to be a fairly well-defined set of corridors that are going to be replicated many more times in addressing spent nuclear fuel.

JIM WILLIAMS: Those corridors were negotiated with states by, actually, a few people from the Department of Energy, one of whom is named Ralph Smith, who actually engaged with states over about a nine-year period. And he was a great person for states to deal with and didn’t give up on a thing, but he was a good person to work, and that work occurred over a long period of time with agency support up above. So Ralph could go to Larry Harmon or whoever and get some scope for his negotiations.

EWING: Okay. I think we need to move on. Thank you very much for the presentation.

What I’d suggest is, we have pressed into service a DOE and an NRC representative, so I’d ask them to take just five or ten minutes to respond and comment, and then we’ll have questions from the Board and staff. But I want to leave time for questions from the public at the end.

So Jeff Williams from the DOE. Jeff is the Director of the Nuclear Fuels Storage and Transportation Planning Project.

JEFF WILLIAMS: Thank you. Yeah, this was just some impromptu remarks, and I just wanted to say that the BRC recommended that we start this process back up with the Regional State Groups. This was not part of NE's R&D portfolio when we started our program. It was just July 11th that we established cooperative agreements with the help of our procurement people in Idaho, which was a new thing to put these groups in place, and we really do look forward to interaction.

The one point that I think we made, Pete Lyons made, and I made it as well is that we're not the same as RW was two or three years ago. We have a fraction of the resources, we have a fraction of the staff, and we're not going to be able to do the same things that we were able to do before.

And also the other point that we stressed at that meeting is that that there is a good bit of uncertainty. There were a lot of requests for, okay, well, this time let's establish this and let's not have it pulled and tugged by the administration's policies. However, we're really not in a position to promise anything like that. So we've started this; we're trying to take this in little bits and pieces at a time. I think one of the major things that we would like to work on in the near term is this 180(c) policy and procedures, and probably to many of you on the Board this is new foreign talk. As a geoscientist it took me several years to learn all these things about transportation as well, but 180(c) is providing--it's required out of the Nuclear Waste Policy Act to provide funds to states and tribes, funds and emergency response training.

The Office of Civilian Radioactive Waste Management had published in the Federal Register a policy three different times with comments they were moving forward with putting this in place when the program was defunded. So that was one of the major things that has been recommended to us, and we do try to--we are hoping to get that completed this year.

I think Jim's ideas about forming partnership is a great idea, and I just hope we can do that with what we have. And maybe the project will grow and develop into something where we can do that. But with that--and he did talk about developing a full transportation program. We're just not prepared to do that right now with the people and the staff and the focus where we are.

But with that, I'll stop and let Earl--or if you have any questions for me.

EWING: So, quickly, are there questions from Board members? I have in mind at the end we'll have all three available for questions.

All right, thank you.

So we pressed into service in the hallway early this morning from NRC, Earl--I'll confess, I don't know your last name. It all happened so quickly. But we appreciate your being here, so introduce yourself, please.

EASTON: My name is Earl, Earl Easton. I'm with the U.S. Nuclear Regulatory Commission, and I'm in the Division of Spent Fuel Transportation and Storage. I've been there longer than I'd like to admit; started in 1982. I've had the great honor of attending all the state meetings since April 28, 2004. You can ask me why that's an important date and remember that date later. But, I tell you, the NRC has found this very, very valuable. And let me give you a few reasons why we have found this interaction very, very valuable.

If you look at the safe transportation in the U.S., you'll find it's a partnership. It's a partnership primarily between the Department of Transportation, who deals with carriers; NRC, who deals with packages; and states, who deal with state and local conditions. It's a partnership. We have to make sure all the partners know what each other is doing and hold each other accountable for those roles assigned. When you look at shipment of stuff like transuranic to WIPP of our spent fuel to Yucca Mountain, you throw in another partner, DOE. DOE is both a regulator and a user, so sometimes they sort of have both roles. So it's important, we think, to get all these parties together to sort out the roles and hold each other accountable for each of their roles.

Be aware that commercial shipments are shipped differently than government shipments. Under the old Yucca Mountain plan, DOE had security responsibilities. If our licensee which are a public utility would ship, NRC has the regulatory authority. Sometimes this can be confusing to states. There's a dual system, although DOE committed to using the NRC or NRC equivalency, but a lot of times this is confusing to states. We are in the process of changing transportation security rules, so we try to go out and make sure the states allow and participate in that project.

This is a little disjointed just because it is.

Also, we have sort of piggy-backed on this process to enable us, the NRC, to proactively deal with the states. I give a lot of credit to DOE, who set up these groups. We didn't have a forum, really, to deal with states in transportation on a quick, effective method. We sort of honed in on it. We thought it was so valuable that when Yucca Mountain funding went away, the NRC actually jumped in and provided bridge funding to keep the groups viable. We view it’s that important.

One of the reasons--Jim mentions the NAS study, which was a comprehensive look, 2006, at transportation in the U.S. NRC, DOE, DOT were co-sponsors of that study, and we felt ownership of that study. So there were a lot of recommendations that came out of that study, and I’ll pick three in particular that the NRC assumed ownership of. And that was security because for commercial shipments, that’s ours; how does full-scale testing fit in, because we certify packages; and one of the recommendations was long-duration, fully-engulfing fires. They had some questions. So we have just done five, six years of studies on long-duration, fully-engulfing fires. They’ve all been put out for public comment. They’re all being documented. They’re all being finalized now.

Lastly, because I don’t want to take up too much time, we have a lot of issues coming up. How are we going to license high-burnup fuel for transportation? If we change the way we license stuff, we want the state to understand that they are partners in the regulation of transportation. Waste confidence, which is an environmental impact statement that we have to determine what the impact is from long-term storage and subsequent transportation, we want to get the states involved. We may use this as a forum.

Also, we know that there are some activities on the horizon such as Carlsbad. Carlsbad may very well propose an interim storage site. We will probably be the person who licenses it. But before we get to the licensing phase, we may want to have a series of public meetings. The NRC would support public meetings when it came to transportation and explaining the storage regulations.

So I just wanted to end up with a few notes, and these are sort of in response to the questions. I would rather have answered the questions and actually given a presentation from the ones you asked Jim. I found that working with all four State Regional Groups, each one has its own personality and each one has its own priorities. But there are a common core of priorities that they have come together and actually work out. But within their groups, they each have different priorities.

I found it particularly pleasing in the spring when the State of Oregon went out and did a series of public meetings within the state on transportation safety, and a lot of the material that was used is material that was supplied by the NRC and which we dialogued and explained. And so we sometimes would like to see more leverage so that the states understand our role and can talk to a more immediate audience. And so that’s another value we look in this group.

With that, I’ll sort of cut it off. I know we’re running short of time.

EWING: Okay, thank you very much. But stay up front, and I'd like to ask the previous two speakers to join the panel, and then I'll open it up to questions. So first questions from the Board?

Okay. Questions from the staff? Yes, Doug.

RIGBY: Doug Rigby, staff. This is a question for Earl, NRC. I was wondering if in the environmental impact statement, this new work that's going forward now, you just mentioned that, in addition to extended storage, the subsequent transportation, is that an explicit part of that environmental impact statement, the transportation part?

EASTON: You're referring--

RIGBY: Your waste confidence--

EASTON: --to the waste confidence.

RIGBY: Right.

EASTON: I really--

EWING: Please identify yourself before you speak so--

EASTON: I'm Earl Easton with the Nuclear Regulatory Commission. I really can't get into many of the details. As you know, the Commission is now manning a separate group to do waste confidence and sort of strategizing what is going to be in there and at what level we assess the impact. And I can only say, as a commercial, stay tuned. And for the details we'll be doing scoping meetings, we'll be doing outreach meetings, and one of the things that we're looking at is extended storage and does that have impacts on transportation. But this is primarily, I think, going to be focused on storage.

EWING: Yes, Efi.

FOUFOULA: Foufoula, Board member. So you mentioned a nice example of the Oregon state to understand the role of NRC. What role does Energy take to involve the states in that understanding?

EASTON: Well, the particular example is, the representative from Oregon that attends Jim Williams' meeting, Ken Niles, he was requested to do a series of meetings throughout Oregon on transportation of waste, mostly with Hanford. And so he actually called and asked certain questions, how would I explain it, what videos do I have, what presentation materials. I talked them over with him on the phone. This was part of his presentation. But that would not have happened, I would guess, if we hadn't proactively dealt with the states over a period of ten years. I mean, Ken first had to trust me that I was telling the truth; right? The videos I gave him, he had to be able to explain the context of those and believe those. So that's part of the role. We go out and explain what we do in this partnership. We also try to get the states to tell us what they do as part of the partnership. Did that answer--

FOUFOULA: Sure.

EWING: Are there are comments along the same line responding to that question from the others? You needn’t, but just checking. Other questions from Board or staff? Yes, ma’am.

ZOBACK: Yeah, Zoback, Board member. There is a subtext--and I’m just going to ask the question since I’m new to the Board. Has DOE previously been providing the funding for the State Regional Groups? And now NRC is? Is DOE going to take that back up?

JEFF WILLIAMS: Okay, yeah. What’s happened is, DOE initiated this in the 1980s, and we provided funds through these four groups and other groups as well. Indian tribes, which we would like to bring in, we just don’t have the resources yet, but we’re trying to figure out how to do that. But we did that from the 1980s through 2009 or ’10, whatever it was, when the Office of Civilian Radioactive Waste Management was defunded with the withdrawal of the license application. When the Blue Ribbon Commission did their report, they stressed the importance of planning for transportation, and they stressed the importance of dealing with the states, and they encouraged DOE to start this cooperation back up.

And so we did put that in place this year, July 11th. We have now provided funds to four Regional Groups. We, the Southern States Energy Board, the people who would have been here if they would have come. And so this is just something brand new we initiated, and then we had this kick-off meeting with them October 3rd and 4th. So that was our first reengagement with the people--

EASTON: And just so there's no misunderstanding about the NRC funds, when the OCRWM program disappeared and the funding went way down, the NRC viewed this as such a valuable resource that we sort of said, well, when will Jeff Williams be back in business? We guessed three years, so we fought to get three years of funding. It wasn't at the same level that these guys can provide, but we fought to get three levels of funding as a bridge, not loan but a bridge.

Now Jeff's back in the game, we'll sort of retreat to the sidelines. Because, remember, this was set up by DOE to coordinate DOE shipments, and we didn't want to crash the party and take over, you know, all that, so--

ZOBACK: No, but I think it's admirable that another federal agency would step up to do this. That's the kind of cooperation we need to see in government.

JEFF WILLIAMS: I did want to add one other thing. There is another part of DOE called the Environmental Management, who is responsible for WIPP shipments, who have also stepped in to kind of fill that void in the meantime.

JIM WILLIAMS: Just a quick comment. When our funding crashed in May of 2009, crashed to zero, our committee at that time decided not to disband but to continue. And on the idea that just because the OCRWM program crashed, it does not mean that there aren't plenty of issues, some coming out of NRC, some coming out of others, that require attention and some response. And so we've kept in business over these three years. We are the same committee, same chair, same key members as we were three years ago; and in the interim, you know, I've been sort of in the uneasy position of working without funding, but it's been drawing on, you know, reserves and other kinds of catch-as-catch-can plus Earl's funding last year. So we've kept in business, and so this is a reactivation meeting, not a start-up.

ZOBACK: And I again want to applaud the State Groups for staying engaged in the problem over this transition.

EWING: So let me ask--actually, I want to be sure to let the public comment if they want, and I'll come back to you later.

So are there any questions from the audience? Yes. And please identify yourself.

TREICHEL: Judy Treichel, Nevada Nuclear Waste Task Force. I think with this whole issue of transportation, once you get to the public, you're going to be hit with the question about how you're beginning at the middle or possibly even the end and not at the beginning; and they're going to want to know how you made the decision to transport at all.

Was it because somebody just said get this stuff out of here, or what was the reason for that? And how did health and safety of the public get enhanced because you transport it? And that's going to be something that the partnership, all the players, are going to have to answer; and you're going to have to answer it throughout the whole system and why that decision was made.

JEFF WILLIAMS: And I'd like to say that the decision has not been made. I mean, this was in the recommendation of the Blue Ribbon Commission, and they said that in the near--their recommendations were to move forward on interim storage, and their recommendations were to move forward on planning for transportation, get the continual repository program moving, and that a new organization should take over the responsibility for this and that in the near term the Department of Energy should do some initial planning. And I think, as you know, there has been no administration position yet on the Blue Ribbon Commission report, and there's been no public decisions. So in the near term--we're in the near term planning stages with the little bit that we can do at this point in time, so there's been no decisions made.

TREICHEL: Yeah, okay, just keep that in mind when you do decide.

EWING: Okay, thank you. And we have one last person here. This will be the last question.

HOFFMAN: Thank you, Mr. Chairman. Mike Hoffman. And I represent Lincoln County and White Pine County in Nevada. And I guess my question is just perhaps for any of the panel members. We heard earlier that the trust and confidence on transportation has a lot to do with trusting both our health and safety officials. The emphasis of this transportation plan is now and always has been on State Regional Groups. The BRC clearly recognized that local governments play a key role in getting a solution for radioactive waste management. I'm wondering if the three of you or any of you have thought about how to engage local governments, because they do not share the same opinions as their states, and oftentimes state benefits and state health and safety kinds of focuses do not trickle down to local governments. And I would think that the National League of Cities or the National Association of Counties might be good entities to bring into this process and get some local government perspective. I'm curious if you've thought about that.

EWING: Whoever answers, briefly, please.

JEFF WILLIAMS: I'd say, yeah, we certainly have thought about that. However, without a place to go and a decision on whether we're going, we have nowhere gotten near that point in time. However, with the possible potential focus of shipment from shutdown reactor sites, it is possible to better focus that and deal with the locals on that level of routes out of that place. But we're just not to that point at all in this program.

EWING: And Earl from the NRC.

EASTON: We do have examples where we've reached out and tried to help more local communities. It's usually when we're asked to assist. I would cite an example in Wisconsin when they're shipping university fuel. And they were sort of bewildered by the security system, so we got a request in from the state, and what it ended up is we had a meeting with all the local law enforcement and emergency response people along the route. We got them all together in one location and went through the route, and everybody was allowed to ask questions and talk about resources. And we support that, but we have a finite budget, which is funded by license fees, and it's impossible for us to go out to every locality. That's one of the reasons we picked on the State Regional Groups, because they're already in existence, they're a cheap resource for us because they're already there, and we sort of depend on the states sort of doing the next level of outreach and getting back to us with requests.

Now, I understand states have a split personality, and I mean that in a good sense. We're partners with states; we're co-regulators in transportation. But we realize there are some states involved in licensing actions: PFS, Private Fuel Storage, in Utah, Yucca Mountain in Nevada. So sometimes their state representatives take on different roles, and sometimes they are hard to distinguish.

But these State Groups are really to focus on the cooperation, the partnership, from the NRC point of view, because we have a process to do licensing. So I know sometimes, I guess, some localities and certain areas sort of get neglected, if you will.

EWING: This is the closing comment.

JIM WILLIAMS: Well, Mike, I take your point, and I think we need to do more of that. I also point out that at this meeting last week we had representatives there from Nye County and from Eureka County in Nevada, and they were participating throughout.

EWING: All right. I'd like to thank our panelists, particularly those who were pressed into service, particularly Earl. I have the feeling he was just passing down the hall. No, this has been excellent and, I think, to everyone's benefit. To those who may have additional comments or questions, I'd remind you that we have time at the end of the day for further discussion. So thank you very much.

So the next presentation is by Monica Regalbuto, Deputy Assistant Secretary for Fuel Cycle Technologies, and she'll be providing an update on activities of the Office of Used Fuel Disposition.

REGALBUTO: Good morning. I am very pleased to be here speaking to you about the recent activities of the Office of Used Fuel Disposition. A special welcome to all the new Board members. We do look forward to working with all of you. And I particularly want to acknowledge the NWTRB, DOE, NRC, and other federal agency staff, which really are the group of individuals who bring continuity and corporate knowledge to our programs. We would not be where we are today without the hard work of these individuals, as we have gone through so many changes over the years--well, not that many years, I guess. It seems like a lot of years--over the last couple of years.

Just as a little background--and I know the previous panel touched on this--when the Office of Civilian Radioactive Waste Management was terminated, its functions were relocated to various DOE offices. Specifically, the research and development functions were transferred to the Office of Nuclear Energy. Other functions were transferred to the Office of General Counsel, Office of Legacy Management, Office of Environmental Management, and so on. So what you’re looking today are the functions that were transferred to NE, but there are other pieces of OCRW that are in various sections of DOE. So just keep that in mind.

In this slide we show the latest organization of the Office of Nuclear Energy. The research and development functions are located in the Office of Used Fuel under the Fuel Cycle Program, which I lead, and you will see that we're NE-5. Planning Projects is shown in the little dashed box, and we'll elaborate a little bit more on that. And then the NE-53, which is the Office of Used Fuel, it's the research and development area.

Moving us a little bit forward--before I go there--I'm sorry, I moved too fast. We also have an area embedded in here, which is the NEUP programs, which is the Nuclear Energy University Programs. Some of you may be familiar. That is an independent part from my organization, which is NE-5, where we run the university program to--you know, we normally take 20 percent of all of those budgets and move it into the university program, and that's a competed (phonetic) program that is run every year. We have integrated research areas. Those are bigger grants. And that's where we go and select new ideas from the university community.

The Fuel Cycle Technologies Program seeks to balance both near-term and long-term objectives. The near-term objectives are listed on the left-hand side for you, and those are listed in the red box. In that area we support the nuclear power of today. Specifically, we address two big areas. One is storage and disposal of high-level waste and used fuel, and the other one is accident-tolerant fuels, which is a program that we initiated after the Fukushima events.

On the right-hand side you're going to see the longer-term programs, and in that we focus on alternative nuclear energy systems of the future. Specifically, we look at different cycle options. We have a system study that is currently underway. We finished Phase 1 for that. In Phase 1 we looked at different parts of fuel cycles for the future. Phase 1 did not include the repository waste forms. Now we're starting Phase 2, which includes waste forms and repository; and we are looking at all those options. The main emphasis on the long-term is to increase resource utilization and reduce the quantity of long-lived radiotoxic elements in the used fuel that will be disposed in the future. Both of these activities are conducted while we manage proliferation risk, but, for sure, the biggest challenge of today is used fuel disposition.

So let me bring us back to since the last time we met. We have done some restructuring in NE-5 organizations, specifically in support of used fuel. And we did this to better address the program needs related to planning projects and research and development. You see the consolidated storage project team showed in the green dotted on the right-hand side. That is focused on develop design concepts for consolidated storage facilities; prepare for large-scale shipping campaigns to centralize storage facilities; and evaluate system architecture alternatives. Both Mark Nutt and Jeff Williams will be discussing this in a little bit more detail in the next two talks. And this Planning Projects is headed by Jeff Williams, who was here in the panel.

In the R&D Office, it continues to be led by Bill Boyle, and Bill is sitting in the fourth row to my left. And the focus is to develop technical basis for extended storage, which some of you were discussing in the previous panel; develop technical basis for transportation of high-burnup fuels, which is also an area of great focus for us; and evaluating the different repository alternatives. Both the Planning Projects and the R&D activities are carried under current legislation and budget framework and are recognized--they are fundamental to the nuclear waste program.

And this is just a quick summary. Many of you know this better than many of us. Nuclear power is an integrated part of the administration, all of the above energy strategies. It provides approximately 20 percent of the nation’s electricity supply; and of the total electricity supply, 60 percent if the emission-free comes from nuclear. We have about 104 operating plants, all running at about 90 percent average capacity factors; and most of those plants are expected to apply for license renewal for the next 60 years of operation. There is an expected U.S. electricity demand projected to increase to about 24 percent by 2030. And there are representatives from EPRI and NEI in the audience if you would like to discuss a little bit more details towards the role of nuclear energy in our energy portfolio.

But each year the U.S. plants produce approximately 2000 metric tons of spent fuel. The estimated inventory by the end of this calendar year is about 70,000 metric tons of used fuel stored in pools or dry storage. About 27 percent of that is stored in dry. And that is projected to increase and grow to about 88,000 metric tons by the year 2020. The current policy of used fuel is direct geological disposal, and at least one repository is needed.

The Office of Fuel Cycle Technologies is concerned with all aspects of the fuel cycle, you know, cradle to grave, minus the reactor. So that’s what my office does. We go all the way from mining and milling to conversion, enrichment, fuel fabrication. Anything related to the reactor as part of what we call NE-7 Portfolio is led by John Kelly and is on the first org chart that I showed you. And then we have the two back-end facilities. The current fuel cycle in the United States is an open but incomplete fuel cycle. As of today we are missing two categories of facilities shown in the red box, one for consolidated interim storage and the others for final waste disposal.

To develop a U.S. path forward, a used fuel managed strategy is needed, and I think all of us in this room recognize that. The BRC provided recommendations to help guide the management of used nuclear fuel and also for fuel cycles of the future. In addition, it affirmed the need to conduct research and development on these advanced fuels that represent advantages to today's open fuel cycle strategies.

Much has happened this year, and that's why it feels like many years to me. Most notably, the Blue Ribbon Commission issued its report in January. The main recommendations are listed in this slide for reference. I do not plan to read them all, but I will shared with you that we have closely read the report and paid attention to these recommendations. These recommendations have led to the near-term program shifts that I just described to you and potential restructuring in the long run as the new federal corporation or federal agency gets standing. While we're still in the midst of fine-tuning our strategy, work continues and is being initiated in areas which are essential for us to move forward.

Specifically, the BRC confirmed the importance for the Department of Energy to continue its work in the used fuel program as we gel together with this new strategy. Our activities that are underway in our Office which address issues raised by the BRC to move us forward, we have activities--and you heard a little bit about it in the first panel--beginning laying the groundwork to implement consolidated storage; begin providing funding for stake holders in preparation of the movement of spent fuel from shutdown reactor sites to this consolidated storage; and we also have activities related to keeping the repository program moving forward through valuable non-site-specific activities, including research and development on geological media and work to design improved engineering barriers.

Oh, what happened? Well, I will just describe to you this arrow figure, and I hope it printed out in your package that you have more than an arrow. So those of you, there are copies in the back if you would like to see the figure. It's page 10.

Okay. So for the balance of my presentation, I would like to focus on ongoing activities on the various used fuel disposition program areas. If you have a paper copy, on the left-hand side there are three boxes, and those describe our three program areas; that is, storage, transportation, and disposal. All three of these program areas have a research and development component. So when OCRWM went away, everything was lumped into this R&D portion. And it wasn't clear, you know, how storage and transportation non-R&D activities were being managed. So this year we are restructurized to make that more clear to everybody and help us address the BRC near-term recommendations; and we created what you see on the right-hand side if you have the paper copy, which is the nuclear fuel cycle storage and transportation near-term planning projects, which is the new Office that Jeff Williams is coordinating, and Bill Boyle remains coordinating the research and development activities.

What I will do first is cover the project activities for storage and transportation, and then I will cover all the research and development activities at a high level in all three program areas: storage, transportation, and disposal. The next two talks will focus a little bit more on the specific details of some of these programs. Some of you have heard some of our R&D portfolio on disposal, but we can do that at a later date. And Bill is here if you would like to talk to him at lunch time or during the breaks.

So this is at a high level. In the area of transportation we heard in detail today--and, just to recap, the objective is to ensure the implementation of a staged, adaptive, consent-based transportation of spent nuclear fuel and high-level waste. It implies re-engagement with regional groups, as the groups shared with us this morning, and employing successful approaches from past experience, for example WIPP, this objective alliance with the BRC recommendations shown in the textbooks, which is development of routes from shutdown reactor sites in a collaborative manner. So I don’t want to go too much in detail, because you heard about it this morning.

Some of the specific activities is developing a planning report for the shipment of stranded fuel from shutdown sites to a consolidated interim storage facility, and Jeff Williams will cover this in his presentation. The panel also mentioned the fact that we were truncated on that Nuclear Waste Policy Act 180(c) policy regarding how we finance and provide technical assistance to states along transportation routes, and we will continue this effort now that we are restarting these activities. Development of communication products; complete assessment of transportation hardware, which we did not discuss in detail today, but this implies casks, rail cars, support, security, and so on. And this we do in cooperation with NRC.

In the program area of storage, the objective is to begin laying the groundwork to implement consolidated storage: Build on previous DOE work and also, very important, industry storage licensing efforts; evaluate design concepts for consolidated storage; develop communication packages for use with potential host communities which describe various attributes of these storage facilities; initiate development of consent-based process through a siting process; evaluate the benefit of a programmatic environmental impact statement; and evaluate system benefits of standardized packaging, which is, again, an area of quite a bit of importance to us. So those are the activities that we have on the planning projects. Those tend to be more heavily focused on interaction with community-based groups, industry, and so on.

I am going to jump to the research and development area. And the area of storage and transportation is not all planning projects clearly. There is still an R&D component in this area, and the objective is to prepare for, again, the eventual large-scale transportation of spent fuel and high-level waste. We have significant efforts to develop the technical basis for a number of items: extended storage of used nuclear fuel, fuel retrievability and transportation after periods of extended storage, transportation of high-burnup used nuclear fuel, and better understand potential degradation mechanisms in long-term dry cask storage, including identification of data gaps to support license amendments beyond 40 years of dry storage, continue material testing to support modeling and simulation of used fuel again, and participate with industry and others on full-scale storage demonstration of high-burnup used fuel. And this is a very important activity with us that we’re in the process of putting it together.

In the area of disposal, there are three overall objectives: Provide sound technical basis for the assertion that the United States has multiple viable disposal options; increase confidence in the robustness of the generic disposal concepts; and evaluate the BRC recommendations for developing a near-term plan for taking the borehole disposal concept to the point of demonstration.

Some of the current research and development activities in the area of disposal are listed here. We focus on increasing confidence in generic disposal concepts, and Peter Swift is our lead in this area, and he is also here in the audience if you would like to discuss with him. And I forgot to mention John Wagner is from the laboratory community, and he is assisting on the planning projects. As part of this increased confidence in the generic disposal concepts, we plan to evaluate engineered barrier systems for mined repositories in salt, crystalline rock, and clay/shale. And some of you may have heard some of Peter Swift's presentations and Bill Boyle's presentations in the past addressing these items. Enhanced understanding of natural system performance, specifically groundwater flow and radionuclide transport in geological media; integrating repository design concepts and host rock geology through thermal load management. We have had some presentations of that in the past, too.

So I just want to emphasize that in addition to the domestic, what I call, R&D activities in disposal, we have also leveraged international collaboration. We are very pleased that, you know, we have re-engaged formal collaboration in research and development in programs in Europe and Asia. While the U.S. was focused on YMP for a number of decades, there was progress being made in the international community in other media. Some of the specific collaborations are currently ongoing. We joined the underground research laboratory with Mont Terri in Switzerland. This gives the Department of Energy access to data from all Mont Terri R&D and also the opportunity to conduct new experiments in their facilities.

We also rejoined the Grimsel granite underground research laboratory in Switzerland, and this allows us to get a better understanding of generation rate and interactive mechanism for colloidal formation.

In addition, in the spring of 2012--just recently--the development of coupled models and their validation against experiments, Decovalex, which is an international organization that started Phase 2 of their projects, and we are partnering with them and starting with them in this enterprise. And starting in 2013 the KAERI Underground Research Tunnel activities, we're starting their collaboration next year.

We're also looking forward towards the Aspo Hard Rock Lab in Sweden. We're just in the process of finalizing our agreement, and I thank Idaho operations for assisting this in all the procurement areas that we have to do with this international community. Bill Boyle, as I mentioned, is here; and if you'd like more details on this international collaboration, he'll be happy to discuss with you.

Just some closing remarks. The Office of Fuel Cycle Technologies is committed to the development of used fuel waste management strategies. As Jeff mentioned, we are not where we used to be in terms of waste management. We are not OCRW. Some of the functions went to different parts of DOE. We do have the main R&D and the project planning component of the disposal of used fuel.

The Used Fuel Disposition program is laying the foundation for the development of storage, transportation, and disposal options, but clearly we have to do it under the current legal framework that we can only operate today until things change; right? Project plans are closely tied up with BRC near-term technical recommendations, and we continue to adjust in order to meet our changing priorities. So we are very open to feedback. We are very open to new ideas, because we are in the process of moving along. And I think one of the things that will happen over the years is this process--we'll always be learning from new areas that we keep on learning.

Projects are underway to address key issues. Some of these activities will eventually move to the new single-focus organization; some may not. At this point, you know, we are being as flexible as we can be, but we're also becoming very focused so that the activities that we do will support the next organization, whatever that organization happens to be. And we're trying to be good stewards of the money and the funding that we are provided, and we're grateful for that.

So, with that, I'll entertain any questions you may have.

EWING: Okay, thank you very much. Questions? Linda.

NOZICK: Nozick, Board. Monica, you talked about under the NFST project the idea of communication products. That's a very valuable endeavor for a whole lot of reasons.

REGALBUTO: Yes.

NOZICK: I was wondering, what's the process you go through to identify what those products exactly should be and then how you evaluate their effectiveness.

REGALBUTO: There was a previous experience when the Nuclear Waste Policy Act first was initiated before the amendment came in. There are still a group of people--right now they are located in the Office of General Counsel--which used to be part of OCRW. They used to put together these packages to the communities. In general, you know, one has to go and address what is the community interested in hearing. Normally they want to hear about the risk. First of all, they want to know what is it that you’re trying to build, you know, what is it that you’re proposing to bring to my community. So some are preconceptual designs, which is one of the areas, for example in intra-storage (phonetic), that we have, I think, three funded organizations that are bringing some of those designs so we can explain to the public what is it you’re trying to build. We have to explain the risk associated with these facilities that they are and then address any concerns that they may have in order for us to present a communication package. So it’s an interactive approach. It’s not like fact sheets, you know, that doesn’t work.

NOZICK: So it’s operated out of what office? I’m not sure I heard that.

REGALBUTO: Well, some of the team members from the past right now are working for General Counsel. So, you know, we have people from the former OCRW that are throughout the DOE system. So we will regroup whoever--

NOZICK: So you’re going to reorganize who is doing these packages?

REGALBUTO: Yes, yes.

NOZICK: Because, I mean, it’s a very critical--

REGALBUTO: Yes. And it’s important--Jeff, you want to add something?

JEFF WILLIAMS: Yes.

REGALBUTO: I see you going like this.

JEFF WILLIAMS: Jeff Williams of the Department of Energy, I just wanted to add, this is something that's been put on our plate as, you said, a very important item to do; however, we have not even initiated this. For FY13--we don't have our funds for FY13; however, this is something that we definitely do want to focus on. It's something that the Blue Ribbon Commission recommended the importance of, and they're the type of things that Monica just talked about.

REGALBUTO: So we're in the thinking process, not in the execution process, because we don't have a budget. But we can be proactive and start thinking what is it that we're going to need so when we get the funding we're ready to go.

NOZICK: Okay, thank you.

EWING: Steve.

BECKER: Steven Becker, Board. I'd like to follow up on that. I too agree that the communication component is critically important. In the past several years the federal interagency Nuclear/Radiological Communication Working Group has done a great deal of research on radiation communication, radiation-related communication, and I'm just wondering if there are plans to interface with that body to take advantage of the research that's been done.

REGALBUTO: We do plan on those communication packages to include other federal agencies. You mentioned one of them, which is significant. NRC is another one. EPA is another one. We do have to have a complete set of items, because it’s not just about DOE; right?

BECKER: Yes.

REGALBUTO: It’s about all the other federal agencies and all the different stakeholders that do have a say in this process.

BECKER: So the CDC has also done a great deal of research.

REGALBUTO: Yes, the CDC, exactly. So, you know, there is a number of them out there, and for that we do need to have a budget. But that doesn’t prevent us from starting to brainstorm what is it that we need to do and who do we need to engage with.

BECKER: And may I briefly follow up on a question I asked earlier? With respect to the 180(c) process, are there plans for including local and state health departments?

REGALBUTO: The plan is to include both state and local. As the panel was mentioning first, you know, the Regional Groups are the first reaching activity that we have, because it’s organized and, you know, when you go to local, who local is. Under our current framework, we cannot predispose that their specific community is going to be that local community. So it kind of puts us in a little bit of a bad situation. We can do it on a voluntary process. If a local community wants to come to participate, they're welcome. But I cannot go and reach to a local community on the premises that they have been preselected because there has been no preselection process. So on a volunteer basis is different. You know, we are under a legal framework still.

EWING: All right, Lee.

PEDDICORD: Yes. Peddicord. Board member. You had mentioned the current and expanding international collaborations you're developing, which I think sound extremely positive. My question is: Will those include accessing any data information available on high-burnup fuel and those issues I've identified with storage and transportation?

REGALBUTO: I'd have to ask--Bill, is high-burnup fuel part of the portfolio, or is it only on the disposal and repository geological sciences?

BOYLE: William Boyle. DOE. The slide you showed, that was all disposal-related. But we do participate in the extended storage program, ESCP people call it. And it's focused, in part, on high-burnup fuel. So there are international participants in that as well.

REGALBUTO: And, you know, we also have the industry-led effort on that, which we're still in the planning stages, you know, where we plan to lower cask and follow it for ten years. So that is on the--but that is more on the domestic side, and we’re working with the utilities on that.

EWING: Okay. Sue.

CLARK: Clark, Board. I wanted to shift the focus a little bit and just ask you, for the education of the Board, can you just talk at a high level about the interface between DOE, NE, and the programs you talked about and then DOE-EM.

REGALBUTO: Yes.

CLARK: And then my second question is specifically on your Slide No. 3 and the balance between current power today and then future power. What can you say more about that balance in terms of dollar amounts or how you’re thinking about that?

REGALBUTO: Okay. So the first question regarding our involvement with EM, we have a very, very close collaboration with the Office of Environmental Management. My previous job was with them, so we work together. A special interest, for example, is waste forms coming out of the defense program, which currently now are scheduled to meet YMP disposal standards; right? And Yucca is no longer being funded. You know, where does that leave us in terms of glass? Do we have more room for different types of formulation? Those are all of the exploratory, you know, level. But it does impact; right?

We also work very close with WIPP; okay? WIPP is the only working geological repository in the world as of today, and the lessons learned from WIPP are incredibly important to us. Not showing in here, you know, is always the issue of GTCC waste, which also comes out of the decommissioned sites. We not only have high-level waste, we’ve also got GTCC, which also needs to be addressed. GTCC falls under EM. It’s always been under EM. But we’ve closely worked, because in this case we’re the generators instead of EM being the generators. So we do work very close with them.

You know, some of the back-end technologies--some of them have been developed by NE in the past, and they actually have been implemented in the field by EM. Sometimes EM develops technologies, and we implement them in NE, so it’s a two-way street. Scientists usually are the same folks, and we are in the process, for example, of having one separations roadmap for the whole department, which also includes NNSA in their radioisotope production area.

So we are, you know, consolidating more of our resources together, because we do all benefit, and we do have a limited amount of actinide chemists in the system, unfortunately, and all three of us, including Office of Science--that would be four--tax under the same resources. So better coordination is much better for the whole department.

Your second question was related to energy of today and energy of tomorrow, which is shown in the green. These are near-term activities, you know, clearly driven by, one, do we want nuclear to continue to grow. We have a problem today; that's used fuel disposition. Accident-tolerant fuels came in after the events in Fukushima. The Senate has taken a strong point in that. And in that I have to maybe elaborate a little bit more, because it's just a box in there; but, you know, we can talk about it later on.

In accident-tolerant fuels we have two parts; okay? One is development of fueling cladding. We have very nice IRPs that we sent to the universities. Two of them were awarded this year with really, really a good focus on passivation layers, for example, for Zircaloy cladding, some proposed development of new fuels. It's all of the above. I call this a drag and drop on the current LWR fleet, so we're not planning to replace the fuel. It's just--I mean, to replace the reactor. It's just replace the fuel. In John Kelly's program, NE-7, they concentrate on the off-battery part of these accident-tolerant fuels, the generators, the loss of power, and so on.

In the right-hand side is what we view as the traditional program, if you want to call it that way. That is the traditional fuel cycle R&D portfolio. One way that I like to capture that is, the base of designing a new reactor in isolation of the front end and the back end, in my opinion, are over; okay? It’s not about building the most spiffy, nice machine that can do whatever you want and do a local optimization on that machine. It really is to address an energy system which is cradle to grave. So make better use of your resources and generate less radiotoxic waste on the back end. So maybe you go a little bit more into a burner-type reactor, closed cycles that produce less risk-based type of waste forms.

In terms of--you’re asking about the funding.

CLARK: Well, the balance between those two boxes.

REGALBUTO: The balance between the boxes--on this side, you know, obviously all former OCRW type of activities are in here. Accident-tolerant fuels is--you know, it’s roughly $15,000,000 if you want to call it that way. It’s distributed between industry, universities, and some national labs, different costs, you know, for that development. It’s a big industrial engagement in this one.

These are more R&D type of activities. I did mention the system studies, for example. That is one that we are awaiting results for the next two years, which will guide the determination of R&D dollars in there. Many of the activities that come from the right-hand side, for example in fuels, that learning has been utilized in accident-tolerant fuels, so some of them, metallic fuels for example, are imports from the other side.

In terms of funding requirements, we do go through our prioritization process. We don’t just say, hey, you take 50, you take 50, you take 25. That’s not the way we do it. What we do is we have an integrated prioritization list. Each of the areas put together their prioritization list; there is a discussion based on current needs and current political pressures; and base it on what we need to move forward regarding near-term--a balance between near-term. We create a master integrated prioritization list, and then, depending on the funding that we have, we go through those activities. If we get more funding, is the next one coming off the list; if you get less funding, you got to take off. In addition, you have to take into consideration some of these activities are three- or four-year activity years. So if we know we’re not going to get support, we cannot get it started.

So that’s how we balance. It really is done by prioritization.

EWING: Last question is Paul’s.

TURINSKY: Yeah. Turinsky on the Board. Monica, one of the BRC reports wants this away from reactor storage. Can you take me through how the decision will be made whether to move forward on that recommendation and the timeline for building it?

REGALBUTO: On reactor storage?

TURINSKY: On away from reactor storage, consolidated storage.

REGALBUTO: Yes. Consolidated storage, you know, is currently very limited on the Nuclear Waste Policy Act. We can plan; we can, I think, build; but we cannot open it until the repository is open. So that’s going to take a change in the law. Unfortunately, you know, this is beyond our control. It has been addressed by some of the proposals in the Senate. Jeff is going to discuss that in detail, looking at the stranded sites first and then looking at the other sites. So if you’d like to hold your question, Jeff’s presentation is going to cover how we go about that.

TURINSKY: Well, I was interested in the decision-making process.

REGALBUTO: The decision-making process, we recognize that because the repository program is on hold, we understand that there will be a need for consolidated storage; but right now we do not have the power to build one because of the current framework that we have to work in. So the law will have to change in that case. We will plan activities; we will say what we need to do and, you know, how a proposed facility will look like; but as a proposed facility, conceptual at this point. We don’t have authority to go forward in any of those. But, you know, I always say that doesn’t stop people from thinking. So we can think; we just cannot execute at this point.

EWING: Okay, last question, Efi.

FOUFOULA: Foufoula, Board. So in addressing the BRC recommendation for borehole disposal, what are the implications probably long-term on the whole fuel cycle package--

REGALBUTO: Borehole disposal has been around for a long, long time; right? And, you know, there are people who like the concept, and there are people who don’t like the concept. One of the things that we tell ourselves, first, is, you know, there are new technologies for drilling that have not been addressed. Sandia National Laboratory actually invested their own funds in putting together the most updated information on, you know, drilling technologies and so on. It was part of the laboratory research and development dollars that they have discretionary ability to use. So that was a very good start.

Obviously borehole disposal, you’re talking 70,000 metric tons; right? That does not mean that, you know, that we’ll start advocating boreholes all over the United States. But there may be certain types of fuel whose characteristics may be conductive for a borehole. So what we’re trying to do right now is give borehole a fair chance. A lot of people argue about boreholes, but there is no data to say yes or no, is it even doable?

So, you know, I think while my colleagues--Bill Boyle mentioned in the past, look, we study every single geological type of form, but we haven't really put any emphasis on boreholes to really say, here's the data to support that. And that's where we are right now.

EWING: So I'm going to--I realize there are still a few questions, but we have to pay a little bit of attention to the schedule. So I'll call this session to an end. If you have questions, Monica is still here; so please take advantage of her. And we'll reconvene at 10:15.

Okay, thank you very much to all of the speakers.

(Pause.)

EWING: The next speaker is Mark Nutt, Deputy National Technology Director, and he'll be discussing used fuel disposition system architecture study.

Mark, it's all yours.

NUTT: Thank you. Thank you for the opportunity to talk to the Board about this.

First, I'd like to acknowledge that I'm not the only one that participated in this effort. We had a team of people from Argonne, Sandia, Oak Ridge, and Savannah River National Labs. If I would have put all their names up on this cover sheet, it probably would have filled the whole thing. So it's been a large, multi-lab team effort to pull this off.

Used nuclear fuel system analyses of the types that involve oxide storage have been done before, primarily in the ‘90s when monitored retrievable storage systems and multi-purpose canisters were being considered to augment disposal at Yucca Mountain. Well, since then conditions have changed since those analyses were completed, and they need to be updated based more on current situation, which is the utilities have loaded, as Monica indicated, a large number of canisters into dry storage and continue to do that. And there is now consideration of different geologic environments that potentially affect waste packaging sizes. The need to do these types of system analyses have been recognized by both the Board and by the Blue Ribbon Commission in their final report to Congress, so we’ve started on those analyses.

Before I start discussing them, there’s some insights that were gained prior to and during these analyses, and assessing the feasibility of direct disposal of the dual-purpose canisters and activities related to implementation of standard canisters are underway. There are potential benefits associated with each; however, there’s uncertainties regarding whether they could be implemented, when they would be implemented, and what the benefits would be when implementation would occur. Regardless, there is legacy, single-purpose, and dual-purpose and continued use of dual-purpose canisters at reactor sites is underway, and those canisters will still have to be managed.

When we’re referring to a system within the discussion today, we’re talking about all the facilities and all the operations at reactor storage to ultimate disposal in a repository; so when you hear me talk about the system today or the waste management system, that’s what I’m referring to. And how this system is operated will really influence the design and operation of downstream facilities. There’s approximately 30 different vendor designs that are being loaded, both vertical and horizontal designs, and how this inventory and mix of canisters would evolve in the future depends on how the used fuel is managed at reactors. This essentially defines the boundary condition for what has to be dealt with down the road, and I’ll talk more about that later.

The facility concepts you could put in place would depend on several different variables, for example, acceptance rates, start dates for acceptance when we start picking it up from the reactors, and how the used fuel would be managed at the reactors and when it would start to be picked up. One of the considerations that we looked at this year that’s on the box below, the comparison, is whether to put everything in canisters at the reactor and transport it off-site; or when a storage facility becomes operational and fuel acceptance begin, to keep some of that fuel as what we call bare fuel or uncanisterized fuel, transported in reusable transportation casks. There's trade-offs associated with the two, and the question is what are any system-level benefits that could be achieved by one over the other.

So our objectives are really to obtain quantitative information and insight regarding these and other considerations that can be gained with an analysis of integrated disposal system architecture. The objectives are to develop the tools, capabilities, and apply them to quantitatively evaluate a range of potential used fuel management system architecture alternatives. Flexibility is going to be a key part of our analysis, what system architectures allow for flexibility and which ones become more rigid, essentially what conditions lock in--or what scenarios lock in conditions that couldn't be undone later, what scenarios allow for flexibility and deployment, could stage a staged or phased deployment approach.

A wide range of factors are going to be considered as we move forward in assessing each of the alternative architectures. Cost is just one factor. Others will be considered. Some are listed up there. One, for example, is worker exposures along the way in the different operational aspects. Our goal is really insight. We on the technical side and the laboratory side are not going to draw conclusions or recommendations. That's for other people above us to decide. There's a lot of other factors that contribute. We're looking at the technical, quantitative-type information to feed into a future decision-making process.

Fiscal Year 12, which we're still kind of completing for the work we're doing, saw a resumption in the fuel system architecture development with a broader focus than was looked at before. Again, the potential future systems are different than they were fifteen years ago or even so much as five years ago. The system has potentially changed. The overall objective of the Fiscal Year 12 activities were first to develop and then demonstrate the capabilities on a limited number of cases. The initial effort involved a systematic evaluation of the disposition pathways followed by a down-select of those to evaluate for this fiscal year followed by selection of assumptions, boundary conditions, and system inputs to use in the evaluation.

In parallel, we developed logic simulation capabilities for evaluating a broader set of disposition pathways that were looked at before and applied those tools to the selected disposition pathways, the assumptions, the boundary conditions, and the inputs we considered. In addition, we developed modular design concepts, the facilities that could be used for each of the disposition pathways, and could figure the results of the logistics modeling to those simulations for the various cases we considered. So we're a fourth group out there doing some design concept work. There's the three industry teams that were mentioned earlier, and we're actually doing some of it on the lab side.

This chart is what we've been calling our Disposition Pathway Overview. We kind of treat it as a high-level problem statement showing the different pathways through which used nuclear fuel can transition to ultimate disposal in a geologic environment. Right now this is the only side we have in place today, as was indicated earlier. We're storing fuel at the reactors wet, and we're off-loading it to dry to keep pool capacities. The rest of this system is what we're looking at and then how this system is operated and how it influences the downstream operations.

There's a range of options for at-reactor management, including the implementation of standardized canisters at that system, which we've got down here. Management at an interim storage site, how would you run this facility, and where and when you would re-package fuel provided that the direct disposal of dual-purpose canisters doesn't prove feasible or a site is not suitable for doing that. So there is a need in all of our analyses that we're looking at this year for a re-packaging operation to get it into a disposal configuration, a canister that can be disposed of.

Each pathway through that chart was followed through, and we identified nine broad disposition cases. These involved different at-reactor management alternatives and where and when packaging or re-packaging could occur. And, again, we're assuming in our analyses that the re-packaging and disposal in canisters of the size suitable for disposal in the environments we're looking at has to be done. We down-selected from the nine the two broad disposition pathways we wanted to look at for comparison. One was the transport of all fuel away from reactor sites in canisters, assuming that every reactor site could put the infrastructure in to load large dual-purpose canisters and move it off-site. The other one is to maintain the fuel that's in the spent fuel pool that once acceptance starts in a bare configuration, transport it as bare fuel, in addition to the legacy canisters that would have been loaded.

The second alternative--the other part was where re-packaging was done. We assumed it would be done either at this repository when fuel arrived or at the storage facility when fuel would be shipped. That down-select considered commonality and capabilities--sorry--commonality and capability requirements, complexity in the system, and flexibility. One of the cases in our broad nine cases was re-package fuel into what we're calling the way the disposal size canisters at receipt at the storage facility with the dates we chose, and I'll talk to it in a minute. We decided not to include that one because that would reduce flexibility later. We don't know the ultimate size of the disposal canister right now, so we said let's do it at the end when the material is going out to the repository.

We selected assumptions and input and boundary conditions listed on this slide--I'm not going to walk through every one of them--to really constrain the problem. But they do provide us a broad enough range to show trends and gain insights with the cases identified earlier and how they would respond to these different assumptions. An example is the range in acceptance rates that we chose: 1500 metric tons, 3000, and 6000 metric tons per year; and the times we picked to start facility operations, we assumed storage facility operations start in 2020 or 2035, and repository operations start in 2040 and 2055. As Monica indicated earlier, we're assuming planning dates based on--assuming planning dates, no basis.

The assumptions we made in here are not meant to imply that a system would actually be operated this way. An example of that is perhaps the oldest-fuel-first acceptance priority, a youngest-fuel-first shipment from the reactors, and the first-in-first-out shipment from a storage facility to a repository. One of the underlying aims--these are typically things that have been looked at in the past in the past-type system analyses, so it was a good logic starting point for us. As an example, we could have picked oldest-fuel-first acceptance from the reactors, but we decided to go with youngest-fuel-first, feeling that would most likely minimize the need for additional on-site storage, since they tend to load the older fuel into the dry storage canisters first. If we go get the youngest fuel out of the pools, if possible, that would minimize additional needs for on-site dry storage.

This initial set of analyses allows for gaining insight regarding how the integrated system dynamics--how it would respond to the variables we looked at, give us an understanding of the trends, and really point us to where the next set of analyses should investigate. As I indicated, we didn’t evaluate all these combinations. These waste package sizes, there’s been presentations--not to this Board, but Dr. Hardin, Ernie Hardin, presented them earlier--that talks about the waste package sizes we’re looking at; and those essentially map to the various media that are being considered by the Used Fuel Disposition Campaign.

The logistics modeling that we did provided the foundation for the analyses. It gave us the information on annual quantities, annual rates of material arrivals, needed capacities that facilities would have to accommodate, etc. In order to model the scenarios that we were considering, the legacy tool set that DOE had previously developed needed to be modified and improved. We did that, and the updated tools were used to evaluate different scenarios leading to the end state, which is a production of those waste packages. You can see the size, the numbers of the waste packages of the different--or disposal canisters--we're not producing waste packages yet--but to produce those number of canisters that have to be disposed of.

The models we put together track the individual fuel assemblies throughout the disposition pathway, from the pool into reactor storage, from storage to a consolidated storage facility, from there to a repository, including packaging and re-packaging into disposal canisters. One important item to note is all the fuel projections--all the fuel discharges that were used in our projections from 2002, which is the last time the Department of Energy has data from the industry. So we're projecting forward from that date using an Energy Information Agency forecast on nuclear generation and some algorithms to project how much fuel would be discharged from each reactor. The results of the logistics modeling were used to establish the requirements for the facilities that could be deployed to meet each one of the scenarios we looked at.

Some of the insights we gained is, there’s a trade-off with a higher acceptance rate. They do require less on-site storage but larger facilities downstream. One thing we notice is a 6000 metric ton--the high acceptance rate we picked really only leads to an incremental benefit in reducing on-site storage--the amount of on-site storage needed, but it resulted in pretty large facilities downstream. And show you that a little bit later.

How the fuel is managed on-site, when the acceptance from the reactors begin and the rates all have downstream impacts, really, as I said earlier, what’s shipped away from the reactors establishes the boundary condition for what occurs in the rest of the system. A delay in the start of acceptance or acceptance at a slower rate results in more fuel being placed in dry storage at the reactor. That can decrease flexibility later and the system begins to more lock into everything being in canisters.

So if there is a benefit at all of maintaining bare fuel in the system and being able to process it as bare fuel begins to go away with delays in acceptance or with slower acceptance rates, the same thing applies to a standard canister. If there’s real benefits to doing standard canisterization, the longer it takes to get that implemented would mean more fuels going into the dry storage casks at reactors; and that benefit could tend to decrease.

We saw that acceptance rates exceeding the annual discharge rates of approximately 2000 metric tons a year would reduce the need for on-site storage once acceptance begins. If they're discharging a rate of 2000 metric tons and it's being accepted faster than that, you can start turning that around. However, the larger acceptance rates don't necessarily decrease the peak amount of fuel that can ultimately be placed in dry storage. You can see that by looking between--these are 1500 metric tons, 3000, and 6000. There's a big drop between 1500 tons and 3000, not so big between 3000 and 6000. And essentially the peaks occur right about the time you start the acceptance, so the utilities have had to put that much fuel in; and then regardless of whether you move faster, that's going to be the peak. What the larger acceptance rates will do is decrease the amount of time that the fuel would spend in dry storage. You could pull it off and out of the--off the pads at the sites quicker.

The real key is managing the inventory in the pools at the reactor sites. It likely would be desirable on the utilities' part to not have to transfer additional fuel to that reactor dry storage once acceptance begins. One thing we're seeing is oldest-fuel-first probably wouldn't do that. An oldest-fuel-first strategy would give preference to the fuel that's already in dry storage, because that's what they've loaded. You'd pull that fuel off; and in order to maintain fuel pull capacity, additional fuel would have to be off-loaded out of the pools into dry storage. Youngest-fuel-first can. We're seeing that there's some limitations once a large quantity of the legacy fuel, the existing inventory, has been removed and all that's left is shorter cooled fuel to be transported out. There's thermal limitations on the casks that require some delays, some decay storage within the pools to allow it to be moved.

There could also be challenges to the system when the reactor fleet begins to shut down, roughly starting in 2035, running through mid-century. And there's a desire on the utilities' part to off-load the pools to do decommissioning and demolition of the plants sooner. There'd be a large amount of canister loading that would be done into those systems.

Alternative strategies for accepting fuel from the reactors and for shipments from a storage facility to a repository is an area where we think some further work is needed. Again, the initial assumptions we made this year were selected to gain insight on how the system would respond and provide the insight that we've been talking about.

One other potential area to be investigated is to treat the storage facility as an integrated used fuel management facility to decouple reactor used fuel management needs, you know, their desires to manage their system, that could be different from the requirements for a repository. If there’s thermal management issues at a repository that differ from how the reactors would want to manage their fuel, if you could use the storage facility perhaps as a buffer and temper that, is an area we want to look into.

We saw the processing rates and inventory scale with throughput rate; that’s expected. The faster you go, the more fuel you have to process, the bigger the inventories will get. Again, one of the insights we gained is that a 6000-metric-ton-per-year acceptance rate would lead to large facilities, and the capabilities of those facilities may not be utilized over the life of the facility. Again, the legacy inventory would be able to be worked off at that higher rate, and then the processing--the actual acceptance and processing rate would more match the discharge. Again, that would require processing facilities and lines that are high for a period of time and then decrease as the legacy inventory. You can see that happening with this curve. That’s a 6000-metric-ton cumulative receipt at a storage facility. That’s 3000 and that’s 1500. You can see these stay linear. This one decreases and essentially goes to almost about 2000 tons a year as things move along. So you design to handle that, and then you operate at that for a period of time.

Storage capacity, which is shown in all these charts that are probably impossible to read out in the audience and even on the slide charts, but we found that storage capacity is a function of the acceptance rate and the start of operations of the repository relative to the start of operations of the storage facility. That's kind of what you're seeing here. This is a storage facility starting in 2020, repository starting in 2040. This is a storage facility 2035 and 2055, and these are the different acceptance rates, 1500, 3000, 6000. And you can see there's some fairly large differences between the two. So higher acceptance rates means larger inventories; longer storage periods means larger inventories. You combine the two, and you get the largest facilities needed.

When we put bare fuel in the mix--this is all canisters. Everything that's going to the facility is canisters. If we put bare fuel in the mix, there is a reduction in the dry storage inventories at a storage facility. The trade-off is, you now have bare fuel that has to be stored. So the fuel is either coming this way or it's coming this way.

I'll add a note that the analyses we did this year didn't consider additional storage that may be required for repository thermal management. We essentially assume that the repository starting in 2040 could pick up and move at the rates we wanted, and there is no thermal management needed at the repository. If you include that, there is a--I believe it will increase these inventories. Unless the direct disposal of the dual-purpose canisters can be demonstrated, a site could be found, they could be disposed of, a large used fuel handling effort will be required. One thing is that these analyses looked at the disposition of about 140,000 metric tons of fuel, the existing fleet operating through a 60-year--assuming they all get 60-year lifetimes and operate to the end of that lifetime.

In total it’s approximately 400,000 fuel assemblies that would have to be packaged or re-packaged into disposal canisters. There is always going to be a need to re-package some quantity of dual-purpose canisters. They’ve been created; they’re being loaded right now; they’re in the system. If everything gets loaded into large dual-purpose canisters, over 11,000 of them--we’re projecting over 11,000 would have to get re-packaged. Maintaining some fraction of the fuel as bare fuel would reduce that number; and, again, the trade-off is having to have a bare fuel storage capability, for example a wet pool, a spent fuel-type pool. And, again, any benefit of doing that decreases as delay in acceptance or slower--for delays and acceptance or slower acceptance rates.

You know what, I actually--that was the slide that should have went with that last bit of talk.

The development of modular design concepts allowed for the construction of facility layouts for the wide range of scenarios that we're looking at. And I should have put a chart in here. With the combination of the four different broad cases and the input assumptions that we made, we ended up with 36 different cases that we evaluated all the way through. So allowing--looking at modular facilities, let us look at the layouts that would go with each one of the scenarios that we looked at. The designs we looked at were modular concepts for dry. We did vertical and horizontal dry storage systems, and we looked at a wet storage pool for bare fuel storage and for a re-packaging plant. Here you're seeing a vertical dry storage concept and a re-packaging facility--packaging and re-packaging facility.

Unit operation times were estimated for all the handling and processing steps within each one of these. We then used those with the logistics modeling results to determine what the requirements were. As an example, the peak canister arrivals at the storage facility, combined with the unit operation times to receive a canister and put it out into dry storage, told us how many receipt bays would be needed for that facility. And we were able to do this modular for each one, lay it against the scenario logistics output, and size these things.

As expected, the facility sizes measured on these charts is a storage footprint. It doesn't include all the footprint that may be associated with the facility. It was just what was the footprint associated with, say, the pads. What we saw was the facilities were larger for higher acceptance rates and for longer duration. It essentially maps back to the inventories that would have gone into storage, and larger inventories require larger facilities. Keeping a fraction of fuel that's bare kind of reduced the overall footprint, but it's a trade-off between dry storage pads to wet storage pools and basins. One of the examples is we have over 50 to 75 3500-assembly basins that were in--for an acceptance rate of 3000 metric tons per year for a 2020 start of storage operations, 2040 start of repository operations.

Also, as we expected, the number of processing bays or lines increased with throughput. You're essentially moving more fuel, you need more facilities by which to do it. Again, we observed that at a 6000-metric-ton rate all the processing lines would not be utilized for the entire operational life of the plant. And, again, as these peaks come early, you disposition them, and then you drop back down to receiving at the rate it's discharged from the reactors. And the chart that I showed on Slide 13 demonstrates that again.

In laying out the facilities to match the scenario cases that I talked about earlier, we saw that having all the fuel and canisters didn’t necessarily result in a need for a larger re-packaging plant operation. Again, there is always going to be a need for having to open the dual-purpose canisters to re-package the contents, and there is always going to be the same number of fuel assemblies that would have to be re-packaged into the same number of waste packages. So the facility size didn’t change so much, but the number of the canisters that would have to be opened is lower, and that could have broader system impacts; namely, worker exposure could be one of the differences. And we’re starting to look at that, as I’ll mention on this slide.

So we did accomplish our objectives. We re-established an important foundational capability to assess the potential used fuel management alternatives. We developed methodologies and tools. We applied those tools to a select set of used nuclear fuel system architecture alternatives. They did provide us insight into potential disposition pathways, identified areas where additional work is needed. Our measured milestone report is coming out, a draft to the Department at the end of this month. That’s why, as you look through this, you’re seeing a lot of these figures and charts listed as a preliminary.

We came up with activities that we’re going to look at in the next fiscal year. We started developing a worker exposure methodology, and we're going to continue to do that. We plan to implement that in our logistics simulation and look at the cases I just mentioned or talked about with respect to that. We want to implement within the logistics code blending and aging at the storage facility to look at the impacts of thermal management at a repository. We also want to be able to look at the alternative used fuel shipment strategies from the reactors and from the storage facility, as I talked about. We want to look at different bare fuel storage alternatives besides what storage pools, including transportation casks/maintenance fleet facilities within our logistics framework; look at sensitivities regarding pool densities. We've assumed high-density storage within the facilities we looked at; look if there's impacts associated with going to lower densities.

And now that we're starting to see it could be a large re-packaging effort, start looking into advanced re-packaging techniques: What's the state of the art, what are engineering gaps, what needs to be done to potentially develop advanced automated re-packaging techniques--dry, remote handling--and to support that, initiating process flow diagram and process node descriptions for re-packaging facilities.

With that, I'll entertain questions.

EWING: Okay, thank you very much.

Questions from the Board? Linda.

NOZICK: Nozick, Board. Just some really simple questions. The software package you're using to do that?

NUTT: It's a Visual Basic tool. One part of it's a Visual Basic logistics tool that was developed by the Office of Civilian Radioactive Waste Management in about the 2002-2003 time frame. The other part's a transportation operation model that was developed at Oak Ridge. We're linking the two together. We had to do some updates. The old model that RW developed didn't have the ability to do re-packaging at a storage facility. We put that in there. And there are a few other things that we had to just update it to bring it--to be able to do what we wanted.

NOZICK: So, like, the picture on Slide 16, the picture of that facility, is that coded actually into the simulation so you're seeing the detail close or--

NUTT: No, no.

NOZICK: Okay.

NUTT: The simulation is just a logistics flow. It's essentially annual, so we're figuring out how much fuel--

NOZICK: Okay. So it's book--

NUTT: We then laid these facilities--we had the logistics results, we had these facility concepts, and then it allowed us to size how big those facilities or how many we would need to meet that scenario.

NOZICK: Okay. Second question. There’s no uncertainty here; right?

NUTT: Oh, there’s a lot.

NOZICK: No, in the model. Those are simulations, not the answer.

NUTT: No, no.

NOZICK: There’s lots in the real world. And then the third question. Is there any discussion of what happens if you were to put multiple facilities? Yes, it’s hard to site even one, but is there any discussion in the--

NUTT: Yes, we’ve been discussing that and looking at impacts. That would be--

NOZICK: Because they’re not likely to be equally-sized facilities, for examples.

NUTT: No. It’s one area we’ve talked about. It’s one area we--it’s on our list of things to potentially look at, and it would require some code-development work.

NOZICK: Okay, thank you.

NUTT: Sure.

EWING: Paul.

TURINSKY: Turinsky, Board. Following up on the uncertainty, is your report going to indicate the risks of these various scenarios?

NUTT: No.

TURINSKY: Why not?

NUTT: It's a logistics facility-type report. We're not doing risk assessments.

TURINSKY: Yeah, I'm not talking about safety risk. I'm talking about disruption of some facility and how that flows back through the system.

NUTT: No, we're not doing that this year.

EWING: Just for myself to follow-up, on evaluating the risk you do plan to develop worker exposure methodologies; right?

NUTT: Yes, yes.

EWING: So that would be the principal way of evaluating risk.

NUTT: Correct, for the worker. So we will look at the impacts of that that way. But for the type of risks that Dr. Turinsky was looking at, no, we're not doing that.

EWING: All right. Other questions from the Board?

BECKER: Becker, Board. When do you anticipate having some preliminary findings related to the worker exposures, and are you interfacing with NIOSH in this exercise?

NUTT: I'd have to talk to the folks at Oak Ridge about the second question. They're the ones that are doing that work for us, so it's a good question to bring up to them. I can't recall when we scheduled that information to come available in Fiscal Year 13. It's there. I just don't have it off the top of my head.

EWING: Other questions from the Board?

(Pause.)

Okay, from the staff? Yes, Gene.

ROWE: Rowe, Staff. A couple questions. For your pool size, you're assuming all high-density fuel racks. Have you any plan to--especially with the impact going to higher burnup--to looking at Zone 1/Zone 2 fuel racks and the impacts of that?

NUTT: I think that's part of the evaluation this year that we put on the list for '13.

ROWE: Okay. The second question is--I don't know if this should be to you or to Ernie, but I get the impression from you that the need to re-package is due to package size only; okay? Do you--

NUTT: That's the consideration right now.

ROWE: Okay. So you're not looking at criticality?

NUTT: No. We picked the package sizes based on the work that Dr. Hardin had done last year.

ROWE: Okay, well, I'll wait for Dr. Hardin--

Sorry, Ernie.

EWING: Dan.

METLAY: Metlay. Board staff. I'm a little confused, because four or five years ago the main model that RW was using for these types of activities was the total system model, and I didn't see that acronym.

NUTT: Correct.

METLAY: What happened to the total system model?

NUTT: It's still there. The front end of TSM--the TSM pre-processor was CALVIN. And in looking--when we were looking at the tool sets we wanted to use and even working with some of the developers, the general feeling was to step back to use CALVIN and update CALVIN rather than trying to update TSM and try to put storage facilities and do re-packaging. So that was the choice. We stepped back to get to CALVIN and then did some updates to CALVIN to bring it up to what we can do now.

EWING: Other questions from the Board? Doug.

RIGBY: Doug Rigby, Staff. Two questions. To follow on what Gene said, in your simulations you mentioned for the fuel pool you'll maybe look at impact for higher burnup. I'm wondering for storage, for transportation, and you mentioned for disposal, you are looking at heat. So impacts for this trend to higher-burnup fuel, is that being considered both for heat, for the dose, and maybe for the waste forms for disposal? Is any of those impacts with the high-burnup fuel being considered?

NUTT: Not in the analyses we've done today. We've assumed that everything can move. There are some thermal limitations that are in the logistics tools on loading casks and moving fuel that are thermally limited, so there is a-- the fuel projections that we made, we do project burnup. We do project the enrichment. So we have an idea what the thermal constraints are. It does limit it. We haven't completely closed the system yet with the feedback from the repository side to how long that fuel might have to be aged before it can go in. So, yes, the thermal piece is on the list.

RIGBY: Okay, second question relates to Slide No. 8. And you mentioned that you can't really--at least the idea I got that you're not ready to go ahead with a recommendation to go to standard multi-purpose disposal canisters since you don't know what the requirements will be for disposal. On the other hand, you know, you mentioned later that it's better if there's some canister that--you know, if it's chosen and you maybe start to use that, I was wondering--I guess there's a couple of different philosophies. If, indeed, there was a multi-purpose canister chosen, you could design the repository to accept that rather than the repository--you know, larger in clay. You have a larger-- we'll have to see what Ernie, I guess, says, but you could have a larger size and then backfill it with clay or something. Do you have any comments on necessarily which way the tail of the dog should be wagged?

NUTT: Not yet. And that is part of the standard canisterization effort that's underway this year is to start looking at some of these--we want to take these tools and apply them to that to look at where the benefits would be using standard canisters. So I honestly don't know.

EWING: So, as follow-up to that--and maybe I lost the thread of the reasoning--but smaller packages would lead to less re-packaging just because--

NUTT: It would lead to the same fuel assemblies. If you assume everything has to get re-packaged, it leads to the same number of fuel assemblies that has to get moved. Where it has impacts that we're seeing is the back-end size of the facility as you weld closures to prep for release. And if you have to transport all those canisters over the road, in that case bigger canisters may be better, because you're moving less. So there's trade-offs between these.

EWING: Okay. Other questions from the Board or staff?

All right, thank you very much.

We'll move on to the next presentation, which is we hear from Jeffrey Williams again. So the title is "Logistical and Operational Issues Associated with the Transport of Orphan Fuel to a Consolidated Storage Facility."

JEFF WILLIAMS: Thank you. Again, welcome. You can see I've actually changed the title of the presentation from "Orphan Fuel" to "Transport of Stranded Fuel from Shutdown Reactor Sites," and that's to be entirely consistent with the

Blue Ribbon Commission’s report. They used the term “orphan” in different ways. They used it to refer to greater-than-Class C and for fuel that had no safeguards, but they did not use it related to shutdown reactor sites, so we have changed that terminology.

There’s a lot of slides in here; however, I’m not going to go over every one of them. I have a lot of slides on shutdown reactor sites that have pictures and information on there that I leave you for reference. And there was an earlier question from Dr. Turinsky about consolidated storage facilities, and this presentation is really geared towards what does it take to get fuel out of the shutdown reactor sites, not the design or what it takes to build a storage facility site.

Okay. So what we’re going to talk about here is why we initiated this study. We’re going to show you about the locations of the shutdown sites, the inventory at shutdown sites, and then what the scope of this project is. We’re going to talk a little bit about the characteristics of these independent spent fuel storage installations that are at the shutdown reactor sites, and we’re going to talk about the transportation infrastructure at and near the ISFSIs and the steps required to move the used fuel.

This comes from the Blue Ribbon Commission’s report where they recommended--and, again, as I said before, there hasn’t been a decision to implement their recommendations; however, we’ve started initial planning in case those recommendations come to fruition. First of all, they recommended prompt efforts to develop consolidated storage facilities; they recommended early preparation for the eventual large-scale transport to a consolidated storage facility; and they also recommended that the focus be on putting shutdown reactor sites where there’s stranded fuel at shutdown reactor sites first in line.

These recommendations, coupled with budgets that were implemented in the FY12 time frame and the presidential request in FY 13 that basically directed us to put some effort on addressing some of the BRC near-term recommendations, this is why we initiated this study. I think we finally got the work in place in about April.

And then also in April there was, as part of our budgeting process, another bill introduced by Senator Feinstein that basically said the same thing, was to conduct, she called it, a pilot program to license, construct, and operate a government-owned or privately-owned consolidated storage facility with priority given to spent fuel at sites that have been shut down. There’s been other interest, and we’re hearing a lot of different outside people saying that this is the right way to proceed.

And, actually, in looking back at this and looking at the long history of the development of this, it really helps to focus the program as opposed to in the old days when we thought about we have to shift from 104 reactors, and some of them are truck, and some of them are rail, and there's a whole variety of different fuel, and we have to deal with all sorts of issues. This really is something that, in my opinion, would help to focus the project.

So we've looked at a number of these things in the past, so what we're trying to do here is, what do we know about the sites, trying to identify what's the gaps in the knowledge about the sites, and what do we need to start doing now. So we're conducting this preliminary evaluation of the nine shutdowns, the nine stranded sites. And, as I said before, we're characterizing the site inventory, the site conditions, and the near-site transportation infrastructure and experience doing heavy hauls or moving large things out of the sites; and it's going to characterize the actions necessary to remove used fuel. And, again, we have a report to be issued in a couple weeks, October 31st, that identifies these issues.

A number of these things have been looked at in the past, infrastructures. We go back to Nigel working on this in 1990 or '89 or whatever it was. However, a lot of this information is dated, and there's not one report anywhere that's just focused on the nine shutdown reactor sites that seems to be of interest today. So, in any event, that’s what we’re planning to do.

Actually, in 1995, looking back through the history, I found a report called the “Maine Yankee Site Servicing Plan: What does it take to get fuel out of Maine Yankee?” Well, Maine Yankee at the time had not put their fuel in dry storage the way they have today. And so that’s completely dated, and those are the kind of things that need to be updated.

Okay, well, where are these shutdown reactor sites? We’ve focused on nine. You can see there’s--you can group them into three regions: the Northeastern region, the Midwest, and the East. There’s a couple other sites that people might want to think about. I think the BRC talked about Fort St. Vrain reactor in Colorado that is now DOE-owned fuel. This has just been focused on commercial fuel, because that’s what we haven’t contracted to deal with commercial fuel. However, that’s something that could be considered.

Morris, Illinois, which is a shutdown reprocessing plant, it’s close to the Dresden reactors, but they have a lot of fuel that was sent there in the ‘60s and ‘70s that now utilities are paying rent for. And it’s costing them more to pay rent for that than it is to ship it back and put it in dry storage; however, the communities where the dry storage is don’t want them to bring it back.

Another reactor that has announced they’re going to shut down is Oyster Creek, which would shut down in the 2019 time frame. That’s what Exelon has announced.

So, anyway, you get the idea. On the site that shows the quantities, we have UNF 34, UNF 5. Those are canisters of fuel. And I’m going to go over that in a little bit more detail.

This gives you an idea of what these shutdown reactor sites are like. And people talk about canisters, and they talk about storage facilities. Down here on the lower left is a vertical concrete cask at Yankee Rowe, and on the right is a horizontal storage, and this is at Rancho Seco in California. Above in the center is a canister of spent fuel. In this canister--this actually comes from Oconee, because I visited there in 1990 and took this picture, so it’s not the actual canister that fits in these two things, but it’s similar in nature. And so this is a welded canister that has 24 PWR spent fuel assemblies in it that sits in the lower right one in a horizontal configuration or in the lower left in a vertical configuration.

The canisters at all the shutdown reactor sites have certificates for transportation, so they were certified by NRC for storage and for transportation. Actually, the picture of this one in the top is only a storage canister.

From the outside you can’t tell the difference. Inside a transportation canister has additional support and additional criticality controls. And some of the newer--the older ones were storage only. Most of the newer ones are transportation as well as storage. And there is one shutdown site that actually has a canister of fuel in a transportation cask itself. That’s at Humboldt Bay. So that’s a metal transportation cask. Here you’d have to take that canister out and put it in a transportation cask to ship it away.

So out of the nine shutdown sites, seven of them have these vertical storage facilities, one has a horizontal storage facility, and one has their fuel in transportation casks. And the last one, which I didn’t list, the Fort St. Vrain in Colorado, that’s actually in a vault configuration; and I don’t have a picture of that here.

Here are the nine sites, a little bit more detail about them. What’s interesting is you can look at--it’s a combination of what was early reactors, which were proof-of-concept reactors. Big Rock Point was only a 72-megawatt electric plant; whereas, Zion down at the bottom, outside of Chicago, is over a thousand-megawatt plant. And this lists the different storage system containers that are there. And you can see it’s a variety of different vendors. The top one, Fuel Solutions, at Big Rock Point, they’re no longer in the business of providing these canisters.

And then you can see the next one down is Nuclear Assurance Corporation. Nuclear Assurance Corporation is very active. All what we call the Yankees--Connecticut Yankee, Maine Yankee, and Yankee Rowe--are Nuclear Assurance Corporation systems. Rancho Seco, one of the very first ones, is a Transnuclear. That’s the horizontal one I mentioned. And then you can see down--the other one is--La Crosse down at the bottom is also a very small reactor, 51 megawatts, as is Humboldt Bay. So you have Humboldt Bay, La Crosse, Big Rock Point, and Connecticut Yankee, which is a little bigger, 150 megawatts or so, very small proof-of-principle early reactors, and then some of the other ones that are production reactors.

This just gives you a graphical representation of how much fuel there is at each one of these different sites. And you can look at the small bumps, Humboldt Bay, Big Rock Point, and La Crosse. Those were the early proof-of-principle reactors. And then you can see Zion has a whole lot more fuel; Maine Yankee, which some of that was, I believe, sent to West Valley for reprocessing; Connecticut Yankee. Trojan and Zion and Rancho Seco are all production reactors; however, they were all shut down early, so they don’t have as much spent fuel or used fuel generated as they could have been.

Another important point is the little red blips on here, which is the greater-than-Class C waste that comes from the decommissioning of the reactors. They have put this greater-than-Class C in the same type of canisters as the used fuel, and so it’s in the same kind of canister. And in order to completely decommission the site, that greater-than-Class C will need to be removed.

Okay, what we’re looking at is--the top bullet really is looking at what’s inside of the fence at the nuclear reactors; whereas, the second bullet is what’s outside the fence. The inside-of-the-fence things are such as what kind of cask do they have; what kind of transfer capability do they have to remove that canister of spent fuel, already-used fuel, and put it into a transportation cask; what kind of cranes do they have; what kind of upgrades to on-site roads are necessary to ship it off-site. So that is primarily the responsibility of the utilities; however, that’s something that is being looked at in this study.

The second bullet down is then, what’s the near-site transportation infrastructure and experience; what kind of roads, railroads, barge capability; and what sort of experience have some of these sites had in transporting heavy things such as reactor pressure vessels or steam generators in and out of the site. And we’re basing this--we visited three of the sites, our team did, and been discussing this with the shutdown site managers.

The next bunch of slides goes through every one of the sites to show you what they look like. And, as I said, I’m going to focus on the first Yankee ones, and then I’m going to skip quickly through the other ones. But this is Maine Yankee in Maine. You can see what a spent fuel installation looks like. And the plans--well, here, let’s just--this is an aerial view. I apologize for it being a little bit dark, but at the top you can see where the independent spent fuel storage facility is, and that’s basically all there is on-site. The former reactor is gone. You can see there’s a barge slip down here that has been used.

And in the next--not this one--but there’s also a rail spur that goes right up to the independent spent fuel storage installation. Both the rail line and the barge slip would need to be refurbished to actually ship out. And this is just a look at the rail lines right here, which is within probably 30 feet, maybe a little farther than that. It’s right on-site where the independent spent fuel storage installation is, the casks, and you can see that needs some refurbishment. We don’t know what the loads are exactly on this rail line, but it’s been covered over with asphalt and grass, but it could be refurbished. This is the barge slip, and to get down to the barge slip you’d need to build a better road to carry these. These can weigh as much as 150 tons or so. In the Yucca Mountain FEIS we considered this a--it was designated what we call a rail site. That barge slip was used to ship the reactor pressure vessel when they decommissioned and the steam generators. The pressure vessel was shipped down to Barnwell.

Okay. And just another picture of the ISFSI at Maine Yankee.

Then we move on to Yankee Rowe in Rowe, Massachusetts. And this one is interesting in that you have a choice of--no, they don’t have a choice. They ship a seven-mile heavy-haul where, when they decommissioned it, it was a seven-mile using a heavy-haul vehicle where they have to close down the road, and it’s a big deal to do this. You can see how much spent fuel is there and how many heavy-haul trips would be needed to ship from here.

And this just shows you where the heavy-haul route is. Up at the top is the ISFSI, the heavy-haul route down there, down to a railroad siding that is right here. And, actually, this tunnel, which you can go through it, is one of the longest tunnels in the world. I think it might be the third longest tunnel in the world. It was built in the 1800s. But you can ship a transportation cask of the size that we need to through there. However, if you were going to--normally in a transportation campaign--we’ve talked about putting three or five transportation casks together on a train--you would need to assemble that train in this area here.

In one of Monica’s slides, you probably didn’t catch it, but they had a little picture of a train that was used to ship fuel from West Valley. And what it showed was there was a locomotive, and then there’s what’s called the buffer car, and then there was a transportation cask. Then they had another buffer car and then another cask of spent fuel, another buffer car, and an escort car. If you were going to ship three to five of these, it’s a longer train--they call them consists--you’d have to put together at this siding location.

Then we move to Connecticut Yankee, another ISFSI here. This was sort of a mid-size reactor. And this one you could use either barge or rail, which would need to be evaluated in detail. In the Yucca Mountain EIS they looked primarily at heavy-haul to a rail siding, but they also looked at a barge. And this shows up here the location of the ISFSI down to the lower right. You would still need to transport it on an on-site road, which probably needs to be upgraded for this weight, down to a barge slip, which is along the--this might be the Connecticut River. Is that right, Peter?--and which would need to be dredged. The former reactor site is up here, completely gone. Oh, there it says Connecticut Reactor Site. But both the barge slip and the canal would need to be refurbished.

And the other choice is the heavy-haul route out of Connecticut Yankee. And the heavy-haul route is about twelve miles, and it does go through some rather heavily-traveled areas where you'd have to shut down the route. And it's a frequently-used road, actually four lanes in part, and then in other parts it's two lanes. And I don't know whether any of you paid attention to the shuttle shipment through Los Angeles, which was--it's bigger than these, but there's a lot of information here, a lot of things that need to go on like moving traffic lights higher in some cases, cutting tree limbs.

But right here, this shows you the canal situation at Connecticut Yankee on the left, and it shows you the rail siding. This rail siding is what was used to ship the steam generators out when they decommissioned, and you can see it needs some refurbishment. It's actually in a little parking lot, and there's a small little business, a hot dog stand actually, in the parking lot. And when they shipped the steam generators, they had to close it down for a month, and they had to negotiate with the vendor there to pay for her loss of business. And so, anyway--and there's a lot more spent fuel than there were steam generators.

Okay. So I'm just going to finish up with the Maine Yankee's and then skip through the rest of the seven.

But, in any event, every one of these needs to use a transfer cask. You need some way to transfer the canister that's in the concrete over pack to a transportation cask. I put a transfer cask picture down here. This is of a horizontal storage down in the bottom, but that's a transfer cask. It's not a transportation cask. It's not certified or capable to be transported off-site in the public. And then in the bottom here in a different configuration, you can see a vertical transfer cask and how they have to lift up--this is down at Humboldt Bay where--or a Trojan, actually, I believe, where they are in an underground configuration or below-grade configuration.

So, anyway, at Maine Yankee you could use rail or barge. Yankee Rowe, it's probably heavy-haul to a rail--it would definitely be heavy-haul to a rail, and you would need some refurbishment. At Connecticut Yankee barge is probably most likely because of the long heavy-haul route. But, anyway, the study is looking at these preliminary aspects.

Skipping on, this is Big Rock Point. As I said, I'm not going to spend a lot of time on these at Big Rock Point. It's right on Lake Michigan. However, in dealing with the State Regional Groups, they don't believe it's feasible to ship through the Great Lakes. So that's something that needs to be dealt with.

Here there's only five casks at La Crosse. And if you don’t ship by barge, the heavy-haul route for these is--it’s a good ways. It’s like 50 miles or so. I don’t remember the specifics, but it’s a good long ways for a heavy-haul shipment. La Crosse--I’ll skip through these--again, it’s on the Mississippi River, and there have been barges along the Mississippi River; however, again, people aren’t favor of it.

This is Rancho Seco. There’s a rail line right to the site.

Zion--let’s see--

SPEAKER: You went by it.

JEFF WILLIAMS: Oh, did I?

SPEAKER: Yeah.

JEFF WILLIAMS: Okay. Yeah, Zion up on Lake Michigan, they’re still in the process of decommissioning. Their fuel is actually still in the pool there; however, they have a contract with NAC and, let’s see, Energy Solutions--I think they call it Zion Solutions, too--to build their independent spent fuel storage facility for around 61 casks and probably maybe on the order of 4 or so greater-than-Class C casks.

Rancho Seco, horizontal. Rancho Seco has a rail right to the site.

One that I do want to point out, Humboldt Bay, it’s been designated as a rail shipment; however, the heavy-haul route for Humboldt Bay is 170 miles, so this would be a significant heavy-haul. But one thing about Humboldt Bay is that this is the site that has the fuel in metal transportation casks, so all somebody would have to do to transport these is buy what they call the impact limiters that sit on the end zone. So it would be ready to go, except there is the heavy-haul situation.

The Trojan site and the--anyway, you can look through these at your leisure, but just wanted to finish up here. Oh, this is a heavy-haul of a reactor pressure vessel, so it gives you an idea of what they're like. And normally along with this, if you were going to be transporting spent fuel, there would be state police and all kinds of people walking along with it. It may travel about two miles an hour, so you could--the one out of Connecticut Yankee took them all day for a seven-mile trip, and they had people walking along with them and news crews and security and so forth.

Let's see--oh, I think I missed this one. Yeah, this is just sort of a recap now that you've seen the pictures of what we're doing in the initial evaluation and which will be completed this year. By the way, this is being led by a team of labs right now, Sandia National Lab, Pacific Northwest, and Savannah River. And they're developing a project plan that has a representative schedule in it. However, to actually get down to do this, it's going to take a lot of detailed planning; and it's going to take interactions with the local people to address issues like heavy-haul versus barge and interactions with the local officials.

This is a slide I could probably spend a couple hours on, but it gives you just in the high-level the steps that are necessary to ship used fuel from the sites. It's a notional schedule, and what it shows here are things in the blue that would be done by either the Department of Energy or GOVCORP or any kind of--whoever was the implementer, whoever had the job to do this.

The first bullet is the initial planning you need to develop things like a QA plan. You need to establish agreements between the sites and DOE. There is presently in place what we call a standard contract with every one of the utilities where they pay into a fee that they've been doing since 1983, and in return DOE takes their fuel. However, it was developed in 1983, and it didn't anticipate all the things necessary to make this happen. So that's an important piece of business that would need to be done.

Some of the bigger things that need to be done is, you actually need to solicit bids for transportation casks. As you saw, there's only a couple transportation casks. There's one at Rancho Seco. The ones at Humboldt Bay are good. The other seven sites do not have transportation casks. We would have to go out and purchase those. The good thing is those have been designed and certified by NRC, so you don’t need to go through that process at this point in time. However, there’s five different ones. There’s, like I said, the Energy Solutions one at Big Rock Point, which are no longer in the business of doing this. And then there’s Nuclear Assurance Corporation casks, there’s the Holtec cask, and then there’s the Transnuclear cask as well.

You would need to solicit bids for rail cars. I didn’t really talk about rail cars, but in the last several years the American Association of Railroads have passed a new standard called the S-2043 that lay out what rail cars should be designed like to carry spent fuel. And this is important because if they’re not designed like that, you have to travel really slow. And if you travel really slow, then you have coal cars and so forth that are coming by, and you get in the way of interstate commerce. So the Navy actually has started a design of one of these rail cars. They have special brakes and so forth so that they can travel at higher speeds. The Navy has started to do this for the de-fueling of the Enterprise and for what they call an M-290 cask. Now, it’s even bigger than the ones we have, so there would be some evaluation whether you need some modification of that rail car.

In addition, the buffer cars and the security cars need to be designed, so you need to solicit bids. You'll actually need to test these things. The PFS Project started to test these down in Pueblo, Colorado, several years ago; but it's never been completed. Of course, you need to determine what the routes are and the modes of transportation, as we talked about. You need to implement the 180(c) aspect, which we talked about before, which is providing funds and training to the local communities for emergency response and so forth and tribes as well.

And then you're going to need to plan for operations, training, dry runs involved, and, finally, load and ship. And we've been looking at how long it would take to load and ship; and if everything went okay, it might take three or four years to do that, to get the fuel out of the sites. Of course, this all--you have to understand and assume that you have a place to ship to, and this study has not addressed that at all.

The last slide, some key points related to schedule. And the first one is DOE, or whoever the implementer is, would provide transportation casks. And this is as a result of the standard contract that we have between the utilities that says who does what. And the way the standard contract reads is that DOE provides the transportation capabilities; okay? This would be the case, except for the two that I mentioned before at Humboldt Bay and Rancho Seco. There's already transportation casks there. The site owners are the ones who are responsible for loading the casks and preparing them to ship. If you go to those sites, you can see that basically all they have right now are guards and a couple of technical people that have been there for awhile. So that capability would need to be developed in some way. As I mentioned before, you need to get a rail car, buffer cars, and security cars that meet the requirements of the American Association of Railroads' new standard.

Let's see, the schedule assumes that we have a destination. I mentioned that. The schedule assumes that we will engage with state, tribes, and other federal agencies and that the rail line meets the minimum standards for transportation and used fuel.

In one case early--back in the--skip that. When the Office of Civilian Radioactive Waste Management was in place, one of the State Regional Groups in the Northeast, along with the American FRA, Federal Railroad Association, went out and assessed the capability of some routes. That's the type of thing that would need to be done. They only did it for two sites, and they didn't do it for shutdown reactor sites. It was Ginna--I can't remember which sites they were. But, in any event, that's the type of things that need to be done prior to shipment.

In conclusion, we've initiated this preliminary evaluation. We're characterizing the actions necessary. We're developing preliminary schedules. As I've said several times, all sites have fuel and storage configurations with NRC transportation certificates of compliance. We'll need to manufacture transportation casks, go out and buy them; however, they don't need to be designed. And, lastly, as I mentioned before, the canisters--when the standard contract was written in 1982, there were no canisters of spent fuel, and the standard contract, if you look at it, talks about what fuel is. And it describes a PWR assembly that's 14 by 14, and this is what the waste acceptance criteria is. This has not been addressed to date, and this is something that needs to be considered.

So each campaign from each site, I think, needs to be considered really as a project; however, you need to integrate them all together to make sure that they all fit together. Maybe you could do the Northeast ones first or maybe the West Coast ones first, or maybe you'll look at it from the standpoint of what type of cask you can buy that's easiest.

And, lastly, I want to emphasize, the administration doesn't have a policy or a direction right now to do this, and this is just initial planning in the event that we are given the direction to do that.

If anyone has any questions, I'd be happy to answer.

EWING: Okay, thank you very much.

Questions from the Board? Mary Lou.

ZOBACK: Zoback. Board member. This will be a naïve question, but sometimes those are the toughest ones. Can we go back to the map right here at the beginning, Slide 6? So the bottom line is, DOE has a responsibility to accept the waste from the utilities; correct? Well, as you mentioned, there are sort of three clusters of these sites, and you described a pilot project. And I think pilots are a great way to go, but it turned into a 20-year pilot project, and it’s huge, and it’s enormous. And as I look at these three sites, it seems to me--I’m not sure--I’d love to see a map where everything is on one map, where all the defense waste is. But let me go to the Western U.S., because I live in California.

Hanford exists. It’s already storing waste. You’ve got Trojan that’s very close to Hanford. You’ve got Humboldt Bay and Rancho Seco, which you’ve said are already in transport casks; right?

JEFF WILLIAMS: Yes.

ZOBACK: So wouldn’t a simple pilot be to take the waste from those three sites and put it at Hanford? You have three states to deal with. I’m just trying to take this from a rational point of view; okay?

No, let me finish. By the time all of these analyses are done, we're 20 years down the road. And this isn't a criticism of you. I understand what you're trying to do. But, you know, we just keep making the problem more and more complicated and huger and huger. And if we want to gain public trust, it would be nice to show we could do it in one place, one time. And I heard all the laughter, and I'd like to hear the reaction from the audience. But, you know, I just look at all of the issues, which you very carefully laid out, and it just seems like a huge--and when we're talking about nine orphan reactors, not the 70 or 104 that are still operating, so--

JEFF WILLIAMS: So, yeah, this is a much easier problem than we were dealing with before; however, it is a big deal. And the other--one of the other key recommendations of the Blue Ribbon Commission was that we will find sites through a consent-based approach.

ZOBACK: I understand that.

JEFF WILLIAMS: And I would think that if the State of Washington, the community of Hanford, came out and once the Department and the administration actually put in process a place to do siting and if they came out to do this and said they volunteered, I think it would be something that would be considered. I guess--

ZOBACK: Well, they would have to have an incentive to volunteer.

JEFF WILLIAMS: Right, obviously. That's all part of the consent-based siting approach. But my personal belief is the Department would be open to any consent-based siting approach; if we were given the direction to, this is what we're going to do.

EWING: Okay. Right. So I'll break the rule; and as a follow-up comment or question to Zoback's suggestion, any comments from the audience?

REGALBUTO: The concern for the State of Washington right now is they are housing all the defense waste, and it's been 50 years. And the Department has not taken any Curies out of the state. So the states that normally house defense wastes like South Carolina and the State of Washington and Idaho normally have protocols of you cannot bring Curies-- so, unfortunately, in the case of the State of Washington, we don't have a disposal path right now for the future (inaudible) we produce. And until those Curies leave the states, you know, there is no dialogue about bringing new Curies into the state. And that's normally what happens with the states that house defense waste, and it's an equity issue.

ZOBACK: No, I understand that. It's just there is also a bigger equity issue. Are we ever going to be able to solve this problem?

EWING: Okay, other questions from the Board? Linda.

NOZICK: Nozick, Board. It’s a simple one. So this is just the stranded waste; what about the other reactors? Is there a plan to survey again to update the transportation site studies?

JEFF WILLIAMS: Yeah, I think that would be the next step. So, you know, we have done this last in 2003 or ’04. But if we got to this point, yeah, it would definitely have to be done. And the way I view this is, yeah, you have a pilot, and this is what we do first, and you get, as the BRC talked about, the stepped stage-wise approach, this being the first step. If a volunteer host community accepted this and they wanted more, that would be the next step. And then you would have to go to Mark’s architecture study to see what’s best to take next. Is it out of the pools? Is it out of storage? Are we going to re-package? I’d say, actually, it’s a relatively much easier first step. However, as I was on the airplane yesterday with Monica, I don’t think people ever understand the complexity of just this, like you said.

EWING: Other questions from the Board? Staff? Gene.

ROWE: Rowe, Staff. On Slide 8, if you would, Bill, it shows the 71 COCs expire, and it looks like they’re all going to expire within the next two years. Is there any effort to go through a relicensing? And it’s two questions. Is there any effort to do that, and who is responsible for the licenses? Is it DOE or is it the utilities?

JEFF WILLIAMS: Actually, it’s the vendor is responsible for the licensing. And my understanding--and maybe Earl can correct me--is that the storage--well, the storage facilities are licensed for 20 years, so you can see the storage facility has a different expiration time than the--

ROWE: Right. I’m looking at the 71 license.

JEFF WILLIAMS: The transportation casks are only certified for five years. And from my understanding to date is the NRC has pretty much been--there hasn’t been a whole lot of issue with the recertification of transportation casks to date. And my understanding is that also the ones that are coming up soon are going to be recertified. And I don’t know if--

ROWE: Can we get the NRC’s position on that?

EASTON: Then do I get to ask Jeff a question?

JEFF WILLIAMS: Sure.

EASTON: Transportation casks are certified for five years. And that’s largely because, transportation being an international event, we keep our certification in line with certifications of other countries through the IEA, so that there’s a five-year standard that they do that. Most renewals are routine. If the licensee comes in for timely renewal, if we have to do something with the cask, we let the certificate continue until we come up with a decision. But I think we anticipate that every one of these casks will probably go through renewal without much of a--

ROWE: So when you license, do you license the cask, or do you license the cask canister system?

EASTON: Yes--no--oh, what we do is we do not license individual casks. We license cask designs. Okay, we license the design, and then the vendor can build as many as he wants. Now, for transportation, the transportation package is defined as both the hardware and the contents. So we never just license the hardware; it's also with the contents. So it's sort of a custom-made deal.

EWING: And your question? You had a question as well, as long as you're there?

EASTON: Okay, here it goes. It's basically on the last presentation, but Jeff's in charge of it, so--okay. Remember, the last presentation had nine scenarios to the fuel cycle, and--the Commission, the NRC, as part of the Fukushima effort, has been asked to look at whether it makes sense for the expedited movement of spent fuel from wet to dry. And what that would mean is at some point in time, if the NRC chose to do that, we would order all utilities within a short time frame to move everything into dry storage. That means potentially everything would be in legacy casks, there would be no bare fuel to manage, standardization will--well, the window will have closed, etc., etc.

So I would ask, has that scenario been analyzed? And if not, there are two good reasons to analyze it. One, the DOE doesn’t want to be surprised if we look at something like that. And number two, more important to me, we may want to use that information to decide whether it’s wise to do that, because we have a decision to make that may impact on ultimate disposal. So I would just--real question: Has that scenario been considered and--

JEFF WILLIAMS: No. Actually, I thought that NRC was considering this. That scenario is not being analyzed by DOE, but I would imagine, like you said, there’s those downstream environmental impacts. There’s a lot of consideration--

EASTON: I’m on that Tier 3 panel. That’s why it’s important to me, so we’re deciding that. One of the things that we said is in the cost-benefit analysis we ought to go and meet with DOE or get information from DOE how our decision would impact this whole thing about managing it downstream. And so this would be very helpful if this scenario were analyzed, because we don’t want any surprises, and we don’t have the data to do that.

JEFF WILLIAMS: Right. Mark, you need a follow-on analysis that has no interim storage and no repository until 2050, and then you’d get the impact of that; right?

EWING: Right. Thank you. This illustrates one of the values of this meeting is to bring the agencies together on neutral ground. Let me ask you, Nigel, did you have a last question from the staff?

MOTE: I want to follow up with Gene's question. I was in the same frame of thinking as Gene. If I look at the Big Rock Point example, you went very quickly through we've got licenses for the transportation casks and its responsibility to the vendor. But I believe that Fuel Solutions doesn't exist anymore as a corporation.

JEFF WILLIAMS: No, I said they're not in the business as a vendor. They're not on the--they're not competing, as I understand, in terms of for new dry storage. I mean, it's NAC, Transnuclear and Holtec.

MOTE: So you'd still be able to look to Fuel Solutions to follow through with the transportation cask requirement or whatever--

JEFF WILLIAMS: Well, you know, I actually asked the utility about this, and they said they could possibly look to another vendor to design another cask to carry that canister. However, that would mean it would need to be certified. And so that would--that's something that would need to be evaluated. It's a little glitch in the whole thing.

MOTE: So does the responsibility still fall to the utility?

JEFF WILLIAMS: Well--

MOTE: Let me wrap up with another one. This is only the nine sites, which are the stranded fuel sites. Does that situation exist with a number of other sites where they’re not yet shut down but they’ve brought in systems where there may be the same sort of issue with the discontinuity in the supply? I don’t know if it’s an isolated example of--

JEFF WILLIAMS: I’m not aware of one off the top of my head. I think there is another Fuel Solutions system in Arkansas--

EASTON: If you look at the NRC Digest, which is sort of an almanac that we put out every year, it will have the list of every site, which casks they use, and it has a list of all the vendors and all the casks. It’s on our website. It’s a button on the first page. Hard copies are available on request.

JEFF WILLIAMS: I actually have it in my briefcase over there. I haven’t answered your question in detail. And it’s got a big spreadsheet that lists every one of--

EWING: Okay, I’ll let you two pour over that during the lunch period. So I’ll call this morning session to an end. I want to thank all of the speakers. I think this was an interesting morning. And we’ll reconvene at 1:00 p.m. Thank you all.

(Whereupon, a lunch recess was taken.)

AFTERNOON SESSION

EWING: To kick off the afternoon session, we'll be hearing from Harold Adkins, Senior Research Engineer at PNNL, and the topic is "Modeling Used Fuel Storage Temperatures."

ADKINS: Thank you. I work at Pacific Northwest National Laboratory. I'm here on behalf of DOE, and I need to speak to you about some of the UFD campaign goals and initiatives and some of the work that we've done up until now regarding modeling used fuel storage temperatures. One of the things that I'm going to start with is kind of discussing some of the reasons that we're doing this, some of the safety drivers, and then discuss some of the tools we utilize, validation associated with those tools, some of the work that we've done to vet those tools, and then explain also some of the details regarding work that we've done so far and then where we're going in the future.

I guess to start off, what's our concern and why are we performing these initiatives for the campaign? One of the things that came out of a gap analysis that the DOE did as well as NRC was to prioritize things that had a market effect on degradation processes, and temperatures and temperature distributions were identified as Rank 1 for having an effect on those issues. Some of the things that immediately came up after identifying the Rank 1 priority is that realistic as opposed to overly conservative temperature predictions were required simply due to the fact that if you were to over-predict the temperatures, it would under-predict some of the effects and things of that nature. And just simply adopting some of the industry or typical uses regarding developing conservative models would literally over-predict some of the temperature distributions for set systems.

Over-estimating temperatures, again, just to name a few, over-predict the amount of hydride reorientation that can occur with fuel cladding as well as, you know, making--annealing some of that damage away, which would lead to a false sense of security, and then under-predicting stress corrosion cracking effects as well as deliquescence can also occur, because you're assuming the temperature of constituents are hotter, and this directly relates to the canister shell temperatures.

As previously stated, we need accurate predictions on temperatures from past, present, and future, predictions of the storage systems themselves, to determine the clad and support and safety system behavioral characteristics. Especially critical for transportation is to know if we're at or below the ductal-to-brittle transition temperature for cladding, simply due to the fact that it becomes a lot more fragile and easier to damage. One of the thing to keep in mind is, you know, through the core of a transport system and its payload, the hotter portion--while it’s stored the hotter portion of the fuel will actually go through its ductile-to-brittle transition temperature later in the game than some of the cooler temperatures out in the ends of the fuel assembly. And understanding the temperature distribution throughout the used fuel payload is important to characterize these effects and understand what might occur during transportation initiatives.

Touching back on some of the tools that we use, as I discussed previously, and some that we’ve employed during the campaign currently, and discussing some of the validation application history is what I’m going to go through now. As far as code development, back in the early ‘80s DOE/OCRWM initiated a search to identify an analytical tool that would accurately predict temperatures through spent fuel storage payloads simply to determine peak fuel cladding temperatures and assembly temperature distributions throughout the payload core and then temperatures of safety systems such as seals and neutron shield material for dual-purpose casks that were out on ISFSI pads.

And the capability requirements were essentially “grand challenged” at the time for a CFD code, and the main objective was to include flow modeling within the fuel rod array to enhance cooling and capture those effects; steady-state natural convection to be able to capture that explicitly and accurately characterize it, as well as also at the outer package surface boundary. And then thermal radiation, since it contributes about 20 percent of its cooling capability within the core, the objective was to also capture that as well accurately.

Two codes were selected originally during a survey of existing codes that were available as best available starting points per multi-phase development and validation effort. And the intent was to calibrate the codes for flow and heat transfer with inert gas backfill charges for the systems and also establish what that influence would be through the array--oops, I need to--sorry about that--forward to the next slide--and establish the interaction internally with different fill gases and their influence and then also to verify the implementation of conservation equations--mass, energy, and momentum--and to validate against full test scale data of said systems and some of the higher-capacity systems as well.

Initial verification was performed on single-rod bundles that were simply mock-up fuel assemblies. They were electrically-heated assemblies, and then a down-select was performed on which package to carry forward after performing those evaluations. After that COBRA-SFS was selected as the leader for the particular time. It had a little better predictive characteristics than HYDRA-II. An OCRWM validation effort was initiated at INL after that that released Cycle 3 code, and after that it was basically tasked to evaluate blind pretest predictions of multiple cask systems at a Test Area North facility at INL as part of the validation process.

Over 78 blind test analyses were performed, and I say “over” because I can only find 78 to date, based on correspondence that was previously communicated between DOE and NRC. And of these, I guess, most notably, a Transnuclear TN24P was one of the highlights where we did quite a bit of work. The Sierra Nuc VSE-17 was one where they actually went through and encapsulated some of the fuel assemblies after consolidating them, which is a practice that’s no longer necessarily relied on, because it multiples the waste stream. And then the REA 2023, which had different cooling characteristics and a different type of light water reactor fuel assembly. It was a BWR fuel assembly; whereas, the TN24P, the P is for PWR.

Basically, this slide is included just to give you some of the references, and the one thing I wanted to point out is that at the back end of the presentation there’s two pages of validation references, including some of the work that’s also been conducted to date regarding transfer, transport, and storage systems.

This is just to make an example of some 24P results that I pulled out with some explanation. This is of a system that sits on its side and also has the capability of being set up vertically. This particular orientation is horizontal orientation with the fuel assembly load through the payload core. And what you're seeing through the cross-section of the plot is basically the peaking profiles through the fuel assemblies. And then also down at the bottom of the plot is basically the materials as you cross through this portion of the key up in the upper right-hand corner of the plot, showing where thermocouples were located within the basket when they performed the tests. And I guess most significant here is, the location for horizontal orientation, the thermocouples are located within the hotter part of the core, the peaking point of the decay heating profile within the core of the basket.

And then, I guess, one final note I want to make here is, there are some points here within the data and going from a nitrogen case down--or a vacuum case down to a nitrogen case down to a helium case, simply showing that helium was a better heat transfer--or a conduction media to communicate the heat or migrate it out of the cask. And also these points that are down here are simply due to the fact that--the reason they're so far below is, the only thing that's plotted right here is the predictive temps through the fuel assembly cores, and those measure temps are at the basket surface where there is an extreme gradient, so the spikes simply weren't put in. They were within a couple degrees of each other on the predictions, though.

The next plot simply shows the same cask with only one backfill media, which is helium, and basically looking at the key here showing the thermocouple locations and then the distributions. And one of the things I need to note is that those were thermocouple trees, multiple locations of sensing temperature within the same cross-sectional location, if you will, and, again, you know, within five degrees on most of the predictions and predicting conservatively in most cases.

Stepping out of the discussion of validation going into application, one of the things that was done after the validation initiative associated with the code was performed is DOE funded a review by NRC--conducted by NRC. And NRC subcontracted a team of national experts to review the code for use in predicting thermal performance and accurately predicting spent fuel temperatures, the core of the payload, across the cross-section of storage and transportation and transfer systems available. And after, I guess, positive and favorable reviews at the juncture of when a lot of this was tabulated and concluded that the code did an accurate job of performing the predictions, NRC established a contract with PNNL to perform confirmatory analyses of said system, storage transfer, and transport systems themselves as casework and to do some of the either backup or primary applications, some middle reviews.

One of the things that needs to be noted here is, in this particular campaign we utilized multiple tools, COBRA-SFS, what I would call a legacy code because of its age and date of development. We rely on quite a few other analytical packages due to the fact that there's trained operators as well as something that has a GUI interface where you can communicate your results and details a little more effectively than having to pull specific temperatures and assemble plots.

A lot of these codes that we apply such as some of the examples--FLUENT, STAR-CD and CCM--those are part of the CD-adapco--as well as ANSYS and some other ancillary tools that we've used in the past. They all tie back to the validation initiatives and directly hinge on the methodologies and correlational developments that surround or have been employed within COBRA-SFS itself and have a direct tie back to the validation work.

And, again, you know, part of the reason why we have adopted some of these other codes in this particular initiative is due to the fact that there is existing general purpose commercial codes that there is a number of users that are trained to be able to utilize and take advantage of, as well as the fact that COBRA-SFS is a fairly complicated code to use and requires a seasoned operator and, again, doesn't have a pre or post processor.

Some of the previous applications that we've evaluated with this suite of codes, if you will--now I'm talking more than just COBRA-SFS--but fundamentally the top tier are mostly COBRA-SFS. One of the things that we've done is support a Duke Power NUHOMS module relicensing support initiative. EPRI has funded the dual purpose NAC cask performance evaluations back in the day. COBRA-SFS itself was actually used to look at the feasibility associated with wrapping some of the fuel pins within the FFTF reactor to enhance heat removal from the fuel assemblies.

And then it's also been employed to study something such as the Hanford Canister Storage Building that I don't know if a lot of you are familiar with, but I do have some slides in here that I'll only broach on. Mainly what it is, it almost looks like a tube array or, you know, that it be used for heat removal; and that's exactly what it's designed for. But it's basically a dual-tiered canister structure that are put down in vertical ports and then ducted from one end to the other in a vault, similar to what you would see with, like, a repository.

Spent fuel pool analysis associated with postulated Zirc fire has also been evaluated with COBRA. And then the Skull Valley Contention "H" rebuttal to protect NRC in the capability of continuing to employ ISFSIs as well as what was intended to be, I guess, deployed at Skull Valley, it was also utilized for that.

Some of the recent and current applications that the tools that I had previously discussed are being utilized for, we have performed numerous confirmatory analyses of applicant's middles (phonetic) proposed for storage, transfer, and transportation systems that have been proposed to the NRC for receiving CFCs, and these include the gambit, normal and hypothetical accident conditions that are governed by the Code of Federal Regulations. And we have been doing that work, I think, for almost two decades. We're coming up on two decades.

Some of the work that we've also been recently involved in--I say recently, it's about eight years or more--is some of the extra regulatory evaluation. We're taking a look at what would happen under circumstances that revolved around the Baltimore tunnel fire, the Caldecott tunnel fire--and I'm sure some of you are familiar with that--as well as two other evaluations that are coming out to complement the first two: the McArthur Maze fire and collapse accident evaluation for an over-the-roadway or legal truck transport system, and the Newhall Pass is highly similar except there was no collapse or anything like that.

Some of our current campaign goals and objectives are--we need to--and I'm speaking on behalf of UFDC--need to validate predictive tools for high-burnup fuel and newer, higher-capacity dry cask storage systems. And it's not that we think the heat transfer mechanisms or the physics are going to change. It's merely due to the driver being able to point to something and say that you have the verification and validation history to prove safety and dispel concerns.

NRC is currently asking the industry for inspections to support license renewals, and this is kind of leading into augmentation of validation for some of the tools that are being employed. DOE is teaming with EPRI currently including--they are also supplying funding to perform some of these future inspections.

And then one of the things I wanted to comment on is just--what we did over this last FY is some of the pre-test and post-test thermal predictions performed at Calvert Cliffs Nuclear Power Station. I'll go into that. Some of the objectives there were to determine storage system component temperatures through the cross-section of the core, even though we couldn't measure those out the canister wall and then some of the ancillary storage system components like the concrete enclosure.

It's an internally ventilated storage cask that we selected to model, which is the exclusive system that's used at Calvert Cliffs, although the particular system that's employed there is an older NUHOMS version. I think the original developer--I believe it’s Framatome. Anyway, NUHOMS zero, if you will, because there are quite a few gens of the NUHOMS system marching forward in time that are a little more effective at heat removal.

And then one of the other initiatives was to demonstrate state-of-the-art evaluation capability and analytical practices and kind of show how closely we could predict temperatures and, again, to perform partial verification of set tools and analytical practices.

ZOBACK: Could you say what HSM is? You’ve been using a lot of acronyms.

ADKINS: I forgot.

SPEAKER: Horizontal storage module.

ADKINS: Exactly. I apologize for that. And, you know, that’s a good point. There are quite acronyms. I apologize for those. I will try to go through every single one as I go forward; and if you have questions on ones that I’ve already stated, please ask.

ZOBACK: NUHOMS.

ADKINS: It’s--I don’t remember what the NUHOMS acronym stands for. Please help me.

SPEAKER: Nuclear Horizontal Modular Storage.

ADKINS: Excellent. Thank you. Of these particular systems, no. To give you some background, Calvert Cliffs

Nuclear Power Station is located near the Eastern Seaboard. Mainly what they have is an ISFSI that’s located off-site, and that’s an independent fuel storage installation. It’s located just off-site from where the reactor is located. You can see the reactor here, and then the ISFSI is down here.

Forwarding on--forging. The Calvary Cliffs site--it has a site-specific storage module, CFC. And one of the things that we relied on and EPRI assisted us with is, they have a solid model representation with all the parameters of this particular system, and they provided it to us to integrate into a thermal model. The other thing that was of tremendous assistance is dry storage canister details that were extracted from a Monte Carlo N-Particle, MCNP, model that we migrated into a SolidWorks model that could be mated with the dry storage cask itself and converted into a thermal model. John Massari--that was courtesy of John Massari, Calvert Cliffs, and they also had drawings that they communicated and passed on that we could utilize.

Going forward and taking these solid model parameters, transforming them, we merged them into a STAR-CCM, which is part of the CD-adapco suite computational fluid dynamics model and solved--I should explain the HSM-1 and HSM-15. HSM-1 is the colder--it’s the coldest canister. It was the initial loaded canister--and correct me if I misspeak--and then the HSM-15 is actually the lead canister, and it has the highest decay heat load currently. And that was the one that I'm going to make the example of in the temperature distributions. And this just merely gives you some of the model specs of what came out of it with the K-O turbulence model and some of the options that were utilized out of the CD-adapco suite.

One of the things you can see down here is highly resolved, highly detailed in the vicinity of the basket and the fuel assemblies and then migrating outward where we have components like concrete and things of that nature with a little less detail, because they're really not huge drivers to the heat removal potential of this particular system, because it is internally ventilated.

Some of the thermal prediction results--and this is for the HSM-15, because it's a little more spectacular than the 1; the 1 is a lower decay heat load. Just to give you an example, this particular system had a--it was just upwards of a 7-kilowatt decay heat load, which is actually quite low by today's standards of some of the casks that are currently being loaded. But, anyway, just to go from left to right, top to bottom, one of the things that you'll see here is this is showing the velocity magnitudes and meters per second of the internal ventilation media, which is air from the ambient migrating through around the canister. This is a central split vertically of this system and then from inlet to radiation block ball and then out through the exits. And then one thing you'll also see is the helium convective environment within the canister since we did a vertical cut. Or, as to the right, what you see here is dry storage canister shell temperatures ranging anywhere from 83 to 256 Fahrenheit. And I apologize for the unit's mix here. Usually when we report things to NRC, I don't know, maybe it's something that we've established, but it's customary that we report them in Fahrenheit and then, you know, you're going to see a mixture of the two, because I think UFDC likes the metric system.

Anyway, going down further here, this is basically just showing you the temperature of the air as it migrates through as it heats up and where it stacks up against heat shields. This particular one, like I was stating earlier, NUHOMS has gone through a number of different revisions where they've actually ported the beams to make it easier for the air to migrate around the canister and things of that nature. And then it also now has a vertical exit vent and a little more porting on the heat shields that are in place to protect the concrete. What you can see is it's migrating out through the exit vents.

And then the last one is just showing concrete temperatures in general, and these are ranging anywhere from 58 to 123, well below the limits, because of its low decay heat load.

So how did we compare? Reasonably well if you take into account--and, again, this was the pre-test prediction--reasonably well if you take into account that one of the previous or initial evaluation boundary conditions that we selected were based on a seasonal average of 58 Fahrenheit. And, oddly enough, when we showed up to do the sampling, it was substantially hotter. It was 82 Fahrenheit, and that was, I think, the peak that was measured during the actual temperature measurement of the ambient in that particular location. In the week just prior to that, there were quite a bit higher temperatures.

And one of the things that also needs to be noted is, you know, when you consider constituents going through the basket cross-section, the fuel has a really high thermal inertia, so it responds fairly slowly, but the canister shell responds a little more abruptly to ambient changes. So the very first--the difference in 82 to 58 Fahrenheit is pretty substantial.

But just to go through some of the original numbers, where we had a good location--where it says n/a we didn't have the potential or capability for performing measurements here. And then we also had some measurement anomalies through--as we extended into the door and you saw the image of the cask with the door removed, we had a tool that went in and actually touched the thermocouple this side of the DSE, the dry storage canister shell, to measure the temperatures and fairly complicated and hard to use just due to the nature of radiation dose and things of that nature and all the other things that need to be kept in mind as well as it being higher temperature in nature.

But I guess the main thing is, is out towards the opening is where we got the most accurate temperatures, and we were about 12 degrees off for the most part on average. And then there were a couple locations where we got good measurements of internal support rails, and we were still quite a bit off.

Anyway, primarily due to the ambient canister end temperatures, one of the things that we, after doing some sensitivity studies, found out that the end temperature, which typically isn’t super-critical because we’re usually worried about the peak cladding temperature on the fuel, is highly sensitive to what kind of contact the fuel can make contact with in the bottom and whether it’s in intimate contact or backed away and got jostled during the loading process, if you will.

Anyway, backing up, some of the anomalous temperature readings that occurred past the zero point insertion. And then one of the other things that was disclosed to us after performing the analysis is that the vent configuration for this particular site-certified system is a little different than others. It has some bug screens that are high-mesh density and actually provide a little larger pressure drop, so that lowers--you know, it influences the cooling capability by reducing it ever so slightly.

So taking all these things into account, one of the things that we come back to--and this is primarily due to our original ambient assumption--we're about one, two degrees off on some of the predictions between the thermocouple measurement to the HSM-1; that was the cold canister. But in suit for the lead canister I think we were three degrees off, and this is, again, Fahrenheit.

And then as we go on down through, you see that we have really good comparison except for two particular locations at that zero point insertion. And they're on the vertical faces of the canister and what we believe is basically when the door was pulled, it was out of place for 40 minutes, and air is rushing in to cool that off, because it's substantially hotter than the ambient.

Just going through some of the maximum component temperature predictions, concrete temperatures were--you know, depending on the HSM-1, which is the cold, up to the lead canister, which is the HSM-15, they range anywhere from 133 to 158, very low, about half of what the ACI limit is, regulatory limit. And then DSE, the canister shell temperatures, 208 to 290, depending on, you know, the systems again, and then fuel temperatures ranging anywhere from 279 to 422. And to put that in perspective, 400C is your limit and we're at about 217C. And then looking at the heat shield temperatures, really not a huge driver, 143 to 187. Obviously all the components due to the low heat load are well below the thermal limits.

And this plot was simply added to show and convey or communicate the difficulty we had with some of the tool measurements. If you look at the thermocouple data--and this is for, I believe, the HSM-1, which is the only one we could insert the thermocouple into--mainly on the outside at the zero insertion point we got really good agreement. And then as we--you know, as you would have anticipated, the K heating profile, as you go from one end to the other end of the fuel assembly, it's going to have a parabolic shape in how it dissipates its heat due to decay and based on its neutron influence in the reactor and after it's kicked out, and we're not seeing any evidence of that on the outside surface. This was actually the predicted temperature.

But one thing that we find that's significant about these two points is they're coincidentally the same temperature that was predicted of the air itself as it sweeps around the canister, so it's about where it would be measured about a half inch above the canister. So it mainly tells you that we’re measuring probably the air temperature alone.

Where are we going in the future? There’s two EPRI inspections planned during FY13. What we are currently doing now and plan to do in the near future is some sensitivity and uncertainty analyses to drive our evaluations and kind of focus where we want to point our research and to, I guess in a lot of senses, control costs associated with that initiative. We want to extend the CFD code validation capability by doing a little better sampling and working out the bugs in some of our measurement approaches; work with industry to validate codes during vacuum drying in high-burnup used fuel under prototypic conditions; and that would, again, go into the suite of validations that’s gone behind some of these tools in their development.

And then one of the things I wanted to nail before closing is that current codes, applications, methodologies can be extended from storage and transportation to disposal; and one of the examples is the case work that was done was well over a decade for the Hanford Canister Storage Building.

And, with that, I’d like to close and answer any questions.

EWING: Right. Thank you.

Questions from the Board? Paul.

TURINSKY: A simple question. I didn’t see any error bars on your thermocouple readings.

ADKINS: That’s a good point. And I think they’re currently working on that. All we got was the raw data that we did the rudimentary comparison on. And I think that is something that will actually go--correct me if I’m wrong, John--into the report that stems from EPRI’s evaluation of that particular system.

PEDDICORD: Peddicord. Board member. Back on Slide 3, when you were talking about the clad going through ductal to brittle transitions and so on, which is really interesting, the question that comes to mind is fuel coming out of the reactor going into what storage. Is that going to cool down sufficiently to first go through a transition, then you put it in dry storage, heat back up again, and then over time come back through it, and would that leave some residual stresses that could affect clad integrity over the long term?

ADKINS: There is that possibility, although I’m not the materials expert here on the DBTT issue. And I know that there’s a lot of different schools of thought associated with that, so I don’t know that I could answer that accurately. But yes, there’s a potential for that to occur.

PEDDICORD: And then you also noted that, given the axial profiles, that this transition would actually occur along the fuel pin over time as well, too.

ADKINS: Yes.

PEDDICORD: So if you go through those phase changes--

ADKINS: Excellent question.

PEDDICORD: --again, you wonder if there might be some added stressed introduced that--

ADKINS: Exactly. But, you know, it’s a multi-faceted problem, too. And I apologize for interrupting, eager to answer the question. One of the things to keep in mind, too--and, again, I’m not the materials guy, so I’ll have to defer this question. We can definitely get that information to you. But one of the things to keep in mind is, zones of damage that will occur are a lot less--the damage is a lot less pronounced at the ends of the fuel, is what has been expressed to me, just due to its fluence characteristics within the reactor. So you can have a mixed bag.

PEDDICORD: Sounds like some intriguing possibilities here, though.

ADKINS: Excellent questions.

PEDDICORD: Thank you.

EWING: Paul.

TURINSKY: Turinsky, Board. That stimulated another question. Where the fuel gets either very hot when they’re drying it and they draw the vacuum and there’s no helium, that would be an interesting case to simulate, and it could look at some of these issues of hydrating and all that takes place there.

ADKINS: Hydride reorientation. And I’m not--

TURINSKY: So are there any plans to look at that particular part of packaging?

ADKINS: And I defer that to our UFD campaign individuals. I can't speak to that.

SWIFT: That would be a yes.

EWING: Okay, thank you. All right, let me--

SWIFT: Peter Swift. Sandia National Labs. Yes, we do have work going on with that. The temperature during the drying and the hydride reorientation, we actually have experimental work going on at Argonne, looking at hydride reorientation in cladding that's been irradiated, and we can present that some other time.

ADKINS: Thanks, Peter.

EWING: Thank you. Steve.

BECKER: Becker, Board. You mentioned looking at a number of extra-regulatory fire cases. I'm just wondering what kinds of things were learned from that work.

ADKINS: Actually, that's an excellent question, and that one's definitely been intriguing. You know, depending on the capacity of the system and its sheer size, one of the things that--and what I'm going to do is open--I'll just speak briefly and open the floor for whoever wants to address this a little more.

But one of the things that was quickly discovered is how robust a spent fuel system is, especially some of these larger capacity casks, because they’ve got just a huge thermal inertia behind them. And typically, when you look at it from a thermal perspective, where you start getting into trouble from the fuel cladding itself is simply due to the fact that its avenue for heat transfer removal is shut off for awhile. It’s not due to the thermal insult on the package itself. You know, as long as the package is designed reasonably well--and, you know, one of the things that the regs are in place for is to make sure that there is kind of a stoutness test and vetting of where, you know, you’re going to put your seals and things of that nature under impact limiters in the design process and development process. But one of the things that we have learned is, literally, you know, it takes quite a bit, and you have to be very decisive on the path that you take to try to fail a spent fuel system.

I’d like to open it up to Earl just to comment in addition to--

EASTON: These extra-regulatory fire transfers were done on behalf of the NRC. And let me just say where I think they’re coming out. If you look at real-life fires, most of the heat gets carried away by diffusion, and it limits the actual temperature of the fire. It’s not the--where we really get the challenges is where you block that diffusion. That’s why we’re studying a rail tunnel fire, a highway tunnel fire. The other two examples were an overpass that sort of collapsed down, it’s like a tunnel, and the Newhall Pass was a highway tunnel.

That said, I don’t think that the results are catastrophic, but they may indicate that they are over the regulatory limits in some case. We plan to put out some sort of summary document on all these fire tests at some point. But, again, it tends to be where you’re in a tunnel or an enclosed space. We immediately went to the Association of American Railroads and tried to put operational controls to even lower that probability. I felt compelled to say that since they were--and we would be glad to brief you guys on this whole, you know, series of studies if you would want to.

EWING: Okay, thank you.

ADKINS: One of the things, too, that those studies have encompassed, evaluation of small to large capacity casks, all the way up from, you know, a legal truck to well above a heavy-haul rig.

EWING: From the staff, questions? Yes, Kirstein.

KIRSTEIN: Kirstein, Staff. Do you have any plans to collaborate with the external temperatures that can occur during a repository preclosure period? In other words, temperature predictions during the ventilation phase for normal and off-normal events, for example loss of ventilation in a repository. There may be a requirement for package retrieval up to a century or so, so maybe knowing those temperatures during preclosure period of a repository operation would be worthwhile.

ADKINS: We have had some minor discussions. And I guess one of the things that we might want to do is postpone a little bit for Ernest to go through his presentation; then we can discuss maybe how to couple those together and what would make sense.

EWING: Doug.

RIGBY: Yes. In the past when I've tried to locate some of these kind of predictions and information, for instance, I know for regulatory purposes, this is proprietary, you can't get it. Is your information available to the public, to us?

ADKINS: Yes.

RIGBY: Okay, good.

ADKINS: The one study that was done for Calvert Cliffs will eventually be rolled into an encompassing document that's going to be made available to the public by EPRI, and I believe it's also available through UFDC and then the works that have been performed from the NRC. Two of the four extra-regulatory evaluations are readily available and have gone out for public comment.

RIGBY: Could I ask a question about validation quickly also?

ADKINS: Sure.

RIGBY: By the way, Doug Rigby, Staff. I'm wondering, with your validation, your pre-test, that is a Class A-type prediction where you have some starting point, you predict something, and then you go out and measure and see what you get?

ADKINS: Yes.

RIGBY: If so, your validation--what is your time-equals-zero conditions? Where do you start? And then how far have you--how far does the prediction--has it been validated for a full-scale case?

ADKINS: As far as into the future many years type of deal, there's definitely some data collection that needs to go on for that type of venture. I believe that we still have systems that we can pull information from to utilize directly, albeit they're lower-burnup systems. But, you know, when you look at the vehicles that are going to change a thermal behavior, there's not much that changes after it comes out of vacuum drawing as long as things go as planned, if you will. That's kind of a poor answer. I apologize. But, I mean, mainly, when you look at spent fuel cladding, it's graded pretty substantially so that emissivities are high. Baskets are fairly high, you know, when they go through even some of the shells, when they go through the pickling process, welding, what have you, surface roughness go into that; but not a lot of it changes with the inerting atmosphere. But definitely to be able to put the seal on the validation initiative, more data collection would be required.

RIGBY: Where did you start your simulation for Calvert Cliffs? What was time equals zero?

ADKINS: Oh, Calvert Cliffs, I apologize, should have commented on that, and there was quite a few details. It actually has--the predicted burnout of scale that we worked with Oak Ridge and Calvert Cliffs with on, the duty cycle and burn at each particular fuel assembly, how they were loaded in the cask, and what they did is basically go through and date those out to the exact inspection date. And then the only thing obviously that made the tremendous difference in temperature on places that were measured was the ambient. And the reason we weren't able to just roll that in, other than for me to speculate when we went through and noticed, hey, this is substantially hotter than what we use, is we had to do those evaluations months in advance before we actually landed on-site to do the testing. But it was done with the intent of capturing the temperatures at the sampling date of the actual decay.

EWING: Last question. Efi.

FOUFOULA: Foufoula, Board. So yesterday at INL we heard two relatively new research directions. The one was on material characterization through new thermographic technology done to nanoscale, and the other was very high-resolution modeling of, again, coupled processes over time but very high resolution. And I wonder this, both the technology for very small-scale changes in the material and also, you know, the performance of the whole system over time, isn't that affecting to one degree or another temperature predictions through your--

ADKINS: I don't know what the comments were made yesterday and, you know, what it directly referred to and what it encompassed, so I can't really comment on that. But, yeah, I mean, accurate characterization of all the materials and things of that nature and how they behave over time is or main objective, you know, and that goes into the hydride reorientation phenomenon and some of the annealing that would go through vacuum drawing, all of those need to be taken into account and understood a little more effectively. And that's specifically why, when Peter commented on the hydride evaluation work that we're going to be doing, that's the target. So yes.

EWING: Just to follow up, what we saw yesterday was almost atomic-scale modeling, say, bubble formation, fracture formation, things that would affect the thermal conductivity as a function of time, radiation field. So I think the question is, would that level--or do you anticipate that level of modeling being coupled to your thermal model?

ADKINS: Yes and no. From a thermal perspective, once things are buttoned up, and if you have a pretty accurate characterization of the type of decay heat load that would come from the urania within the fuel assembly, and you've modeled the specific heat transfer highways, I'll say, whether that be the incorporation intricately of the system that is carrying it, you should be able to get pretty close. And in some ways I look at the thermal--even though it's absolutely important in understanding a lot of the other phenomena, it is kind of the tail on the dog, simply due to the fact that not a whole lot changes, and as time goes on it will only get a little bit better, the heat rejection, over the course of when the decay heat is reducing.

But, you know, the main driver of being able to predict that in real time currently and in the future is important. I'm not discounting that. I don't know--you know, based on some of the evaluations that we've previously done, I think we're plus or minus ten degrees Fahrenheit with some of the previous or historic COBRA predictions, which is well done. And, you know, that incorporates some of the different vacuum drying scenarios, different backfilling, even backfilling contamination when you have one gas in there and then you backfill it with another gas and evacuate it, its influence of a reduced atmosphere, pressurization by enhanced pressurization to augment its cooling capability, things of that nature. We have a pretty good feel of where that would run things. And then the other thing that can come out of this is sensitivity evaluations of set parameters.

Hopefully I answered that question.

EWING: Thank you. We need to move on, but thank you very much.

ADKINS: Thank you. Thank you.

EWING: The next presentation is by Ernest Hardin. He’s at Sandia National Laboratory, and the title is “Generic Disposal Concepts and Thermal Load Management for Larger Waste Packages.”

HARDIN: Very good. I’m a geoscientist. I had the privilege of leading a small team for the past year and a half or so to look at some disposal concepts and the thermal load management that we could achieve with them. I couldn’t put everybody’s name on here, so I should call out that Phil Rodwell and Mark Dupont of Savannah River and Montu Sharma and Mark Sutton of Livermore contributed significantly to this. So I’m hoping that this presentation flows smoothly through a couple of years of work in a couple of phases, and it gives you a good idea of what we’ve learned.

I’m going to reach back to the January 2012 briefing and just basically maybe do a little bit of review on the concepts that we presented then, which were the enclosed emplacement modes in crystalline rock, clay or shale media, salt--namely bedded salt--and the deep borehole concept. And I’ll present a quick summary of the thermal analysis for those and then move on to a finite element analysis for the generic salt repository, and we’ll look at waste package sizes up to the 32-PWR size and then launch into the open emplacement modes. And it was our task to develop some of those and then present a thermal analysis of them as well and just summarize.

Now, why larger packages? The earlier results that we presented in January pretty much focused on smaller packages, 4-P up to 12-P sizes, and there was interest at the time in various what-if scenarios and interest in us looking at packages as large as 32-PWR. That corresponds to 68-BWR assemblies in typical practice. And the interest basically runs along a couple of different lines.

EWING: Excuse me. Go ahead.

ZOBACK: I think PWR is pressurized water reactor, but I have no idea what 32--is it ten feet by four feet or--

HARDIN: Yeah, I recognize that I’m kind of out on a jargon--

ZOBACK: Yeah.

HARDIN: Yeah. So how big is a PWR fuel assembly? It’s roughly, I’m going to say, 30 centimeters on a side and 4-1/2 meters long; and it consists of roughly 200 tubes filled with uranium oxide fuel. The tubes are roughly 1 centimeter in diameter. And then there are some brackets and spacers and whatnot that hold the whole thing together. It holds about 450 kilograms of heavy metal equivalent. The overall mass of the thing is on the order of 700 kilograms. That’s a PWR assembly.

ZOBACK: One PWR?

HARDIN: Yeah, that’s one assembly.

ZOBACK: And 32, are you going to stack those up?

SPEAKER: No.

HARDIN: They’d be in a rectangular array of some sort. 32 happens to be one of the geometric configurations whereby one fits square items into a circular pattern.

ZOBACK: Okay, thank you.

HARDIN: Okay, thank you.

So why the 32? Well, the utility preference now for dry cask storage is for larger canisters with welded seals. They’re interested in limiting worker dose and obviously in limiting their costs, and they seem to be able to achieve all that by going to larger canisters. So we’re operating in that environment. There is a potential that we may someday in this country be using a standardized canister; and, for the reasons I’ve just described, it’s liable to be larger. And so this is sort of our target for this study.

So what is a disposal concept? It has three parts. We start with the waste inventory and the geologic setting and the engineering concept of operation. For the work I'm going to describe here, we're going to be talking about commercial spent nuclear fuel with burnup of 40 or 60 GWd/MT. The 40 is what the power plants are generating today. The 60 is a bounding case. Over the past 30 or 40 years burnup has gradually increased, and we expect it to do so in the future.

We've also looked at representative plutonium MOX and high-level waste types from reprocessing, and I'll refer you to that report. We've done thermal analysis in the enclosed modes for those.

The geologic settings that we've looked at are listed here. I just wanted to clarify that the sedimentary label that you're going to see in this presentation is sort of a catch-all for a family of lithologies such as alluvium, but it might include something like the impermeable limestone that the Canadian program is looking at disposing of intermediate-level waste in. It's a kind of catch-all that we use. And hard rock here, we mean granite or maybe metamorphic or even indurated sediments or welded tuff, for that matter. But the idea is that this is a material with good stand-up time; that is, the openings are stable for time and heat tolerance.

And then the engineering concepts of operation that we're going to cover here include the enclosed modes, so these ones here that were addressed in our January briefing.

The crystalline one is essentially the KBS-3 concept from the Swedish program. The clay/shale concept is based on some concepts borrowed from the Andra program in France. The generic salt repository is more home-grown, and I'll describe it in more detail. And then there's the deep borehole concept. That has been, I believe, presented in great detail to the Board on at least two occasions, so that will be in the record.

The open modes over here then are specifically for spent fuel. We don't really need them for high-level waste, and we can talk about, if necessary, some of the reasons why that would be.

So, launching then to the thermal analysis and how it was done, some of the temperature results that you're about to see were calculated using a model that's very simple compared to what Harold Adkins just showed you. It's superposition of analytical solutions. You can get a very good first-order estimate for a repository thermal analysis or scoping calculations using an approach like this. The package of interest is at the middle. It's represented as a finite line source. Its neighbors are point sources. And then the neighboring drifts are line sources, and the correct heater strengths and so forth are all integrated together. The solutions are summed, basically.

And it's even possible to make an approximation to what's going on in the very near field here by making a steady state approximation and sort of back-calculating temperatures in radial zones as they impinge on the waste package surface. So that's the calculation approach.

And here's an example of the type of results that you'd get. So the case here is a bounding case for a 60 MWd/MT spent fuel ten years out-of-reactor, which is fairly young. It's in a 4-PWR package, and we used clay or shale properties. So, for example, the average thermal conductivity was 1.75 W/m-K.

And we present rock wall temperatures. This is not at the waste package surface. I'll show you some of those kind of results here shortly. Of course, here is the calculated temperature history, and the message here is that the contributions to that history from those different sources I showed you for the package itself, its neighboring drifts, changes with time. And so in early time it is indeed the central package that drives things, and in late time it turns out to be the adjacent drifts. Why? Because there are more packages there; and if you change the drift spacing, you get a correspondingly larger effect.

So this is a summary figure of the thermal analysis presented in January. And it might take a little bit of explaining, so I'll give it my best shot. What this figure shows is the amount of surface storage time that would be needed for a package containing a certain number of PWR assemblies, given that we have to meet these temperature limits, and that would be 100°C for the granite or the clay concept and 200°C for the salt. Now, these temperature limits here are not, by any means, carved on stone tablets. We get a fair amount of questioning and pushback on these limits, but I will say that the Swedish program has adopted 100°C as a limit for the temperature of their clay buffer around the package, that the French program has adopted 90°C as a limit for the clay formation around some of their packages. And the concern there is for a multi-phase heat and moisture movement in the near field, which would cause some coupled thermal-hydrological-chemical responses that would in all likelihood degrade the properties of that near-field clay or shale material.

And the salt number is based on a couple of things. There’s a history there. The German program uses this limit, the original salt repository project in the U.S. uses a somewhat higher limit, but it’s also somewhat conjectural and is the subject of current ongoing laboratory testing.

So the point of the figure here was plotted by Harris Greenberg at Livermore to show what happens if we relax some of these limits, what happens to the aging requirement for these different size waste packages. But the bottom line here is that there really is a big difference between these concepts and salt, and so I throw this out here for your information. This is the information that pretty much put the program on notice that we really were talking about somewhat small packages, 4-PWR size, possibly even derated to a smaller size equivalent, for some of these concepts if we were to follow the lead of the Swedish program or the French.

ZOBACK: Excuse me, can I interrupt for a second? I'm just trying to understand the model. A clay buffer, I seem to think, means the clay is packed around the canister; whereas, salt you've created a cavity and there's air around it? I'm confused what your boundary conditions are. Are you just putting a canister and putting the geologic media right up against it or is there air?

HARDIN: Great question. Answer is yes. You've got the clay buffer idea, and the salt would be--as a matter of fact, the canister would be emplaced on the floor of an alcove and covered with crushed salt.

ZOBACK: Okay.

HARDIN: Okay. And then that crushed salt over time under the impetus of the closure of the opening in the rock would consolidate into near-intact properties.

So I'll back up. So here is the generic salt--I'm not going to present a set of calculations for salt where we try to understand better and capitalize on the thermal performance I showed you previously. And this is the generic salt repository layout. This herringbone arrangement basically is a way of getting the high power packages onto a grid for heat dissipation. And these are--we call these alcoves, and the package would be on the floor at the end of an alcove. We have extracted that to rectilinear geometry for our analysis, and we used the multiphysics Sierra code package at Sandia with a very current set of constitutive models. The idea here would be to test the thermomechanical dependence, because we know this crushed salt is going to evolve with time, and then try to understand the impact of that on temperature and then use a temperature-only approach for some sensitivity calculations.

This little chart down here gives you the rough dimensions of the different waste packages that we considered in the model. There really isn't a whole lot to say here about those. Those are flexible and can change a bit, 10 to 20 percent, depends on the design.

ZOBACK: The 32-PWR is 2 meters in diameter?

HARDIN: Yeah, I think any--right, any plausible concept that we could come up with for one of the commercially available 32-P canisters inside of the disposal overpack, a much heavier can would fit into that envelope.

ZOBACK: Okay, thank you.

HARDIN: So, yeah, here's sort of the close-up of that arrangement. We propose a semi-cylindrical cut-out in the floor to enhance heat transfer from the package. And the little chart that kind of got reformatted shows that the thermal conductivity of intact salt does go down in temperature, as it does with most geologic media, and there is a pretty significant effect from porosity in the crushed salt material.

And I won't get into the comparisons for the thermomechanical response, but suffice to say that it's a fairly small effect and we'll proceed with temperature only.

PEDDICORD: Peddicord, Board. How long does the reforming take place of the crushed material around the canister before it looks intact?

HARDIN: Yeah, it's on the order of, I'm going to say, a hundred years. In certain situations it might take less time, for example, at the bottom of a shaft where you just stacked various types of granular material on top of it in a shaft seal arrangement. You've loaded it, and you've loaded it immediately, and it will consolidate fairly fast in one of these tunnel openings. It requires that the intact rock structure around it gradually collapse onto it, and that takes time.

PEDDICORD: Thank you.

HARDIN: We ran the calculations to 200 years.

So this one summarizes the finite element calculations. And one of the things we find that's interesting--by the way, the shaded region is merely that which exceeds our 200°C temperature limit. I was surprised to see these line up like this and correlate pretty well, but they do. And I'll draw your attention to a couple of the points on here, these three right here. And so with a 21-PWR package, 40 GWd/MT, 50-year age out of reactor, we get--well, we're under our 200°C limit, put it that way. If we go to a higher burnup, we're just above the limit. If we go to a larger package at average burnup, we're just above the limit.

So these are useful results. They show us that we can indeed, on thermal grounds, probably handle these larger packages in a generic salt repository. And the correlation here is useful for a system study such as Mark Nutt described earlier where the CALVIN code has already within it the capability to impose thermal limits on various steps in the handling and disposal of spent fuel. And it also turns out that for the other geologic media that we've talked about, you get the same type of correlation. And it's a little surprising, given that we're talking about a range of package sizes, that what's really important to first order is the power output of the package and not so much the details of its geometry.

So now we begin to talk about open modes. The idea is we'll put the package in the drift, surround it by air, and, importantly, we can ventilate it for a period of time, removing heat, so obviously we can put a hotter, larger package in there to begin with. The concept combines features of storage--or functions of storage and disposal.

So at the beginning of the year then, we have this problem statement: Add to our reference portfolio some open mode concepts that allow earlier emplacement of larger, hotter waste packages. Some of the possible benefits from doing this are cost and schedule efficiency, which is tied back to fewer package-specific operations of all types. There might be some other economies of scale, the same sort that have driven the utilities to use larger and larger dry storage systems.

Here’s one: Flexibility not to transport spent fuel or at least to limit the transport of spent fuel with age, let’s say, over 50 years. So if there is a concern with long-term storage on the condition of the spent fuel, the capability to emplace these larger, hotter packages earlier addresses that concern. And then obviously, if we were able to even go so far as to directly dispose of a DPC canister, then we have cut out of the whole picture a whole set of repackaging steps and associated costs. So there’s the motivation.

And this is a chart where we--I’d try to convince you that we’ve taken a systematic approach, but we have identified a couple of attributes of a disposal concept here. Are we talking about a plastic medium that is capable of sealing itself, or is it what we call more competent to our in-drift? Is it high permeability or low? And is it saturated or unsaturated? And, finally, the fourth attribute: What do we do to it before closure to enhance or ensure its performance?

And so we end up with an option here where we're in a soft shale, one that's capable of collapsing and sealing fractures so there are no open fractures. So you could think of this geologically as a young shale, massive in its thickness and extent. And so maybe it doesn't require backfilling, but we could get clever about how we close this, and I have a picture to show you that.

If we are in hard rock under unsaturated conditions, we have the option to go to some novel types of barriers. These are the things borrowed from the Yucca Mountain concept such as capillary barriers and drip shields, etc.

And then we move over here. This sort of catches a bunch of other possibilities where we have a great, massive, extensive rock formation, likely sedimentary, but maybe it has water flux or it has enough permeability that we think it needs to be sealed at closure. And so in this case we would backfill the entire facility with a low-permeability backfill material. So those are the concepts.

So we add them to our list of reference concepts, and we have these. I'm going to show you some thermal calculations that are mainly based on the shale unbackfilled mode that also apply here. I'm not really going to talk much about thermal analysis for the hard rock unsaturated, because everything you need to know about that you can probably find in the Yucca Mountain license application, and the deep borehole concept is presented elsewhere.

This is a schematic, not to scale, for the shale unbackfilled mode. And the idea here is we'd have drift segments in which we'd put and use what we call in-drift emplacement. We would lay the packages down, and we'd put, say, ten of them down, and then we'd leave a gap. And then we'd have a crossing drift that we would reenter at closure, and we would seal this drift and thereby seal off the intervals where the packages are. And there are various reasons why we came up with this, but one of the problems is installing backfill at closure in a thermal and radiological environment. It's something the engineers don't want to do, and it's expensive. So this option gets around that. Of course, there are some complications. You've got to have worker access to this crossing drift at closure, so that's going to require some shielding. We're going to have to use either a shield plug or a labyrinth so that ventilation can exist across that opening but that we control the radiological conditions. So, anyway, this is a novel concept, and we've carried it forward.

The other one is the sedimentary backfilled mode. These sinuous drifts reflect that this is a tunnel boring machine or TBM-type layout. It would be excavated with a large mechanical boring machine. And we would place the packages in here, ventilate for 50 to 100, maybe up to 300 years--we've done some various calculations--and then go back and reenter at closure and deposit a granular, low-permeability, clay-based backfill material everywhere.

And then the hard rock, unsaturated concept. I would draw your attention to a comprehensive design selection study that was done for the Yucca Mountain license application. Looked at a lot of different alternatives and identified some of the advantages. We could ventilate prior to closure for at least 50 years. This allowed us to put the waste in when it was younger and hotter; didn't require a lot of surface decay storage. If it was found necessary to cool the repository, you can maybe keep it below 100°C forever. And we merely extend that ventilation period out 100, 200, even 300 years. These are all ideas that were discussed with the Board at length in the early 2000s.

Because it's unsaturated, you would find what we call free drainage in the facility. Because you have free drainage, water is going to go through it rather than follow along the openings, and therefore you don't need backfill. The problem with--or the requirement for backfill comes in when you have a hydrological situation where the repository openings form a network of pathways, and you've got to do something about the possibility that for thousands of years you could have water moving along those pathways, entering at one point, picking up all the released radionuclides, and exiting somewhere else. Backfill prevents that.

Shallow depth here, we're talking about at least 200 meters. But when you're that close to the surface, you have some other engineering options for access such as ramps that might not look so feasible for deeper settings.

Now, here's a key point. I've gotten questions on why don't we have a hard rock saturated mode. And it relates to the idea that, remember, this is an open emplacement concept, so you've got nothing around the waste packages right up to the point of closure. And at that point, because it's saturated, you'd have to install that low-permeability backfill everywhere. So that backfill becomes really an important component of the system for long-term performance, and you're relying on your ability to install it in that radiological and thermal environment using remote operations. And that's something that we shied away from in this study.

So, quickly, by way of thermal calculations, this particular set identifies host rock thermal conductivity as really the dominant parameter in any discussion of thermal management. So what have we got here? This is the wall rock temperature. This is a 21-PWR, 40 GWd/MT, 50-year storage. This is a very Yucca Mountain-like waste package, actually. And it shows what happens if we use 50 years of surface decay storage and then 250 years of forced ventilation prior to closure. And in that closure, of course, temperatures jump up. During the ventilation we remove 75 percent of the heat, which is easily doable from our Yucca Mountain calculations. And our takeaway from this was that, if we’re going to talk about high-conductivity rock formations, 3 W/m-K seems to be a good threshold.

And then we looked at the sensitivity to ventilation duration. So here’s the same sort of development here: 50 years of surface decay storage and then emplacement and then either 50, 100, and so on, out to 250 years of ventilation followed by closure. And we see that there’s kind of a--this is actually an optimistic assessment from the standpoint of ventilation efficiency, and yet we still don’t see much payback for all that ventilation time. And I don’t think anyone in this room wants to recommend that we keep this operational for 300 years. So, basically, what we learned from that is, there is a diminishing return from ventilation after about 200 years for sure.

Now, there’s more to this. We also looked at drift spacing, and these are the parallel drifts now in which we put the waste packages. And by extending that from 30 to 40 to 50, we get a commensurate decrease in the peak rock temperature. The bottom line is that drift spacing is really probably a better approach to use than this long-term ventilation.

Capitalizing on that idea, we developed a design test case. What we’re trying to do here is figure out a way to get this facility closed in 100 or 150 years. And so let’s see if I can explain this. We start out with surface decay storage of 50 years, so this is pretty typical for the inventory as it exists or as it will when we get around to repository operations. And we’ll use average-burnup spent fuel, a typical ventilation efficiency, 21-PWR package, and we can compare that size to the thermal results we obtained with the Yucca Mountain design, for example. So 21-PWR becomes our reference. And the idea here is, what if we allowed the near-field host rock temperature to go above 100°C? What would we get from that?

And so these are thermal curves without backfill, and this would be at the rock wall for this case. And this is 3 meters into the rock wall. So then adopting a sort of sacrifice zone of over-temperature shale in this case, using shale properties, yeah, we find that we can meet a 100-degree limit but at a distance of 5-1/4 meters from the drift centerline.

So this is a challenge, actually, to our natural barriers team to tell us what is the impact of doing this, because it makes a big difference in terms of operating the repository, and it keeps open the possibility for an open emplacement mode, one where you can put in larger, hotter packages, but you're doing it in a low-permeability medium, a soft medium like shale. And the thermal results show temperatures in the neighborhood of 100°C, which is--those numbers are well within the uncertainty range for this calculation.

So, to summarize, I presented three different open mode concepts that we'd add to our portfolio. I say "tuff" here. This could easily be a soft tuff, a non-welded tuff, for example, which I would put in the sedimentary category for this. And I've shown you that the larger, hotter packages can meet the temperature limits in a generic salt repository or in a hard rock unsaturated concept, and that is with less than 100 years of aging to closure and with waste package sizes of 21-P or greater. And I've also showed you--it didn't list it, but I've also showed you our so-called design test case, which would allow you to do something similar to that in shale.

And these two tables I'm going to show you try to summarize the big picture here. Can the EBS sustain peak temperatures of up to 200°C? Yes, in salt that is possible. Does the formation have high thermal conductivity, which we defined as 3 W/m-K. So salt gets two checks here. Some of the other concepts get no checks. And you can see that that has a direct bearing on how large a package and what a typical minimum age would have to be before you could emplace the waste in a repository.

And for the open modes, the same type of thing. Not too many checks in boxes here. We see that it is possible for some of these concepts to close a repository in somewhere between 50 and 150 years.

And where do we go from here? Well, we are working directly on the disposal for DPCs--the possibility of disposing of DPCs. There are various issues there. Regulatory framework, that is to say, we’re going to take a DPC that’s been licensed for storage and transportation and is welded closed and sits on a pad somewhere at a utility facility, and we’re going to try to--we’re basically going to try to get it licensed for disposal through technical arguments without opening the can. So that’s a non-trivial objective.

There are some key FEPs, as we call them, features, events, and processes, especially postclosure criticality, which will probably be the subject of some future presentation. And we are proceeding with some generic performance assessments on some of these concepts, that is, a calculation of the expected dose. We are doing thermal and logistical analyses. We’ve got thermal calculations underway to refine those finite element calcs I showed you, and Mark described the logistical work that’s ongoing.

Cost comparisons are also in the offing. We’ve done some, Mark’s done some more, and they’re going to be put together into a system cost comparison for various alternatives.

And in the disposal R&D area, there is much interest in understanding the importance of those temperature limits and the possibility of heating the host media above those limits and, in addition, engineering materials or admixtures to existing materials that improve stability or heat transfer.

That’s all I have. Thank you very much.

EWING: Okay, thank you. Questions from the Board? Go ahead.

ZOBACK: A couple questions about validating the model. At WIPP--I realize it’s different type of waste but assume you can change your heat input--have they done this kind of semicircular thing in the backfill with crushed salt, and are they measuring the temperature? I mean, can you check your model?

HARDIN: Not explicitly, as you suggest.

EWING: Ernie, stand near the microphone, please.

HARDIN: Yeah. So not explicitly in the way that you suggest. That may be forthcoming. There are some proposals to do underground testing at the WIPP facility itself. However, I should point out that in the 1980s there was extensive thermal testing done at WIPP, so we understand it's thermally-activated responses and it's heat transfer.

ZOBACK: So some of that went into the parameters for your model?

HARDIN: That's exactly right.

ZOBACK: Okay. And then the other question was about the shale, and aren't the French doing a shale study, and is there data from their--do they have an underground lab?

HARDIN: Yes, they do. It's at a depth of 500 meters in the Callovo-Oxfordian shale at the little settlement of Bure in eastern France. And, yeah, they have thermal tests underway, long-term ones, also chemical diffusion and other different aspects.

ZOBACK: Is that a young shale or an old shale? Would it be easily deformable?

HARDIN: Well, it's an old one. I think it's a hundred million years old, of that order.

ZOBACK: Okay, thank you.

EWING: So may I ask a question? Ewing, Board. So you listed the benefits of essentially having a larger and hotter package. What are some of the--what’s the downside of this question?

HARDIN: The disbenefits?

EWING: Uh-huh.

HARDIN: Well, I think you’ve seen thermal management as being problematical. I’ll give you one major one, and that’s handling such a large, heavy package, getting it underground safely. In some lithologies such as salt, we don’t think that a ramp is the way to go. A shaft is much easier to seal. And so, okay, now we have to lower something that weighs over 100 tons down a shaft, and the largest payload capacity existing shaft hoist in the world--there are two of them. One’s in Germany, and the other is at WIPP; and they have capacities on the order of 40 metric tons. So there’s a big gap there in that conveyance.

EWING: Let me offer some potential downsides to such an approach, and that is--and I’ve said this before--it’s not that we’re disposing of heat, we’re disposing of radioactivity. And the mobility of the radionuclides is mainly a matter of chemistry. This is a broad-brush statement. So raising the temperature in a system, very roughly speaking, for every ten degrees, it’s an order of magnitude in terms of the reactivity.

So this temperature, the difference between hot and cold, is a big difference in terms of the mobility perhaps of some of the radionuclides. And also at higher temperatures, particularly in clay, the concept of sacrificing part of the rock because of the higher temperatures and change in properties also goes against the idea of having the rock as a passive barrier; that is, not disturbing its properties. The properties that you measure and rely on as a barrier are the properties that will be there over the longer term. So I understand the motivation and potential benefits, but I'd also suggest there is a chemical side to the process rather than looking at physical barriers.

So that's my little soap box.

Lee, you're next.

PEDDICORD: Peddicord, Board. On Slide 10 where you had what turned out to be this really quite interesting correlation emerge, virtually linear, I don't know if you'd expect that going into it or not, but I see the far point to the right there, the upper one is the case for the 32 assemblies at 60 GW, 60,000 MWd/MT, which far exceeds the 200-degree limit. But the question is, the assumption of the 40,000 MWd/MT that you kind of build into this, more and more of the fuel assemblies coming out are tending towards the higher burnups, and 60 may not be a bounding case anymore. They may be getting higher than this as well, too.

One of the questions that comes to mind is, would you have the option of kind of optimizing loadings in these where you would mix assemblies of different burnups? You can certainly do that analysis. It would be a little more complicated, but to optimize in a larger way what you’re going to be putting into an emplacement.

HARDIN: Yeah, there are couple questions in there. If in the future we are implementing a standardized canister, there might be thermal criteria that would control the loading of the fuel, but they don’t want to be sealed and shipped off to the repository. If we’re talking about a 32-PWR DPC, then we don’t have the option to do that. Okay?

PEDDICORD: Okay. That makes sense. Thank you.

EWING: Okay. Questions from the staff? Gene.

ROWE: Rowe, Staff. Just a quick one. Have you looked at any natural ventilation, or is that something in the future?

HARDIN: Yeah, that--I mean, that would be done in the future. He’s referring to the idea that cold air coming down one shaft and warm air going up another, you have a tendency for natural circulation.

KIRSTEIN: Ernie, could you make a comment then about heating granite and/or salt above these temperature limits you see up here?

HARDIN: Okay, I’ll comment on that.

KIRSTEIN: Sacrificing some of the geologic media.

HARDIN: Huh. Well, I'm not sure that you need to. You know what, you could fight the battle that, you know, for example, salt might be resistant up to tolerant of 250°C, or you could wait 15 years before you emplace the waste. That's my answer there. With granite, I would draw on our experience with the Yucca Mountain welded tuff where the 200°C limit was by no means a firm fixed limit. What we began to see was in a reduction in ultrasonic philosophy and thermal conductivity at that temperature, which means that cracks are accumulating, so we tried to stay under that.

EWING: Other staff questions? Doug.

RIGBY: Are you packaging these results with the previous one and releasing some sort of report?

HARDIN: Yes, we are. There's a draft, if you will, that's available now; and in about a month we'll submit a higher-level deliverable to our management.

EWING: Other questions? Thank you very much. And I'd also remind you that if you want to speak at the end of our session to please sign up at the back of the room so that we can schedule accordingly.

We'll take a break now, and we'll start again at 3:00. Thanks very much.

(Whereupon, the meeting was adjourned for a brief recess.)

EWING: All right. This afternoon we'll be discussing waste and waste forms at INL. And we have a single speaker but two presentations, and it’s Joel Case.

And I’ll turn it over to you, Joel. It’s all yours.

CASE: Thank you. First, can everybody hear me? Fine. I’m Joel Case. I’m with the DOE Idaho Operations Office. I have dual roles right now, starting a new role. I’m the Sodium Bearing Waste Treatment Operations Manager. DOE calls it Operations Activity Manager, but I’ll be taking over from the DOE ID side, the operations of IWTU. I know we toured you all out there yesterday; at least you saw the video. I’m also the FPD for the Calcine Disposition Project. So it’s kind of fortuitous that I’m the person to talk to, at least from a DOE standpoint, on these waste streams.

I’ll be talking about sodium bearing waste disposition plans. As we go through presentation, if you have any--generally, just ask questions as we go through? Is that--or do you want to wait--

EWING: It’s your choice. What I’d suggest is, if Board members have a point of clarification, please ask, but otherwise let’s hold the questions till the end.

CASE: Okay, that would be great. So we’ll get started.

Sodium bearing waste we talked about a little bit yesterday. The IWT mission is to treat the sodium bearing waste, the liquid highly-radioactive waste we have out there.

Just a little background. INTEC Tank Farm, I don’t know if they pointed that out to you as you were walking through INTEC. We have eleven large underground storage tanks, stainless steel, 300,000 gallons capacity. They are contained in concrete vaults, various forms and fashions. We have three configurations, but the stainless tanks are the same, different type of vault structures as they did different designs as they constructed those.

We have undergone closure, both the RCRA and DOE, 3116 closure. That’s for the radioactive portion. These tanks contain liquid waste that have RCRA, Resource Conservation Recover Act, hazardous waste also, some organics and heavy metals, cadmium being probably the major constituent and mercury. So seven of the tanks are empty and were cleaned back in 2006-7 time frame. We’re using four more tanks. They were grouted up, and they met some performance objectives that were under our DOE order requirements, State of Idaho requirements for hazardous constituents. DOE and NRC monitored that under what’s called the 3116 process for closure of high-level waste tanks.

Four tanks are in service. Three of the tanks contain the sodium bearing liquid waste. It’s approximately a little less than 900,000 gallons; inventory is about 850, 875 plus or minus. We have one spare tank that’s slightly contaminated that had some low-activity waste, about 500 gallons, not sodium bearing waste but some incidental waste that came into the process. I forget what the--it’s about 500 gallons. But that tank is Tank 190; it’s pretty much empty; it’s a spare tank.

We used the tank farm facility to store--really, we’re reprocessing fuel here. The major mission at INTEC was to reprocess DOE fuel, Navy fuel, DOE government-owned fuel, really, for uranium-235 recovery. And the nice thing about our tank farm, they are stainless steel, and we didn’t have to build new tanks because we had what was called the calcine waste facility process, and then we built a new waste calcine facility. It’s basically a fluidized-bed thermal oxidation process that process the liquids as they are generated and stored at the tank farm. We did batch operations over the years to produce the calcine. And I’ll be talking about that waste stream that’s currently stored. It’s about 4,400 cubic meters.

Right now the constituents of the sodium bearing waste is very little, less than one percent first cycle, and decon solutions are some second and third cycle extractions. I’ll have a chart as we go into--it kind of explains the generation of that and what that is.

During the operations when we’re reprocessing fuel here and running the calciner, we tried to keep second and third cycle segregated from the first cycle raffinates. We had some tanks there that had some cooling pools at the bottom. We tried to use those tanks for the higher-activity waste. Now, there was some co-mingling as we operated, but there was a concerted effort to keep the reprocessing waste first cycle separate from the second and third cycle and what we call sodium bearing waste, because at INTEC all the liquid generated out there went to the tank farms.

Our reprocessing activities, we had a lot of laboratory analysis, both radiological labs, organic labs, that did chemical analysis. Everything drained into the tank farm. So that's where you see some of the--and when we did D&D activities at the NWCF on campaigns, we ran that, really, to failure on some components like our manipulators, the nozzles. So we did a campaign usually at about a year, year and a half, and then we cleaned the system out, using a high-sodium concentration liquid.

As I mentioned, the first cycle was the primary process using the calciner. We had a consent order cease use with the State of Idaho. Since this is Resource Conservation Recovery Act, it's regulated also under the State of Idaho. We have a consent order under RCRA that required us to cease use of the tank farm and also part of the Idaho Settlement Agreement, which was a court order that covered all our waste streams. Transuranic has high-level waste and low-level waste and mixed waste. We had to also process all the high-level waste by 1998, which we did. But we do have less than one percent of that 850,000 gallons of sodium bearing waste that we pedigree as, really, first cycle.

And we have to have this waste, according to the current consent order, done by December 31st. When we talked out yesterday, you know, we're going to miss that schedule. We're talking with the State of Idaho, because IWTU, the processing facility, is not--we had an event in June during start-up. We're recovering from that event, and the schedule is right now currently looking to go back into start-up in the February time frame, but we have to negotiate with the State of Idaho on that consent order to change the date.

This is just a graphical presentation of the tank farm, the three active tanks storing the waste. We do have a small amount of solids--it's more of a flocculent--that's contained--when we did the last campaign of the NWCF and when we shut down that facility, the New Waste Calcining Facility, we tried to consolidate all the liquids from the tanks into three tanks. Tank 190 is a spare. So all the sodium bearing waste is contained in Tank 187, 188, and 189. We tried to move the majority of solids into Tank 187. So that's where they are. And, again, we plan to treat this using steam reforming process to produce the carbonate solid.

Again, I've gone through this layer. It's only about--we've got about--I'm trying to think how many inches of solids. It’s about 40 inches, I think, the last measurement we have in the tanks. The campaign--there is a blending campaign strategy, as we talked about that yesterday, for blending the solids in with the liquids—they’ve got a formula recipe, because we do have a hold-and-blend tank to process this waste. In the New Waste Calcining Facility there is a hold-and-blend tank. They’ll do the blending there and bring it over to the waste feed tank at IWTU.

But if you look at our inventory and getting back to disposition plans, the activity is 99 percent due to the cesium/strontium. Solids activity, it’s partitioned between the solids and liquid. Cesium predominates in the liquid phase solids, because we do have some adhesion, we believe, in some of the analysis of the solids. It’s a little less, and some of the other nuclides are in the matrix of the solids.

Now, this gets key to the origin of SBW because of our path forward. We’ve always said we’d like to manage this--we manage this as transuranic waste because of the pedigree and origin. This is--that we have of the operational campaigns and how the liquids were generated and the--you know, it’s a lot of color there that’s kind of jumbled. But if you really look at the first cycle and the whole definition of high-level waste source base, so there is issues with the origin of this waste. And is the high-level waste, is it transuranic waste? That's one of those questions we've been working through with headquarters, and there is a process we're using to get the waste determination to WIPP.

But this is part of the data we have that shows, you know, how much is left remaining. And we did see--processing the high-level waste, we felt we got all the high-level waste process except for that one percent in '98. We stopped reprocessing fuel, I believe, in the '92 time frame, was it, when the Secretary made a decision. We had an inventory--I think it was '92 that we stopped reprocessing waste at INTEC, but we did have a large inventory backlog. So this is just kind of a graphical pictorial of the generation of the waste, you know, based on our records of the reprocessing campaigns out there and the calcining campaign and the sampling we did. And just have the definitions, pointer here, you know, our definition of what the waste origin is and what it consists of.

And that's just a different way of--the graph of--and, again, from a Curies standpoint--we'll talk on the calcine. It's about a factor of 10 less curie inventory than we have in the calcine, and that's historically if you average it over.

And this just gives a little bit more detail of the constituents. This is example sampling data averaged out over the tanks. So transuranic concentration, based on the process we're looking at--because that's really key for the--oops, sorry--it's mainly 238, 239 total Curies, you know, about 1800 Curies. We estimate the treated product is going to be about 150 to 200 nano-Curies per gram of transuranics based on our characterization data.

So looking at this as treating this transuranic waste, it does meet the definition for TRU. The other aspects of this of the WIPP waste acceptance criteria, it's a very long list of requirements. We've gone through initial assessment of that back when we were awarded the contract to process this waste, and, you know, we worked with WIPP very informally, can we get this waste down here, and fissile inventories. It does meet all their WIPP-WAC based on a very high-level conservative analysis.

So we feel it should be managed as transuranic waste. We've started a process to get a waste determination that way. But this just gives you a feel for what we have as constituents. But end product to solid, about 150 to 200 nano-Curies per gram of transuranic waste. Now, WIPP-WAC has a whole list of other isotopes you have to also report, and I think if it's one percent or more, you have to report it in the waste. So we have worked with them on that. And the only question is thermal. Some of the waste of solids may be bumping up on their thermal limits, but, you know, we did take a very conservative analysis on that in our initial scrub.

And that gets to the heart of the question, classification. You know, classification of this waste is in question because it is co-mingled with first, second, third cycle, if you look, about less than 9,000 gallons. We did do a lot of both contractual and acquisition strategy, and we did our EIS process to select a treatment process. The State of Idaho is a cooperating agency on our EIS, but in the Record of Decision we did state that our preferred preference is to dispose of this waste at WIPP, as transuranic waste.

DOE Order 435--that’s our internal radioactive waste management order--has a process and does allow waste classification to manage this waste as TRU, and the high-level criteria, you know, have key radionuclides been removed to the extent technically and economically practical? Can it meet the disposal criteria for TRU waste? And I mention we have gotten a preliminary assessment working with WIPP on the WIPP waste classification. And can they abate in solid form? And, as you saw yesterday, our process is a solid form that will be packaged in the RH-74B canisters.

We have previous reviews. One of the things early on in the EIS process was we asked the NRC staff to do a--we consulted with them on our position and the process for removal of key radionuclides. And, again, our process for calcining, we--all the high-level waste--we removed all the liquid inventory into the calcining, the key radionuclides. It’s in the calcine waste. What’s remaining is just incidental waste to that process.

And the National Academy of Science also did the review of our EIS and selection process. This was a key item they looked at, and that study in ’99 confirms that you should pursue this option of getting this waste to WIPP, and they looked at our thought process for that. And this is all publicly available. It’s still on the NRC website.

One issue that came up during the process is Hanford, ourselves--Hanford has some tanks, about eight tanks, that are tank wastes they believe should be managed as transuranic also. We are working with them on the process with WIPP. During that period the State of New Mexico, under their reissuance of their permit, the RCRA permit they have, basically precluded tank waste from Idaho, Savannah River, or State of Washington to go there. They said if you do propose that, you’ll have to go through another Class III permit mod for the State of New Mexico. So they kind of hold the trump card. That’s a process we’d have to work out formally with them and submit that through WIPP. So they have that in the WIPP permit, so that’s more of a regulatory issue as opposed to waste determination. So we’ll have to work through that issue. And I believe right now Hanford is actually--they have eight tanks of tank waste that they're starting to work into the next permit mod for Hanford--I mean for WIPP.

Waste determination, we have an internal process under DOE Order 435 under the high-level waste section. And the next slide kind of shows very high-level what that process is. And it's really no different with, you know, have we gotten rid of the key radionuclides? This is highly-radioactive waste, but have we removed those to the extent possible? And then it really feeds into the WIPP-WAC process. Oops, I'm sorry.

(Pause.)

EWING: I'm sorry, you'll need to speak at the--oh, you've got it.

CASE: I've got the mic.

EWING: I'm sorry, okay, sorry.

CASE: Can you still hear me?

EWING: Yes, of course.

CASE: I mean, this is very high-level projections. There's just a lot of policies in this. But this is the key criteria. The Subpart C Performance Objectives are really from the 10-CFR-61 low-level waste criteria. We would flow into this process. So, you know, we manage this waste under AEA authority and DOE order, so does it meet WIPP-WAC? You know, we have to demonstrate this. And then it goes up and if less than Class C--it is less than Class C, that's really not our--that's an NRC requirement, and we don't really classify our waste as Class C.

So, really, the real key thing working with our internal process is this definition of highly-radioactive is removed and key radionuclides. There is a guidance document out there from DOE. But that's really the key process for us. It does meet the WIPP-WAC. We've had discussions with NRC again at the staff level. It's consultation. They agreed that our process looked viable. We've also looked at the whole definition, is it highly-radioactive waste under the Atomic Energy Act, if you look at what is high-level waste (inaudible) source phase. This process for that--I think we gave a position paper to you, Nigel--that talked about that. But this is the process we've used. It looks very simplistic, but there's a lot of hurdles from a regulatory and policy-wise, because, you know, it's that whole definition of high-level waste.

Where we're at now, contractually, in the CWI contract, this was also part of the contract that this is TRU waste. Sodium bearing waste is TRU. It was originally going to be just-in-time shipment. The contract was modified to allow storage of transuranic waste, because when WIPP issued the--when the State of New Mexico issued that permit requirement, changed the permit, we put things on hold to focus on construction of the facility and work it at a higher level, working with the folks at Hanford and headquarters. So we haven't done much interaction since probably the 2008 time frame on this issue. We started a working group; Frazer Lockhart at EM is working with us to kind of reinvigorate this and work with the WIPP folks and internal folks on the regulatory process, DOE and external, to just beef up our argument and start putting the package together.

So we do have adequate storage for long-term. You saw that yesterday. That was added to the contract when we realized that this was going to be not feasible in 2012 under the current contract, so we changed the contract, not to say it's not TRU waste, but we needed to have adequate storage. We are packaging them in canisters that can be shipped in the RH-74B. You saw the pintle design yesterday. That's all driven by WIPP-WAC requirements for solids. That was--passed that design on to them. They gave us informal approval of it. So, you know, everything's postured, so what we have to do is, really, take that next hurdle and start the process internally to get the waste determination under our order.

And there are some interesting lawsuits that were out there back--NRDC lawsuit that challenged DOE's waste determination process under the order. It really never got resolved. It got remanded back. I forget which court it was, but basically said it wasn't a ripe decision. It wasn't time for a decision because we weren’t doing anything to send high-level waste to other than a repository. And that lawsuit basically said, you know, you can’t get out of Atomic Energy Act definition, you know, high-level waste source-based definition, DOE’s process really wasn’t consistent with the legislation on high-level waste. So those issues--you know, those will be issues that will have to be worked with the lawyers once we gear up again.

So any questions? I mean, the key points--meets transuranic waste, WIPP-WAC. We have this waste classification issue that will be long-term issue to work through.

EWING: All right. Lee.

PEDDICORD: Peddicord with the Board. On your chart here of the inventory, just to help me understand, is the top line, the yellow area, is that the--

CASE: That’s the sodium bearing waste.

PEDDICORD: And that’s the cesium and strontium?

CASE: The final inventory--this--we really stopped adding waste back in the 2004 time frame, so it’s a little static. We have an evaporator system, so where we’re at, it’s a little less--that shows a million gallons, but this is really the current inventory. We do run evaporation campaigns out there.

PEDDICORD: But those are the fission products.

CASE: Those are the fission products; correct. So that's the sodium bearing waste, and this is the first, second, and third cycle.

EWING: Other questions? From the staff? Nigel.

MOTE: Nigel Mote for the staff. Joel, you went through the various thinkings and historical insight of DOE, and then you said, "When we need to make the decision, we will." So when are you going to do that, and when will it be a final decision on whether this is high-level waste, low-level waste, low-level waste mixed with other wastes? And, as you know, the Board's interest is that the Board's mandate includes management of high-level waste; and if it's not high-level waste, then we'll thank you very much for being here, but we may well not see you on the same topic.

CASE: I'm afraid it's probably a long-term. We have a working group I mentioned. We had that initial discussion, but there is not a lot of energy with other issues in the department. I think what we're waiting for is, let's focus on the Hanford tanks. They'll start that process of tank waste. And that's going to--I'm trying to think--the next WIPP go-around on their permit, they have to revise their--resubmit their permit to the State of New Mexico every five years, I believe it is. So Hanford is working on that package, so I'm thinking five-year time frame at least.

Frazer Lockhart is here.

LOCKHART: I think your answer is as good as any that I could add to.

CASE: Okay. Frazer is our EM counterpart helping here with us.

LOCKHART: Frazer Lockhart from the Tank Waste Management Organization. I've worked with Joel and his predecessors on this for a couple of years now. But I think what Joel reflected is accurate, that priorities right now and also some uncertainties with both Hanford and Savannah River had the attention there, combined with the fact that with the processing not yet officially started, there is not the urgency either. So between those things, it is on the radar, but it's not at the top of the list. And so we're continuing, I think probably best represented, by being postured as well as we can to make the case when we kind of get the window to do that.

EWING: Nigel.

MOTE: I've got just two quick supplementaries. You mentioned at RDC lawsuit. Is there a time scale for resolving that? Supplementary number one. Supplementary number two, you're heading towards processing this waste on the assumption that it can go to WIPP. If the determination is that it cannot go to WIPP, are you putting yourself in a corner by selecting this process when that may not be the most advantageous if the waste has to be disposed of as high-level waste?

CASE: That's a good lead-in to the next presentation on the calcine project. First, to answer your question, I don't know if there's any--I'm not aware of any activity on the lawsuit.

MOTE: I'm presuming it's going to have to be resolved at some time, or is there a statute of limitations on that?

CASE: I'm not aware. I know there was concern when they did some tank closures at Savannah River. They just closed some additional tanks. But that seems--nothing really rose out of that. A Seattle court threw it back to Idaho, if I recall correctly, and I don't think there's any time frame for that to close it out. So it is out there. My guess would be, if we really made an effort to start sending waste to WIPP under that, it might pop up. That's a question--I'd have to go back to our lawyers back in headquarters. But I'm not aware of any activity.

Back to your second question on we make a waste form and it can't go to WIPP, what are we going to do with it, that was one of the decision processes for steam reforming, because what we do--short answer is, we'd integrate into the treatment campaign for calcine. Right now the calcine treatment is HIP if we go to the back end. Now, there'll be some technical issues, because even though it's a carbonate waste form--it is a little different from what the calcine is, but it is a powder.

EWING: I have a question. Ewing, Board. So, from what you've just said, your strategy is to let Hanford go first with their seven tanks. I'm not familiar with the composition of that waste and the history of that waste stream, but is it as compelling a case? Is it a simpler--

CASE: My knowledge of it when we worked with it, it's contact handled, number one, and they have probably a stronger argument on it really wasn't related to reprocessing, so it was waste--I don't where the processor was from, but it wasn't from reprocessing. And it's contact handled, so it's not--

EWING: And so where do the transuranic elements come from in--

CASE: At Hanford? Frazer, are you aware? I'm not aware where it came from.

EWING: Aren't these the details, though, that you really need at your fingertips to confidently go forward with your strategy?

CASE: Well, I know these details. I don't know their details. Like I said, it's been about, really, five years since we kind of shut down this process. We just reintegrated it--restarted. But you're right.

EWING: Lee.

PEDDICORD: Quick question. Peddicord, Board. Is this entirely an EM program, or is it an NE-5?

CASE: This is entirely an EM program. This is part of the ICP, Idaho Cleanup Project contract.

PEDDICORD: Thank you.

EWING: Right. Any questions? Board? Staff? So this is a good introduction to your next talk. So this is what you do if you can’t send it to WIPP.

CASE: Right now the strategy is a process on the back end of the calcine treatment process, which right now is HIP. I’m the Federal Project Director for this project also. Enough said there.

Related, won’t go through all this. We already talked about generation of sodium bearing waste. We reprocess fuel here to recover U-235, tank farms. The one addition, we process the waste through the waste calcine facility, a fluidized bed technology oxidation process. We ran two separate calcine facilities, the WCF, and then we replaced that operational campaign with NWCF, which was shut down. The last campaign was 1999. Generated about 8,000,000 gallons of liquids of high-level waste that we’ve processed through the calcine facilities that generated approximately 4,400 cubic meters of the calcine, which we store in the calcine storage bins.

This is an example picture of a calcine solid storage facility. They are concrete vaults with bin sets, stainless steel bins. The calcine was pneumatically transferred from the calcine facility into these stainless steel tanks, bins. Each bin set--there’s seven bin sets. One is empty. Bin Set 6 is half full. They’re all built a little different. Five of the seven do have access ports for retrieval. Bin Sets 1 and 2 were not designed for that, so there’ll be challenges for retrieval, at least on those two bin sets. Small granular bed material, a fluidized bed. A very, very good process.

Question is, why did we shut it down? We ran that under an interim status with the State of Idaho, again, hazardous waste treatment. This facility was built before RCRA was applied to DOE, the Resource Conservation Recovery Act, so it cannot meet some of the standards for thermal treatment. So we did a last run in ’99, and then we were under a consent order to shut the facility down and replace the treatment of the liquids. And that’s what we have for IWTU. So that’s a very good process. These bin sets, very robust.

This is just a pictorial of the current storage volumes we have. I mentioned Bin Set 1 and 2 and 3 are pretty much all underground; 4, 5, 6 and 7 are half and half. Again, different volumes contained in those. Bin Set 1 and Bin Set 2 will be a little more difficult to retrieve, because they do not have access ports. We’ll have to actually design the system, which we do have preliminary conceptual design for the retrieval access.

So the calcine project--and this is a pictorial. You were out there yesterday, so you probably saw all the bin sets. This is the old--when we ran the calcine facility, this is the stack where we had the emissions. If you've been out here when we did run reprocessed fuel and ran the calcine, you could usually see a yellow plume, NO-NOX. Sometimes I call that the color of money, because we were operating and processing waste. But that was a real big issue from an EPA standpoint, because we couldn't meet some of the standards for maximum achievable control technology for some of the other emissions, because very, very corrosive environment. So the facility was shut down. We have approximately 4,400 cubic meters of the calcine stored here in these facilities.

The project scope, I did talk--in January I know I presented to the Board. We have a lot of new members, so some of this will be redundant to some of you, but, just to remind, the project is to design and construct a processing facility using the existing IWTU to the maximum extent practical. And that decision was made mid-design of the IWTU facility. We went from a performance category, seismic category. We're not going to build two huge facilities, so there was a study done, a recommendation from EM, that we really to make this a dual-purpose facility, build the shell at least robust for a Performance Category 3. And that's just some more seismically robust facility based on a higher source term that the calcine has. I mentioned it's about a factor of 10 higher in radionuclide content. That drives the facility to a much more robust seismic qualification than for treating just sodium bearing waste.

LDR is land disposal restrictions. That's a RCRA requirement under hazardous waste requirements, so we have to pick a treatment that basically produces a waste form that doesn't leach the hazardous constituents, heavy metals being the main concern for us, cadmium being one of the major ones. Packed in the container, and then we have a requirement under our settlement agreement to have this waste road-ready by 2035, which seems like a long time.

Our key milestones that we had, you know, these are all internal to DOE. It's project management order, but Critical Decisions--basically, we do have a mission need, and that's what's called Critical Decision-0. It's the internal programmatic from a project management standpoint. That was signed back in June 2007. We had to issue a ROD per the Idaho Settlement Agreement. I mentioned the EIS that selected steam reforming and made the decision SBW should be TRU. There was a phased environmental impact statement process. The last Record of Decision was selection of a treatment process for calcine. That decision was made, and they issued the Record of Decision back in December of 2009, which met that milestone.

There was a whole selection criteria process. What really drove the decision process on at least criteria--there was both technology criteria, cost criteria, but, really, I believe it was--because right now for high-level waste treatment standard for BDAT and LDR is vitrification. If you look at this waste form, there were some technology challenges with vitrifying calcine, also the waste volumes. Looking at the HIP process, we were looking up to about 50 to 60 percent volume reduction in the final waste form versus for vitrification. It was 30 percent; 33 percent seems to be the standard at BWPF. This waste's a little harder just because of some of the heavy metals and the waste the way it is.

So what really drove the HIP process was not so much technology maturity, except that it is used in industry. It has a very good track record for making powdered metals. If you look at the number of canisters that--at the time this was done, the disposal charges that we had to assume per canister at Yucca Mountain, I think before the project was shut down, the latest cost estimate per canister was about $700,000 per canister. So that drove a lot of the decision making process on selection of this technology, minimizing volume in canisters, and also technology maturity and cost. The cost for this--when you look at some of the cost ranges for some of the other options, this was much more in the mid-range compared to vitrification.

We do have a requirement to submit a Part B permit application for the process by December. That's under the Idaho Settlement Agreement. We are going to meet that. We've been focusing on that activity. We have the draft permit application. It's about four volumes, getting a lot of technical information, conceptual design data; but that will be submitted to the State of Idaho for their review December 1st.

We also have a schedule we have to submit under the site treatment plan. That is also a requirement under resource conservation. It's a Federal Facility Compliance Act Agreement. All the sites--usually they have mixed waste in the complex. They negotiate these with their states. So this is regulatory-driven. We have a milestone to submit by end of this year, you know, a schedule for procuring contracts, construction, system testing, commence operations, very high-level, but the State of Idaho requires that at this stage of the project. And, again, I mentioned our settlement agreement milestones have this waste road-ready by December 31, 2035.

What have we been doing? Hot isostatic press, as I mentioned, it’s been in commercial use, again, not for this type of--you know, not for treatment of radioactive waste. It’s a very good process for making--working with powdered metals, parts and components. You look at the different temperature ranges, 2,500 degrees C and pressures up to 60,000 psi. It’s a pressure vessel with a furnace. It’s isostatic pressure, so it comes from all sides equally, uses argon gas.

For our process we’re proposing is a temperature range in the 1000 to 1,200C, 7,000 to 15,000 psi. Nuclear engineer and nuclear safety, high temperature/high pressure raises red flags with me, so we’ve spent a lot of effort understanding the process commercially, the accidents they’ve had, because they have had--I’m aware of, we’ve talked, we did bring commercial people on, but there have been three major accidents, I think, in the country with this process, one in the Boston area, I think Upstate New York, and I forget where the other one was. But that’s always a big issue in the DOE when you’re dealing with this type of waste, these type of scenarios. High pressure/high temperature does raise flags. So a lot of effort on safety documentation at least on reliability in some of the studies to make sure the process--we don’t have, you know, focus on that.

It does produce a glass-ceramic waste form, so that was another attribute. We feel it can meet the requirements to get in as good as glass. You hear that term a lot. So we've been doing a lot of studies on samples, surrogate samples, on waste form development to meet both land disposal restriction, the leachability requirements, and good as glass from a high-level waste repository standpoint. And we're using the current waste acceptance, the WASRD document. I forget what that stands for, but EM owns that document now that we don't have a high-level waste program. But that is a standard we're working to.

I mentioned the volume reduction. That looked very attractive to us in the sense much better in vitrification, because the best I've seen with BWPF is about 30. I think they've gotten up to 33, 34 percent with some of the sludges.

This is the process--a very high schematic of the process. Here we've broken--the numbers here are just really more like a work breakdown structure, the process element structure, so you don't really need the focus. This is just for our analysis purposes, both from a technology maturity, the process we're looking at. We've broken it down into key processes, but the first process for this will be retrieval from the bin sets. And that's a whole set of technical challenges. Some of the calcine has been in there over 30 years, so you ask questions about caking, can you get it retrieved; as it's aged, is it still in a flowable material. So there's studies we've done on that.

Also, the best way to do penetrations of, like, Bin Set 1, the plan here is to do prototype testing. We have the empty bin sets, so do mock-ups using the empty bin set. We have done some studies with the calcine surrogate on pneumatically transferring out. So that’s one of the key elements is retrieval of the waste.

And then I get into--retrieve into--it goes into where we have a train, we have to bake out the calcine, because in HIPing you don’t want any moisture. So there’ll be a bake-out facility in IWTU, the process cells, we’ll heat that. And we’re using temperatures--we hope to be able to get all the mercury out also. There is some residual mercury, we believe, in the waste; so we’ll use a mercury condenser and then amalgamate the process to get a very small fraction of that secondary waste. And that can be disposed of probably as mixed waste down--usually Energy Solutions--they can take that or on-site it on—our RTA facility--disposal facility.

We have a HIP can fill station, after you bake it out, the HIP can train. We’re doing a lot of studies. I’ll talk about the technology work we’ve been doing on the HIP can. That’s kind of key to the process, because you want to design a can that does compress in a very nice manner. HIP furnace--sorry, big thumbs.

We’re looking at three process lines. Because of the schedule, we're assuming a 12-year operational campaign, so we'll have three HIP machines. The size of the machine we're looking at a HIP unit of about, oh, I think it's about 5 feet by 30 inches. And that was to enable it to fit in the existing cell structures that we have at IWTU. But three cell lines, cycle through, and, again, temperature, you know, a lot of off-gas. We're trying to use as much of the off-gas train we have out there already, the GAC beds, ventilation system, but there'll be some modifications. The real gut--we'd have to remove all the steam reforming of equipment process vessels and replace with the HIP can furnace, the heating/drying station, and there'll be a new annex here for transporting and shipping to a repository.

But this is a gut, so you have a HIP can, HIP furnace, which will take into the HIP machine. Right now cycle times, we have some bounding ranges we're looking at to meet that 12-year campaign and then remove it, load it into a canister for shipment to a repository if and when one is available.

Any questions on the process flow? It's very high-level.

You were at IWTU yesterday. This is the facility we intend to use, retrofit it to modify it to place this process out after we complete the sodium bearing waste campaign, D&D the facility. I'll strip out all the process cells with the vessels we have now, which is a major task in itself.

This is the existing facility I mentioned. We'll have to build an annex. This is a little bit better depiction. This is the existing what we call four-pack and two-pack where the existing steam reforming process is now. We'd be utilizing the process cells for the HIP process. Transport, really, this will be the loading stations. We have lag storage for the canisters and the hockey pucks, very big hockey pucks, I call it, the HIP waste form, the HIP cans, and then to load out here and ship. So this would be a new annex to the facility, but mainly for the load-out of the treated product for shipment. We're at very preliminary --

So some of the more key technical things we've done over the last three years is--is HIP cans key to the process. Lot of modeling we've done, because you want a can that basically compresses in symmetric waste form with the isostatic pressure, and you don't want a can breach, so that's really key. We've done qualifications up to half-scale, which I mentioned we're looking at--the half-scale is 20 inches by 30 inches in diameter, about 4 by 5 feet. And, again, that was driven a little bit by the configuration of the process cells we have so we could fit the HIP unit in.

Waste form is very important for this process. We've done 25-gram samples. We're looking at going from small-scale, lab-scale, up to a full-scale facility to test waste form. They key here is, the waste we have and the calcine--our reprocessing campaigns were mainly aluminum fuel, zirc fuel, some cats and dogs, but we're looking to get basically one formula for the recipe for the final waste form product. So we're working on our--our lab scale is both different mixes of calcine surrogate, high in alumina, high in zirc, high in sodium, and some mixes in between. To be able to--our goal is to get one recipe for the process. That's the ideal goal, recognizing because of the different calcine characteristics and configurations, the waste we have there--it is layered, if you look at the operational campaign of fuel reprocessing. There is layering of different fuel types, so we're trying to bound that by the waste form testing.

We've done nine--we used ANSO, Australian Nuclear--I forget the acronym--but they're the ones that, you know, did a lot of work with us. They were able to do spike samples over at their facility in Australia, so they've been supporting the project.

Furnace filter tests, if you look at--we'll load the can into the furnace. But if we do get a breached can, we don't want to basically contaminate the whole HIP cell, so one of the real key things is have filter that would contain any--if we do have a failed canister during the process, it doesn’t contaminate the whole furnace, etc. we’d have to replace in the process. So we’re doing testing. We’re working with Avure, which is a company out of Sweden, but they’re in this country. They have 50, 60 years of process knowledge with HIPing. They sell these machines, so they’re on board. Because our contractor, they don’t have much experience. We’ve brought all the resources in we can, Avure, ANSO. Bodycote uses this process also to help us on our technology development to work these issues. So we’re working basically to mature the technology for, if we do get a breached canister during the process, we don’t contaminate the facility.

HIP can profile really goes into the HIP can modeling tests also. Again, we’ve done small-scale HIP can tests to model as we scale up to make sure we understand parameters and what’s key for the HIP can and the process so we get very good isokinetic--you know, we get a can that doesn’t breach and get good, uniform process and getting the HIP can and HIP--you have the ceramic process that meets waste form requirements. So that’s been ongoing.

And then the engineering aspects of supporting the RCRA Part B permit, we’re really at a conceptual level with the process, which is a little different from what normally you submit a permit. Usually you should be in final design. The State of Idaho has been working with us, understanding, you know, we don't have--we have a lot of technology maturity issues we have to work as we go scale up on these tests.

So this is what we've completed up to date. All that's been sent over to us for review in supporting the Part B permit. We're reviewing all this data now at DOE. It was a contractual requirement to get this submitted to us by August, and so it's under review. We have done a material balance for the process.

Key to this also is understanding the waste you have, because it's very expensive to sample calcine. We have some actual real waste calcine in storage that we want to use as we scale up on the test to validate the recipe we have. That's stored at INTEC. So is it representative of all the calcine? No. But it'll at least help us with real waste form testing as we scale up. And the intent is to build a full-scale test facility, because one of the lessons learned on technology maturity is--IWTU is a good example--one-tenth scale, scaling up to full scale, sometimes they don't scale up quite as good as you think.

But this is where we are on the project status as of this month. We have had a number of reviews, lot of questions about technology. These are internal reviews we've had. DOE uses what's called a Consortium Risk Evaluation, CRESP, and they came out in May. One of the issues was, well, what about cold crucible vitrification, this nervousness about this waste form, getting it qualified for a repository. They came out, spent a lot of time with us. They recommended that we do some backup work on vitrification, cold crucible specifically.

Then EM had what was called a technical evaluation group, EM-TEG. They came out last year and also looked at our technology maturity and looked at our technology roadmap. We do have a very good technology roadmap, and I didn’t show that, but it guides all our areas, and we use the technology development level. Right now most of our elements of the process are at a 3 or 4, so that’s more at the lab scale. But DOE requires, under their project management, you should be at a technology development Level 4 for all the critical technology elements of the process before you get CD-1 approval, which is to move into preliminary design.

They gave us a good review scrub, didn’t say HIP’s not a good process. They did identify two risks with waste acceptance of the glass-ceramic form. And basically what that is--it really related--they said, you know, you still are going to have to go through a process to get this waste form accepted; and where you’re at, you don’t have much data to demonstrate that it would meet the standard borosilicate glass. So they identified that risk for us, which we understand.

Don’t have a slide on this, but where we’re going in the next few years--in January I talked about the 2013 to 2015 time frame. We're really going into a stand-down with the project. We're submitting the Part B permit to the State of Idaho December 1st, no later than December 1st. Budget profiles for the current contract and with our EM budgets really had minimum funding to--we're just going to address State of Idaho comments on the process. We're really not going to mature the technology, do any further engineering work. It's really going down into a stand-down mode and just respond to State of Idaho comments on the permit. The intent is, after the 2016 period we'd scale up again, we'd gear up the project. So I just think they're just giving me some more time to work on IWTU.

So that's where we're at. Any questions?

EWING: Questions from the Board?

(Pause.)

Could you say a little bit about the waste form that's produced? What are the main phases in the--

CASE: I'm not the right person to ask that. I'm sorry.

EWING: Questions from the staff? Nigel.

MOTE: Nigel Mote of the staff. Last time we were--

CASE: Back to his question, I can get you the test report; so if you'd like, we do have--

EWING: Yes, please, that would be great.

CASE: All right. Because we do have a--like I said--

EWING: Yeah, sure.

CASE: Okay. I didn't mean to interrupt you, Nigel.

MOTE: That's all right. The last time we were here, I remember seeing a process that had been developed as an alternative to HIPing, and that was a cold--if I say it was an epoxy, I don't mean epoxy in chemical form. But it was like two reagents mixed and then have the calcine waste blended in. It had been taken to final tests with simulants, and I saw that as being a very useful replacement; because, as you said, there's been concern in other countries in applying HIP to radioactive materials, because it's high pressure and high temperature. And the high pressure in a pressure vessel means you have a lot of latent energy there, which, if something does go wrong, gives you potential for spreading radioactive materials around. So cold and non-pressurized seemed a lot better. I understand that was defunded very soon after you had the visit, and I don't know why.

The second alternative was yesterday at the end of the trip we saw a HIPing small-scale demonstration. But in the discussion we were also told that there had been a demonstration done of high-temperature but mechanical press as opposed to a pressure vessel process. And that seemed like it would also get rid of the potential energy from using a pressure vessel.

Can you comment on why neither of those have displaced the--

CASE: I know that MFC Argonne back in the older days, they've done a lot of work for us on HIPing. They had a nice setup out there. The mechanical pressing, I don't know why that went away, because I think you were here in 2010, correct, the last time?

MOTE: Yes. I didn't see it at that time. I saw the cold low-pressure. Yesterday we heard about the high-temperature mechanical pressure.

CASE: Looking at alternatives--how I say this--we looked at using, continuing to use, BEA now on their processes, but the costs were just really--from a project standpoint--I know you guys don't like to hear that answer sometimes, but we had options to look at on testing, and we weren't looking at alternatives to high pressure. We hadn't gotten to, okay, do we have an issue with energy and pressure? We're just not there. We're doing reliability and maintainability-type studies and preliminary safety analysis. But, really, looking at alternatives to the high-temperature/high pressure, we haven't done anything in that area.

Now, there is pressure--because of the budget concerns over the next three years, let's--I won't say revisit the decision, but we have time and opportunity to look at issues related to this waste form and this process. But, again, the support we got from MFC--I call it Argonne West, so I've been here too long--you know, good support. We would like to continue that support, but in the budget profiles we had other options to do the testing, and they couldn't commit to a real schedule for us.

I don't know if that answered your question. We did not look at alternatives to the high pressure. And then continuing to work with them, that was really due to scheduling and budget issues.

MOTE: All right, thanks.

EWING: Other questions?

(Pause.)

Okay, Joel, thank you very much for two talks. And now--

CASE: So any follow-up you guys have, I'll work with Nigel, because we can get you the--

EWING: And just for my personal interest, I'm always--

CASE: Okay, yeah. And we have sent a lot of information, I think, already, maybe not specific to this project, but other stuff. So just work through Nigel, and we'll get you the information.

EWING: All right, good. Thank you.

CASE: Thank you. Appreciate the time. Thanks, guys. And glad it's not blowing now.

EWING: So the next and last session of today's discussions are the public comments, and let me get the list.

(Pause.)

So I have two listed, and I'll just go down the table. No, three. Sorry. So, Judy.

And, again, please identify yourself and your affiliation.

TREICHEL: This one works better?

EWING: Here, whatever you'd like.

TREICHEL: Okay. My name is Judy Treichel from the Nevada Nuclear Waste Task Force, and the Task Force got its start even before the Yucca Mountain project. We came into being about a year before Yucca Mountain in Nevada was singled out, so we've been around for 26, 27 years, a very, very long time.

And the Technical Review Board, of course, came along with the Yucca Mountain project later than that; and they've been a really, really important of this whole nuclear waste discussion for a very long time, because the Board provided a platform for presentations, but it also was the one place where the really hard questions were asked of the Department of Energy and it's contractors. And they had to provide answers or at least find answers or at least think about things that they had never thought about before.

And more important to me and other members of the public was that it provided a place where we could ask questions. And in some cases, depending upon who the Board was, who the Chair of the Board was, there were times when the Department of Energy was asked to sit right in these seats right here and answer our questions; and that never happened in any other place. So we have a rather warm place in our heart for the Technical Review Board, and we're so glad that they are still here even though, hopefully, Yucca Mountain is gone. But if another effort is made to find a storage site or a disposal site, it's very important to have an entity like this.

Today it was very interesting listening to presentations. I haven't been to Board meetings for awhile, but there were questions being asked today about disposal and about storage that have been asked over the course of the last 10 or 20 years and were never really answered, and they're still working on these questions. And for most of the time that I've been involved, it was we've got to get Yucca Mountain done, and we've got to stay on schedule, and we've got to--it doesn't matter if we answer these things; we'll figure it out once we've got the spot. And, as you've seen now, the spot went away, and now it's finally time to answer those questions. And I hope that they do get answered before we go any further.

I made a comment earlier about if this program starts again or any similar program, they’ve got to start at the beginning. And it’s the public that pays for whatever happens; either it’s through their electric bill or through their taxes. And it needs to start out with what the public expects, what they expect with nuclear waste storage or disposal, and what it is--how this gets done. And it’s not just because somebody decides waste needs to not be in the place where it is, needs to leave that place. They don’t really care where it goes, but just get it on the road, and that looks like progress. And the public is never going to accept that.

So at some point, if there is a program that starts to take shape, I would certainly like to see it begin at the beginning and have the public understand why it’s happening, not just what’s going on, but how come and how it makes them safer and better off and whatever and certainly--and by the public. I don’t mean particularly the volunteer. There’s a whole lot of places between where the waste is and the end point where the volunteer is. And that was talked about with corridor states and so forth. So that all has to begin early. And any future program should never be schedule-driven. So thank you.

EWING: Thank you very much. So Beatrice Brailsford.

BRAILSFORD: Thank you. My name is Beatrice Brailsford. I am with the Snake River Alliance. The Snake River Alliance was founded in 1979, and we are Idaho's grassroots nuclear watchdog and advocate for clean energy. I have just a couple of comments.

You know, this whole--the BRC review recommendations has kicked in a whole new process that's sort of going along with maybe not some of the underpinnings having been put in place appropriately as in who does accept the BRC recommendations and who doesn't and how do we articulate that acceptance legally, socially, and all sorts of ways. But at least it has, if nothing else, certainly roiled the nuclear waste world in a way that it hadn't been roiled in many, many years.

So I will speak only to one aspect that the BRC focused on, noting that the Snake River Alliance's long-held conviction is that nuclear waste should be stored as safely as possible, as close to its point of generation as possible, and that a good deal of the efforts that we have seen in Idaho to address the nuclear waste problem--and we have been the victim of some of those efforts in Idaho--are addressing a political problem, not an environmental problem, and that, I think, we have to be very cautious to not keep going down that road no matter what we call it, consent or whatever. Judy noted appropriately, you've got to be fixing the right problems if you're going to move forward on this whole question.

So what I want to talk about, though, just so briefly is consent. I will note that the Blue Ribbon Commission, which, you know, was not elected, was not--it's just 15 or 18 people. It did, though, give some roadmap help. It had a lot of steps before you get to consent, before the government gets to the point of inviting consent, so, you know, whether or not we replace DOE in this conversation.

What are the generic standards for any new nuclear waste facility, storage or disposal? There are a lot of things that have to happen, according to the Blue Ribbon Commission, before we go out and invite communities to apply, because we might be wasting a lot of time, if nothing else, if we go out and--you know, whoever raises his hand first and says yes the loudest. And I know that there are some--you know, nuclear waste has a certain appeal to some folks, I guess.

But what I want to note from a purely local parochial place, Idaho has said no. We are a non-consent state. People in Idaho started expressing concern about nuclear waste coming into Idaho in the 1960s, and by the 1970s we started actively resisting that. That resistance, that concern culminated in the early 1990s when waste coming into Idaho was stopped. That impasse led to what we call the 1995 Settlement Agreement. And Joel talked about it, and I'm sure you probably know all about it. But one of the key components of the 1995 Settlement Agreement is that commercial nuclear waste is banned from Idaho. That settlement agreement was affirmed in a statewide referendum in 1996. 60 percent of Idahoans voted that they wanted to get nuclear waste out of Idaho, and 40 percent of Idahoans voted that we wanted to stop all shipments from coming in. So what happened was a hundred percent of the people of Idaho who voted in 1996 said, We do not feel comfortable having nuclear waste in Idaho. And that's just bedrock folks.

So as we're going forward looking at--you know, I didn't hear so much you guys talking about how do we go about seeking, achieving consent, but do remember that you are entering a world where a lot of the invitations have been refused already. There are a lot of places in this country that have already actively said no. And I would say that one of those places that has said no for the longest time and the loudest and as firm as we can say it is Idaho. Thank you.

EWING: Okay, thank you very much.

Darryl, Darryl Siemer.

SIEMER: Hi, I'm Darryl Siemer. I am an ex-consulting scientist from INL. I'm a Ph.D. chemist, and this is the Technical Review Board, so I'm going to talk about technical stuff. I really haven't heard very much about the technical aspects of what waste management is here. In particular, with the plans for the waste at this site, what should happen to it, and I'm talking about high-level waste, that generated by reprocessing, not spent fuel.

Now, this includes, of course, the sodium bearing waste, and I guess yesterday you went out and saw a brand new building with some shiny equipment in it. You were able to tour it up close and personal, because this thing is over a year behind schedule and consequently hasn't been rendered radioactive yet. It's behind schedule for a reason. An extended decision-making process was undergone many years ago, almost a decade ago, that led inevitably to some substitute for calcination for sodium bearing waste.

Now, to begin with, the reason that you are looking at this kind of facility you looked at yesterday was that there had been a decision made when the folks that ran the chem plant--my bosses at the time, because I worked at the chem plant as a scientist in the laboratory. We were given a new mission when reprocessing died to come up with uniquely efficient ways of dealing with the waste accumulation that the chem plant had generated over the years from processing all that fuel. And the folks put in charge of that, of course, were the folks that were in charge of the reprocessing operation, which, of course, led to a paradigm, the adoption of a paradigm for waste treatment, which was reprocessing. Only this time, instead of redissolving fuel elements, making a liquid out of it, extracting a component, the uranium, out of it as the product, now we were going to redissolve the calcines, the stuff that had already been calcine, generating huge amounts of NOx going up a calciner, which had not been--even though it was freshly rebuilt, there had been no attempt at making it work in a way that didn't generate huge amounts of NOx and consequently was tremendously out of phase with the environmental movement; that is, you shouldn't be putting out giant clouds of visible gas when you process something. And no other facility in the country could do something like that; but, of course, we could because we were special.

But we calcined the waste generated from reprocessing. And when reprocessing died, these folks who had been running that plant decided that we would reprocess the waste. Consequently, the separations paradigm was adopted. Now, since most of the waste had already been calcined, this meant that you redissolved the calcine, and you extracted something else from it, in this case those components which render it high-level waste or especially radioactive, especially toxic. Now, to do that, of course, you have to produce a liquid so that you can extract it. When you do that, then you're going to generate another waste; you're going to have to deal with that, too. But once you've extracted the things you want to extract, now it's low-level waste, and you don't really have to worry about the low-level fraction.

But the bottom line was, the paradigm adapted, would it redissolve everything, put the nitrate back in, and generate solutions you can do extractions with? Well, the remaining liquid waste, the sodium bearing waste, the stuff that was still in the tanks, of course, was already suitable for these extractions. Because it was suitable for these extractions, they dragged their feet every way they could to not calcine this stuff, because they wanted to convince everybody that it made sense to redissolve calcines and implement separations.

Incidentally, a technical point, it was all justified by the notion that Yucca Mountain, the thing that we were told, the place that this stuff was supposed to go, wouldn’t be big enough to take our 4,500 cubic meters of calcine unless we somehow reduced its volume. Now, if you look at the size of the mountain and compare it to 4,500 cubic meters, you realize that was a phony assumption. People never seemed to question it--at least they didn’t question it for about five years--that somehow we had to--it would be worthwhile reducing the volume of this stuff in order to ship it off to a giant mountain. But it was a fine way to spend money and to do research for five years, so that’s what happened.

Well, eventually that fell through; that is, people did finally realize that volume reduction was not a valid driver for our waste program. Therefore, the dissolution of the calcines really didn’t make much sense.

But we’ve dragged our feet on calcination. We had never updated the calciner, and it would have required a very simple update to deal with the sodium bearing waste and turn it into calcine, which is what we could and should have done two decades ago. The technology, the way to calcine sodium bearing waste with an already-paid-for calciner, which already exists out there--and I understand it still exists out there--is to simply stir some sugar in with the waste before you calcine it. Then you’ve got the direct reduction of the nitrate in an acidic solution when you heat it up by sugar. And when you do that, you make a new calcine, a carbonate calcine.

Well, since we didn’t do it and regulations came up and we told everybody--well, DOE had told everybody that it couldn’t be done, then they didn’t do it. And when the separations thing fell through, calcination was dead because we had killed it, because we wouldn’t implement this sugar calcination technology developed in 1957 at Argonne--because we didn’t implement it, then we had to find something else. So what were we familiar with? We were familiar with fluidized beds.

So these salesmen came along selling a fluidized bed process, only they couldn’t call it calcination, they had to call it something else. They called it steam reforming. And instead of adding sugar to it, they would do it with a solid reductant, coal--or elemental carbon in one form or another--but coal was the main reductant. So in order to convert sodium nitrate into a solid material in a fluidized bed reactor, you have to reduce it; you have to convert it to a carbonate.

Now, with sugar, very simple and straightforward process, could have been implemented. We didn’t do it. And when the snake oil salesmen came by and sold us this, at that time we bought it. Now, of course, I was a scientist out at the site, and I did object to this, because it didn’t make much sense. We had run numerous calcination or reforming experiments with different reductants, and the bottom line is, when you use coal or charcoal as a reductant, it doesn’t burn very well. It’s not that homogeneous reaction like that of dissolved sugar with nitrate molecules interlinked with solution. That’s a very quick reaction. With coal, it’s heterogeneous and very slow, meaning that the coal doesn’t all burn.

Now, I don’t know what you saw yesterday, but a representative product from a steam reformer is black, and it contains, depending on which--well, we ran numerous pilot plant tests. Hazen did pilot plant tests of this stuff at many different times; they always contained a large amount of elemental carbon. Elemental carbon is what plugged it up the last time they tried to start this process up. It plugged it up solid, blew stuff out the stack. And thank goodness it happened before they went hot, because that facility is still cold; that is, it could be modified to do something more useful and less problematic. And that's what should happen.

Now, the sodium bearing waste, Mr. Case's talk was all about--it wasn't technical. It's all about the classification of the waste and why we decided, according to the way we looked at it, to do what we did and almost no description of the process itself. Somehow we're just going to turn it solid and it's going to go to WIPP.

EWING: Darryl, if I could interrupt for just a moment?

SIEMER: Yeah.

EWING: We specifically asked if they addressed the classification problem, because we're trying to decide whether it's in the mandate of the Board. So if there wasn't enough technical content, that's partly because of what we--I'm sorry.

SIEMER: No, no, I can hear you very well.

EWING: Well, but it's being recorded. That's partly because of our directive in terms of the content we needed.

SIEMER: Well, again, decisions like this--you know, we've been kicking this around for many years. The stakeholders, the folks in Idaho, were told before the decision was made to do steam reforming out here--one of the things that was very strongly hinted at, at least, was that this stuff was going to be reformed into this fine product, which could be shipped off immediately to WIPP.

In fact, that was in the original contract. There are something like 250 contract changes since that contract was let up till now, and every one of them dealing with the sodium bearing waste project has moved the goal line to make it easier for the contractor to succeed. Well, they never succeeded. DOE has finally admitted this process will not do what we were told that it was supposed to do; that is, convert it to something which would be shipped off to another state. Couldn't do it. They finally admitted it.

It was supposed to be inexpensive relative to the alternatives. It wasn't. The first bid was 45 million bucks. They are over 570 million on this. That's 13 times higher. They had to extend the contractor's contract for another three years to somehow get something done on this. They can't find another contractor that's going to take over that technology. And, most importantly, if they manage to get it to go, they then will not be able to convert it to something suitable for disposal at a high-level waste repository.

A question which is still being asked: Is this high-level waste or not? Now, it’s totally non-conservative and non-necessary to assume that this stuff has to be kept separate from the rest of the waste that was calcined out there. In fact, while efforts were made to more or less keep things separate, it isn’t separate. The radioactivity of this stuff is on the same order of magnitude as is the waste that has already been calcined, which everybody admits is high-level waste. Its chemical toxicity is the same. There’s a different distribution of chemical toxins in it; there’s more mercury in sodium bearing waste, less cadmium. But, in terms of it being a nasty stuff that should be buried somewhere in a form where, if water gets to it, it doesn’t dissolve, or if wind gets to it, it doesn’t blow away, it’s equally important to deal with sodium bearing waste as we dealt with the waste that has already been calcined.

These distinctions that have been made are totally artificial. They can’t even decide whether it’s high-level waste or not, and they’ve been thinking about this for 15, 20 years. And their decisions--they get themselves into--they drive themselves into a point where they have to make a decision, and the danger is always that they will make the wrong decision.

Going to steam reforming was a wrong decision. Not calcining it with sodium bearing--not calcining it with the existing calcine or using this sugar calcination was a wrong decision. Calcining anything in a way that blows NOx up the stack, totally unnecessary, was a wrong decision. Committing to HIP--whatever we decide to call high-level waste when this process is done of converting the remaining liquid waste into a solid, committing to HIP, that stuff, will be a wrong decision.

One of the technical problems with this steam reforming process is that it cannot be HIPped. In fact, it'll be almost--well, it will be extremely difficult to vitrify, which means that if this process goes on--this steam reforming process goes on, actually starts, first thing that'll happen is they'll crap up a facility. That means render it so radioactive that any further changes will be extremely expensive and very difficult to reverse. Taxpayers can't stand another 100-million-dollar hit or whatever it will cost.

So don't go hot until you absolutely know what you're doing. That's something that needs to be done, and they shouldn't start up just because the schedule says they want to start up by January or February or April.

The process should be changed. It's very straightforward. They do have a fluidized bed reactor; they have an off-gas burner, another fluidized bed. This process could still be implemented without the elemental carbon. They shouldn't be using coal as a reductant. Use something that actually burns and doesn’t create carbon. Elemental carbon is the really most problematic fraction of the product of this stuff. When you run this steam reforming process, you end up with gobs of elemental carbon, meaning you can’t HIP it. If you put elemental carbon and metal oxides in a HIP can, heat it to a thousand degrees, what happens is you create carbon monoxide. You create a gas. It’s a gas former. Okay? You can’t HIP this stuff that’s got elemental carbon in it. If you put a calcine, this material, into a glass melter containing that much elemental carbon, it’ll crap out all the metals in it, except the alkaline metals. They’ll actually reduce and end up in the bottom of the reactor.

So if this process is implemented as they propose to do it, they lock themselves into a corner where they cannot convert it to a waste form which is suitable for disposal. Suitability for disposal--it’s got to be water-insoluble and it can’t be a dust. Well, steam reforming makes a water-soluble dust. Now, it can be calcined. You can still modify IWTU--and they should--to do sugar calcination. At least then you get a clean carbonate calcine, which can be vitrified and which can be stored in the empty bin set.

I don’t know whether you saw the bin sets out there or not. There are six bin sets that have stuff in them.

There's an empty one, Number 7, which could contain everything, all the sodium bearing waste about three times over, after it's been calcined. And that's what should happen to it. The taxpayer has already paid for this bin set. It's out there. It's been out there for 15 years. It doesn't contain anything.

Well, what should be done is you calcine the remaining reprocessing waste; that's the sodium bearing waste. You do it with sugar instead of carbon. You can use IWTU since we've already spent $600 million on it; go ahead and use the new process, only change the chemistry; make a calcine out of it; put it in the bin set; and then wait until a decision is made what should be done with this calcine, combined calcine of the chem lab. Sodium bearing waste is not really different, and it can be changed. The whole process can be changed.

HIPing, I think, is an inadequate or an inappropriate choice for this. The justification for HIPing the calcine was based on the same old arguments we were hearing 25, 30 years ago. The main one the DOE seems to be interested in is volume reduction again. We're still back to the notion that a waste form has to be small. It really doesn't have to be terribly small.

Now, if you compare the volume of the stuff you would make from all of the high-level waste at the chem plant, the calcines plus the sodium bearing waste with borosilicate glass vitrification and HIPing, yes, there is a large difference, about four to one; that is, HIPing can produce a high-quality, leach-resistant waste form with about a quarter of the volume of borosilicate glass.

However, there's also been a great deal of work done on a phosphate based glass. And we happen to have a guy at a phosphate plant just right down the road, so the main ingredient is really cheap. A phosphate glass would put all the calcines and all the sodium bearing waste, and they should be done together. The reason is is that the sodium in the sodium bearing waste is a necessary part of glassmaking. You need alkali in order to make a glass that'll encapsulate all the ingredients of the calcine, and it should come from the waste.

EWING: Darryl, could you wrap it up in a couple minutes?

SIEMER: Okay. Well, vitrification via a phosphate glass will produce about 4,000 cubic meters of waste form, not 11 or 12,000 cubic meters of waste form as you get with borosilicate glass based on some guesses. The waste loading is about three times higher with it. The performance of that waste form for this kind of waste--remember, the calcines at the chem plant and the sodium bearing waste all together are only moderately heat-generating. So we don't have to worry about these waste forms getting terribly hot. A phosphate glass performs very well under those conditions, better than borosilicate glass. It’s easier to make. You can put all the calcines and all the sodium bearing waste into the same waste form.

And that decision should wait, just like HIPing should wait. DOE has set itself another artificial goal, that somehow a decision has to be made and committed to by December of this year. That should be put off until a decision that you guys hopefully can influence is made of what really should be done.

When the NRC did its evaluation of what should happen to the chem plant, one of the things that came out right on top was put the calcine in the bin sets and leave them there until they cool off. That’s another option.

EWING: Okay, thank you very much. And also thank you for the documents that you’ve sent to the Board.

Any other comments? I think I’m at the end of my list.

All right. I’d like to thank everyone who has stayed throughout the entire day, particularly the speakers. It’s been very informative, and it’s been of great help to the Board. And so I declare us adjourned.

(Whereupon, the meeting was adjourned.)

C E R T I F I C A T E

I certify that the foregoing is a correct transcript of the Nuclear Waste Technical Review Board’s Fall Board Meeting held on October 17, 2012 in Idaho Falls, Idaho, taken from the electronic recording of proceedings in the above-entitled matter.

October 27, 2012 ______________________________

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