UNITED STATES

NUCLEAR WASTE TECHNICAL REVIEW BOARD

TRANSCRIPT

SPRING 2013 BOARD MEETING

Tuesday

April 16, 2013

Marriott Courtyard
480 Columbia Point Drive
Richland, WA 99353

NWTRB BOARD MEMBERS PRESENT

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Steven M. Becker, Ph.D.
Susan L. Brantley, Ph.D.
Sue B. Clark, Ph.D.
Efi Foufoula-Georgiou, Ph.D.
Gerald S. Frankel, Sc.D.
Linda K. Nozick, Ph.D.
K. L. (Lee) Peddicord, Ph.D.
Paul J. 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: So good morning, and welcome to the Nuclear Waste Technical Review Board meeting, our spring meeting. I'm Rod Ewing, Chair of the Board.

I have some introductory comments that I'll make in just a moment, but the first thing I should say is that the use of this bugle call is a tradition with the Board which I have been inclined to abandon. But what I see is it really works, so we're already ahead of schedule. So if you stay on schedule and show up on time, then you won't have to listen to the bugle. But if I see interest lagging, then we'll revert to this sound.

I'll introduce the other members of the Board in a moment, but I want to start by saying a few words about the Board, its charge, and what we hope to learn today.

First order of business is to thank the organizers of our tour of the Hanford site yesterday. The tour was excellent. We saw a lot of different facilities. In fact, I have taken the tour many times over previous decades and saw for the first time some of the facility. So we're, as a Board, very grateful for the time and effort that everyone took to organize that. And particularly I want to thank the speakers on the bus. They were very informative and frank, and it was a wonderful interactive experience.

A few words about the Board. The Board is an independent agency in the Executive Branch. We are not part of DOE or any other federal agency. The Board was created in the 1987 amendments to the Nuclear Waste Policy Act to perform ongoing evaluation of the technical and scientific validity of DOE activities related to implementing the Nuclear Waste Policy Act. These activities include transporting, packaging, and disposing of spent nuclear fuel and high-level radioactive waste. The Board reports its findings and conclusions, recommendations to Congress and to the Secretary of Energy. And I will call your attention to a one-page handout that you can get off the table outside, which summarizes the charge to the Board, and on the back there is a list of the Board members.

The second point is to discuss for just a moment what the Board hopes to learn from this visit to the Hanford site. Relevant to today's meeting is to emphasize that the Board's technical and scientific purview does not include the safety or operation of DOE-owned facilities. This is the responsibility of the Defense Nuclear Facility Safety Board. We also do not review DOE management or disposal of low-level radioactive waste. Our technical and scientific review of DOE activities at the Hanford facility is focused primarily on vitrified high-level waste, which will require disposal in a deep mine geologic repository, and any other waste stream that would be considered as high-level waste and, of course, spent nuclear fuel.

Appropriate issues for the Board include: What is the inventory and the state of the spent nuclear fuel and the high-level radioactive waste at Hanford? What is the technical impact of the delay in opening a geologic repository? And what are the volumes and compositions of the waste at Hanford that will require geologic disposal?

I also want to say a few words about the Board holding a meeting during the time of budgetary constraint. Of course, during our tour of the Hanford site we heard of people who weren't on the tour because of furloughs and so. Like all federal agencies, our budget is and was affected by sequestration, but the Board does have some flexibility to address the most important and timely issues. Thus, we allocate our resources to address those timely and critical issues. And, for the Board, the visit to the Hanford site is particularly important, because we need to understand the origin and form and the volumes of the high-level waste that will require geologic disposal, as well as the DOE-owned spent nuclear fuel.

The second reason that we pushed ahead with this meeting is, we wanted to provide the opportunity for members of the interested public to comment on the issues and to directly interact with Board members and representatives from

DOE and other federal agencies. We know, from more than 20 years of experience, that holding face-to-face meetings is the best and most efficient way to accomplish these objectives, and in a moment I'll discuss a new approach toward enhancing those interactions.

And then, finally, I should point out, the Board will follow up this meeting, as it does with all meetings, with letters to the relevant DOE offices, which convey our observations and recommendations; and these letters are posted on the Board's website.

Now let me introduce the members of the Board. As I mention their name, I'd ask them to simply raise their hand so that they can be identified. As I said earlier, my name is Rod Ewing, so I'll raise my hand; and I'm a professor at the University Michigan.

Steven Becker is a Professor of Community and Environmental Health in the College of Health Sciences at Old Dominion University in Norfolk, Virginia.

Susan Brantley is a Distinguished Professor of Geosciences in the College of Earth and Mineral Sciences at Pennsylvania State University, where she is also the Director of the Earth and Environmental Systems Institute, and she is a member of the National Academy of Sciences.

Sue Clark is Regents Distinguished Professor of Chemistry at Washington State University.

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

Efi Foufoula is the Distinguished McKnight University Professor of Civil Engineering and Director of the National Center for Earth Surface Dynamics at the University of Minnesota.

Linda Nozick is a Professor in the School of Civil and Environmental Engineering and Director of the College Program in Systems Engineering at Cornell University.

Lee Peddicord has served as Director of the Nuclear Power Institute at Texas A&M University since 2007, and he is Professor of Nuclear Engineering at Texas A&M.

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

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

One of our members, Jean Bahr, is attending a workshop on behalf of the Board that, unfortunately, conflicts with today’s meeting. Jean is a Professor of Geosciences at the University of Wisconsin-Madison. She is also a member of the Geological Engineering Program and is faculty affiliate to the Nelson Institute for Environmental Studies. Jean will join the Board tomorrow for our business meeting.

All of the Board members serve part-time, but we have a full-time staff that provide tremendous intellectual support as well as continuity in our efforts. The technical staff are seated at the table against the wall.

I should mention that the procedure for how we conduct the meetings is: Questions will be taken at the end of the talks, first questions from members of the Board and then members of the staff. We'd ask the public to hold their questions till the end of the day where we we'll have a public comment meeting and have those interactions.

Now let me briefly review the day's agenda. We'll first be welcomed by a representative from the Office of River Protection. Then we'll hear a presentation from DOE's Office of Environmental Management about approaches taken across the complex to manage DOE-owned waste, including issues associated with the type and amounts of waste streams, the disposition strategy for each, and how the management of these wastes has been affected by the delay in the geologic repository.

Next we'll learn about vitrification as a complex-wide management practice for the disposition of high-level radioactive waste. A glass waste form has been selected for disposing of high-level radioactive waste; thus, vitrification is the focus of the morning session.

We will have two panels. The first will present the technical experiences with waste vitrification from perspectives in France and various laboratories in the U.S., including Hanford, West Valley, and Savannah River. And then the second panel is composed of experts from Savannah River, Catholic University, and Pacific Northwest National Laboratory, who will discuss DOE's waste form technology development program, including new waste forms, synthesis of waste forms, and the long-term durability of those waste forms.

After lunch a panel composed of representatives of tribal, state, and public organizations will present their views on the most important technical issues associated with the disposal of high-level waste and spent nuclear fuel stored at the Hanford site. We understand how important these issues are, in particular for those of you who live in this region. And so we look forward to hearing your views and the discussion that follows the panel.

The panel discussion will be followed by a non-Hanford-related update on the analyses being performed by DOE's Office of Nuclear Energy on the potential for the direct disposal of the very large dry storage containers currently in service at nuclear power plants.

The last presentation of the day will be on DOE’s recently-issued strategy for the management and disposal of used nuclear fuel and high-level radioactive waste. This strategy is the administration’s response to the final recommendations of the Blue Ribbon Commission on America’s Nuclear Future, and it includes DOE plans for moving forward on the disposal of high-level radioactive waste and spent nuclear fuel; hence, very relevant to issues at Hanford. We are extremely pleased that Dr. Pete Lyons, the Assistant Secretary for Nuclear Energy will join us today to make that presentation.

As mentioned earlier, hearing the views of the interested public is a very important part of these meetings, so we have scheduled time for public comment at the end of the day. We welcome your comments, particularly those related to the Board’s scientific and technical mandate. Please enter your name on the sign-up sheet at the table near the entrance to the room. If you prefer, written remarks or comments can be submitted, and they will be made part of the meeting record. Oral comments will appear in the transcripts of the meeting. All transcripts and other meeting materials, including submitted written comments or statements, are posted on the Board’s website.

Immediately following the meeting there will be a special event that I hope you will find useful and informative. We have arranged for a small poster session on vitrification and other technical topics that will provide you an opportunity to meet and talk to some of the scientists and engineers who work on these important issues. The posters will be just outside of the meeting room. Please let us know whether you think this first-of-a-kind, for the Board, event is useful.

Finally, I need to say that during the meeting Board members freely express their own personal views and opinions, or you might infer their views from the types of questions they ask. We certainly encourage this, but we also want you to know that the comments of individual Board members during the meeting are not the official--not to be taken as official Board statements. The Board's positions are found in our reports and letters to Congress and the Secretary of Energy.

Finally, at the end of this long introduction, a few housekeeping details. Please turn off your cell phones. When you speak, please identify yourself and your affiliation so that we have it for the record; and please speak into the microphone so that we can have a complete transcript of the meeting.

So, because of my long-windedness, we are now behind schedule.

So it's my pleasure to begin the meeting and turn the podium over to Stacy Charboneau, who will welcome us on behalf of the Office of River Protection.

CHARBONEAU: Good morning. I'm Stacy Charboneau, the Deputy Manager for the Office of River Protection. And on behalf of the Office of River Protection and the Richland Operations Office, the two EM offices responsible for the cleanup at the Hanford site, we are honored and welcome you back to the Washington State and the Hanford site.

It's a beautiful day out there, and it's a beautiful river out there; and it just underscores the mission that we have here to clean up the Hanford site. I hope you enjoyed your long day yesterday, the tour of the Hanford site, and you even got to experience some of our historically famous termination winds, I think. Back in the early days of the Hanford site when the construction forces were in full force, when strong winds like that would kick up and kick dust across the Hanford site, many folks would leave; so they've been termed the termination winds here at Hanford.

As a part of the tour that you had yesterday, I hope you had an opportunity to really see and underscore the progress we've made with regard to the cleanup at the Hanford site. Certainly that's more evident than ever along the river corridor where hundreds of facilities, many nuclear facilities, have been demolished and removed from the river corridor. Additionally, hundreds of waste sites have been cleaned up, soil contamination moved up to the central plateau and disposed of in an environmental restoration disposal facility.

You saw an opportunity to see the Waste Treatment Plant and the progress made there with over 60 percent construction complete with excellent progress being made on the low activity waste facility, the analytical lab, and the balance of facilities there while we continue to resolve technical issues specific to high-level waste and pretreatment.

Maybe not as evidence yesterday was the progress that’s being made on tank retrievals, given that the large underground tanks are underground; but certainly progress is being made there with over ten tanks emptied in the C farm area. Three were underway retrieval today. And so as we prepare the feed for the Waste Treatment Plant, we continue retrievals out of our single-shell tanks. And most recently you’ve probably heard some about the leaking tanks at Hanford. Historically, we have identified 67 tanks of our single-shell tanks to be assumed leakers. And just last fall we identified one of our double-shell tank inner shells was leaking into the annulus of that double-shell tank.

So this certainly underscores the urgency of the cleanup mission we have here at Hanford, and we welcome your insight into our path forward and the progress on our path forward in retrieving this waste, vitrifying this waste for permanent disposal.

We are fortunate to have Albert Kruger on the staff at the Office of River Protection, and you will hear from him later today specific to glass formulation and the waste forms that we are looking at for the final treatment and disposition of the waste for the 177 underground tanks and the 56 million gallons of tank waste we have here at Hanford. And we hope that you'll hear from many other research and scientists today that also will have contributed to our mission here at Hanford and are helping us along that mission in resolving some of our technical issues in that waste form and disposition of that waste.

So, again, welcome to Hanford, welcome to Washington State, and we hope that you have a very enjoyable and fruitful meeting here today. Thanks.

EWING: All right. Thanks very much.

And so we'll continue with the program. The next speaker is Ken Picha, and the topic will be The Complex Wide Overview of the Department of Energy Office of Environmental Management Program.

PICHA: Good morning, everybody. Dave sends his apologies for not being able to be here, so you get the

B team here.

The last time I was in the Hanford area doing a public meeting, it was on basically discussing the Department's alternatives for dispositioning scrap metals that were either in a--had been in a radiological area or had been potentially contaminated. And I'll tell you, I much prefer this topic. I think, although there is not unanimity on all the details for how we proceed with tank wastes and disposition of some of our materials, I think we can all agree that getting waste out of the aging tanks, some of which had exceeded their design life, and solidify into a solid stable form is a good thing.

So this is just a topic that we're going to talk about. The NWTRB had provided some information about some of the topics that they wanted us to talk about. We're actually going to talk about some of the radioactive waste derived from tanks wastes, talk about our interactions with the Office of Nuclear Energy, and Dr. Lyons will be here--if he's not here already--to talk about some of the nuclear energy activities--and we have some role in working with them to support what they are doing in terms of implementing some of the BRC recommendations--and then talk a little bit about the impact of a delay in opening a geologic repository.

So, first, a little bit of discussion about the EM program. EM started in 1989. We had over a hundred sites that we worked on. As you can see now, we've actually done quite a bit of cleanup. We're down to about 16, 17 sites. Of course, the hard ones are the ones still to go: Hanford, Savannah River, Idaho, Oak Ridge, some of our larger sites. And this, by the way, is a slide that was in Dave Huizenga's budget roll-out presentation.

We have immobilized over 5,000,000 gallons of radioactive liquid waste. That includes a little over 600,000 to 700,000 gallons in a couple tanks at the West Valley Demonstration Project, and then also the bulk of it represents the waste we've solidified at Savannah River at the Defense Waste Processing Facility. And then we've basically taken all the plutonium that we were responsible for managing in the complex, and it's in safe storage at the Savannah River site.

This is a slide that basically describes where we are in our tank waste program. As you can see, the large sites are Savannah River and Hanford. As Stacy said, we've got a number of tanks at the Hanford site, 177 tanks; 149 of those are single-shell tanks and 28 are double-shell tanks. There's about 175 million curies of waste stored in those tanks and then about 50--it varies when we do this--55, 56 million gallons. And we're projecting to have about 9,700 canisters. Of course, that number is subject to variability, and the work that Albert is doing with some of you-all in the audience here will help see if we can reduce those numbers.

At Idaho there were 15 tanks and the--I don't know whether it was prudence or luck, but they decided to stay on the acidic side at Idaho, and so they ended up with a little bit of an easier mission to clean up their tanks. So they've actually closed 11 of their 15 tanks. They have about 900,000 gallons remaining of liquid waste that they will be targeting to treat perhaps early next year--starting to treat early next year into a sodium bearing waste form using a steam reforming process. And then the calcine, which is where most of the high-level waste volume is, is in a number of bin sets; and the preferred technology for solidifying the calcine or treating it for final waste form is a hot isostatic pressing process.

At Savannah River we had 51 large tanks. Four have been closed, two are essentially clean, and we're hoping that we can start closure activities later this year. There's about 37 million gallons of tank waste there. And there is where we actually have an operating vitrification plant. It started up in 1996. We have about 3,600 canisters to date. The melter that they have there just finished ten years, and I think they have a lid heater that has failed, but they're still able to get good throughput. And so we'll see how long that melter lasts.

And then the last site is the West Valley

Demonstration Project. There the vitrification campaign, as I said, only had about 600,000 or 700,000 gallons to process. Most of the volume there was treated through a pretreatment process and solidified as a cement into what they call drums--they were actually square drums--stored on site and eventually disposed of in Nevada. So they only ended up with about 275 canisters, which are on site in the old chemical process building where they actually did reprocessing. And they're planning a storage pad to store those 275 canisters until there is a final disposition place for those.

So this is basically our tank waste management strategy in a nutshell. Obviously safe storage is a priority. As Stacy indicated, we do have some tanks that indicate at Hanford a decreasing loss of levels that they're looking at and exploring fairly carefully to understand what's going on in those tanks. The next step is retrieve the waste from the tanks to prepare for some kind of treatment process. And at Hanford, Savannah River, and West Valley we basically are going to separate the waste into a low-activity fraction, which is most of the volume--it's over 90 percent of the volume--but varying per site anywhere from, let's say, two, three percent radioactivity of the curies to as much as five percent.

And then at those sites also we are going to be treating the high-level waste through vitrification. And at

Hanford here we also have the low-activity waste vitrification facility, which will be treating a good portion of the low-activity waste generated.

And at Idaho we'll retrieve and dispose calcine. It says "directly" there. That's an old slide. I apologize. That's not the case now. That's not the baseline. The baseline is to HIP it for a final disposition. And then, finally, to stabilize tank waste residues for in-place closure at our four sites.

So this is just a slide that shows the DWPF, the Defense Waste Processing Facility, at Savannah River and the Integrated Waste Treatment Unit at Idaho. As the slide shows there, we completed construction in 2012. During start-up testing there was an issue with the off-gas system that has caused us to go back and look at some of the design of some of the components and do some redesign. And it's delayed--our start-up--probably until sometime in about 2014.

The Department's radioactive waste management activities are governed by a number of regulations and laws. I'll point to the one in the upper left under our Atomic Energy authority. We have a DOE order that implements that for managing our radioactive waste, and the Department actually has three radioactive waste categories: low-level waste, transuranic waste, and high-level waste. Now, we'll talk a little bit later about low-activity waste, which is basically the separated portion of the tank waste that’s relatively low in radioactivity and high in volume, but it’s not a formal radioactive waste classification.

So this is basically just a slide that shows some of the different--and I picked Hanford for several reasons. One is, we’re here obviously; and, two, it probably has all the potential disposition pathways that we are looking at for our tank waste program. And it’s just meant to show a pictorial representation of the different pathways of the waste. You can see in the left-hand side--

(Pause.)

So the Department in, I believe, the ‘70s and ‘80s ran a process to extract much of the cesium and strontium from the tank waste, and that’s in about 2,000 capsules that are stored in a waste encapsulation storage facility here on the Hanford site. But the bulk of the tank waste, the 56 million gallons, will go through a pretreatment process down here and be separated into a high-activity and a low-activity fraction, of which the bulk of the volume--as I said before, the low-activity waste will be converted to a solid form and disposed of as low-level waste into an integrated disposal facility here on the Hanford site. The high-level waste component will be treated via the high-level waste facility--vitrification facility--and that represents the bulk of the radionuclides and 5, 10 percent of the volume for ultimate disposition in some kind of a repository.

And then last month the Department, through a NEPA action, announced a preferred alternative to look at some waste that's in 20 tanks and which was associated with things like the PFP finishing process, that we believe we have--for some of those tanks that we have a good process knowledge that we can determine the wastes are transuranic waste and go through all the permitting processes, make a determination that it's transuranic waste, retrieve that waste, package it, and send to WIPP. And, in fact, just recently the Department issued a Department request to the State of New Mexico to start down that path. So I think those are the main disposition pathways for our tank wastes.

With respect to spent nuclear fuel, we primarily manage those at the same sites as we do our tank waste, with the exception of West Valley. The bulk of our spent nuclear fuel that we manage here at Hanford, most of that's in MCOs in the canister storage building out on the site. And you may or may not have seen that on your tour. I'm not sure. Okay. We have some spent nuclear fuel at our Idaho site, defense and non-defense. We actually have title to some waste from the gas-cooled commercial reactor at Fort St. Vain near the Fort St. Vrain site in Colorado. And then the rest of our spent nuclear fuel is at Savannah River. And a lot of that is domestic research reactor and foreign research reactor fuel that we’ve retrieved as part of our Global Threat Reduction Initiative and actions associated with that.

The Department, through the Office of Science, operates the high flux intensity reactor at its Oak Ridge site, and the cores from that are being stored at the Savannah River site. We don’t show that on here, but that’s part of our fuel that we manage and store it at Savannah River.

EM is partners with the Office of Nuclear Energy. Our main efforts have been to support them in looking at different proposals for a repository. One of those that we have some experience with through our operation of the waste isolation pilot plant in New Mexico is certainly looking at the viability of salt repositories. In 2012 NE and EM jointly sponsored a workshop to look at a salt research and development study plan. We have supported that activity, including a potential underground research laboratory in the WIPP area here, as show on this slide. We followed that up with a workshop in March of this year with a focus of identifying additional R&D activities and with an attempt to try to get to an integrated path forward later this month.

Now, we are doing this in support of NE as they look at--our work primarily in that arena has to do with technical validation of data, analyses, and we are doing this in accordance with a deliberate process as NE is implementing some of the recommendations from the Blue Ribbon Commission to look at consensus-based approaches for selection of a repository. And we have continued to meet regularly to coordinate our activities.

One of the things that WIPP has done is we started with contact-handled transuranic waste. There wasn't much heat generation. I want to say about five years ago we started placing and disposing remote-handled waste that certainly has some capability of heat generation. One of the things we're looking to try to do this year or start--I'm sorry, next year--is start some heater tests at WIPP that could be used to look at how the salt formations behave under more intensive heat sources. So that's something that we'll be doing and certainly working in conjunction with Office of Nuclear Energy.

One of the things we do each year or have done each year is, the Department prepares an environmental liability report. With a $6 billion program, give or take, this is going to go out for a number of years. We have fairly significant liability for the Department, so one of the things we did is we wanted to look at, well, what is the liability associated with potentially a 20-year delay in opening up some kind of a repository? I can remember several years ago when we were thinking--it must have been several years ago--2012 was a date that we were looking at. And then it got progressively pushed off, and now we don’t necessarily have an identified place to put this or a specific time. So we did just look at sort of a case of what would happen if we delayed a place for putting our high-level waste and spent nuclear fuel for 20 years. And the results were about a $1.1 billion liability, which basically continues our safe storage of treated high-level wastes at our four sites and spent nuclear fuel as well.

Certainly in terms of how we would store those materials, there is not a significant difference. The big, I guess, cost-intensive aspect of that is we might need more storage facilities than we originally planned. Right now we have two storage facilities for our canisters at Savannah River, and we’re looking at potentially starting to close on completing and filling the second one sometime in the next five years. So we’re already thinking, okay, what do we need to do to plan for additional facilities for the high-level waste?

So, our impact of repository delays on agreements, most of our agreements with states and other regulatory bodies are basically having to do with tanks. There are cease-use requirements. There are tank waste retrieval milestones. Both, as Stacy indicated, were well underway to meeting our C tank farm retrieval milestones. Savannah River has similar milestones, both for bulk waste removal from specific numbers of tanks as well as tank closures. We also, in the form of site treatment plans, have regulatory agreements to retrieve the waste and treat it to some kind of a waste form. And then at Idaho, under an agreement with a former governor, we actually have a date to have our high-level tank waste road-ready.

We continue to review the impacts of delays in the repository program with our regulators. They have been very understanding in terms of that. But the biggest risk reduction is to get the waste out of the tanks and treated.

And that's about all I have.

EWING: Okay, thank you very much.

And so now questions from the Board? Sue?

CLARK: Sue Clark, Board. I was wondering if you could go back to Slide 10.

PICHA: Okay.

CLARK: And I'm curious, first of all, if you've got a typo about Savannah River--oh, one too far. Should that be 30 metric tons heavy metal? Because on all of the other ones the defense and the non-defense add up to--

PICHA: Yeah, yup, thank you.

CLARK: So that should be 30 tons. But then you also went on to say something about fuel from Oak Ridge that's not included in that number; right?

PICHA: It is included in that number. I'm sorry.

CLARK: Oh, it is included.

PICHA: Yes, yes.

CLARK: Okay. And so--

PICHA: It’s not--I just didn’t break it out separately and show Oak Ridge on the (inaudible).

CLARK: And that fuel is now included, is that in the defense part or the non-defense?

PICHA: Non-defense.

CLARK: Okay, great. Thank you.

EWING: Other questions? Paul

TURINSKY: Paul Turinsky, Board. Could you give me some insight when you’re allocating resources?

EWING: Paul, speak close to your microphone.

TURINSKY: Could you give me some insight when you’re doing resource allocation, budget allocation? What sort of factors come in to deciding if we should be putting this resource of this site to this resource at this site? Obviously you--I think it’s pretty obvious, you never have enough resources to do everything you want to do. So what sort of issues do you consider in doing that?

PICHA: Sure. Well, tank waste in nuclear materials is the highest priority for the EM program, so that’s sort of an overlying principle. And then we look at what we’ve historically allocated to the various sites in terms of, okay, what’s our nominal baseline? I don’t want to use the word baseline, but what have we typically been funded? And then we also look at what's going on at the specific sites in terms of what might be driving the need. For instance, at the Savannah River site the real workhorse for their pretreatment will be something called the Salt Waste Processing Facility, and I didn't show a picture of that. Construction is about 60 percent--seems to be a common number--and we were hoping to have that on line about mid-2014 with a late finish of 2015.

Well, turns out now that's not feasible. Various things led to construction delays, and so we're looking now at what is an optimum time frame to bring that facility on line and start operations for the site, given that we don't really want to have a--either produced sludge-only canisters in the high-level waste program or salt-only. We're trying to--we'd like to do that with the balance. And they do have a prototype version of that technology that's currently operating on the site, and they have some--they're looking at, actually, capabilities to ramp that facility up and that will maybe mitigate some of the impacts.

But the fact is, we hadn't budgeted for construction dollars in either FY13, FY14, FY15; so we had to do some accounting in that regard and say, okay, how are we going to provide funds for construction on that facility, do all our baseline activities in terms of safely managing tank waste there at Savannah River or operate DWPF. And at Hanford here, given some of the recent things that Stacy talked about with the potential leaking from six tanks, resolving the technical issues, and proceeding with a different approach to addressing some of the more thorny technical issues having to do with the pulse jet mixed vessels that we are going to a large--I'm sorry--a full-scale test and using some of the actual vessels, that's probably going to be a bit more than we planned. So it's really a consideration of all those aspects together.

I'm not sure I answered your question specifically, but--

TURINSKY: How does public health risk enter decision making?

PICHA: Well, certainly the leaks from the tanks is something that is a consideration. So the folks here are looking at some different alternatives, and we wanted to see if we could--for instance, you'll see that in the '14 budget the tank farms actually got a little bit of a boost up so that we could consider that as part of our--in our overall thinking.

TURINSKY: Okay, thank you.

EWING: Okay. Mary Lou.

ZOBACK: That was a really nice summary. Thank you. And a couple of points just for clarification and one for my own enlightenment. On Slide 8 where you summarize the gallons--tank inventory and then the curies--

PICHA: I’m not sure I actually went over that slide, did I?

ZOBACK: I think you skipped over it, but your tests show the same material. Why are the curies so much larger at Savannah River than at Hanford even though the volume is less?

PICHA: It’s because they pulled out the cesium and strontium into the capsules.

ZOBACK: Okay. So that--

PICHA: If you consider them together, it’s more comparable.

ZOBACK: Okay, good. So that was a good thing to do.

The other question I have is on the liability. You said the 20-year delay would result in a $1.1 billion liability. That seemed low. Is that $1.1 billion a year or $1.1 billion over 20 years?

PICHA: No, it was--I don’t have the details with me, and I can get the details, but it was over that 20-year period.

ZOBACK: Over the 20-year. Okay, thanks.

EWING: Okay. Jerry, did you have a question?

FRANKEL: Jerry Frankel. So you spoke about the tank issues. And, of course, it impacts us through the pressure that it puts onto a final repository. Given everything and what we've heard previously, I'm just wondering what the level of confidence is that exists now in the Department of Energy in the ability of the tanks to contain the waste for some decades now that they're needed.

PICHA: Well, certainly this has raised questions. Last month Stacy came to Washington. We actually had some discussions with some congressional folks and some other folks. And I think they have a very robust program to look at and do some health, if you will, of the system and the various tanks to understand how viable the tanks are. We are trying to get out of the single-shell tanks and retrieve waste into the double-shell tanks. We are looking at some alternatives that may be able to speed treatment up of some of the tank waste that might open up some additional storage capacity in the double-shell tanks. But it's certainly an area of focus. We have a single-shell integrity program; there's a double-shell tank integrity program. And I can tell you that Stacy and her folks are more vigilant.

EWING: Okay. Efi.

FOUFOULA: Efi Foufoula, University of Minnesota. Will you go to Slide 13?

PICHA: Okay.

FOUFOULA: You (inaudible) point out that continued development--improved techniques for reducing costs and schedule of treatment is an important element and is a very important element, it seems to me, in the next five to ten years. Can you give an insight on how much research and development investment (inaudible) on that specific component to reduce costs and schedules treatment?

PICHA: Sure. It turns out that the Office of Environmental Management doesn’t have much of a technology development budget. We’ve been trying to push for that and haven’t been real successful, but some of the sites are doing their own technology development activities.

For instance, we’ve looked at an improved solvent that will go into the prototypical salt treatment facility at Savannah River site. We also are looking at an at-tank pretreatment or in-tank pretreatment facility--or capability--I don’t want to call it a facility--capability that could provide some additional pretreatment capability at Savannah River and provide an earlier pretreatment capability here at Hanford.

I think you’ll hear from Albert Kruger later today that they’re doing some glass formulation studies that may look at reducing both the number of high-level waste containers as well as low-activity waste containers through understanding the glass composition and the waste characteristics.

So it’s a number of different things that we’re doing.

EWING: Yes, Lee.

PEDDICORD: On your Slide 3--

EWING: Please identify yourself for the record here.

PEDDICORD: I'm sorry. Lee Peddicord, Board. The hearing focused primarily on the Hanford, Idaho, Savannah River, and West Valley sites. Is it correct that, of the other 13 sites on your map on the right, none of these will be generating any high-level waste?

PICHA: I believe that's true. New York, the West Valley site, already has high-level waste. Idaho, Savannah River, and Hanford, that's correct.

PEDDICORD: So none of the other will?

PICHA: Correct.

PEDDICORD: Okay, thank you.

EWING: I have a few questions from the Chair, if I may.

PICHA: I mean, unless you're talking about high-level waste including spent nuclear fuel, then we still have (inaudible) cores coming to Savannah River.

PEDDICORD: Thank you.

EWING: Rod Ewing, Board. On Slide 9, what is the disposition or the future path for the strontium and cesium capsules? It looks like it goes back into the high-level waste; is that--

PICHA: Well, I was just trying to show that they were pulled out and separated.

EWING: Right.

PICHA: They were analyzed in the recently-approved released Tank Closure and Waste Management EIS here at Hanford, and I should know what we selected as the preferred alternative for disposition for that. I don’t know off the top of my head, but I will get that information. I’m sure folks here in the audience are aware of it now.

EWING: All right. I’d be very interested to know it, because I think there has at least been discussion of mixing it back into the high-level waste.

PICHA: Yes, yes, there’s been discussion of that. There’s been discussion of straight disposal at other places. Part of it’s a waste classification issue as well. So--

EWING: All right. And then a second question. So as the country moves forward with a strategy for a geologic repository, probably we can now consider a variety of different types of geologies. And it’s clear the waste form will be glass. Are there any research programs that ask the question: What type of geology, what type of geochemical environment, would enhance the performance of the glass?

PICHA: None that I am aware of, but I haven’t been that engaged in that part of it, so I can’t answer that question. It’s probably better left to the folks that will be speaking later today.

EWING: Right. Okay. Thank you.

Okay, Steve.

BECKER: Steven Becker, Board. In light of the events in Japan in 2011, both the nuclear industry and many agencies have been taking another look at seismic issues, and I'm just wondering how that has affected your work.

PICHA: Good question. After the Fukushima accident, our office--the Department's Office of Health, Safety and Security initiated an action to look at beyond design basis accidents across the DOE complex. And we looked at that for all of our facilities. And it turns out that the facility that probably poses amongst the highest risks is the waste encapsulation storage facility here at Hanford. They're being stored in liquid right now and water. So they're looking at different approaches. I'm not specifically involved in that program, but from previous involvement I understand they're looking at different approaches to mitigate those kinds of considerations.

But it turned out that we weren't that badly positioned in terms for design basis activities and even in the beyond design basis. That was the main facility of concern. There was one other that's escaping me, but there was a rigorous process to try to understand the impact, so I can't say that. And those results are probably on the HSS website. I can't say that for sure, but--

EWING: All right, let me turn to the Board.

Dan. To the staff. Sorry.

METLAY: Dan Metlay, Board staff. Thank you again for your presentation. It was most illuminating. Let me apologize at the front if I missed this in your presentation.

In the President's budget for FY 14, I think, is there funds for the salt heater tests included in that budget?

PICHA: We're trying to have flexibility to initiate those tests. I'll just put it that way. We're looking at some flexibility to do those tests.

EWING: Nigel.

MOTE: Nigel Mote, staff. Again, thanks, Ken, for the presentation.

I'd like to come back to a clarification on the point that Mary Lou Zoback asked. Could you tell us what the environmental liability means in the environmental liability report? Last week in Dr. Lyons' testimony before the Energy and Water Development Subcommittee of the Senate Appropriations Committee--I'm sorry, the House, I beg your pardon--he said that the annual cost of the liability payments to utilities for extended storage on the utilities sites would be approximately half a billion dollars a year, so in 20 years that would be $10 billion. And that only accounts for spent fuel.

Now, on the DOE sites, I think I've heard that there is a potential for expanding the storage capacity at Savannah River site for the vitrified waste because of the inability to remove it from the site, so presumably there's another liability there.

PICHA: Correct.

MOTE: So is this liability that you have here, $1.1 billion, not the same issue as the total cost? For example, the judgment fund is the source of funds for the liability payments to utilities, and is that why this is lower--

PICHA: That's not included. It's not. This is EM-managed materials only.

MOTE: Oh, it's only EM. Okay.

PICHA: Correct. I'm sorry.

MOTE: Okay.

PICHA: Yeah. So every year the Department does an environmental liability audit to look at basically the EM program and what the costs are for completion of the EM program. So that's--I should have caveated that.

MOTE: Okay, all right, thanks.

EWING: Other questions from staff or Board?

BRANTLEY: Sue Brantley, Board. You gave a really nice overview of the number of tanks, like a snapshot, and then how many have been closed, etc. Any plans on the part of DOE to make new tanks? What would make you make new tanks? Can you just talk about, you know, the other side of the equation?

PICHA: Sure. At Savannah River we certainly are not planning to have new tanks, because, as you can see, we’re trying to close tanks; and we’ve got some success in terms of closing four and hopefully another two this year. At Idaho, same thing, we’ve closed eleven tanks, and we’re hoping to continue to close the rest. At West Valley, basically, there we have not closed any tanks; in fact, the decision on how to proceed with, I’ll say, the disposition of the residues in the tanks has been a bit deferred. What they have done there is they have installed a tank drying system, and they keep the relative humidity below some level to control liquids in the tank. And they have an issue with intrusion into their vaults that--in which the tanks are housed.

At Hanford that is a question that’s come up, particularly in light of the six tanks that have indicated loss of levels. The site here and us at the headquarters have been looking at different approaches for how we might be able to come up with, I’ll say, an approach to help to mitigate that as well as be incorporated into a system-wide approach for tank waste treatment in terms of things like blending wastes and characterizing waste, sampling waste. So we’re looking at a few different options in that regard.

EWING: All right. To keep us on schedule, I think we'll call an end to questions, but I want to thank you for a very clear and useful presentation.

PICHA: Thank you.

EWING: So the next presentation is by Carol Jantzen from Savannah River National Laboratory, and Carol will give us an overview of Vitrification as a Complex-Wide Management Practice.

JANTZEN: Well, good morning. My name is Carol Jantzen. I've been at the Savannah River site since 1982, and I was there for the groundbreaking for the Defense Waste Processing Facility, so I've been there a long time and have a long history in vitrification. And, of course, Rod knows me from my previous days when I was doing ceramic waste forms.

I was asked to talk about vitrification as a complex-wide management practice for high-level waste. And, specifically, I was sent an e-mail, and I paraphrased these bullets out of the e-mail that I was sent by Bruce as to what I should be speaking about. I put in the timeline of how high-level waste glass and glass-ceramics were developed. There was a famous down-select between glass and ceramics in Atlanta. I've got one slide on that, because people like Rod and Werner and I lived through this.

And then I was asked to speak about what types of glass will be produced and how much of each type and how many waste canisters, how are the strategies different at the different EM sites, how are they similar or how are they different. Now, these last two bullets could be a talk all unto themselves, so I had to kind of shoehorn that in at the end of my talk.

And this talk runs long. I’ve got some introductory slides for people who might not be as knowledgeable about the history behind everything, how we got here to where we are today. So I’m going to try and go quickly through the introductory slides and make it all the way to the end so that we can talk about what are the technical and performance standards for glass as a waste form and what kind of tests do we use for the determination of the long-term performance of glass with respect to disposal in different geologic environments.

My slide is older than Ken’s, so my numbers don’t agree with his exactly, but the concept is still there in terms of gallons and curies. I think Ken had 37 million gallons at Savannah River; my slide says 32. And I think he had 55 million gallons at Hanford, and mine says only 50. And it’s not that it’s varying; it’s just that people’s estimates (inaudible) at what’s out there go up and down over the years.

I think we all know that things like what are colored in yellow are the elements found in waste. So if you’re going to make a glass out of this stuff, it’s not really simple, because you've got two-third of the periodic table to deal with. On top of it being two-thirds of the periodic table in the waste itself, we add additional elements like lithium and boron to help flux the glass and make it pourable, meltable at reasonable temperatures like 1150 so that you're not volatilizing too many of the--or the radionuclides are not volatilizing some of them at all. And then what I've done is I've circled the ones that are long-lived radionuclides, the ones that kind of get to be important when you're doing a performance assessment. You know, if they come out of the glass at any significant rate, they are the ones that are going to drive your long-term performance assessment.

I know there are several geochemists on the Board, and I have a background in geochemistry. And so I wanted to highlight the fact that our glass, especially the high-ion glass and the high-aluminum glasses, which the high-ion comes from the PUREX process and the high-aluminum wastes come from another process, if you take the boron out of it and renormalize it, it's very, very similar to a tholeiitic or an ijolitic basalt in terms of its aluminum content and in terms of its iron content. And that makes it somewhat easier when you are looking at the crystallization. I think you're going to hear some talks this afternoon about the crystallization of the high-level wastes. It simplifies down to looking at either Nolan or Bailey and Schairer's basalt tetrahedron, iron, silica, aluminum, and alkali or alkaline earth. You're going to hear some about the crystallization of spinels and the crystallization in nepheline probably in this afternoon's talks. And that crystallization is actually driven by this ternary inside the quadrilateral, and this ternary over in here, you can actually define a pseudobinary across the fields of nepheline and spinel in there. And, as I said, it all comes out of the older literature around 1966 for basalt magmas.

The other thing you're going to hear about, you're going to hear about things like--you know, we've got sodium nitrate in the waste at Savannah River. We add formic acid, and we bring some of the salts down, the sodium down, as a sodium formate, sodium oxalate, things like that. But what happens when it goes into the melt obviously is that these anions come off the formates, and the oxalates come off as CO2; the nitrates decompose, come off as NOx. And so what you get out the other end is just glass on an oxide basis just like you would have for any geochemical or basalt or rock that you analyze, so everything that comes out is oxides. But you are going to hear some very, very complex chemistry that goes on when you add these additions.

And I'm going to kind of go through this quickly, but basically what this is is this is a timeline, this is increasing melt temperature. The phosphate glasses tend to melt at lower temperatures. The borosilicates are kind of in mid-range, about 1100. The nepheline syenites, which the Canadians were interested in, melted even higher; and the Canadians and the Germans were also interested in looking at glass-ceramics. And so the solid arrows indicate what country was looking at these waste forms at what particular times. I think everyone has now gone to borosilicate glass except maybe Russia, who is still making aluminophosphate-type glasses.

In the U.S. the borosilicate research actually started at MIT back in the very, very late 1950s, a professor by the name of Goldman. They were taking ceramic glazes and trying to put nuclear waste into it. The glazes melted at very high temperatures, so they put boron in to flux these glazes, and thus we came up with borosilicate glass. A gentleman who worked for Professor Goldman actually is one of my neighbors in South Carolina.

The first borosilicate glass that was actually poured was over in the U.K. in 1962. I've got a solid arrow here, because the research and development was in the U.S. That research and development then went over to the U.K. and to Europe. We weren't doing very much here in this country. And then it got picked up again in both the U.S. and in Europe. In 1975 the Savannah River site decided to look at borosilicate glass. This is the down-select, also known as the Great Atlanta Shootout or the Hench Panel, that occurred. I've got some details on the next slide.

Our DWPF groundbreaking after that down-select was in 1982 or 3. I can't read it from here. We went through cold runs in 1994. We did non-radioactive runs in the melter. We then went radioactive in 1996, and our second melter was in 2003. And, as Ken said, we just passed our tenth anniversary on our second melter.

The DOE Hench Panel, it was a three-year study comparing simulated high-level waste glasses and ceramics. These are all the different types of waste forms that were looked at. So basically we were looking either at glass down here or at durable crystals up here. There is now a tendency to look at things in between here at glass-ceramics to get more waste into the glass. They did product scores, and they did process scores. They were looking for something that was continuous or semi-continuous, so glass got a very high score for that. Whereas, you can see that SYNROC and some of the tailored ceramics got higher product scores; they were more durable-type waste forms. So, in the end, when they put them together, borosilicate glass was chosen. It was recommended for Savannah River and West Valley, and it was recommended that ceramics continue to be studied.

In 20/20 hindsight, I think we've learned a lot about why glass is actually more similar to ceramics than we thought at the time at which this decision was made. There's been a good deal of x-ray absorption fine structure work done on the structure of glass. Everybody always thought that glasses were completely random structures. What they found is that they've actually got polymerized regions, these PR things that I've labeled here, and they've got depolymerized regions. And so your cations like aluminum and silicon help the polymerization and some of your other modifiers break up the network. This work was done in 1985.

So they found this short-range ordering and medium-range ordering in alkali borosilicate glasses. They don't have the long-range ordering that ceramics have, but they do have very good bonding characteristics. They have also found that things like uranium sometimes tend to cluster in groups, not necessarily totally depolymerize, but more depolymerized than the PR regions. They have also found that molybdenum, which is of interest to the people in France, also forms in these depolymerized regions, and so does sodium sulfate, which is one of the reasons that sodium sulfate doesn't like to be soluble in borosilicate glass, because it goes into these depolymerized regions and can easily come out as a secondary crystalline phase.

So we've learned a lot from actually looking at the structure of glass about what makes it durable, what doesn't make it durable, what makes it precipitate out something like sodium sulfate or sodium chloride.

I was asked to talk about how much there is what kinds of glasses. Right now everyone is making borosilicate glass and/or intending to make borosilicate glass. At Savannah River we've produced 6,350 metric tons of glass between 1996 and March 2013. We've made 3,603 canisters. We have that many more to go. West Valley had their 275. They made about 500 metric tons between 1996 and 2002. And the Hanford waste, if I've used the right projection here, which I think I have, it's about 32,000 metric tons that will be projected to be made and over 10,000 canisters. And the document that I read said that the cesium/strontium capsules would somehow be incorporated in those as an additional 120 canisters. And I wasn't clear whether that meant if it was being put back in or whether it was a separate disposition path. So that's just kind of a placeholder for it in that table.

At Savannah River we've had 17 years of continuous radioactive operation at the DWPF. I told you we did two years--about a year and a half--of non-radioactive runs that we call cold runs. This is the number of actual canisters we made on a yearly basis. The first year we only operated five months. We started in April, I think it was, and made 64 canisters. And you can see we progressively went up. As the feeds became more difficult, the canister content went down. Here we had a lid heater fail in, I think it was, late 2002 or early 2003; and so there was an outage while we changed the melter out. When we got the new melter in, we changed our liquidus, our crystallization model, which enabled us to put more waste into each canister. We added a glass pump in 2004. It works like a coffee pot percolator. It sucked hot glass up the stem and then splurted that hot glass out on the top of the melt pool to help melt the cold feed that was coming in. We slurry feed so the feed is cold, and it helps melt that cold cap material that pours in.

And then we removed the glass pump and added argon bubbling. We run a reducing flowsheet. We keep the total iron at about .2 to minimize volatilization of technetium and ruthenium, and so we didn’t want to bubble air and disturb that redox equilibrium, so we chose to bubble argon. And, as I said, our first melter lasted eight and a half years; our second melter just passed its tenth anniversary; and both of them, actually, interesting, are failing because of the lid heater. There is actually nothing wrong with the rest of the melter.

SPEAKER: (Inaudible.)

JANTZEN: A lid heater. I’ll point one out in a minute.

Now, I was asked to talk about similarities and differences, and I’ve broken that into three parts. I’m going to talk some about the hardware--I'm going to go over the hardware pretty quickly--flowsheet designs--they are complex flowsheets, but I'm going to have to go over them quickly--and then the process control strategy. I think, you know, where there are differences, it's like this group of tomatoes. Some are green, some are yellow, some are red, but they're all tomatoes. So they're all melters, and it's all vitrification.

The similarities, they're all joule heated, electrically heated. They all use Monofrax K-3 high-chrome refractory, use Inconel® 690 electrodes. They're all slurry fed. The canisters are all 304L stainless, and the nominal melt temperature is 1150.

Differences are in the melter: size, shape, primary type of melt pool convection. At Hanford--let me go back over here. At West Valley they use--the melter was a square configuration, 2.2 m^2 surface area, and it had only natural convection.

At Savannah River our melter is round. We didn't want to have--we originally started out with natural convection. We didn't want cold corners in the melter where things could crystallize, so we went with a round melter. In 2004 to 2010 we used this airlift pump that was like a coffee pot thing, and then we switched to the argon bubblers, and we have four bubblers in that melter.

The Hanford high-level waste melter, again, is--I've got advanced joule heated. Advanced means it's bubbled, so ours went from being joule heated to advanced. It's a square configuration; it's air bubbled; it's larger than any of the two before it; and there are six bubblers in that melter--plan to be in that melter.

Here's the canisters. The canisters are West Valley and DWPF's canisters, two foot in diameter by ten foot tall, and the high-level Waste Treatment Plant canisters are 15 foot tall by two foot in diameter.

This is the DWPF melter at Savannah River. Right there are the lid heaters, sir, right there, those two lid heaters. When you start a melter up cold, you have to melt the melt pool down; and so the lid heaters help you do that, help keep the plenum hot. There are some electrodes. We have an emergency canister to drain the melter if we have to. This is the normal--normal pour goes up this teapot-like thing, and we do what is called a differential pressure pour, which makes it a semi-continuous flow of glass. The bottom drain is for emergencies. The floor is slightly sloped. There is an offset here between the floor and the pour spout in case crystals or noble metals accumulate at the floor of the melter. We have a complete dual jumpered off-gas system, so if one system gets plugged, we use the other system, and the off-gas plugs are actually water soluble so we can steam clean the off-gas systems.

The size of the melter was limited by the crane that could lift it. This is the crane actually lifting the old melter out of its cell in 2003 to put the new melter in. It was designed for 238 pounds of glass an hour, which is 2.6 metric tons per day. We actually did get those feed rates with certain feeds; but now that we have the bubblers, we get those kinds of rates routinely. And the off-gas is made of Hastelloy® for resistance to acid gases, because you get things like dilute sulfuric acid coming over or dilute hydrochloric acid coming over from the halites that are in the waste.

This is the West Valley melter. It had a shape like an inverted prism, so very, very steeply sloped sides. It used an airlift pour, so the glass comes over here, and the airlift is in here; the sloped floor, again, for crystal accumulation or noble metal accumulation. They didn’t have lid heaters, but on start-up they did hang some heaters in to get the melt pool started and then took those back out. They had a single off-gas system with certain spare components. The size was 50 metric tons. The pour rate is--that should be 45.5 pounds per hour, which is about one metric ton a day. And the off-gas, again, was Hastelloy® and Inconel® for resistance, same as DWPF.

And this is the high-level waste glass melter plan here at WTP. They are planning to run two melters. They've got a bubble rise overflow that is used for both normal and emergency pours. They've got a flat floor, but there is a very large offset of the pour spout to allow for noble metal or crystal accumulation. No lid heaters; single off-gas system for each melter with spare parts; almost 79 to 90 metric tons. The melter itself holds about 11 metric tons of glass, and so replacement is not by a crane; it's by rail. This is what it's designed to produce. And, again, the off-gas is made out of acid-resistant alloys. Actually, let me point that out. You can see the rail system down in there.

This is the DWPF flowsheet, and this gets very difficult, so I'm going to try not to go through all of it, but kind of point you in the direction of what's important. This is the waste out in the tanks that's separated. You've got this sludge fraction, and then you've got this supernate fraction. As Ken said, the supernate then goes through salt processing, any one of these processes. Some of them are on line, and we're waiting for that salt waste processing facility to be completed, but we had these other technologies in place. It removes the cesium and the strontium and the actinides and brings them back over to this hold tank so that they can be combined with the sludge waste that's coming in from this stream over here. And then the decontaminated salt supernate goes to grout that’s poured into vaults at our site.

The sludge then goes to a million-gallon tank, and we do things like wash the sludge to get the soluble salts off the sludge so that that can go back to the salt, and thereby we’re minimizing the amount of waste that we’re sending forward to the high-level waste glass melter. We’re getting rid of these soluble non-radionuclide-containing components to here just to make sure that they’re clean. We again process them through here to get rid of cesium and any actinides.

So we do our sludge washing. We do aluminum dissolution. The aluminum dissolution, the aluminum comes out as sodium aluminate, which is soluble. Again, that helps us reduce how much sludge we have to send forward to the melter. This is all done in a million-gallon tank. That goes over here. This becomes our qualification tank, which is another million-gallon. If I take a sample of that tank and I take the uranium, I can actually take the uranium from that tank and predict how much uranium there is going to be in the glass all the way over here, because all of the processes that happens here happens with this formic acid, oxalic acid, those kinds of things, so that the cation content of the material that I’m analyzing here does not change in this box that’s called the vitrification facility.

So the qualified sludge goes from here. It goes into here. It gets acids added to it. The reducing acids, they allow you to strip the mercury out--steam-strip the mercury out. They bring the mercury down as metallic mercury. When all that processing is finished, we go over to the SME, we add the frit, the glass formers. This is our hold point: Are we or aren't we making acceptable glass? I'll show you when I get to the process control strategy how we treat the melter's black box, which is why I've got it colored in black. We meter in whatever we need to meter in from this vessel to here. We go to the melter hold tank. And basically what we've done during our cold runs was we cut cans open, and we sliced doors in cans, and we sampled to prove that we could predict what's in the canister from what was in this vessel here. And that's why that's our hold point.

I have written down here all the reasons we go through this SRAT, sludge receipt and adjustment tank. This is everything that happens in there. I don't have time to talk about it all. But this tank is basically hydroxides, nitrates, and carbonates when we're done.

I don't know as much about these, so I tried to keep these as simple as I could. West Valley had one tank with high-level waste sludge in it, and they had a secondary small tank with THOREX waste in it. They had these zeolite ion exchange columns. So they took the supernate, and they ran it through the ion exchange columns. That all went out to grout. They then washed their sludge two or three times over, took that rinsate, let it set, took that decant off, ran it through the zeolite columns, that went out to grout.

Now, when that was all finished, then they took the zeolite columns, put them down into the sludge, and then they mixed in the THOREX materials. And you'll notice they've got stir bars in all these tanks, and we have stir bars in all our Savannah River tanks.

They were then able to make smaller batches where they came over to this tank, and they would choose a chemical composition, a target, because they knew what the composition of this tank was after they got all the zeolite and the THOREX into it. And then they would--so that this tank became their qualification and acceptable hold point.

And this is as simple as I could try to make the Hanford flowsheet, the operations that happen at the tank farm, operations that happen in pretreatment, and operations that happen in the vitrification facility. These are your million-gallon tanks in the tank farm, the kind of ones that Savannah River uses to do all their mixing and pretreatment in. In Hanford there's a separate pretreatment building that handles all the pretreatment. And then this material goes forward. And the hold point for the qualification are these tanks over here. And there is a recycle loop, which is almost off the edge of my picture, that comes back in here for pretreatment.

So, in summary, the flowsheet differences are the DWPF blend sludge in the tank farm to dampen composition variation; we perform pretreatment in the tank farm; and we qualify the sludge in million-gallon tanks in the tank farm. A typical batch is only 300,000 to 800,000 gallons, and so this minimizes how much analyses you have to do, because you've got a constant 300,000-to-800,000-gallon batch. We call it the macro batch concept. You don't have to take more samples if you're still processing the same macro batch.

DWPF we use REDOX control. West Valley uses REDOX control with sugar, and they did not bubble air. WTP uses sugar also, but it's not really for REDOX control; it's to reduce the nitrates. But they're bubbling air through their bubblers, and so this re-equilibrates the melt pool to oxidizing conditions. It works out that you get about 30 to 33 percent retention of the technetium in a single pass. That's why they have that recycle loop in there to go back to pretreatment. When you keep recycling, you can get up to 80 percent of the technetium retained in the glass.

All mix/blend transfer tanks are accessible due to concerns about viscosity and erosion/corrosion from crystalline sludge particles, and all of the tanks are stirred mechanically. That was true for DWPF and West Valley. WTP, some tanks are actually stirred, the ones closest to the melter, and some are accessible, but many of them, I'm sure everybody's heard, have either the pulse-jet mixers and/or they're in "black cells".

We use a frit, a melted mixture of glass formers, at Savannah River, chosen on the makeup of a large macro batch. And this leads to only one transfer error and one analytic error during batching when we get to the discussion on process control. DWPF handles it this way. West Valley and Waste Treatment Plant did not and will not.

Okay, so in terms of what do you have to know about a glass to be able to process that glass, this list here--you have to know certain things about the product. You have to make sure it's durable; you have to make sure it's homogeneous. And I'll talk about homogeneity and composition in a minute. The regulatory, you can either test a range or you can model TCLP. You need to know thermal stability; you need to know mechanical stability. Process, you need to know all these things to be able to get it into the melter and be sure you're going to get it out of the melter.

Okay, I'm running really late. All right, so this is a balancing act, and, if I have to, I'll just go right to the end.

The important thing here is that if you're going to allow crystals to form, either durable crystals or non-durable crystals, you have to be careful with the non-durable crystals. They often incorporate radionuclides; for example, sodium sulfate incorporates cesium and strontium, just as an example. If you allow crystals to form, you have to worry about the durability vectors from the crystals.

One of the reasons we make homogeneous glass is we don't have to worry about these durability vectors from anything that's not homogeneous or crystals or the grain boundaries. If you're going to allow crystals, you need to know what the durability vectors are. This is a spinel crystal. I have peeled away the leached layer on top of it after I've leached it with a piece of Scotch tape, and you can see the grain boundary dissolution underneath the spinel crystals. So you have to know what these vectors are if you're going to allow crystals to form.

At Savannah River we use what's called feedforward statistical process control, because we've got these multiple waste streams, because we have to be very, very confident that these property constraints are met to the 95 percent. And so what I want to talk about is how Savannah River defined the process control region for DWPS and how we qualified the DWPS process control region during non-radioactive start-up and how we actually used this for waste qualification.

This is our process control. You'll hear some people talk about it a little bit more this afternoon. We base this on the glass properties. So we use multivariate theory to control limits within this multi-dimensional composition space. So you can take any frit, any waste, Waste 1, Waste 2. If it's got the right durability, right along here, anything to the--let me see--that's your right of this line makes durable glass--then all of these other intersecting lines are the other properties, like you have to know that if you put it into the melter it's going to have the right viscosity back out of the melter.

And I know this is a lot of stuff to digest.

And so this particular process control system keeps us in control 95 percent confident that we're going to be able to make glass. We can target right down there at the maximum waste loadings. The model accounts for model error, analytic error, tank transfer error, and heels. When you do tank transfer, you've always got to heel the previous material in there. So, while these are the models, all the inner little bands are all the error bands that help you account for all these different sources of error.

I'm not going to go through this, but this is our viscosity model. For example, we like to keep it really, really simple; so we put a minimum number of components in our models, and we try--if we have something else that we think is going to be problematic like phosphate, sulfate, titanium, we set a limit. At this point in time we are going to be, actually, adding a titanium term to the model. But if you don't need a titanium term, if that model with its seven parameters defines your system at an R^2 of .97, then you don't need as many terms in your models.

And all our models developed over very, very, very wide ranges where 110 poise and 20 poise, for example, is the limit of what the melter can actually do. So you've developed your model over ranges that are wider than what you're applying it. And I'm just going to use this as a very quick example. The question came up: Do we need a uranium term, do we need a thorium term in our viscosity model? But we looked at what was out in the literature on uranium and thorium bonding by Gordon Brown of Stanford and other people, and it turned out that the $Uranium^{+6}$ and $^{+4}$, they had two bridging and four non-bridging oxygen bonds, and so they cancelled each other out, and we didn't really need to put a uranium term in our model. So, again, it's keep it as simple as you can possibly keep it in terms of your sources of error.

This was our cold runs. This is what I told you about. We developed the process control system that I just spoke about. We wanted to make sure that we could treat the melter as a black box, so we cut open the canisters that were sectioned. There were 30 of them. There were 56 that had the walls removed. And we have this little glass sampler that you can push into the stream of the glass and pull it back out. And we analyzed that, and we analyzed the cans, and we had our projections, and we proved with 106 different types of samples that we could control. Not only could we control if we had a constant tank full of, let's say, low-viscosity high iron, but if we fed in high aluminum on top of high iron, the feed would be slowly changing, because melters act as continuously stirred tank reactors. So you have to be sure when you're transforming from a high aluminum to a high iron or back to a blend, you have to be sure that your process control system actually can handle those transitions in waste feeds.

This is the acceptance part. I hope I can do it in five minutes or thereabouts. I've talked about the 95/95, that you've got to be 95 percent confident that you've met all these parameters, and the first and most important one is this durability. So the way these models work is that we've taken into account the interactions between components. I showed you that on the previous slide. And we know that this range of glass is processable. We've done it for the last 19 years at DWPF.

And so the process control was then used to demonstrate the acceptable process by these kinds of linking relationships. If you control the process in a given composition range, then you've got composition control of your glass, of your product. If you've got composition control, then you've got dissolution rate control. And if you've got dissolution rate control, then you've got performance control and acceptable performance.

To prove this, we developed a thing called the environmental assessment glass, which was a glass that was used in the environmental assessment by the DWPF in 1981, and this has become a standard glass around the DOE complex. And so we've done lots and lots of tests on the environment assessment glass. We know where its upper and lower 95 percent confidence bands are. So this is the lower 95 percent confidence band of the EA glass durability tested by a lot of people. We did all kinds of round robins.

Then you have some kind of durability model where glasses over here are less durable and glasses over here are more durable. And you've got some kind of model; I don't care if it's empirical or first principle, but you've got a model. You've got an upper 95 percent confidence band in the lower. And so where the upper 95 percent confidence band of your model intersects the lower 95 percent confidence band of your standard high-level waste glass, then you are 95/95 percent confident that you've made a good product.

What was done at West Valley--and I think that's what’s going to be done here at DWPT--is they had only that one tank. They chose the target, and then they went 95 percent on either side of that target. This actually talks about the models that are being used here at WTP. And I don’t have time to go through that whole slide.

This is actually the one I wanted. They chose a target at West Valley; they analyzed the tank when they did the tank transfer; they found the lower and upper 95 percent confidence bands of that material; and then they made it into glass. They harvested shards out of their canister, out of the top of their canister, with a vacuum device. So here is how they targeted their feeds that were going into the melter. Here is the analysis of the shards from the canister. And if the average and the upper and lower 95 percent confidence bands on what was in the can matched up--the limits matched up to within what it was in the batch before it went into the melter, then that was considered 95 percent acceptable.

And I’ll let you read this for yourself, but a production facility can’t wait until a melt or a waste glass has been made to assess whether it’s acceptable or not. So we made the acceptability decision on the upstream process rather than on the downstream melt or glass. We used mechanistic and semi-empirical models. The model is mechanistic (inaudible) intercept, so they’re really semi-empirical.

The alternate methods are what's called statistical quality control, and you've got the targeted middle of your region. The glass product is sampled after the vitrification is complete and then compared to what it was before it was complete. It's sampling is analytic-intensive compared to a minimal sampling of actual product if you do the statistical process control.

This is another little bit of history. The repository is kind of in the middle. And everybody--the Environmental Protection Agency, the NRC, is talking to the repository. The waste form producers--DWPF, West Valley--were talking through the DOE Office of EM to the repository, and we were also talking to the EPA. We provided the data that made glass (inaudible) the best-developed available technology for high-level waste (inaudible).

So here's the real issue, and this is the one that could be a talk all unto itself. The waste form must be acceptable to a repository yet to be sited and/or built. In 1982 we had the Nuclear Waste Policy Act Amendment; we had multiple repositories, tuff salt, basalt. When it was amended in 1987, we were told to just look at tuff in the Nuclear Waste Policy Act Amendment. In 2009 the administration cancelled Yucca Mountain.

But, you know, it doesn't matter if it's 1982, 1987, or 2009. The problem is still the same. You're making glass, and you don't know when there's going to be a repository ready, and you don't know what it's going to be. So we had to come up with a strategy. One of the strategies was to develop this glass durability standard, this EA glass. It meets all the repository requirements, because all the other glasses--if it meets all the requirements, you've tested all your production glasses or a lot of your production glasses; okay? And if the EA glass makes it and all your glasses are better than the EA glass, then your glass is going to be acceptable; all right?

What we did was also we related--we developed and related a short-term test to measure how our glasses performed against EA glass. This is ASTM C 1285, also known as the Product Consistency Test, and its title says what it is. You want to make sure that your product is consistent. You want to make sure that the glass that you're making today is as good as the glass that you made 18 years ago or 17 years ago; okay? So you want to make a consistent product.

And then we also did all these other things. We performed long-term tests on high-level waste glass and natural analogs. We performed repository relevant tests. We made these rock cups out of basalt and salt and tuff. We used various groundwaters. In the case of the basalt, we actually equilibrated it in an argon glove box to make low EH groundwater. And we performed materials interactions tests. We related--we did some tests at WIPP with heaters. George Wicks did that work in WIPP, in STRIPA and granite and in Ballidon and clay in the United Kingdom, and we related long-term and short-term testing.

What I didn't say up here is that we actually always thought, well, if we had the results of this short-term test, someday somebody will come along with a repository relevant test, and we'll have to relate the response of our short-term test to a repository relevant test. Well, what happened was when they did the Yucca Mountain Total Systems Performance Evaluation, they actually used this approach here.

And this is kind of the time frame of how everything happened, and I'll try to summarize this. I don't want to read it all. Basically, back there around 1982 just after glass was chosen as a waste form, some people did some geologic repository modeling, and they said that fractional dissolution rates between 10^{-4} and 10^{-6} parts per year would be about the best that you could do with any waste form. And this wording found its way into 10 CFR Part 60.113, which specified those numbers.

And so when we made the EA glass, we chose a glass that gave a durability in between those two numbers where that would last anywhere from 10,000 to a million years. And what's interesting about that is that it was for any repository type geology. The modeling was done out at Lawrence Livermore. It's in some very old documents. And it didn't matter what the repository geology was if you could guarantee that the glass would have this particular type of durability.

Then both the MCC and the ASTM developed a whole suite of tests--I list them all here--that could be used to look at the mechanisms by which borosilicate glass dissolved. Now, the important thing is that that glass standard, the EA glass, is a borosilicate glass standard. And it's a borosilicate glass standard because we used all these tests, all these ASTM tests and MCC tests, to understand the durability mechanism. We don't understand the durability mechanism as well for other types of glass, for phosphate glass, for example. So, theoretically, you would have to develop another standard. But I've put here all the things that are specific to borosilicate glass and kind of where we are right now.

And I want to get to my last slide. These are the waste acceptance product specifications. The ones in blue on the left-hand side of the slide are the ones that have to do with the glass itself. And you see right here that product consistency, more durable than the EA glass by two standard deviations, so that you can project the durability. And we measured the production glasses. We still use that little glass sample or put it in the neck and check and run the durability standard in our high-level caves.

The rest of the standards that are over here have to do with the canister itself and with the canistered waste form. This is Rev. 3 of the WAPS, Waste Acceptance Product Specifications. Our site has not adopted it yet, because it’s just fairly new out.

And then what I call the roadmap of predicting long-term behavior is an ASTM standard that took a long, long, long, long time to develop standard practice for the prediction of the long-term behavior of the materials, including waste forms used in engineered barrier systems for geologic disposal of high-level waste. And it’s a roadmap for defining your problem, defining your repository environment, testing, modeling, predicting, model confirmation.

This is the prediction part of it. This is the testing part of it. This is the modeling part of it. There are loops that go back around through here. There’s your natural analogs. I wanted to point that out. And we have managed to get all the way down to here, which is the prediction for the repository when we got to the total systems performance evaluation.

These are some of the submodules. How do you develop an accelerated test? (Inaudible) my cartoon. Very important when you do an accelerated test that you accelerate the right mechanism. This came out of a--okay, everybody gets the point of the slide. This actually came out of an August 1998 workshop on developing test methods and models to simulate accelerated aging of infrastructure of bridges and buildings. So you've got to make sure that your test doesn't overdo it.

And then these are all the tests that I talked a little bit about. Right here I thought was kind of interesting. MCC, from 1980, developed a lot of tests, and most of those have become ASTM-type tests now. The ones that they didn't develop were the repository interactions tests. Those were never developed.

EWING: Carol, I want to be sure and leave time for questions, so--

JANTZEN: Yup, yup, that's it, that's it. That's my last slide.

EWING: All right.

JANTZEN: That's the roadmap.

EWING: Okay, thank you for covering really a huge amount of history and information data. It's very, very useful.

So questions from the Board? Jerry.

FRANKEL: Jerry Frankel, Board. Thank you again for this talk. It was really educational for me. And, unfortunately, it brought up a lot of questions that I'd like to ask, but I'll try and limit it to one. I'd also like to congratulate you and Savannah River for 17 years of successful operation of the DWPF. Quite an accomplishment. And I think that the experience is really, really valuable.

What I'd like to ask you about is the durability and reliability, not of the glass but of the facility components, say, rather than the melter. So how has it performed over this time period, say, compared to expectations of its performance and what lessons have been learned that maybe are valuable to the WTP?

JANTZEN: It's interesting. I think the only failure that we had on start-up was, in that teapot pour spout thing, we had a disengagement problem. The molten glass would come over a knife edge, and it would disengage too quickly and then wander around before it found its way into the can. And what we wound up doing was actually manufacturing a part that fit into the existing knife edge that made another knife edge further on down. So of all the things that could have gone wrong during start-up, that was the only one that we had some difficulty with.

FRANKEL: But over time how has it held up, the durability over time?

JANTZEN: It's held up very well. I mean, we've learned some things like we’ve decided to put a heated bellows in the pour spout so that when you run higher concentrations of waste in your feed, as the glass pours--it’s about the size of your pinky or a pencil--it starts to cool, and so sometimes it can start to crystallize if the pour spout is not kept very warm. So we made a heated bellows in the pour spout so that we could handle higher waste loadings in the glass. I mean, almost every one of the issues that we’ve--and things like the heated bellows, they’re in a very corrosive environment and very hot environment, because they’re seeing the glass pour. So we have to keep spares; we have to change them out.

FRANKEL: And the rest of the facility (inaudible)?

JANTZSEN: I think we’ve had one vessel that had developed a hole in it, one of the three vessels that we mix in with the stir bars. Occasionally we have to replace a paddle. Occasionally we had to take--we had to go in with the crane and weld a patch over the hole in this one vessel. But every cell is accessible by a crane, and so when you have to do an engineering fix, you have to have things be accessible.

EWING: Mary Lou.

ZOBACK: Mary Lou Zoback, Board. I have a question going back to very early in your talk when you showed the output from the 17 years of operation, and in 2010 there was a huge increase in output when the argon bubbling was added. So where did the idea for the argon bubbling come from? Was that R&D being done by the program, or was that a commercial process that you adopted or what?

JANTZEN: That was R&D that had been done by Vitreous State Laboratory.

ZOBACK: So it was funded by DOE?

JANTZEN: Yes, in support of WTP.

ZOBACK: Okay, thank you.

EWING: Other questions? Sue.

CLARK: Sue Clark, Board. And, actually, I have two questions. But to build on what Jerry was asking about earlier and thinking about what's planned here at Hanford, based on your experience at Savannah River, does that provide any confidence that might help with this issue of black cell? You know, this idea that you would create a black cell that needs no maintenance and you have no accessibility for many years, is there anything that comes from Savannah River that adds any confidence in that?

JANTZEN: We don't have black cells.

CLARK: Yeah, well, I mean, I guess where I'm going is, if anything, your experience is that you've had to go in and do maintenance.

JANTZEN: I think it's smart to assume that you'd have to do maintenance in facilities that last this long.

CLARK: Okay. And then another--my second question has to do with an early slide where you were talking about the different types of glass. And so there was some early work on phosphate glasses, but we never really--

JANTZEN: That was done at Brookhaven by a gentleman by the name of Hatch.

CLARK: And was, in the whole Hench Atlanta Shootout, any consideration of these phosphate glasses, or had they already been eliminated?

JANTZEN: I think there were phosphate glasses on that list.

CLARK: Oh, okay. I didn't see it. It looked like it was more of just a borosilicate (inaudible) versus--

JANTZEN: It was the--all right, how do I want to say it--not all phosphate glasses are created equal. The aluminum phosphate glasses seem to hold up very well. That's why the Russians have continued using them for almost all of their wastes. I didn't have time to go through it, but there was lead-iron phosphate glass developed at Oak Ridge by a gentleman by the name of Boatner. It had crystallization issues. It was a lead-iron phosphate. A lot of the crystallization issues and solubility issues, the radionuclides didn't--for example, didn't want to go in it very well due to the lead in it.

Now, the University of Missouri, you know, iron phosphates where there’s no lead in it, I’ve read some of their work--I haven’t read everything--but the phosphate glasses could be corrosive to your melter materials of construction. So I think the iron phosphate glass at University of Missouri is an acceptable glass, but you would have two issues. You’d probably have to go to a cold crucible induction melter to get around the corrosion issues, and you would probably need to prove that it--you’d have to do one of two things: prove that it leaches the same as a borosilicate glass or develop a different glass standard.

There has been difficulty--you know, you make a glass standard, you make these tests, and people take them--and I’m going to call them mix and match, you know, so people say, well, you know, I’ve analyzed my sodium-iron phosphate glass, and the sodium is lower than the sodium that comes out of the EA glass, so I’m okay. Well, not necessarily, because you haven’t proved that it leaches by the same mechanism.

And while I’m on that soapbox, we did extensive testing over about 15 years to prove, for example, that sodium and technetium are in the same kinds of deep polymerized regions in the glass, so they come out at similar rates. So you can--if you measure the sodium, boron, and lithium that comes out of your EA glass and compare that to the sodium, lithium, boron that comes out of your production glass that you made yesterday, okay, you can say, well, then

I know my--you know, nothing comes out faster than those. And the only radionuclides that come out as fast are either technetium or iodine-129, so you've got--but we had to do those experiments and prove that the tech-99 and that the iodine-129 came out as rapidly or congruently at the same rate as the sodium, boron, and lithium.

CLARK: Great, thank you.

EWING: Other questions? Sue.

BRANTLEY: Sue Brantley of the Board. I actually have two questions also. The first question is: Let's say you were magically put in charge of the Hanford Waste and the Vit Plant as a promotion.

SPEAKER: A promotion, huh? Okay.

BRANTLEY: One of the issues that we heard about yesterday was not knowing what's in the waste that comes into the plant, the composition. What would you be worried the most about, based on your extensive knowledge? You know, what elements or what compositional variety would you be the most worried about?

JANTZEN: It's not so much the compositional variety. What worries me when I delved into this for this talk, more than I had in a lot of years, is the small batches that they're trying to qualify. And while that strategy worked at West Valley--

BRANTLEY: I'm not sure I know what that means. Can you just tell me what that means, the small batches that they're trying to qualify?

JANTZEN: Well, we've got to go back to that flowsheet slide. I don't remember which one it was. Let me see--

BRANTLEY: Well, just conceptually, what are you saying?

JANTZEN: We qualify a 300,000-to-800,000-gallon batch. If you're doing smaller batches, you've got all these analyses that have to be run. And analyses take time. So if you don't get--and both West Valley and WTP are--that green octagon--they're qualifying on tanks that are much smaller than the tanks that we're qualifying on; okay? So you've got more analyses to do. And when you're--like I said, if you've got a heel of a high iron waste and you're feeding in a high aluminum waste, you've got some considerable variation in the composition over time as the melter has less iron and more aluminum into it.

So I think that can be problematic if you haven't either blended off things in the tank farm, which we do a lot of blending in the tank farm. We work very closely with our tank farm people. They have our models. They actually come up with a system plan for the (inaudible) years, and they look at what tanks they can blend to try and, I'll call it, help us, you know, help themselves. I mean, we're all in this together. And I don't see that cooperation here.

BRANTLEY: Okay. Then my second question--

EWING: And last. I just don't want everyone--

JANTZEN: (Inaudible.)

EWING: Yeah, go ahead.

JANTZEN: Rod, I just got a promotion. Now, wait a minute here.

BRANTLEY: I don't have that kind of power, so--this is from your Slide 39 or something. But you talked about a rate that would work--a rate of dissolution of your glass that would work for any geological repository, you know, 10^{-5} parts per year, and it came from some report. Can you just talk a little bit more about that so I understand that? I mean--

JANTZEN: It's actually in the National Academy report, the waste forms report. Rod and I were on the National Academy panel that wrote that document. And those two slides, the ones with the blue--light blue, dark blue stripes--they were numbered in the NAS report, and the pertinent references are given there.

EWING: All right. Well, I know there's a lot more to ask about and discuss, but it's my job to keep us on schedule. So we'll take a break now, but I encourage people to use the breaks to continue the discussions, and we'll start promptly at 10:15 with the panel discussion. Thank you.

Thank you, Carol.

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

EWING: So my first call is for panelists to come forward and take their seat at the labeled places up front. For the balance of the morning we'll have two panels, both focused on vitrification, the technology and process, and the second panel on waste forms, glass and alternative or other waste forms.

So we'll change our procedure a little bit. The moderator for both panels will be Professor Werner Lutze from Catholic University. And so I will cede to Werner the power to call on people for the panel members and staff, and he'll run the panel discussions.

And I just ask that you not screw up, okay?

LUTZE: Thank you, Rod. I follow your model, you've screwed up already. Six minutes behind schedule (inaudible).

Anyway, this morning we're going to have two consecutive suites of presentations. One is focused on the technical experience of vitrification, and the other one is focused on the waste form. But I would like to say right away that the presentations will probably cover both areas more or less, because there is such a close relationship between the waste form and the way the waste form is made.

We have, in the first part of this session, four speakers. And, as you can see, we have asked them to make presentations as they feel necessary. There are no titles given here, but they will all address these basic issues that I just spoke about. And we will have the discussion after the fourth presentation, 30 minutes, and then we go to the second suite of three presentations and have another 30 minutes of discussion.

So, to start, I would like to introduce Stéphane Gin to come up and give us a presentation. Stéphane is a visiting scientist from France at Pacific Northwest Laboratory, and he is here for a year and works on the understanding of (inaudible) corrosion glass. But he will probably also address other issues.

Please.

GIN: Thank you, Werner. Good morning, everyone.

I have a very brief presentation of the French experience in high-level waste vitrification today. I start with a brief history. And my main message here is that we have started in France research in vitrification following research on glass formulation, glass properties, and vitrification technology in parallel. And we started this research at the end of the ’50s with a first important realization in ’78 with the commissioning of the AVM facility (inaudible) vitrification of Marcoule for the vitrification of high-level waste from defense fuels and then about ten years later the commissioning at la Hague of the R7 and then

T7 facilities that have six vitrification lines. Those six vitrification lines were first hot crucible melters with smaller size compared to the U.S. melters we have seen previously. And in 2010 we started--we have replaced one of the six hot crucible melters by a cold crucible melter for the vitrification of more corrosive (inaudible) from the different wastes.

What is also important to note is that we've decided to massively invest in nuclear energy in France after the first oil crisis. And we have also decided to reprocess all of the fuels. We have currently 58 nuclear power plants or 58 reactors in France, and it gives something like 1,230 tons of spent nuclear fuel that is reprocessed each year in France. And all the (inaudible) waste coming from this reprocessing are vitrified into borosilicate glass.

So, as I said, the research started at the end of the '50s and continues at a constant effort. About a hundred people are currently working in developing new--or improving glass formulation, improving vitrification technologies, and recently, since a couple of years, we have invested in modeling the different processes we have to take into account for improving the technology and the materials to cover what happened in the melter, what are all the physical-chemical properties of the materials, and also the prediction of the long-term behavior in the future geological disposal. I want to talk about that briefly just after.

So about one hundred people working in this field in the frame of what is called a joint CEA-AREVA laboratory at Marcoule with a lot of cold and hot facilities and different scales from pilot to scale one process for preparing vitrification in la Hague. The AVM facility has been stopped at the end of last year, so the only remaining facility for vitrification in France is in la Hague (inaudible) industrial scale.

Okay. I will not skip this one, but I will be very brief, because it has been explained. In fact, we (inaudible) in parallel to improve the quality of the material and the vitrification technology that allow the fabrication of this material. So the quality criteria and the qualification of the material take into account the material's properties and the related technology with all the parameters allowing to fabricate the material. So you have the different properties we have to take into account for this strategy.

These are some figures related to the vitrification, so I have compared the situation in France with three important figures. One is related to the fraction of spent nuclear fuel reprocessed. In France (inaudible) it's about 100 percent. It's very different in the other countries that have developed or continue to develop vitrification.

In terms of amount of glass produced at the end of the last year, you can see that we have produced the same amount of glass in France as in the U.S. About 7,000 tons of glass have been already produced. But in terms of radioactivity confined in glass, because the commercial fuels that are reprocessed in France have a higher burnup than the defense fuel you have in the U.S., the amount of radionuclides confined in glass is much bigger in France. To give you a comparison, we have already in our 7,000 tons of glass one hundred times more radionuclides that you have in the Hanford tanks, so it’s a huge amount of radioactivity that is already confined in borosilicate glass in France.

So in all these countries, even if the situations are different, there is a common need of geological repository with a need of designing a smart multi-barrier system and a need of reliable prediction of the glass durability but then on the fate of radionuclides over something like a hundred thousand up to a million years.

I would quickly insist on the fact that, contrary to what has been said previously, we think that the glass durability strongly depends on the design of the multi-barrier system. We have two examples here. One is the current design in Belgium with a super-concrete container surrounding the canister and the overpack, and this concrete material will allow the solution to be very alkine and prevent the corrosion of the iron overpack and delay the beginning of the leaching by groundwater. And in the case of the French design, we have only borehole dig in the clay host rock and the canister directly placed in contact with the clay. So we have no buffer in this case. And the very high alkaline pH in contact with the glass will dramatically decrease the glass lifetime once the leaching will start. So that's a big difference.

The glass lifetime in this case is expected to be around a thousand years; whereas, it's possible, if the design is favorable to glass, to exceed millions of years. So the concept is very, very important on the glass durability. And I don't believe it's easy to say we have a performance demonstration that is independent of the scenario.

So two important milestones in France 2015, so very soon we expect to have a license for opening a geological repository in the (inaudible) of the Parisian Basin in clay formation. And, if yes, we'll have about ten years to build the site and start stirring first the intermediate-level waste and then the high-level waste from 2025. That is a demand of the 2006 Act on Waste Management in France.

And the last one, we believe that there is a general need in the world of better understanding the glass mechanism, the rate-limiting mechanism, to improve the predictive model, and to be able to have reliable prediction over this very long period of time. So there is a large international corroboration on glass corrosion starting in Seattle with the U.S. teams in 2009, and now six countries are collaborating within this important topic that is glass corrosion and improving the (inaudible) rate-limiting mechanism in order to improve predictive models.

So I'm here at PNNL for working in this field for a year and will be back to France with this new experience in the next couple of months.

Thank you very much for your attention.

LUTZE: Thank you, Stéphane, for making up for some time. We will go on directly to the next presentation, which is presented by Mr. Hamel. Mr. Hamel is from the Waste Management Plant, Assistant Manager at WTP for the Office of River Protection and Project Director at the Department of Energy.

And I think your original background is chemistry, but you went heavily into engineering with many years of experience in project management, among others project team leader at DWPF. And you are going to present material on WTP (inaudible).

HAMEL: Actually, I have a very focused presentation. I'm going to talk about vitrification lessons learned from

West Valley, as applicable to the Waste Treatment Plant. And I'm going to focus basically on the high-level waste melter and melter design and operations very briefly.

This is the West Valley high-level waste processing flowsheet. I think, as everybody is aware, West Valley operated from 1996 to 2002, vitrifying 275 high-level waste canisters in about 660,000 gallons of high-level waste; and in the waste was about 23 million curies of activity. The basic unit operations here for West Valley are the same as WTP's, although on a much smaller scale; and, in addition, the waste is much more complex out at Hanford.

As you can see, there's a pretreatment box in the waste tank farm, which includes a separation of the low activity from the high activity fractions, very similar to WTP's design, and the de-ion exchange is done in the Tank 8D-1 labeled over there prior to the high-level waste being sent over to the vitrification facility. Very similar to WTP, there is basically a concentration step and then a glass former addition step. Then it would head into the melter, ultimately to be air-lifted into high-level waste canisters and then ultimately to a high-level waste repository.

Moving on to the next slide--I've got that.

SPEAKER: (Inaudible.)

HAMEL: Sorry. I am trainable.

This is the high-level waste vitrification in cell.

And over in this section here, that's where the melter is. That's where I'm going to be focusing. Over on this section here, that is the melter off-gas system, and that's the SPS scrubber and the high-efficiency mist eliminator, all the basically off-gas trains focused there. Over on this side, this is where the canister handling portion of it is, which includes welding, cerium IV decon, and ultimately movement to a transport cart that actually runs on rails right there and then from there be taken to an interim storage cell.

This is the West Valley melter. Of note for this melter is the fact that it ran for seven years. It actually went hot in 1995 and was shut down in 2002. Of that time period, in 1996 through 2002, it was actually processing high-level waste. So it ran for seven years. It had some minor difficulties, but it did not fail. It actually had more projected life left at the end when it was shut down.

These are the specifics of the melter, as you can see, that it's basically about one metric ton a day. I'm going to put up a slide next that will show the HLW melter from WTP as designed. One thing that you will note is that the capacity of the WTP HLW melter is much higher. It's about three metric tons a day. So one of the challenges that is here is the scaling factor from going from West Valley to WTP.

This is the WTP melter. Now, one thing you'll note also is that one of the big changes in the design is based on basically the electrode structure. There's two side plate electrodes for this melter as opposed to the three electrodes from the West Valley melter. That design change was based off of lessons learned. What was seen in the West Valley melter was that noble metal sludge actually accumulated in the bottom of the melter; and while it didn't short the melter out, it decreased the resistance of the melt, which required more energy to keep that glass melt pool up and going.

So, based on that, WTP has made a design change, taking out basically a bottom electrode that was in there, and now what it ends up doing is it would be harder if noble metal sludge were to actually precipitate out of the glass melt for it actually to basically short or decrease the resistance. So that's one of the significant differences in the design there. Similarly, you can see that the capacity is a lot greater here. It's a three-metric-ton-per-day melter. Also, you will see, if you look down at the design, that there's actually two pour spouts as opposed to one pour spout on the melter here, which gives you the increased capacity.

Some of the key lessons learned from West Valley that have been incorporated into operations and design at the WTP. The electrical connectors that were inside that actually went on the top of the melter and actually delivered power to the electrodes basically were and had pathways to the plenum of the melter, which actually resulted in contamination being delivered ex-cell into the operating aisles.

What was happening is that during the operations, you were seeing pressure fluctuations in the plenum area, and the contamination eventually migrated out and was detected in the operating aisles. While there were no contamination events, there were no uptakes or personnel contaminations, this was a significant evolution, an event that needed to be corrected. What they did at West Valley is they actually opened up the electrical jumpers so that they vented to the in-cell. And, in addition, on the ex-cell portion in the operating aisles, they put HEPA filters so that they were filtered.

Another lesson learned involved the actual pouring of the glass in the melter discharge area. There are heaters that hang from the melter top that are basically silicon carbide ceramic melt tubes, if you will, to keep the glass hot while it’s pouring. Because they are very fragile and they basically were originally cycled, they basically did not last longer than twelve months, so they had to be replaced. Throughout operational experience, it was found out that if you actually connected them to backup power so they didn’t lose power, they were kept thermally hot, it decreased the thermal cycling on that and actually increased their life of service. So that was a change that was made during West Valley and is something that we're looking at incorporating into the WTP design.

On the melter plenum, the way they operate, because of the way the feed is dropped onto the melter glass pool, you actually get pressure surges and spikes in operation. One of the things that was put in that was actually helpful in terms of controlling the overall glass pour in the pressure system was to put a quick reaction valve that basically vented and allowed pressure to equilibrate in your plenum area. So that actually was very helpful and actually basically made operations much more stable.

During start-up we saw what we call basically angel hair formation, and that was an excessive accumulation of very thin glass fibers in the pour area. And the challenge with that is, what happens with those glass fibers is they actually get in the way of the pour stream and can basically obstruct your pouring. That was actually solved with the addition of an orifice that actually restricted air flow past your glass pour. What was actually happening is, your air was coming up and it was actually taking small fibers off your pour and forming basically what looked like fiberglass, and it was getting in the way of the glass stream.

In the off-gas system between the melter and the plenum, we were seeing basically salts that were volatile from the melt actually accumulate in the off-gas jumper, and that was restricting your off-gas flow. One of the ways to solve that was basically to inject water into your melter plenum, which is operating at about 600 to 700C, and it would volatilize obviously into steam, and that would flush basically your off-gas jumper. So, because the salts were water soluble, they'd end up in your SBS, and basically that was a routine maintenance activity we did to keep the melter operations stable also.

During melter start-up we had at West Valley an initial melter dam failure. The melter dam is basically a plate that holds your glass back from your pour area, and it's incorporated into your refractory. And two things happened there. During transposition of drawings, actually two welds were actually left off, and they were not caught. Obviously that would cause problems. And during the expansion of the dam during your thermal heat-up, what happened was that they basically popped; the welds that were in place basically popped.

In addition to that, after reexamining the thermal heat-up curves and the strategy for that, it was found out that those curves were too quick, that they weren't allowing for enough soak time to basically allow the surrounding refractoring metal to basically come to equilibrium. So during that heat-up you had basically undue stresses in the wrong areas.

And those are some of the significant lessons learned that happened at West Valley that are being translated into the design and operations of the WTP high-level waste melter.

LUTZE: Thank you very much. We're obviously much faster than expected, and we'll therefore have more time for discussion, which is great.

Our next presenter will then be Jonathan Bricker right here.

I think you are a chemical engineer by training with fluid dynamics as a specialty. You are now with DWPF, and you are in charge of continuous improvements and advance in the technology of (inaudible) and the process--

SPEAKER: Could you speak into the microphone?

LUTZE: --and the process itself. Yes. So I would like you to make your presentation.

BRICKER: Thank you, Werner.

So this morning we heard an overview of the Department of Energy Office of Environmental Management, as well as an overview of vitrification as a management practice for the high-level waste. What I'd like to do this morning is to take the next ten minutes to talk a little bit more specifically about the progress of the high-level waste program at the Defense Waste Processing Facility. So this presentation is a little bit different than the talks that you heard this morning, that you'll likely hear this afternoon, and it's less technical. And it provides a little bit of an operational experience to today's talks.

And so, with that, since I come from an operating facility, we usually begin these types of presentations with a safety message. I'd like to do that since we're running a little bit ahead of schedule.

So a lot of you are following the tragedy at the Boston Marathon yesterday morning. And I woke up this morning, I was watching the news, and I was watching a news conference by the chief of police for Boston. And one of the things that caught me or struck me is that he mentioned the importance of the see-something-say-something mantra. I don't know if any of you have heard of that. Well, that's something that we use at the Savannah River Site and something that we really care about. And if you ever have the opportunity to visit the Savannah River Site, you'll see that sign everywhere. So if something is out of place, it probably is. So I encourage you to continue to use that in the workplace as well as outside of the workplace.

So what we'll do today is, I'll provide you with progress to date for the Defense Waste Processing Facility;

we’ll provide an overview of the Defense Waste Processing Facility for those of you unaware; and then we’ll talk briefly about some of the recent improvements made over the last five years. We’ll talk about future challenges for us and work ongoing to face those challenges, and then I’ll end by talking about some lessons learned over our 18 years of experience.

So currently progress at the Defense Waste Processing Facility, we’ve processed as of last month 4 million gallons of high-level waste, and that translates to about 14 million pounds of glass produced, representing 50 million curies, and that’s out of an estimated 150 or 155 million curies associated with sludge waste. Note that we have and we will continue to process by-products from salt waste processing. These numbers do not account for that. We have also produced 3,600 canisters. Actually, I checked this morning, and we’re at 3,618, for those of you keeping track. And that’s out of about 7,500 planned over the life cycle of the facility. So that’s just to give you an idea of where we’re at today.

Regarding the graph, here I show the number of canisters produced as a function of fiscal year for the last five years. Of importance to note is, Carol mentioned the installation of bubblers to our melter in September of 2010. So, prior to that, we were averaging about 200 canisters per year. Since then, you can see the increase in production to 264 in fiscal year ’11, 275 in fiscal year ’12, which was a production record for the facility. During that same fiscal year we saw a single-month record of 30 canisters produced in December. We also saw a twelve-month rolling average of 337 canisters, just to give you an idea of the capability the facility has.

What’s even more impressive is that not only are we producing more canisters, but putting more waste into each canister. As you can see, the waste loading trends here in red. This graph, I think, in part speaks to the environmental risk reductions, but it does not tell the whole story. So one of the things that we mentioned is that we’ve filled half our canisters, but we’re at about a third of dispositioning the curie count; right? One thing I’d like to point out is, over the last four years of production at Defense Waste Processing Facility, 25 million of the 50 million curies has been dispositioned, so we’re starting to attack that higher-risk material.

We’re currently processing Sludge Batch 7. Sludge Batch 8 will start in a few weeks here in May. There are 18 batches planned. And we will talk a little bit about, as I go through the presentation, that production performance for fiscal year ’13 currently does not meet targets. And we’ll talk about that, and I’ll roll some of that into some of the lessons learned.

So, for those of you unfamiliar with our process, I thought I'd take a few moments just to go through the process very quickly. The process really starts in the tank farm in the batch preparation and batch qualification portion. We prepare material in one-million-gallon prep tanks. We qualify the material in one-million-gallon feed tanks at the Defense Waste Processing Facility. That qualification process includes both simulant as well as real waste testing, and really what we're getting at here is to determine the processing windows with which DWPF can process within and some of the additives, which we'll talk about the acids in the frit additions.

The Facility receives sludge from the tank farm in a batch process, so our sludge receipt and adjustment tank is a 12-thousand-gallon tank, so nominally we take over about 7 to 8,000 gallons of sludge each batch. We also receive, as I mentioned earlier, by-products from salt waste processing that currently goes through the actinide removal process and the modular caustic side solvent extraction unit, so we receive a solids-rich stream from the actinide removal product. We also receive a dilute nitric acid stream, which contains cesium from the modular caustic side solvent extraction unit. Those are added during the sludge receipt and adjustment tank. The material is then adjusted with acids, specifically nitric and formic acids. Carol talked about some of the reasons with which we add those acids for mercury reduction, manganese reduction, REDOX control.

Once we've added the acids, we then go through a concentration step and a reflux step to be able to remove the mercury through a steam stripping process. That material is then moved on to the slurry mix evaporator. The sole function of the slurry mix evaporator, just as its name implies, is to be able to add frit and to concentrate. We add frit in two different processes. Bill mentioned the decontamination process at his facility. At our facility what we do is we essentially sand blast the canisters, and so we use a dilute slurry with frit. We recycle the frit, add that to the SME, we blow off the water, then we also make up the rest of it through a process of frit additions.

And then Carol mentioned in her talk, this is really the crux of the facility, in which the slurry mix evaporator is the hold point where we make sure that the glass is acceptable for transfer to the melter feed tank. The melter feed tank is a transition in the process from a batch process to a continuous process as the melter feed tank continuously feeds the melter. The melter, of course is a joule-heated melter. We added bubblers again in September of 2010, which has drastically improved the throughput at the Defense Waste Processing Facility.

And then what's not shown on here and what I won't talk about today is canister handling, which is downstream. That's not a limiting factor for us. And then something I will talk about a little bit that's not represented here is the recycle that's sent back to the tank farms, some of the challenges that presents to us in the liquid waste organization flowsheet as a whole. But, again, this process works to produce highly durable borosilicate waste form.

I'd like to talk a little bit about some of the improvements over the last couple of years. Really, we've made extensive improvements to increase waste throughput. We've worked really hard over the last couple of years to address, really, two things, one of which is the new processing demands producing at a higher rate; the other is the new waste streams. So in 2007 we started receiving by-products from salt waste processing, so trying to manage all those new constraints.

I'd like, if I could, to skip to the second bullet here, melter bubbler installation to increase the melt rate. So, prior to the installation of the melter bubblers, the capacity of the DWPF melter as well as DWPF batch prep was similar. In fact, actually, the DWPF melter was the rate-limiting step. Upon installation of the melter bubblers, you can see now we have the rate-limiting step, the burden of the facility moving from the melter to the batch prep. And that’s where a lot of our focus has been over the last couple of years.

And one point I’d like to make that I don’t think was made earlier is, really, within the last five years the only major change or alteration we’ve made to our flowsheet is the melter bubbler installation. But even that, in and of itself, was a relatively ingenious improvement in that we retrofitted the existing melter with the bubbler, so there was a lot of good work done there.

The other thing that we’ve worked really extensively on for the recent improvements to the batch prep is looking at reduction in cycle time, this particular step. And a lot of what we’ll see here is, we spent a lot of time with the analytical improvements--I think Carol hit upon this in her talk--in that it is very time-intensive to do the analytical portion, so that’s something we looked very hard at.

The other thing is--something I want to point out is, remember, it’s not all about cycle time. It’s a lot about throughput. So another thing that we’re looking at very carefully is maximizing tank volumes, maximizing the amount of material that’s produced, irrespective of the cycle time, for each batch. So that’s something we’re looking very closely at.

And then something I mentioned in the previous slide or two slides ago is a lot of work we’ve been doing to increase the waste loading in our canisters. There’s a lot of work along the lines of tailoring the frit to each specific sludge batch, and we can do this because of our qualification program. Remember, we’re qualifying these batches in a million-gallon tank, and so this allows DWPF, based upon that one qualification effort, to process for 12 to 18 months. So, really, the goal here is to maximize waste throughput to reduce environmental risk.

So some challenges and future work, of course, I think there was a question earlier, there is a growing need to provide flexibility to accommodate variability in the SRR System Plan. This increases our ability to address things like waste feed compositions, differing waste feed compositions, as well as input streams.

A couple of things that we’re interested in doing here is, one is really, as we go through the 18 years of processing, we’ve failed to fully understand, I think, our operating windows. We’d like to better understand those. And then once we understand, then to be able to expand those operating windows to create more flexibility in the system.

A couple of examples of that are an alternate reductant project that we’re working on. That’s a project that we’ve been working on for a couple of years with several different R&D entities. Specifically, what we’re looking at is--I mentioned that we add formic acid to our system. The problem with formic acid is that it decomposes catalytically and produces catalytic hydrogen generation. So that’s something we had to deal with in our off-gas system. And that really creates a small processing window in terms of the amount of acid that you can add. So what we’re looking at is the ability to replace the formic acid with some other reductant that doesn’t reduce--or doesn’t result in catalytic hydrogen generation. So that’s one example.

The other thing that I’ll mention in the lessons learned is that volume management is very important to us. What you don’t want to do is operate a vitrification facility as an evaporator. A lot of water and a lot of time is spent in our process getting rid of the water. So one of the other things, as an example, just to open up these operating windows is the dry frit project where currently the frit is fed as a slurry, so we’re looking at feeding it as a dry material to reduce some of that water.

The other thing that we’re working on is also addressing the operating windows for future waste compositions in terms of the glass formulation and then addressing the demand for higher processing equipment reliability, and this is due to the constraints I mentioned earlier. And, really, the goal here is to position the facility for continuous success.

And then, lastly, I want to end up with some lessons learned, and hopefully these were apparent throughout the talk; but, really, Carol talked to some of these. The first two, the efficiency of the waste qualification program and the success of the statistical process control, that kind of goes into the analytical piece, which can be very cumbersome if you're not careful. We also talked a little bit about earlier the ability for us to perform hands-on work on failed equipment. As we're an aging facility, that becomes more and more important. And then our interaction with our R&D facilities, that continuing interaction, to be able to help us with short-term as well as long-term improvements.

And then, lastly, there is--again, as we're an aging facility, continuous improvement is something that's very, very important. We're constantly looking at that to be able to accommodate change in the SRR System Plan. And then, lastly, I mentioned the importance of volume management in a vitrification facility. Thank you.

LUTZE: Thank you very much for this presentation.

And we are coming to the last one in this session; and, as I said, we will have lots of time to discuss. And the last presentation is made by Albert Kruger, and his background is in physical chemistry and material science. And he worked for several companies in this country, including Saint-Gobain in France, the glass company. And today he is with the Office of Federal Protection, in charge of everything that has the word “glass” to it, we could say. And not only that, but with various aspects of the WTP.

So, please, your presentation.

KRUGER: Thank you. And welcome to Hanford. I used to be with the Engineering Division as the Acting Director, and now I’m a Glass Scientist, thanks to the Secretary of Energy. So I have only one job, and that is the glass.

So I’ve got quite a number of slides here. I’ll leave the electronic copy. Rather than having produced hard copies, the electronic copy is available. There is a lot there for you in terms of the history of the site and how we got to where we are. So I would ask, rather than having generated the paper, you pick up the (inaudible).

(Pause.)

So a quick overview of my outline is that later you will hear about a lot of the work that’s come out of my office since I joined the Department of Energy in 2007. One of the things that you won’t hear a lot about (inaudible) was the introduction of the bubblers into the DWPF melter. Back in 2008 I was told by one of Ken Picha’s predecessors that I would do something of value for one of the other sites. And so with the help of Ian Pegg at The Catholic University, we pursued adding the bubbler into the DWPF melter. That success is clearly evident by the increase in throughput, and it's quite logical to understand that when you have highly refractory materials and a limited amount of flux and only a certain amount of joules that you can drop or currents you can drop between electrodes, anything you can do for heat distribution is going to help you (inaudible). And, indeed, that was borne out by the recent increases in production.

So, with that, we'll begin to discuss what it is that we're doing here at Hanford, where the program has taken off in 2007 when I joined. You'll hear later from John Vienna. You'll hear from a variety of speakers and poster presenters as to the work that's funded from my office into the National Lab here in town, as well as to Catholic University, the Vitreous State Laboratory, where they were the recipients of the government deciding that a scale melter was an important thing. And so the DM 1200 at Catholic University is a one-third scale melter with the prototypic off-gas system built in. So we can really do experiments that are very meaningful and really help us understand in what we'll do in operating our facility. In years past there was a DM 3300, which was the equivalent on the LAW side, and it's since been retired and is very likely part of shipbuilding in Korea, the steel having been sold off.

The background of the Hanford site, unlike the French experience, unlike many of the other experiences, Hanford had nine reactors, they had four different fuel reprocessing flowsheets, 100,000 metric tons. As we get into it later, you will see that there are differences in canister counts from the facility. The license application for Yucca Mountain limited us to a certain allotment of the capacity at Yucca. The high-level defense waste glass was going to have a certain portion. We were allotted roughly 9,700 canisters going into the facility, and the assumption was that there was half a metric ton of heavy metal for each one of those canisters. Those may or may not be a reality, but those were the imposition of requirements from Yucca Mountain.

So when you see 9,700, that’s from (inaudible). When you see other such numbers, those are from projections based on modeling efforts either by the BNI folks, who use a G2 model, which is very different than the tank farm folks and the system plan using H2’s model, different constraints, different assumptions. And so, as an example, you may see numbers for the WTP in the nearly 20,000, and that’s based on taking the minimum waste loading that BNI achieved and projecting it out through the entire mission. So those kinds of subtleties may give rise to great confusion as one considers.

So that is our problem. We have a lot of aluminum, because we used aluminum clad. We don’t have the problems of Savannah River, because we didn’t use a mercury stripping process. And so those are some of the big differences in our base chemistry.

Cesium/strontium was taken out for beneficial use. Unfortunately, there were a couple of leaky wells, and those canisters for irradiation were brought back, and they now sit in WESF decaying. The plant does have the capability, should it be decided that vitrification of that cesium is a good thing, that in the pretreatment facility there are six stub-ins on the north wall that would allow for (inaudible) facility (inaudible) the capsules, solvating the cesium and strontium, which are halite-based--they're chloride salts--and so you would have to drain those into your process very slowly because of the halites. The halites are not particularly desirable in an off-gas, and they certainly aren't desirable to the lifetime of the pipe from the refractory (inaudible) melting. So, typically, we get a safety question as to what would the impact to a dose be or the consequence of adding minimal to none, because you can't add very much of the halite at the same time that you bring in the cesium and strontium.

The reactor as it was back in the day. The reactor is the second reactor in our country after the University of Chicago. It was interesting that, as an undergraduate chemist, the chairman of the chemistry department was actually in Chicago when the pile went critical, and one of my other professors in New York was out at Brookhaven as the Director of Chemistry. And I had absolutely nothing to do with radioactive materials or an interest in it until I came here to Hanford. It was mentioned that I worked for Saint-Gobain. I subsequently learned that there was a branch of Saint-Gobain called Saint-Gobain Nucleaire; and when the French decided they were going to vitrify their waste, they simply took a piece of the company for which I worked and said, “You’re now in the nuclear waste vitrification.”

From that we--you’ve seen these kinds of slides before, anywhere from 53 to 56 million gallons here, about 176 million curies of radioactivity. Again, the difference between Hanford and Savannah River is, we took out roughly half of the activity and have them in capsules.

We have a mix of double-shell and single-shell tanks. Here is, I believe, S farm being constructed way back when, and those are single-shell tanks. This, I believe, to be the AX farm, based on the evaporator in the background there, and that’s one of the double-shell tanks under construction.

One of the biggest challenges that the contractors have and the Department has to live with is the ability to mobilize the solids, the sludges and the salts that are in these tanks, and to deliver them for treatment. Right now, unfortunately, the operating contractor in the tank farm is limited to about a 7 weight percent slurry. The first receipt vessel within the high-level waste treatment facility was actually spec'd out to have a 15 weight percent slurry with the glass formers added. And so there's a challenge to begin to mobilize the materials and pump it and deliver it to the facility that needs to be worked on.

Groundbreaking for the WTP, there's a picture. I happened to be out there on the day on which the power shovel went out back over a decade ago, and so I snapped a picture of them breaking ground for the WTP. And you've seen the difference since the groundbreaking. That did need a requirement to start construction by having that power shovel out there.

Some of the initial--or some of the troubles you hear about, the secretarial team with Milt Levenson and Tom Hunter and Monica, who is here, they began to address some of the rumblings of troubles in terms of mixing. There were a concept that was brought over from England with black cell. The English black cell, however, has access ports--ours didn't--and what the BNFL left us with. These are some of the initial receipt vessels, and the English also left us with the pulse jet mixer. Those are currently viewed as troublesome and problematic in deciding can you operate the pretreatment facility without access, without maintenance, without anything with pulse jet mixers and these black cells as part of the baseline.

These are some of the vessels going in during construction, 375,000-gallon capacity. There are four of them as the head end of the facility.

The baseline. You'll see reference to the system plan, Rev. 6. They say we'll produce 10,586 (inaudible) won't be one canister above or below that, because they're so accurately (inaudible) to five significant figures. I would not do that. We do know that we have about 60 thousand metric tons of sodium to treat, and we divide that between the two facilities, the LAW glass and the HLW glass. The current waste loadings that folks love to--when they come to the Department to sell us new technologies or a new panacea or a quickening of the mission or lessening of the mission duration is that they will project based on the absolute minimum waste loading in throughput, as defined in the contract with the BNI Corporation.

BNI, in their contract, were given minima for waste loadings of materials and performance. That was not a requirement stated as a minimum and the only thing that should be done; but contractors, being in business to add additional business, BNI went out and succeeded in meeting those minima and never really said, well, we could do better without any additional funds being added. So in 2007 I was brought on by the then-project director, and I was challenged to do better than what the contractor had delivered to demonstrate the full capability of the facility.

So that gave rise to the advanced glass formulations work that we're doing. And the thing that's most important to note is that the mission can significantly demonstrate improvements without any new capital projects and without any changes to the baseline design. I'm a materials person. I'm a chemist. I'm not going to ask the engineers, with the concrete, structural steel, and piping in place, to go and change things. I'm going to use the existing facility. I'm going to get better performance out of the existing melter and hopefully not at the cost of accelerating aging of components as we do it.

So the experience that we have and the opportunity we have to do work at Catholic University with Ian is incredibly wonderful in that we can measure these lifetimes, we can look at corrosion rates, and we typically do this in every set of runs that we do. We look at changes and how they might impact the Inconel steels, how they might impact the K3. And that's all in our reports.

I'll let you go through these. Performance, again, enhancements through improved glass formulations are transparent to the engineered facility.

What are our major accomplishments? We're demonstrating much greater flexibility for what could possibly come in the door for treatment. We are looking at advances in glass science that are allowing significant reductions in container and canister counts, container of the LAW sides, and, most importantly, is by increasing aluminum waste loading in the HLW glass. We no longer have to do caustic leaching in a vessel where we then have the secretary's team wondering about stress crack corrosion of that very same vessel because of the temperature variations. We can get more chrome, significantly more chrome, into the HLW waste form than the contractor demonstrated.

That means we no longer have to do oxidative leaching in some of the vessels. By simply removing the inconvenience of the aluminum, the caustic leach, we now free up pretreatment flowsheet by not having to address as much as--over 90 percent of the batches of waste coming from the farms would have to have caustic leaching in order to have met the BNI glass models. Now it looks like that won't have to be done. A third of the waste batches coming in would had to have had oxidative leaching for chromium. Those can be completely obviated by the new glass chemistry and throughputs.

I'll let you go through that and some of the stuff I've said. For HLW we have troubling ions, the aluminum, the aluminum with sodium because of the naphthalene--you'll hear more about that later--bismuth and chrome, again, crystal formation and precipitation within melts. Those we've addressed. Some here we're now looking at, in lieu of the contractor having about a 11-to-12 weight percent aluminum load in the waste form, I am well over 25 weight percent. The throughput is now--by reformulating the glass in lieu of having 800 or a thousand kilogram per square meter per day scaling factor for the melter, we're now looking at 1,600, 2,000 without really stressing the rest of the system. Ian has been up to over 3,000 kilogram, but there you're talking about playing with additional temperature and additional bubbling. Don't need to do those unless you have to.

And then on the LAW side, we won't talk about that. As I said here, we have about three times the commissioning targets now in our toolbox. Waste loading, we've been as high as 55 weight percent with high aluminum waste materials.

Results for LAW, go right through them. Robustness, things that we have to do is to revise the glass models so as to demonstrate what our real mission or what a different mission might look like once the new glass experience is added to everyone else's experience, we (inaudible) upon what they've done.

Again, models. Here are some visual representations of where the work started as to high-aluminum. Here is a progression of the aluminum increase and throughputs. The understanding we get of the waste form comes from PNNL. We'd like to add SRNL to our work. But, as you can see, there is a very big difference between formulating for glass where you have the same amount of aluminum in your simulant to deal with, but in one case you're very rapidly melting just by reformulating versus sitting there.

And that was the Savannah River experience. They had very refractory materials, and they couldn't get heat, plus they were dealing with a certain frit. And so they would have these periods of time where it appeared no melting was going on and then sudden surges into the off-gas, and they had a large volume of molten glass. Here we're actually doing the work to really understand what are the melt dynamics, what's the chemistry of the cold cap, and even trying to understand how we can retain certain troubling ions from LAW, as an example, by crystal growth within HLW to make refractory type of mineral forms that would be inclusions in the glass and not impact their performance.

Results for the bismuth, very rapidly go through. As you can see, improvements. It wasn't so successful with iron in terms of waste loading, but overall it's a 56 percent improvement between the waste loading and the throughput in the facility. The big message is sulfur. The contractor was originally challenged at a half-weight percent sulfur in HLW feed. We've demonstrated tolerances up to 2 percent. Very little difference in going from 1-1/2 to 2 percent; not really necessary in terms of economy of mission to go much above 1-1/2.

Here again, the kinds of canister counts based on--there used to be an anecdote that the sulfur would cause an increase in the number of HLW canisters. Clearly, we have demonstrated that you can get quite the opposite by formulating appropriately.

Here is overall what our mission looks like based on the glass improvements that we have been able to demonstrate up through a one-third scale. Very significant reductions and at least a third less canisters than others may have thought.

And then that I'll just leave you with, because Werner is here looking at me, and we can answer some questions later.

This is a cartoon. The baseline envelope met the requirements as set forth in the contract, and then the Federal Office glass program became, "We know we can do much better." We went about demonstrating--I like to use a hand; my colleague John likes to use cauliflower, and you'll see some of his presentations later. Mine, I went out and demonstrated what were the tips of the fingers in terms of performance overall, and now I'm filling in the webs between the fingers so that the engineering and flowsheet people can reconsider what feed vectors they send to the plant and know, can I tolerate these different admixtures and can I make good glass if I waste load it.

Sorry I've gone over (inaudible) back to Werner.

LUTZE: Thank you for the presentation.

Thank you for the four presentations, and we have now, I would say, 20 minutes with the little bit of overrun for discussion.

And let me just quickly mention that before the meeting I had communicated with the panelists, these four and the other ones, that I would encourage them to address accomplishments in the past three years, accomplishments in the next three years to be expected, challenges--technical, political, and financial--if there are any, and to point out where support would be necessary from R&D to support engineering. And I have seen a lot of these issues being addressed here very nicely, and that may help with the discussion as well.

So I am opening the discussion for the Board. Rod.

EWING: So this panel deals with the technology; but because Stéphane is on the panel, I want to jump ahead and ask a question. So we have decades of, I think, very nice substantive research in glass corrosion and various conditions. So, just taking the glass as a primary barrier to the release of radionuclides, what would be the best geochemical and hydrologic environment for the disposal of glass?

GIN: I think that after, as you said, decades of research in glass, we can say that the basic mechanisms are well understood. But the problem is, we don't know exactly how these mechanisms are combined to give a rate to given time and considering given environmental boundary conditions. We know that the rate can evolve from a maximum value to a minimum value. We also know what could be the final products based on (inaudible) dynamics, but we don't know precisely at which rate it goes from the maximum rate to the minimum rate, and I would take time to go to the more stable compounds.

So we have models that assume some combination of the basic mechanisms to give a rate, but the world community of experts agree to say that the model must be improved to have better provision, a better forecast of the rate, depending on time and on chemical conditions.

Globally, I can answer to your question, saying that we know that if you want a low rate--and that is a requirement if we want to show that we have a good--we have developed a good matrix for confining radioactivity for the geological time scale. We know that a low water renewal rate, a high concentration of glass former in the solution, are some important conditions for allowing the rate to be very, very slow, but--okay, I said that we know and we are able to predict the maximum dissolution rate for a given condition and given glass composition. But it doesn't look very interesting for the geological disposal conditions, because with a simple calculation you end up with glass lifetime very short, typically one thousand years or something like that. So it's not sufficient to demonstrate that the glass is a good barrier.

To demonstrate that the glass is a good barrier, we have to be in conditions where what we call the residue rate can control the long-term rate, the long-term behavior of glass. And for that we know now that it's better to have not too alkine or too acidic groundwater and not to have a renewal rate of the solution and, if possible, have a lot of glass former like silicon in solution to help developing a passivating layer.

EWING: Okay, thank you.

LUTZE: Thank you.

Yes, please?

CLARK: Sue Clark, Board. So I guess I wanted to try to make sure I understood what I was seeing when I compare between the different talks. I think I saw on Stéphane's slide that the French experience you've produced a lot more glass and a lot more radioactivity in that glass compared to the kinds of things we were seeing at Savannah River where maximum waste glass loading was about 38 percent. And so can you comment?

GIN: We have not produced more in terms of amount of glass. It's quite the same. The total figure I've mentioned is about 7,000 tons of glass already produced in France and similar number in the U.S., combining the different--summing the different sites. But the amount of radioactivity confined--because we have more fission products, because the burnup of fuel are higher in commercial fuel than in defense fuel, we have put in glass more radionuclides. But the waste loading are not higher in France; they are lower. It's just because it's more concentrated in fission products than here because the burnup (inaudible) are different.

CLARK: Great. And so that was my other question. Does waste loading equal radionuclides (inaudible)?

GIN: No, no, because (inaudible) this number of the fuel burnup. That is very different from a commercial fuel.

KRUGER: Another big difference are the amounts of noble metals. In commercial fuel there is a significant amount of noble metals; in our defense fuels there aren't.

GIN: And I have not given the figure, but we've put about three weight percent of noble metals in our glass.

LUTZE: I would like to raise a question to the panel that came up during the previous talk, and that was: We have learned so much about glass since 1980 when we formulated, for instance, the waste acceptance product specifications and so on. Wouldn't it be helpful if we raised the bar a little bit and made the acceptance criteria a little stricter? And I say that because of the acceptance criteria I used to model the performance of the glass in the repository. So if we offer a material that is worse for modeling than the one we can make, then that is not very helpful for those who do the modeling for the repository.

Could someone comment on it here?

KRUGER: I would simply state that--Albert Kruger, ORP. That is a question that came up with the secretary's presentation was taking credit. And I know Monica has a large interest in actual looking at durability of the glasses and taking credit for how durable they really are. In the LA, when it was prepared, it was a performance assessment that was based on a single test, the product consistency test, the PCT test. And if your glass could perform better than the environmental assessment glass in that test, that is pretty much the sole criterion for performance.

Do the glasses actually perform better than that? Yes, they do. The glasses with the high-weight waste loading that I report, typically we don't approach the trip points, if you will, for the EA glass by anything closer than an order of magnitude. In those cases it's two orders of magnitude. But, yet, there is a certain comfort in assuming immediately availability of the nucleides in a performance assessment to bound the risk to the public.

HAMEL: Yeah, if I can pop in on this question, I think, you know, in terms of raising the criteria, I think the glass is being challenged to perform at the level the glass is being demonstrated at. Raising the criteria would, I think, in my opinion, simply reduce the margin between your standard and the performance. The performance is fairly high, as we've seen from Albert's glasses. I don't know if raising your criteria has any benefit to raising the performance of the glass, as is the people that are working the glass such as Albert, are striving for high waste loading and high performance. I don't know if raising the standard gets you any benefit, you know, to answer that question.

LUTZE: Okay. Yes, please.

FRANKEL: Jerry Frankel, Board. So I'm a little confused, though, about this. So, at least for Yucca Mountain, it's my understanding that the TSPA took no credit for the waste form. And I think based on the assumption that the environment that would make its way through the canister would be extremely aggressive to the glass; is that correct?

KRUGER: In the Yucca Mountain model the canister was a convenience for transportation. There was no credit given to the availability of nuclides for diffusion through the environment. So you had this stainless steel container, but it in no way impeded diffusion of the material within the canister.

FRANKEL: No, it was an Alloy 22 canister that was, you know, where the credit was for the lifetime. But then once that was perforated, the glass--there was no credit taken. But--

SPEAKER: Perhaps Peter should answer that question.

SWIFT: Would you like me to?

LUTZE: Go ahead, please.

SWIFT: Peter Swift, Sandia National Labs. And I'm not a glass person at all. I have worked in repository performance, though. And, actually, Stéphane's answer earlier was just great on that one, that if you're driven to--and we are, of course, (inaudible) analysis considers the range of glass performance. And if you're driven towards the rapid degradation end of that, you end up with, as you said, something on the order of a few thousand years for your glass lifetime.

That's actually what happened on the Yucca Mountain Project. We did take credit for the glass, but the best we could do for the distribution that spanned--fractional dissolution rate and surface area were the two important variables in it. And the overall performance was dominated by the tail of distributions that had the most rapid degradation of the glass, lifetimes on the order of a few thousand years.

So in a million-year analysis, that does, in fact, look like no credit. But it was not because we chose to take no credit. It's where the underlying information took us.

KRUGER: The glass that was used in those modeling, was it ground glass?

SPEAKER: Huh?

KRUGER: The glass samples that were used in that modeling were results of ground glass traditionally.

SWIFT: You'll have to get somebody else to answer that. Go back to John Vienna (inaudible).

KRUGER: Right. And that's why I said with no credit, because if you take a monolith and you grind it into hundreds-of-square-meter-per-grams surface area, that's a very different dissolution experiment than taking a monolith and exposing it to the same conditions.

SWIFT: I don't actually know the answer to that question. The work there was done by Jim Kinney and Bill Ebert at Argonne.

FRANKEL: Just to clarify, you're saying that the module--the waste form degradation module in the TSPA was overly conservative? Is that the point that you're trying to make, that we shouldn't be considering the possibility of very fast degradation but the possibility of very slow degradation? Can you clarify that?

KRUGER: I think that it's reasonable to understand what the other end of the extreme is in terms of how will the glass perform in that environment. But from the standpoint of public safety, to say that it's degrading as rapidly as possible, that's a very easy point to defend, that I've taken the least performing aspect of my disposal facility, and here's the consequence to the public. So, from that standpoint, having the most rapid degradation is allowing you to make those statements: I'm not exceeding clean drinking water standards; I'm not going past certain other set points.

LUTZE: Rod.

EWING: Just to join the discussion, I think Peter would agree with me that one of the lessons from the Yucca Mountain Project is that realistic assessments of the performance of the different barriers is really the way to go. Am I safe up until that point?

SWIFT: Sure.

EWING: Okay, thank you. I'm sure we'll diverge shortly, but--

SWIFT: Peter Swift, Sandia National Labs, again. A realistic treatment of the full range of uncertainty. I don't advocate trying to go for a single deterministic, realistic result; rather, doing an analysis that incorporates a realistic assessment of your uncertainty.

LUTZE: Yeah, it wasn't my intention to focus the discussion on all of this here, so maybe if we have other questions from--yes, please.

PEDDICORD: Lee Peddicord from the Board to Stéphane, two questions. You mentioned that you shut down (inaudible) at Marcoule. Do you intend to put in place some capability then that--

GIN: In Marcoule?

PEDDICORD: Yes.

GIN: No, because in Marcoule we had three reactors for the plutonium production and one reprocessing facility. And all this stuff are stopped for a long time, and we are cleaning up the site. And all the high-level waste arising from the reprocessing facility have been vitrified, so it's finished.

PEDDICORD: So--

GIN: And the remaining (inaudible) that could be generated by the decommissioning of the plant will be sent to la Hague for vitrification.

PEDDICORD: Then with respect to la Hague and as you look at trends in higher burnup of the commercial fuel, is that going to impact the way you are processing at la Hague and as you develop (inaudible) capability there?

GIN: It impacts a little the glass composition. And there is a request from the safety authority to demonstrate the behavior of glass with respect to self-radiation (inaudible). Because of the high amount of fission products in minor and long-life minor (inaudible), we have to demonstrate that the properties of the glass would be maintained over time due to the self-radiation.

LUTZE: Yes, please.

FOUFOULA: Efi Foufoula, Board. I have a question for Jonathan. So you emphasized (inaudible) future work the growing need to provide flexibility (inaudible) windows and (inaudible) to put this into perspective with the black cell (inaudible). Is it fair to basically try to make sense of the need for flexibility (inaudible)? That's just the concept of (inaudible) flexibility.

BRICKER: I think, really, what I was trying to portray there was something a little different. And, really, what I was trying to address is the changes in compositions in the feed streams that come through the facility, not necessarily the components that make up the facility. So I was trying to address something a little bit different there. We've seen a lot of changes in just the different material that comes through the facility, so we're looking at flowsheet changes that don't necessarily impact or require us to change any equipment out. So I was getting at something a little different.

FOUFOULA: Sure, I understand. But (inaudible) because this (inaudible) and what comes into the facility, it is something that (inaudible) or accept that it will have some possibility.

BRICKER: Yeah, I mean, the only thing I can comment there is that, you know, we are--because we’re an aging facility, we are putting more focus on maintenance programs, (inaudible) liability. But even in terms of--you know, we mentioned the bubblers earlier. We had an option to either change out the melter or retrofit the existing melter, and that’s what we did. So other than placing more focus on those types of things--and there is something to be said for our ability to use our decontamination cells and actually put hands on the equipment. I think that’s very important.

LUTZE: Any other questions? Please.

TURINSKY: Paul Turinsky from the Board. It seems that Hanford is different in the sense that they used four different reprocessing technologies over the years, which gives you different waste streams. Is the idea of reprocessing that, by the time it gets to the mixer, it all looks the same? Or are the glasses--what’s going into basically vitrification going to be substantially different, and are we going to have a range of glass performance then?

KRUGER: We will have--if the PCT is the single test against which we measure performance, we will always have a glass that exceeds that requirement. Though there were four flowsheets for reprocessing fuel, there was certainly absolutely no concept that I can discover in the manner in which the wastes were managed in the farms. Things were moved, things were sent to evaporators to make space, waste put back in tanks, tank space availability. Yet, at the other end of the spectrum, we enjoy a certain luxury in that there were a certain number of tanks where they were filled once from a specific facility, and then all the piping was cut. Those are maybe five or ten of those small tanks.

But within the liquid, within the tank farms, the underground tank storage, it’s a cauldron, it’s a witch’s brew of what’s in there. Based on some of the estimates that were originally given over history, if it didn’t go out as a product, then whatever was purchased is somewhere in one of the tanks, in addition to rocks, two-by-fours, bricks, cleanup efforts.

And so the glass models that we wish to develop will allow the flexibility that, as waste is staged for treatment, we know in advance roughly where we’ll be operating the facility, whether it’ll be a high bismuth, whether it’s likely to have a high bismuth, an aluminum component coming.

So the analytical scheme along the way allows for staging waste months before it would ever be transferred, determining whether it’s an appropriate waste as it sits to come to the plant, and then, as it moves out into HLW, as an example, the three-, four-thousand-gallon batch that hits that first vessel would have four samples taken. It would be determined from those what needs to be added in terms of glass formers. Then, once that's mixed, up to eight samples are taken, glasses are fused, and you determine whether or not you have an acceptable level of confidence that what the rest of the batch will produce will be represented by those eight--no more than eight samples.

So as we gain process experience, we can back off, as long as we maintain at a very high level of confidence for the process (inaudible) control.

LUTZE: Any other questions? Yes, please.

BRANTLEY: Sue Brantley, the Board. Again, to Albert, I guess I was confused in your talk. You had accomplishments so far, and then you talked about that. Were those accomplishments in developing a model of glass that would allow you to do this, or was it laboratory experiments to making the glass? I didn't quite--

LUTZE: Predictive models.

KRUGER: Right. What we do is we begin with crucible scale. And then as we demonstrate success in a crucible scale, ultimately ends up at VSL with multi-day campaigns. The sulfur work is an example where I showed we had high sulfur with a number of the troubling--iron with chrome and some of the other troubling cations. That was a metric ton of feed as an initial experiment. That will then translate into repetitive multi-day campaigns in the DM 1200 to confirm what we've done.

Once all of those formulation and property parameters are collected and verified and reproduced, along with work that's done at PNNL, we then developed the glass models. Part of our problem to date was, as an example, there's a nepheline discriminator. The nepheline discriminator served its function in order to get a plant at Savannah River operating and operating safely in terms of producing a compliant glass at the end.

But when you actually produce glasses that by this discriminator would have been tossed out, you have to ask why. And the question then becomes, because in the discriminator those glasses had never been produced and put into that model. And so now the effort that we're going through is revisiting what glasses can be produced. And, as an example, for the aluminum we're talking about a thousand data points that are now being added back to the model, the nepheline discriminators being challenged as a method of determining what a good glass is, and it may, in fact, turn out to be a different model for nepheline formation that would give rise to a failing PCT.

And so that's the work that's currently going on and will continue.

TURINSKY: What do you mean by a model? Is that a (inaudible)--

KRUGER: A model means that--

TURINSKY: --or are we doing basic--

KRUGER: We’re doing interpolation based on actually producing glasses and defining a domain in which we’ve done work. There is no extrapolation here. Extrapolation would be--

TURINKSY: It’s neither a physics-based model either, though.

KRUGER: No, no. It’s just where have you been and have you measured properties that are acceptable processing and then ultimate performance, right, no extrapolation, no projections.

LUTZE: I would like to thank the speakers. We have exceeded our discussion time, and we will continue to the next part of our session. If the next three speakers would please come up here. Thank you again.

(Pause.)

Well, we begin the second half of this morning’s session. We have three speakers and the same procedure. We save the questions for the end of the presentations.

And our first presenter is now David Peeler. He is the Senior Fellow Engineer at Savannah River National Laboratory.

And I think you have a ceramic engineering background, and you are in charge of everything that has to do with the glass development at Savannah River. And so please--

PEELER: Thank you, Werner. Thank you, Panel, for having me today to speak to you on the glass formulation efforts for the Defense Waste Processing Facility and some of the accomplishments and some of the improvements we’ve made over the past several years to improve not only melt rate, waste loading, but open waste throughput.

As Werner mentioned, I am David Peeler, Savannah River National Lab, head of the glass formulation team that supports the Defense Waste Processing Facility with respect to glass formulation, improving waste loading, and improving melt rate. What I’d like to do is walk through a little bit. There’s been a lot of discussion on melt rate, waste loading, and waste throughput; and it ultimately boils down to reducing the mission life for the facilities, not only at Savannah River, but also at Hanford.

When we talk about melt rate, we’re actually talking about processing faster; that is, we’re both liquid-fed systems. We want to convert that liquid feed into a glass product as soon as possible. That increases--increasing melt rate produces more canisters per year, your output is more canisters per year, and that ultimately translates into reducing production time or reducing mission cost.

With respect to waste loading, you're making fewer DWPF canisters; that is, you're putting more waste in each can. Again, that translates into lower production time and mission cost, as well as reducing the number of canisters that ultimately go to permanent storage.

But ultimately there is a compromise between melt rate and waste loading that we like to talk about in terms of waste throughput. And waste throughput you can think of as the amount of waste you're processing per unit time; that is, you want to maximize waste throughput to process the maximum amount of waste per unit time through the facility. And if you're doing that, you're emptying tanks faster, and you're closing your mission life.

And I'll demonstrate that here on this slide. Sorry for the very small plot. Over here I'm plotting melt rate or waste loading on the x-axis, and I'll talk about the y-axis on the right y-axis over here, which is melt rate. And, in general, before the implementation of the glass pump or the bubblers that we've talked about previously, we had a general trend that for any frit/sludge combination in DWPF, we would actually see a decrease in melt rate as a function of increasing waste loading. And this is over an operating window, and that operating window is defined based on the frit/sludge system, the waste loading range over which I could process and meet all the processing criteria as well as the product performance criteria that Carol Jantzen mentioned earlier today.

So, again, as you increased waste loading, we generally saw a decrease in melt rate. So then you ask--you have to take a step back and ask yourself, okay, do I target the maximum waste loading that I can where my melt rate is slow, so that would generally push mission life out, but I'm producing fewer canisters, but it may have a negative impact on mission life; or do I come back at a lower waste loading, produce cans faster, but make more canisters? And that was kind of the boundary back in, I guess, the late '90s, early 2000s that we wrestled with.

What we found is--and this is just a schematic--that, depending upon the shape of that curve, you actually had an inflection point there where you could maximize waste throughput; that is, you could process the maximum amount of waste per unit time through the facility. And that's what Jonathan was talking about in terms of an operation space. This is the waste loading that they would target.

Now, with implementation of the glass pump and the bubblers, in a sense what you've done is you've flattened this curve out; that is, you've made the dependence of waste loading and melt rate less dependent, if you will, and you've flattened the curve out, so you can actually go to target a higher waste loadings and still go to more higher--or maximize waste throughput more effectively.

But ultimately what you will wind up with--even if that curve was flat, you will ultimately wind up with a processing or product performance constraint, the models we've been talking about, that will ultimately limit waste loading that you'll be able to achieve. And, as Albert was talking about, one of the missions--and we'll talk about it in a few minutes --is--one of the things that we need to look for in the future is expanding these operating windows to improve the waste loadings over these compositional ranges that are coming down (inaudible) in terms of the facility mission life.

Three things I've listed here in terms of physical or chemical changes we've done to the facility for DWPF is reducing the conservatism in the process control models. Carol Jantzen talked a little bit this morning about this would be a frit corner, a one-sludge composition, which may be actinide removal process stream coming in. This may be the actual sludge coming from Tank 40 or Tank 51. And ultimately you can think of the waste compositions, the two different waste compositions, the frit and the waste loading, defining some multi-dimensional glass base.

Then you start implementing your process control models, and this starts cutting off regions where it won't allow you to go. So you ultimately wind up in this multi-dimensional space with a little sphere in the middle, if you will; and in terms of processing, you want that sphere to be as large as possible. And Carol talked about the implementation of these little lines in here. These are the models; then we add some model uncertainty and some measurement uncertainty to those models. Well, if we can reduce the uncertainties in those models and that sphere grows, we implement a new model, that sphere can grow, that means we can get the higher waste loadings.

The other significant change has been this shift in frit development strategy. When we originally started up, we had a concept that one frit fits all. We had a frit, it was frit-200, and basically it was designed to handle all of the sludges coming downstream for the life of the facility and at lower waste loadings. And when we got incentivized to look at increasing throughput or waste loading or melt rate, we transitioned from this global one-frit-fits-all concept to, I think, a tailor concept where we specifically design a frit for each sludge batch that Jonathan was talking about earlier, that million-gallon tank. So we take advantage of the waste form, the potential of that million-gallon tank, design the frit specifically for that tank, and that allows us to go to higher melt rates as well as higher waste loadings.

Physical additions, we talked about those earlier. Again, the glass pump implementation followed by the implementation of the bubblers through Energy Solutions and VSL, that has dramatically increased melt rate, again, basically essentially flattening this response curve or the curve here so we can target higher waste loadings, maximize throughput, but ultimately we're going to be limited by some process control model, whether it's performance through a melter or a melter-related constraint or a product performance constraint to how high on waste loadings that we may be able to achieve.

With respect to accomplishments, I kind of took you back historically to where we were in the beginning. This is Sludge Batches 1A, 1B, and Sludge Batch 2 where we used this global one-frit-fits-all concept frit. We were nominally targeting waste loadings of around 28 percent waste loading. During processing of Sludge Batch 2 we had extremely low melt rates. We were asked to then design a new frit to increase melt rate and potentially increase waste loading. We designed Frit 320. Frit 320 was implemented along with the new liquid (inaudible) model that Carol talked about earlier, and we started processing Sludge Badge 2 at nominally 34 percent waste loading. And, again, that's the sixth waste loading point increase for that particular sludge batch, which is a significant--translates into a significant reduction in the number of canisters for that particular sludge batch.

And, as you can see down, we designed different frits for different sludge batches, again taking advantage of the waste form potential, designing the frit specific for that sludge batch to improve melt rate, improve waste loading, and ultimately improve waste throughput.

And we've targeted roughly 38 percent, 40 percent waste loadings. The last two or three sludge batches we've nominally targeted 36. If you look back at Jonathan Bricker's slides for, I think, Sludge Batch 7B, I think the overall nominal is around 38 percent waste loading. And as Jonathan talked about Sludge Batch 8, the frit 803 that we've designed, we should start processing that particular system in May of this year.

Future challenges--and this is my last slide--there's a lot of compositional swings in our current flowsheet. Jonathan talked about the sludge processing coming into one side, and we had the ARP stream coming into the SRAT--sorry for the four-letter words there. And one thing that the facility does is it basically has an on/off switch; that is, it can process sludge only for some period of time, then they'll get a slug of ARP product coming in. And that stresses the glass formulation side from the compositional swings that are pretty severe when we're trying to design a single frit that can handle those compositional swings.

And to give you some idea, the sodium concentrations from a sludge-only to a coupled operations flowsheet of about 2,000 gallons of ARP is about a six-to-eight-weight-percent sodium oxide shift. So, again, trying to design a frit that will handle that on/off switch, along with (inaudible) 36, 38 percent waste loading, along with trying to build in the variation that the facility has in terms of hitting that waste loading, is really becoming a challenge to us. So what we’re trying to raise the little red flag of is, you know, try to dampen out some of these compositional swings that we’re seeing and start becoming a more continuous process through that coupled operations flowsheet.

We also have updating models. Again, we talked about that earlier in terms of expanding the compositional range and over which we’re going to process in the future. It is an example now. Currently we are processing the MCU/ARP stream that Jonathan talked about. And from the glass side, we’ve put a limit on what volumes that they can actually process through the facility. And that’s based strictly on a titanium concentration, that our models have been developed and validated over a certain range of titanium. They asked us to look at 7,000 gallons of MCU/ARP coming into the facility. We turned around and said you can't go above 2, because we don't have the data to take you above the 2 to get you to where you need to process 7,000 gallons. So now we've got a throttle on the facility based on the lack of data that we have in hand on how much they can actually process of secondary waste.

So that's going to become of significant importance on trying to get ahead of the facility and trying to get the data necessary to update our models to allow this throttle to be pushed through the floor instead of kind of pulling it back and allowing the facility to operate where they need to be.

I think Jonathan or Carol mentioned high-level waste systems plan, and this is an annual plan that SR puts together that kind of looks at the future mission of the facility. What I see really vital to the success of the facility is getting ahead of the curve; that is, we're really good at getting DWPF--once we have a sludge batch, design the frits, and getting it implemented.

What we lack a little bit, I think, is, again, getting two years out, three years out ahead of the curve, having influence over that high-level waste system plan, to flag the issues that are going to come up downstream and allowing us, the technical guys, to get the data we need to update the models so they can meet their processing expectations. That is where I think we really need to work. That also has a player's role in the blending process as well as the washing strategy the facility uses.

So, with that, I thank you.

LUTZE: Thank you, David.

We move on directly to the second speaker, Dr. Ian Pegg. Dr. Pegg is Director of the Vitreous State Laboratory at the Catholic University of America and Professor of Physics. And I think all I need to say, if you talk about glass, it doesn't take long and his name comes up. So he has accomplished a lot in the area of glass vitrification over the years and not only in the United States, also working with Japan.

And I suggest you just go ahead and make your presentation.

PEGG: Thank you, Werner. Thanks to everyone for coming, and thanks to the Board for the invitation to present today.

I am going to give a very brief overview of some of the activities in the vitrification field that we're involved in and then move on to talk on some of the issues related to waste form development and implementation, most specifically relating to the Hanford Waste Treatment Plant. So let me move on to the slides.

So the Vitreous State Lab--forgive me if I say VSL after I say the name fully--was established in 1968. We're currently about 80 staff. And we have, as you've heard some about, fairly extensive, large-scale pilot testing facilities, which I'll say a few more words about, plus all of the infrastructure for the materials development and characterization that goes along with glass formulation and waste form development.

A necessary aspect of work in this area is, of course, the nuclear grade quality assurance programs, and somewhat unusual for a university is not only NQA-1 program, but also the repository, what was the Yucca Mountain program, the DOE-333P program, that we have in place and frequently audited.

Just in the outline, over the years we developed the glass formulation that was implemented at the West Valley Demonstration Project that was used to convert 660,000 gallons of high-level waste to 275 canisters of glass successfully at West Valley; a program at the Savannah River site, another 660,000 gallons of mixed low-level waste converted into glass that was ultimately delisted, resulting in significant cost reductions in the disposal.

We've been providing support to the Waste Treatment Plant since 1996, and I'll say more about that (inaudible) in the HLW and LAW formulation area; to the Japanese program at Rokkasho, support since 2005. That mostly involves things like mitigation of yellow phase salt formation, increasing waste loadings, and management of the very high noble metals that you find in these high burnup commercial reprocessing wastes.

And, last but not least, but since about 2009, support to DWPF, working with David and Jonathan and others. An example there, we just finished the support for the qualification of the Sludge Batch 8 glass composition that, as David mentioned, will go into service in May this year.

So moving on then to look at the generic question of glass waste form development. And, as you've probably heard from some of the forgoing talks, this really is a question of materials optimization subject to a set of constraints. And those constraints are defined by a number of factors for the particular application, not least of which is the waste composition, its variability, the engineered system that you're going to be using to treat that waste. That's the melter type and its characteristics.

And, of course, the performance requirements on the glass product. So one way of looking at this is here, product quality, which for the Hanford high-level waste is various kinds of standard leach tests, the product consistency test that you've heard about, and then on the EPA side the toxicity characteristic leaching procedure is also a required test.

Processability, this relates to characteristics of running this glass melt through the particular melter, which has its own engineered characteristics. And so we get into things like the viscosity of the melt at high temperature, the electrical conductivity of the melt at high temperature, because it's heated by conducting current through the melt itself. And both of those properties you need to know the temperature dependence and the composition dependence of those properties. You need to understand the phase behavior of the melt. Fundamentally, these melters are liquid phase reactors, but glass has the tendency if pushed to create crystalline phases; and excessive crystalline phase formation can lead to issues such as clogging the melter, preventing discharge. So you need to understand those relationships.

And then, last but not least--we've heard some about this, but probably should hear more--these are economic factors, and David touched on this a few minutes ago. And under that heading are all of these aspects such as waste loading; that is, how much waste is packed into each kilogram of glass that's produced. Obviously the more densely you can pack waste into the glass, the less glass you have to make to work off the pile of waste. That's clearly an economic advantage to packing more waste into the glass. That's what we mean by waste loading.

Another factor that David also touched on is how fast does that waste convert into glass, and there’s a number of factors that come into play there. The engineered melter itself, that will have its own characteristics. But there’s things you can do with the glass and flowsheet chemistry to affect those reaction rates. Fundamentally, these are chemical reactions converting the feed into glass, and by judicious choice of chemistries you can make that reaction go faster or slower, so you have both flowsheet and engineered factors to play with there.

There are other factors that come into play in terms of the economics, things like materials compatibility that affect the lifetime of the melter, corrosion of the refractories, the electrodes, the bubbler tubes, the thermal welds, etc., all of which have costs for replacement and maintenance.

So, fundamentally then, we have this optimization process of looking back over history, what data do we have, what correlations do we have, design formulation subject to these constraints. As a first pass, go out and make these glasses, characterize them, collect data, improve the relationships. This is the small scale, sometimes called the crucible scale testing end of things.

But very quickly then you have to get into testing in real live melters. And some of the unique capabilities that we have at the Vitreous State Lab is not only the largest test melter of its kind--this is a one-third pilot plant for the Hanford high-level waste melter that we saw some of yesterday--but also the largest array of such test platforms, five operating platforms in place. And why so many and why so large? Well, the problem basically at Hanford is the melters we're talking about are the largest of their kind. These are the West Valley melter sizes, the DWPF melter sizes, so DWPF about 2.6 square meters. The LAW melter is 10 square meters, and there are two of them; the HLW melter 3.75 square meters, and there are two of those. These are very, very large melters, pushing the limits of the technology.

And the only real way to understand the performance ahead of time is to look at the scaling relationships. And so we have in place under one roof a factor of 60 scale-up. And the program to support the WTP involved two pilot plants, two one-third scale pilot plants, one for the Hanford high-level waste melter and one for the Hanford low-activity waste melter. As Albert said earlier, this melter was run very successfully for five years, made 8 million pounds of glass, and was decommissioned after the fact, taken apart, examined. A lot of very useful performance information off that melter. Fortunately, the high-level waste melter is still in place. It's been running for over ten years now and is still being actively used for testing to support the WTP. So--

SPEAKER: (Inaudible.)

PEGG: Five minutes. Okay. Well, then we won’t get very far. All right, speed it up.

So the message here is integration of the glass formulation materials aspects with the engineered facility.

We’ve heard a lot about these melter bubblers. And I apologize for the flashing here; that shouldn’t be happening. But, in a nutshell, these are computer models of, actually, the Hanford high-level waste melter. This is the refractory, the electrodes in the wall that Bill Hamel mentioned. The bottom electrode was removed based on the reduction of the temperature gradient due to the bubblers. But, fundamentally, the glass forming materials and the waste fed onto the top of this molten glass. And you have a reaction of an interface, and the rate of that reaction is limited by heat and mass transfer to this cold cap region. And the unbubbled system, this is a viscous fluid. We rely on natural convection, and that can be the rate limiting process for converting waste to glass.

What we came up with some years ago--a subject of a series of patents--is a bubbling technology that creates active mixing, increases this heat and mass transfer process, and the amazing this is, really, that just that simple addition can give you up to five times increase in throughput. And in a nuclear facility, if you can get five times the throughput from the same footprint, that can translate into huge capability advantages. We've heard a lot about the implementation of the retrofit into DWPF. The important thing here is, this technology is in the baseline for both the Hanford high-level and low-activity waste melters.

A few words on the Hanford challenges. And one way to look at this--

SPEAKER: (Inaudible.)

PEGG: Okay, thank you. I'll go as fast as I can and wrap this up.

And I wanted to contrast the challenges at Hanford, really, with the challenges, for example, in commercial waste processing vitrification, the likes of which are Sellafield in the U.K. or at la Hague. And this really comes down to scale and complexity. The scale at Hanford is just mind-boggling, and the compositional complexity just bears no comparison even to Savannah River and DWPF. As we've heard, the whole history of the nuclear reprocessing flowsheet development is out there in the tanks at Hanford. This shows you the ranges of compositions just of some of the major elements in some of the Hanford waste. And just look at aluminum here, from 10 percent on an oxide basis up to some 70 percent. And this is after pretreatment to remove aluminum.

So waste form development here is, it's all glass, but we're really talking about very different kinds of glasses, the borosilicate glasses. But, for example, the high aluminum glasses, we're getting 26, 27 percent aluminum. It's nothing like the glasses at DWPF or in Europe.

The other things to note are the reprocessing waste, the waste that's coming at those vitrification facilities, is coming off a well-controlled reprocessing flowsheet. It's acid waste, very low solids. It's very well controlled, tight composition, low volume. It's just a very, very different problem. This is neutralized acid waste, huge amounts of sodium added, precipitated solids. You have a solids slurry management issue.

And just to roll this up into scale then, if, for example, we took the WTP HLW melter (inaudible) capacity after the first melter change-out to 7.5 metric tons per day, if we use the Sellafield and the French hot wall induction technology, those two melters would have to be replaced by 13 melters. If we went to the cold crucible melting, we'd be talking about 6 parallel lines to get that capacity.

And the (inaudible) just gets ridiculous if you look at LAW. The two LAW melters at Hanford, if you put in the hot wall standard, la Hague melters, you'd be talking about 50 parallel lines to do that job. If you put in the cold crucible melters, 23 parallel lines. We stood next to the LAW melter yesterday. If you can imagine taking that out and putting in 23 parallel lines, with all of the support on the (inaudible) end, all of the support on the off-gas end, it’s just not--could it be done? Maybe. But would you really want to do it? I don’t know.

Very, very quickly then, Werner asked that I touch upon some of these discussion questions. These are some of my thoughts on recent accomplishments, significant accomplishments in the vitrification area. We’ve heard a lot about the bubblers. Obviously that’s close to my heart. I think the installation of the cold crucible on one of the lines at la Hague was a very significant accomplishment. (Inaudible) is still the hot wall induction technology.

The completion of the vitrification program (inaudible) the VEK program also very significant.

Hot commissioning of Rokkasho, it’s had its problems. They did make 190 canisters of glass, hoping to start up at the end of this year.

And then these new advanced formulations that address these very high concentrations of things like aluminum, iron, bismuth, phosphorus, etc., I think, are very important in terms of the economics.

And in the near future, just a few thoughts here on some of the future direction. Perhaps I should stop there and try and make it another time. So thank you.

LUTZE: Thank you, Ian, for your presentation and for keeping in time.

That brings us to John Vienna, the last presentation. So John is Chief Scientist in the Glass Development group at Pacific Northwest Laboratory, and you're a materials scientist, strong materials science background. And you are not only involved in the glass, but in many other aspects of the WTP and the Hanford Project.

VIENNA: Thank you, Werner.

I'm going to take a little bit of a different approach from the previous two talks, and I am going to summarize the research being performed and the aims of the research for both the Office of Environmental Management and the Office of Nuclear Energy that demonstrate the overlap between those; and then I'll give some examples from Environmental Management.

So the Office of Environmental Management is in charge of managing the legacy defense wastes, in general, and that's where most of the focus is here today. And there is a significant effort in waste form development, primarily funded out of the local office here, the Office of River Protection, where Albert and Bill Hamel work and so forth.

One of the many missions of the Office of Nuclear Energy is the development of sustainable nuclear fuel cycles; that's performed under Monica's office here, the Fuel Cycle

Technology office. And both of these perform research. And with these similarities in mission, there is overlap in the waste form research being done, so let me start down the list of research topics.

The first one that you've heard a lot about is improving the waste loading of tank waste in glass. And that's done--and I've got here that it's done to improve economics. That's absolutely true, but, as Albert pointed out, there is an additional purpose for that. The additional purpose is to open up opportunities for other processing actions. Right now the baseline is to pretreat everything by, first, aluminum leaching and, secondly, oxidative leaching to remove aluminum and to remove chrome. During advanced waste loading and advanced glasses would allow us to do less leaching, and it may also allow us to do things like feed the HLW vitrification facility or the low-activity waste vitrification facility directly from tank farms without first requiring the need to go through pretreatment. And so this is a very important aspect, and that's why it's gotten a lot of focus in the previous talks.

The second one is understanding the melting process, and that's being done--Albert talked an awful lot about that and Ian also. There are a lot of coupled chemical and physical processes that occur when you go from melter feed to the melt, and understanding those processes is critical to ensuring that the vitrification facilities run appropriately at Hanford. With the wide variation in waste composition, each of them melt at a little different rate. And the numerous examples of process upsets that have occurred, not just in the U.S. but also abroad from a melting standpoint, what we're trying to do is fundamentally understand that process so that we can predict it, we can optimize the throughput, and we can avoid process upsets. So these two are primarily ORP-focused.

We also want to understand the long-term performance of glass, and we want to do that for a couple of reasons, primarily so we can increase the disposal options. This is a joint fuel cycle technology and EM-funded activity. We had a lot of questions in all of the earlier talk sessions about performance of glass. And what we're doing here is we're studying the long-term performance of glass so that we can look at other disposal options, so that we can remove some of the conservatism in the current models and take advantage--take better advantage of the inherent durability of glass. So this is the first joint project between fuel cycle technology and EM.

We are also developing advanced glass ceramics or crystal tolerant glasses. We're doing that for Office of River Protection and Nuclear Energy in order to increase the waste loading. But also, in the case of fuel cycle technology, we're looking at increasing the performance of the waste form, trying to get a higher performing waste form. We're both looking at advanced waste forms for technetium. We're doing that at Hanford primarily to increase the treatment options. If there are ways that we could remove technetium from the low-level waste stream, treat it separately, dispose it separately, there are a lot of advantages to the process that way. We're doing it for fuel cycle technologies and ORP primarily to improve the long-term performance, putting this long-lived radionuclide, technetium-99, into a very highly durable waste form.

In the nuclear energy side, we're looking at waste forms for pyrochemical processing wastes. Those are required to enable that technology to be used, and that technology has an awful lot of advantages, particularly for metallic wastes, metallic fuels, fast reactor fuels. We're developing waste forms for gaseous fission products. That's also an enabling technology. The rest of the world aren't capturing all of the same gaseous fission products as we would in the U.S. And we're finding coupled processes that can both capture the radionuclide and immobilize it into a waste form; and they have to be long-lived waste forms, particularly for the iodine-129. And, finally, we're developing alternative high-level waste forms for significantly improved performance for nuclear energy.

So what I was going to do is give a few examples of the Environmental Management; but before I did that, I want to point that there is an awful lot of correlation and collaboration between the two offices. There is no accident that Ken Picha and Pete Lyons and Monica Regalbuto are all sitting right next to each other. The two offices do work very closely together. They collaborate in these areas and others. You heard Ken talk about the salt processing. So this is a very collaborative effort, and that’s why I’m presenting it in this way.

So these four examples I have slides for. I’ll get as far as I can through this. First, if we look at waste loading for Hanford wastes, the first step is to determine what (inaudible) of the glass is limited by what constraints. And what we see here is 70 percent of the glass is limited by--and this is high-level glass, high-level waste glass. This is limited by high aluminum (inaudible), spinel precipitation, and nepheline precipitation problems. We have a sulfur limit that’s about 10 percent--I’m having trouble seeing that--phosphate limits at about 10 percent; sodium limits are only 1 percent; and chrome limits are somewhere around the 10 percent also.

So what we’re doing is--this is a snapshot of today. What we’re doing is trying to push back those frontiers. And we’re doing that at a collaborative research project that’s being run by the Office of River Protection, and it involves Catholic University and PNL and DOE. And one example of where we’ve gotten is the nepheline models where we have--here we show ternaries of sodium, alumina, and silica submixture in the glass. And here the white hot regions are the regions where there’s a very high potential for nepheline precipitation on cooling. And the green regions, there is effectively almost no chance. And we’ve got two ternaries. One of them has no boron, and the other one has 15 percent boron. And you can see how both the sodium, aluminum, silicon, and boron strongly affect that.

By implementing this simple model, we were able to--to enable this model, we needed experimental data. So we’ve been collecting experimental data, an awful lot of experimental data, and then we fit it to composition. And by implementing this model, we could increase the average maximum alumina content in glass from about 20 percent to about 28 weight percent; and that’s a very significant impact on both the amount of glass we would produce and the potential flexibility to do less aluminum removal in the retreatment process.

Likewise, we’ve been looking at crystal tolerant glasses for Hanford. The ubiquitous crystal that we see all the time is the spinel crystal. I think you’ve heard it mentioned by both David and Ian. And it’s quite a nice crystal, actually. If you look at the crystal there, it's regular shaped. This is an example of a spinel crystal that precipitated from a glass melt. And, in and of itself, it's not a problem. What becomes a problem is if it agglomerates. And this is an optical micrograph of a spinel sludge. And if this forms at the bottom of the pour-spout riser, it could have fairly significant impacts to the ability to operate that melter. You could plug the pour-spout and not be able to initiate pouring.

And so what we're trying to do is develop a new set of constraints, a new way of looking at the problem, where we truly avoid the deleterious effects of this sludge formation while not limiting the loading of glass as much as we did. And we've got preliminary models for that, and there is a poster on this later this afternoon, so I encourage you to look at the poster for more details.

The next one is understanding the melting process. A lot of complicated physical and chemical processes that are all coupled occur right here in this cold cap region. You have gases generated in the cold cap and in the melt that interact with it; you have multiple liquid and solid phases that interact; and so what we're trying to do is develop models to fundamentally understand that.

One of our accomplishments is we've achieved a one-dimensional model, and that model would basically be the reaction model that would go on top of the heat mass charged transport model that Ian showed in his diagrams where there was a flow inside the melter. He used the cold cap as sort of a static heat sink and mass source. This would replace that set of boundary conditions with a real coupled chemical/physical model, and we’re doing a lot of testing to parameterize that model. And there’s two posters on this this afternoon.

And the last one--and I did want to just maybe go over by one minute, if that’s okay, because there was a lot of questions about glass corrosion early on in the session. And one of the issues is that there is a very broad range of predicted responses. What this is is the Yucca Mountain license application model for glass corrosion. This is what it basically predicts. As a function of pH, this is the log half-life of glass. And you can see that for two different temperatures--we have 25°C here and 100°C here--we have several orders of magnitude difference of glass corrosion.

And, as Peter Swift said, we tend, by the way we did the sampling in the Yucca Mountain license application, to favor the low durability/high release curves much more. And the reason why we have this is twofold. If you look at the reasons, there’s two basic reasons. If you take glass and you put it in static or very slow-flowing water, what you get as a function of time, the amount of glass released, is an initial jump in the amount of glass followed by a residual rate that Stéphane Gin talked an awful lot about. And there is a potential for some systems for that rate, that Stage II rate here, to jump back up again to Stage III.

So one of the significant events that caused these low durabilities is that we didn’t have the data or the understanding to rule out this jump up in rate, this Stage III potential. It only happens under certain conditions. And then the other one was the surface area. We had to estimate the surface area of glass; and as the rate is a per-surface-area rate, every time you increase the surface area, you increase the amount of glass corrosion.

And so we’re attacking those and other problems now as part of the international program on glass corrosion. And what we hope to get out of it is a better understanding so we can use this lower Stage II rate, avoid this jump up to Stage III, and we hope to be able to open up the options for disposal of glass into a range of different environments. We’re studying this glass corrosion not just for Yucca Mountain or not just in deionized water, but as a function of the disposal environment. And so we’re hoping to open up those options.

And that’s all I have. Thank you.

Oh, and there’s a poster on this also this afternoon on the technical details.

LUTZE: Thank you, John.

So we can now proceed to the discussion part. We have about 25 minutes of discussion. So are there any questions? Yes.

PEDDICORD: Yes, a question to David. First of all, your work with the frits was very interesting, and it looks like your return on investment in terms of R&D (inaudible).

The question I wanted to--I'm sorry, Peddicord from the Board. The question I wanted to ask then was: In contrasting your experiences with the situation here at Hanford and given the kind of mixtures that we heard from Albert and Ian and so on, are these same strategies applicable and usable in terms of tailoring the frits to sludges and so on (inaudible) characterize what your experience is.

PEELER: The short answer is yes. They do it a little bit differently. They actually tailor the frit on the fly, because they're using glass formers. So they can bring in a batch, a smaller batch, get its analysis, and then calculate the glass formers and their concentrations on the fly. So they do not use a prefabricated frit like DWPF does, that they will be doing optimization on the fly.

PEGG: Yeah, I think that's a very important point. The question of flexibility has come up a number of times. And because of the variability complexity of the Hanford waste, the decision was made not to use the frit strategy--that is, a premade frit--because the issue is you need to have that frit made in advance, delivered. It’s probably a three- to four-month cycle to procure all that frit. So what actually happens--and we saw some of it at the WTP--is there’s a series of eleven silos of raw glass-forming chemicals, which you can dial in and essentially make the components that would make that frit on the fly. And those ingredients are dialed in based on the batch that comes in; it’s analyzed; you dial in essentially the frit you need on the spot. So that’s a key aspect of the flexibility to respond to the compositional diversity at the WTP.

LUTZE: I would like to ask one question to everybody. As I understand it, the technetium at Hanford and WTP, that is not captured in the solidification process. It goes to the IDF, and there it obviously poses a problem, because that’s one of the critical elements to be released there. So do we have enough data and research done to understand the behavior of technetium in the LAW and the WTP vitrification plants? Anybody want to address this?

PEGG: I guess I can say something about that. So it’s perhaps a little surprising that it’s only in the recent few years that that question has been looked at with any scale in terms of the performance of the unit operations in the WTP. So some years ago we had an EMSP program, looking at some of the more fundamental aspects of the incorporation and structurally of the technetium into LAW glasses. But the question of, for example, the decontamination factors for each of the off-gas unit operations, what is the split between technetium in the feed, the fraction that's retained in the melt, versus how much goes to the off-gas (inaudible). Those were really not run, but there was a program at work the past three years or so where that testing was done. So the LAW flowsheet, there are first-of-a-kind data on decontamination factors across a range of LAW waste compositions. The same information is not available for the HLW side of the WTP flowsheet.

But I think the short answer is, some has been done, but I think more would be very useful.

LUTZE: Thank you.

Any other questions? Yes, please.

FRANKEL: Jerry Frankel, the Board. So I had a question earlier for Carol about the long-term performance testing. But, John, you brought it up again, so maybe you can address it. I'm interested in the acceleration factors in those tests and how you know that you're not making hard-boiled eggs.

VIENNA: That's an excellent question. The root of most of the difficulty in studying glass corrosion--and it actually becomes much more difficult when you go to ceramic corrosion, as some of those are quite a bit more durable. The amount of corrosion that you get is so little within laboratory time scales that you have to do--in some cases, you have to do the acceleration. And so we try to understand the processes that we use to accelerate so that we can back-calculate what it would be unaccelerated. And then we use either man-made or natural analogs to help understand whether we got that correct.

And we have a series of man-made glasses that we know the conditions that they've been in. They've been in the Mediterranean or Adriatic Sea, and they've been there for 2,000 years. And we know the temperature, we know the composition of the solution, and by looking at these samples we are gaining the understanding of the process rates. And we are using those as benchmarks to make sure that what we do to accelerate and how we reverse that process is true to the real data at least out to about 2,000 years.

FRANKEL: So you're using temperature and acidity and--

VIENNA: We use temperature, we use surface area--are our primary two aspects to accelerate.

LUTZE: Just to add to this, one cautioning, of course, and that is, with the natural analogs, these are not compositionally different glasses, so they're not borosilicate glasses. So we have to make the assumption that the mechanism is the same. But it's a good tool that supports the research. Just a little warning.

BRANTLEY: Just on that point--Sue Brantley of the Board--it’s also very different to be buried in the Mediterranean Sea as opposed to being a porous media in vadose zone or something like that; right? I mean, there’s a big difference in terms of that.

VIENNA: Certainly, yes. But it is a known environment. And so at least we have a touchstone that goes out for 2,000 years in the case of the man-made samples, and we use that to compare to experiments that we do with the same glass composition in our laboratory environments. But it’s really ultimately reactive transport models, populated reactive transport models, that allow us to predict what the performance of the glass will be in a disposal environment.

LUTZE: More questions? Rod.

EWING: Rod Ewing, Board. A question for John. So you showed the very nice diagram of the change of the release rate with glass as a function of time and raised the issue of this third stage where suddenly the rate would go up. There are many things that can cause that rate to increase, but fundamentally these are changes in the boundary conditions; that is, the flow rate changes or material--a new phase begins to precipitate. And so, thinking about avoiding that possibility, are there geochemical environments that you can imagine for a repository that would be better or worse because of this possibility?

VIENNA: Certainly, yes. I think that we saw, for example, the Belgian disposal concept, which very much promotes an accelerated rate because of the high-pH cement pore water solution that would be in contact with glass. That is a relatively harsh environment for glass to be disposed of compared to tuff at Yucca Mountain or the argillite in France or some of the other disposal concepts we've looked at.

EWING: What environment would enhance the behavior of glass?

VIENNA: A dry one is one potential; it's just one potential.

LUTZE: Are there other questions?

I would like to ask one other question that would have been to Stéphane Gin, but also to everybody who intends to reprocess in the future. You showed this enormous amount of activity vitrified, which also means that there was an enormous amount of krypton somewhere released during the reprocessing. Is there any active research going on to consider what to do with the krypton as a waste form? I mean, we all know (inaudible) rubidium, and rubidium is a corrosive alkali element. And yet I think something could be done with the krypton.

Stéphane? Is he still here?

GIN: I'm not sure about the studies that are conducted in France for immobilizing krypton. I know that we are doing some work on iodine, because it could be a request in the future that iodine must be confined in durable matrix, and we are starting corroboration with PNNL in this field. But, yes, you said krypton and other mobile elements that are released in the atmosphere or in sea water at the present time. But I'm not sure--the question is more important for krypton compared to iodine. So we are doing some work on iodine. The krypton, I don't know.

VIENNA: I can answer what the U.S. is working on there. The U.S. is looking at a range of options for krypton with such a short half-life. Old (inaudible) fuel, the krypton could be vented with minimal impacts; but for short (inaudible) fuel, by federal regulation, it would have to be captured, and it would have to be stored. The base option that we're looking at is storing it in a compressed cylinder in the presence of a metalorganic framework that helps to decrease the pressure in the gas cylinder and potentially immobilize the daughter product in a network so that it doesn't reach the valves and the side walls of the canister so much. But we've also got an option where we solidify it by sputtering either in silicon carbide or in copper.

LUTZE: Thank you.

More questions? Well, we need more questions. We have ten minutes.

Well, one thing to my mind, and that was, we talked a lot about the bubblers and the beneficial effect of the bubblers by the strong increase of the throughput, which gives us a chance to complete the mission earlier, but there are probably limits as to how much funds are available to do so. Does the funding of the production of canisters go step-in-step with the increase of the production rate? So can you actually make at DWPF as many canisters as you like, or is there a funding limit? Can somebody answer that question?

PEELER: I'd refer to Jonathan on that, if he's still in the audience.

LUTZE: Maybe Carol knows the answer to that. Carol?

JANTZEN: Sorry, Werner, I wasn't listening.

HERMAN: (Inaudible) canisters per year (inaudible) include that in the budget. So there is--I'm sorry.

LUTZE: Come here, please, to the microphone.

HERMAN: Connie Herman from SRNL. From my understanding of the DWPS budget allocation is they assume, with their system plan David referred to, how many canisters they're going to make per year, so there is a high end. They have some flexibility in their budget to be able to accommodate--if you're going to make more canisters, you would need more frit, so a materials budget. So they would have to accommodate that in their overall budget.

So they are planning--you know, if they're going to make 200 cans and they get to a production rate of 300, so the next year they would adjust that for that. So it is a reallocation they do within their budget.

LUTZE: Okay, thank you.

Any other questions? Yes, please.

ZOBACK: Mary Lou Zoback, Board. This is a really naïve question, but it's been bugging me since Carol's presentation. The Savannah River melters are circular; they're round. And West Valley and the plan for Hanford are square. And my experience melting things in round pans--pots--is that that's an efficient way to do it. So what are the advantages of the square design for melters?

PEGG: I think the round melter concept came basically around the tank-type design. The more square or rectangular design, particularly as you get to larger and larger scales, affords a fair amount of simplicity in the refractory shaping. So these refractories are very dense, high-chromium refractories, and straight, flat walls versus curved surfaces, especially as the melter gets larger and larger, so there is a fabrication and construction element involved. But, beyond that, the West Valley experience did not suggest that--and, for example, the (inaudible) experience did not really suggest a significant difference between the round shape and the corners, particularly--

ZOBACK: You don’t get material stuck in the corners (inaudible)?

PEGG: Much less so with the bubbled melters as well. When you have the pool being even more active, it becomes less and less of an issue.

ZOBACK: Okay, thanks.

LUTZE: Well, if there are no further questions, then we conclude this morning session. And I would like to thank all the contributors one more time. Thank you very much.

EWING: And just a few words before we all leave for lunch. I wanted to thank Werner for running both panels. I think it went very well.

We’ll start promptly at 2:15. And we realize that everyone will scatter for lunch. So, just to give you maybe a time advantage, we have notified Anthony’s that there may be a lot of people coming, so they’re ready for you should you choose to eat at Anthony’s. It’s not an advertisement for them, but it may be efficient.

So we’ll see you at 2:15. Thank you.

(Whereupon, a lunch recess was taken.)

AFTERNOON SESSION

GEPHART: Welcome to this afternoon's meeting on comments by tribes, state, public organizations. We have asked the six folks that I will be introducing to share some of their views and, most important, technical issues associated with the (inaudible) of high-level waste and spent nuclear material that is stored at the Hanford site.

The basic protocol to get us through the next hour and a half is, we have about fifteen minutes per individual, in which I will recommend ten minutes for presentation and about five minutes for discussion with the Board so there's an opportunity for the Board and the speakers to engage.

By the way, my name is Roy Gephart, as Rod just noted. I am a consultant to the Board for this Hanford visit, and I retired ten months ago after nearly 40 years with the Hanford contractors and Pacific Northwest National Laboratory, retiring as a Chief Environmental Scientist with the Pacific Northwest National Laboratory.

The only other items I have is, I passed around to the Board and to the staff copies of Russell Jim's discussion. The other talks for which there are thumbnail copies electronically, they are over here on our computer, and members of the Board and others will receive electronic copies of those. Not everyone will have PowerPoint presentations.

So, with that, it is my pleasure to introduce Russell Jim. Russell Jim is the Manager of the Yakama Nation’s Environmental Restoration and Waste Management Program.

Russell, you can sit or you can stand, whatever your pleasure is.

JIM: Good afternoon. Welcome to the ancient land of the Yakamas. This area was the wintering ground for the Yakama for millennia, based upon a slow geographical locale, witnessed by a confluence of three rivers, the Snake, the Columbia, and the Yakima. A little point of irony: Where we are now is where my ancient relatives camped. The camps had their families and extended families move in, and from here they decided in the spring which way to go. They discussed it all winter and decided to go to the usual and accustomed places: Canada, Montana, Arizona, northern California, or the coast. That was the lifestyle based upon not wanting to deplete the resources by staying at one spot. And right now the foods and medicines are coming out. Here they would be near done. They would be gathering them as they went up towards the alpine area.

Another bit of irony I heard this morning, the bugle call that was summoning the people back into the room. It sounded like the one they used to use and circle the wagons.

So what I am going to address is the problems we're having as the most affected people in this region, most affected by the Manhattan Project. The Manhattan Project was moved in here because they knew they needed the abundance of cold water, the cheap electricity from Bonneville Dam. It was an isolated wasteland, and the people were expendable. That was a little upsetting when I read that in 1979. We are the most affected people, but hardly any entity will put that in black and white.

I have read the United State Constitution, in which it states that the treaties are the law of the land. How many in this room have read the Treaty of 1855 between the Yakama Nation and the United States of America? One, two, three, four, five. That's been the problem. Not many have taken the time to read or understand, and so we consistently have to address over and over the logic of the uninformed.

I have a written statement here, and I'll try to finish up in the next five minutes.

"Thank you for the opportunity to speak to the Review Board today. Today the Board is considering daily activities concerning the vitrification of high-level radioactive waste at Hanford for eventual disposal in a repository. The Yakama Nation has concerns at Hanford, which include this matter and which encompass issues far beyond this matter as well. The Yakama concerns arise from our contract with the United States, the Treaty of 1855, which guarantees perpetual rights to fish, hunt, and gather our traditional foods and medicines on open or unclaimed land, including land at the Hanford site. The Yakama land at Hanford was ceded to the United States in the treaty with the provision that such rights would remain forever. The treaty involved a grant of land and rights to the United States by the Yakama Nation, not the reverse.

"For those of you who may question whether a treaty issue is properly in the domain of your review activities, I offer the following: The Board was created under the 1987 amendments to the Nuclear Waste Policy Act and as part of the statutory framework for dealing with spent fuel and high-level nuclear waste. The treaty ratified by Congress and signed by the president is part of the statutory framework for relations between sovereigns and is considered the supreme law of the land.

"Absent an express act of Congress, to the contrary, treaty rights at Hanford are fully intact and have a direct bearing on the issue addressed today. Only the Yakama government has the authority to express its unique concerns regarding Nuclear Waste Policy Act implementation and effects on its rights. We ask that you understand and support full compliance with those treaty rights. Notably, the Yakama Nation contributed to the parent language of the Nuclear Waste Policy Act in 1982, which led to the inclusion of affected tribal governments in the high-level waste disposal review process.

"A distinct area of concern for the Yakama government is potential reclassification of high-level radioactive waste at Hanford. Eleven years ago the Yakama Nation joined a federal lawsuit to prevent the Department of Energy from reclassifying high-level waste. The District Court sided with the Yakama, Washington State, and others. On appeal it was ruled that the matter was not ripe for a decision. Despite this legal uncertainty, I request that the Board consider all the relevant factors which will affect future disposal of this extremely toxic waste.

"During the high-level waste legal challenge, DOE requested that Congress clarify the Nuclear Waste Policy Act. This led to an unusual situation, to say the least, in which Congress was provided--has provided the Secretary of Energy with authority to reclassify high-level waste in South Carolina and Idaho, but not at Hanford. The Yakama Nation, Washington, and others oppose reclassification. Senator Maria Cantwell's efforts prevented such redefinition authority at Hanford in the 2005 Defense Authorization Act. At the time these concerns were articulated by former Governor Christine Gregoire, then Attorney General, in a letter to Senator Cantwell on June 1, 2004, quote, ‘The problems associated with the storage and disposition of high-level waste, however, require real solutions, not avoidance through redefinition,’ unquote.

“If this waste is reclassified, I am concerned that DOE will attempt to dispose of significant volumes of high-level nuclear waste at Hanford near the Columbia River rather than at a geologic repository, as currently required. For the Yakama Nation these concerns are undiminished today.

“In an August 7, 2012, letter to the EPA regional administrator, the Yakama Nation cited possible violations of the Nuclear Waste Policy Act at Hanford. Specifically, it was documented that high-level radioactive waste was historically stored at the 618-10 and 618-11 burial grounds and that such retrieved waste is to be disposed of in the landfill at Hanford. The waste (inaudible) criteria for those landfills forbids emplacement of high-level waste. Of course, the Nuclear Waste Policy Act forbids disposal of any high-level waste in any landfill.

“I request that the Review Board examine the situation in detail. A decision process in which high-level waste exists only if the Department of Energy says it exists is neither credible nor viable. Any violation of the Nuclear Waste Policy Act will result in mistrust by the citizens of this region, will undermine congressional intent, and will pose a grave risk to human health and the environmental protection.

“The situation cited here is of acute concern. On the horizon is possible redefinition of high-level waste, waste which was discharged or leaked from the single-shell tanks, waste left in tanks as residuals, and waste separated in the so-called low-activity waste, a term which has no legal basis. The Review Board would do this region, the nation’s taxpayers, and Congress a great service by highlighting the consequences of this ad hoc high-level waste strategy, which defers to DOE on classification questions and leaves the most important question unanswered: How much of this high-level radioactive waste is planned to be left at Hanford?

“I would like to bring forth another matter to the Board, which involves a consequence of not cleaning up and properly disposing of this toxic material. In 2002 the Yakama Nation initiated the CERCLA Natural Resource Data Assessment for the Hanford site by bringing a claim for injury to resources in the 1100 area. Damages under CERCLA arise from injury to natural resources caused by the release of hazardous substances. The CERCLA was later expanded to include hazardous releases from the entire Hanford site and was joined by Washington, Oregon, the Umatilla Tribe, the Nez Perce Tribe.

“A recent completed preliminary estimate of damages calculated primary restoration costs in excess of 20 billion. This estimate excludes injury arising from any high-level waste left in the tanks, leaked from the tanks, or which may be otherwise left at Hanford. The Yakama Nation would like its treaty resources at Hanford to be restored. Compliance with the 1855 Treaty requires such restoration.

“The treaty signatories did not contemplate the exercise of treaty rights, which cause extraordinary health effects and fatal cancers. Since I believe that your charter is ultimately to protect humans and the environment, I ask that you document for the record the potential impacts to our tribal members and to our treaty rights from any high-level waste which could be left at Hanford.

“The Yakama government has embarked on an effort to research the spectrum of effects of exposure to these dangerous toxins. I request that the Board consider the unique pathways, exposure, and effects from high-level waste to our genetically and culturally distinct people when you are deliberating the disposition of this material and document the impacts accordingly.”

I thank you for your time, and I’ll be glad to answer any questions.

GEPHART: Are there any questions from the Board?

Questions from the staff?

Then we'll proceed with the second presentation.

Thank you, Russell, very much.

The second presentation is by Suzanne Dahl. Suzanne is the Tank Waste Section Treatment Manager for the Washington State Department of Ecology, one of the signers of the Tri-Party Agreement.

Suzanne.

DAHL: Thank you, Roy.

And thank you, Russell, for going in front and leading the way, as always.

On the part of the Department of Ecology in Washington State, welcome to our state, and thank you for the work that you do on important issues regarding high-level waste. I know that other folks on the panel will discuss many of the things--I had some opportunity with you yesterday--thank you--and talked about a regulatory framework, so I'm not going to go back over that. And I'm going to try to concentrate on some specific questions that had been asked when we were setting up for this meeting in the last couple of weeks.

So, as you've heard undoubtedly through the morning, that there is spent fuel at Hanford; there is high-level waste. The high-level waste is in different forms. I'm going to spend a little bit of my time talking about the Waste Treatment Plant and where we need to go and a little bit more answering the question of why is there a need to glassify the immobilized low-activity waste at Hanford.

Hanford has 60 percent of the nation's high-level waste. It's about 195 million curies, an amazing 190,000 tons of chemicals which are hazardous waste. Ten of our single-shell tanks have been retrieved out of the 149. Six single-shell tanks are currently leaking, and one of the double-shell tanks are currently leaking. This is important because, even though we've had 67 past leakers in the past, we had at that point assumed they hadn't been leaking anymore after the liquid had been removed from them. And so we thought that for the moment that they were sound and not leaking into the environment; to step off into this year, into 2013, and have six tanks leaking to the environment and a double-shell tank that's significantly compromised and needs to be taken out of service is a significant issue for the State of Washington.

The waste is managed, from the State's perspective, under the Dangerous Waste or the RCRA regulations, and we have both Tri-Party Agreement, Hansford Consent Order and Agreement milestones for the cleanup of tank waste, and then we also have a 2010 consent decree that's signed in front of a judge.

You guys have seen some similar graph before. Most of the waste from the tanks will--most of the volume will go to the low-activity side. This is important for us. Most of the chemicals will go to the low-activity side; about five percent of the curies will go to the low-activity; 95 percent of the curies will go to the high-level side, destined for deep geologic repository, but that turns out to only be a small fraction of the volume.

So, not to have a pun in your title of the slide, but for us the path forward for tank waste is as clear as glass. We need to maintain focus on building the five facilities that make up the Waste Treatment Plant. And if there’s modifications that need to be made in the design, then we need to take this time to make those modifications so that we have a durable, workable set of facilities when we get started. We need to prepare the facilities and infrastructure that are needed to feed the waste from the tank farms. And, also, if there are facilities or systems that need to be put in place to make sure that the waste coming from the tank farms to the Waste Treatment Plant is compatible with the Waste Treatment Plant, then we need to make sure that we’re doing that now also.

We need to provide current and future safe storage for the tanks waste while the treatment facility is being completed and for the 30 years that it will take to treat all the tank waste; and obviously this means moving as quickly as possible waste from the single shells to the double shells.

And if that in cases means that we need additional capacity to do it, additional tank capacity, then that's something that must be considered.

And then, lastly, we need to construct other support facilities which you can't run the whole Waste Treatment Plant without. That includes a place to put the high-level waste glass as it's being stored and waiting to go to a deep geologic repository. That's a facility that needs to be designed and constructed and funded. And then also, in order to get all of our waste treated, we need to have the additional low-activity systems on board that we need to get the mission done within a 30-year time frame and not an 80-year time frame.

So, just to give you a little bit of history on the immobilized low-activity waste at Hanford, in the mid-'90s, while Savannah River was moving forward with its vitrification facility, the Department of Energy asked the State of Washington to delay our vitrification facility. We had started it, there were some issues, and they asked us to delay it. And, one, there just simply wasn't funding to do both major vitrification facilities at the same time; and there was the need to want to learn from how this facility would work at Savannah River.

And so the trade that was made for that was, we would take the delay. We thought it was going to be a ten-year delay. We had no way of imagining it would become a 20-year delay. And what we got for that trade was the commitment then to vitrify our low-activity waste, because that was the issue at the time was the current studies of the low-activity waste, which was going to be grouted at the time, there were impacts to the groundwater beyond nitrate concentrations that were unacceptable and beyond and other constituents, technetium and iodine. And so that commitment and change was made in the ’90s, and we have incurred the impact from that commitment in the delays, and so we continue to keep our aim towards getting the low-activity waste vitrified.

In 1996 the TWRS EIS then followed along with the decision that both the high-level and the low-activity waste would be vitrified. In ’97, leading up to ’97, from ’93 to ’97, there was a series of interactions between Department of Energy and the Nuclear Regulatory Commission. And they were agreeing on criteria for how you could allow high-level waste that had been separated, low-activity waste, to be disposed of in a near-surface environment, because it’s not low-level waste. It’s still technically high-level waste. You’ve just removed enough of the fission products so that you can dispose of it in a near-surface environment instead of in a deep geologic repository. And there were several important separation commitments that needed to be met to do that, and that's the basis of our pretreatment facility. And then also, in that discussion and in that commitment back and forth between Department of Energy and NRC, was the idea that the low-activity waste would be vitrified.

In 2003 the Department of Energy asked the Department of Ecology to consider other options for the low-activity waste with the idea that if there could be other options that could be found that would be just as protective to the environment, would we consider them. And we said, okay, let us be part of the studies, let us work forward with you, and there was always this promise that it would be cheaper and faster. And we said, okay, we'll enter in with you in looking at it and studying it.

And then that all culminated in a milestone in 2006 where they were to bring the data forward to show what had met the bar, what waste forms would turn out to be, in fact, cheaper and faster and then, in addition, be as good as glass. And at that time none of the other waste forms proved out to be as good as glass or to be protective enough to meet drinking water standards.

In 2010 we had the settlement agreement that resulted in the consent decree signed in front of a federal judge. And in there we agreed to milestones that--there's seven different milestones in there that talk about supplemental treatment vitrification.

And then, lastly, in 2011 the final tank closure/ waste management EIS was issued, and they looked at different options for supplemental treatment. None of them proved to be as good as glass and also to be completely protective of the different drinking water stands.

This is a graph out of the Environmental Impact Statement, and the low-activity glass is the red line on the bottom. The others are either grout or steam reforming or bulk vitrification. And you can see the point of this graph is that none of them proved to be as good as glass. And then if you look at further data in the EIS, you'll find that both grout, steam reforming, and--well, both grout and steam reforming at some point in the future would violate the drinking water standards for nitrate, chrome, iodine, and technetium, and, I believe, uranium.

Some people will ask this question, so I thought I'd put it on a slide of what are the different sites and what do they do with their low-activity waste. And, as far as how they're regulated, all the different sites that you've heard about today are all regulated. Their high-level waste is regulated under RCRA, except for when you get to Savannah River's. The choice was made there to do it under the Clean Water Act. And that has to do with what's the LDR treatment standard, the land disposal restriction treatment standard, associated with RCRA and the metals associated with high-level waste. And the treatment standard for metals associated with high-level waste is something called HL vit; it's vitrification.

And so at Hanford the plan is for immobilized low-activity waste to stay in the near surface in a landfill. The current plan is to vitrify it, although there are some other options being continued to look at. At Idaho--this is a little bit incorrect--their high-level waste will go to a deep geologic repository. Their other waste that's associated with tank waste will go somewhere, and I have it going to WIPP there. And that's probably not correct. But it's written into a consent decree with Idaho that it's not staying at Idaho. So the point is, they're not disposing of their low-activity fraction or any of their fraction of their high-level waste.

At Savannah River we've heard quite a bit of, it is currently being disposed of in a near-surface environment in the form of saltstone. And at West Valley, all of their waste will eventually go off-site too. Their low-activity waste has already gone off-site, and eventually their high-level will go off-site.

So, really, it's just the difference between Hanford and Savannah River. And there is some geologic differences too, is that we have a great depth to our groundwater. They're much closer to their groundwater. And this may seem a little bit backwards, but what happens at Hanford is, our really low infiltration rate and our slow groundwater flow ends up concentrating underneath the landfill. So if your contamination and you're coming down to the groundwater, it ends up concentrating. So if you look at a point of compliance next to the landfill or out a little ways, you'll find that the concentration is greater if you were to dispose of grout in our landfill than it is at Savannah River. At Savannah River you have higher infiltration rates, a much closer distance to the groundwater, and a faster flowing groundwater regime, so it tends to sort of dilute and move the waste along. And so those are the key differences.

And so just a little bit in summary. For the past 15 years we've had a commitment to the assumptions that the low-activity waste was going to be vitrified at Hanford. This is important to us, because a lot of the--a significant number of the mobile constituents are both the radiological ones, and the chemical ones are in the low-activity waste. To date, none of the various efforts to prove out other waste forms have resulted in something that was protective of the environment or as good as glass. There are some land disposal restrictions coming out of RCRA that points to our low-activity glass needing to be in a vitrified form. And we've had recent and commitments going back to the '90s that say that our low-activity waste needs to be vitrified.

So, in summary, Hanford's got a large risk volume that already exists, all the cribs and canyons, the other facilities, eventually the closed tank farms, the past landfills, the current landfills. So we've got a risk burden that's already here from waste that's not leaving the site.

In addition, there has been this long-standing approach to pretreat the chemicals and some of the radionuclides off of the tank waste and leave the chemicals here and send the more highly concentrated high-level waste to a deep geologic repository. And while that is a good economic decision because of the great cost of disposing of logs in a deep geologic repository, it puts an additional risk burden on Hanford on top of our other environmental risk burden that we already have. And so for that reason it's been important and continues to be important for us that our immobilized low-activity waste form be the most durable dependent waste form that we can have, and that's why the State has really settled on that being vitrification.

And then the last thing I wanted to say is, the leaking tanks right now--if you just want to look at observational science, the leaking tanks are telling us that they can't wait decades upon decades for the waste to be immobilized and that we need to move forward with the Waste Treatment Plant; we need to fix the issues that are associated with it; we need to move forward with it. And then, in the meantime, we need to be looking for safe storage of the tank waste.

GEPHART: Are there any questions for Suzanne?

SPEAKER: Hold on.

GEPHART: Hold on.

SPEAKER: Somebody is knocking the cord out that's holding--you moved your chair back.

GEPHART: Let's try that again. Rod.

EWING: All right, thank you.

So in your presentation you define the low-activity waste stream as technically high-level waste. And then, drawing on Russell Jim's presentation, who has finally the authority to declare that it's not high-level waste?

DAHL: The answer to that probably depends on who you ask. If you ask the Department of Energy, I believe they would probably say they have the final authority. I think in the court ruling and in the State's interpretation of the Nuclear Waste Policy Act, we believe that that's not a decision that can solely be made by the Department of Energy. And so that's why it was important for us that in the '93 through '97 discussions with NRC, that NRC was part of that agreement and discussion in defining what could be called low-activity waste.

EWING: Right. But that was, I think, again, in your words, a consultation. And in my reading, the language was very carefully qualified in terms of their consultation. So is this a topic that would finally be settled in court some years from now? Is that the path we're on?

DAHL: I'm not sure that that's where it gets settled. I guess I--

EWING: I guess, more to the point, I'm wondering at the wisdom of following this strategy without a clear definition that this waste stream can be declared as not high-level waste.

DAHL: The State has been happy with that NRC consultation process that happened, and also a similar process is allowed for in the Tri-Party Agreement on the tank residuals when we get there. And we've been happy with that consultation process. And as long as it's something that resembles that, that seems to be something that the State can stand behind. It's when the Department of Energy does it by itself solely is when we have issues.

EWING: Okay, thank you.

GEPHART: Yes, sir.

PEDDICORD: Yes. Peddicord from the Board. So to help me understand, is there then a distinction between the Yakama Nation's solution outlined by Mr. Jim and the State of Washington in terms of implementing the vitrification of low-activity waste, and do you all see that as the reclassification that you referred to? I'm trying to understand if you're consistent on this position or there's a distinction?

DAHL: Do you want to answer it, Russell?

JIM: I'll try a part of it. Part of the 2005 Reauthorization Act 3116 portion allows the reclassification at Idaho and Savannah River but not at Hanford. And coupled with that is the Department of Energy's 435.1; that's an order, a DOE order, yet some feel that it's a law, and it is not. And eventually they want to mesh 3116, 435.1 to gradually mesh together to justify defining low-activity waste, which, of course, you heard and probably know that there is high-level waste mixed in with it to justify leaving it here near the surface of the earth. That's our concern.

PEDDICORD: So the Yakama Nation has a different position than the State of Washington?

DAHL: There is a nuance difference. In the court case that Mr. Jim was talking about, they filed along with others--the State of Washington entered in as a friend of the court, meaning that we had information on both sides of the case, and that tells you at least a little bit that there's a difference there.

GEPHART: Sue.

CLARK: So, following along the same line of discussion but in the context of high-level waste that is leaked, what is the State’s position and then also the Yakama Nation’s position about the material that’s leaked from the waste tank? Is it high-level waste? Is it not?

DAHL: The State has taken the position that the waste that’s leaked is still high-level waste, because the way that you get through the process, whether it’s talking about tank residuals or whether it’s talking an immobilized low-activity waste form, the way you get to not being a high-level waste that needs to go to a deep geologic repository is that you’ve removed sufficient fission products, that you’ve gone through an immobilization technique, and that you’ve looked at the risk of it. Those were the three criteria that were laid out in ’93 with the NRC, and the other things in there, they’re consistent, at least in the State’s mind, with information in the Nuclear Waste Policy Act. And so waste that’s leaked to the ground, there is no magic separation technology or immobilization that happened just because you leaked. So we believe it’s still high-level waste.

CLARK: And the Yakama Nation?

JIM: We go back to the source term issue in the Nuclear Waste Policy Act; and, therefore, we do have more problems. When I was told here last year that--when I questioned, “How much are you going to leave in the tanks?” And they said, “Well, just about an inch,” not verifying that that inch could be some of the most deadliest material. And to do so, then I asked, “Aren’t you concerned about the source term of the Nuclear Waste Policy Act?” And there seemed to be a misunderstanding. I was told then that the source term came out of RCRA, which is not true. I helped write the Act. Thank you.

BECKER: Steve Becker, Board. I’m trying to get my arms around this issue as well. Suzanne, what is the formal definition low-activity waste? Is there a certain quantitative measure? How is it defined in a formal way?

DAHL: It’s actually defined in those interactions back and forth between ’93 and ’97 between the Department of Energy and the NRC, and I can get you some of that documentation that gets you to that. It talks about using single-pass ion exchange to remove cesium and talks about liquid solid separation on each batch of waste that’s processed, and it talks about--oh, I’ve lost the third one. Oh, and then there were some specific tanks that had transuranics in it, and it talks about doing a different separation on those.

And then in that they also assumed a waste performance, that obviously you couldn’t dispose of it if it wouldn’t meet certain waste performance criteria. And the waste performance that they assumed in this discussion back and forth and in the calculations back and forth was vitrification. And it was assumed that it was disposed of in that disposal unit that you guys saw yesterday or something closely located to that in the integrated disposal landfill.

BECKER: So is there a specific level of activity or a cut-off or some sort of criterion for distinguishing what is versus what isn't low-activity waste?

DAHL: There were number specific--and somebody will have to help me because I don't have--I had it memorized and they've left me, but on both the removal of cesium and strontium, but then also those other criteria I named. And I can get them to you.

GEPHART: Any other questions? Board? Staff?

I think, as you heard over the last few minutes, this has been an extremely critical issue for the last 25 years that remains unresolved and that will determine significant adjustments or continuing with Hanford strategy as it is. So it's important. I really appreciate the engagement.

Our next speaker, Ken Niles, is--Ken is with the Oregon Department of Energy, Nuclear Safety Division. This organization provides Oregon's oversight of Hanford remediation. And whenever, throughout the year, I have needed the answer to the question--What's happening south of the Columbia River?--I call Ken up.

Ken.

NILES: Thank you, Roy.

Good afternoon, everyone. Thank you for the opportunity to provide you with Oregon's perspective on Hanford's high-level waste and spent nuclear fuel.

The State of Oregon has had about a 30-year history of working on Hanford issues, since before cleanup and very active during the cleanup process. I've been with the Agency now working on Hanford issues for about 24 years, so we've been a long time interested in these issues.

I'd like to spend just a couple of minutes of my time kind of giving you a bit of a perspective on Oregon's relationship with Hanford and our view, as you will, from south of the Columbia River and south of the border. Georgia is the only other state that really is similar to Oregon in that they're an adjoining state to the Savannah River site, although typically not as consistently active as Oregon has been through the years.

So Oregon's primary concern is with Hanford as potential contamination to the Columbia River, which flows through the site and becomes the Oregon-Washington border all the way to the Pacific Ocean. The Columbia River is often referred to as the lifeblood of the region. Its water is vital for drinking water, for irrigation, supports salmon fisheries, and the Columbia River is a very popular place for recreational activities, camping, boating, fishing, and some of the best wind surfing site in the world. Any contamination that's in the groundwater moving to the Columbia River or contamination now that's in the soil moving to the groundwater and eventually to the Columbia River is what does concern us. So the tank issues, the groundwater issues are high on our list of things that we're concerned about.

Oregon is also a primary transportation corridor into and out of Hanford. If there is ever highly vitrified waste, if there is spent nuclear fuel that leaves the site that goes to a geologic disposal site or to an interim storage facility, it will likely travel through 200 miles of northeast Oregon, which is also currently--although not at the exact moment right now--but it is a transportation corridor for transuranic waste going from Hanford to the Waste Isolation Pilot Plant.

Oregon was very much involved in working with western states through the Western Governors' Association and with the U.S. Department of Energy in developing a transportation safety program for WIPP shipments, and we're also now currently in discussions with the U.S. Department of Energy and other states around the country as we begin preliminary transportation planning for what the Department of Energy has targeted the opening of an interim storage facility in 2021.

So that background out of the way, let me now address the topic of this session, views on the most important technical issues in terms of Hanford's high-level waste and spent nuclear fuel. And, frankly, it's difficult to get to that topic of disposal when we have so many technical issues and obstacles right now that prevent us from getting our waste into a form in which it could even be considered for disposal.

Now, vitrification has been the target and it's been the goal at Hanford for several decades, but we're not there yet. I understand that this Board does not have purview over the design and construction of the Waste Treatment Plant, but when you look at those issues and you look at the overall scope of disposal and disposal form at Hanford, can't get there without talking about the urgency we have in trying to resolve the problems of these facilities and getting vitrification operational at the Hanford site. That's our goal. And I will second Suzanne's comments that there needs to be certainty that the eventual form of the treated waste at Hanford does have a pathway into a geologic disposal facility.

So let me talk about a couple of other waste streams that concern us at Hanford, and some of this has been discussed already by Mr. Jim and by Suzanne. But these waste streams I'm going to talk about seem more and more to be slipping under the radar at Hanford. The first is the waste that is leaked from the tanks, which was just a discussion point. In our view as well, this is high-level waste, at least a million gallons estimated to have been leaked from or intentionally spilled from single-shell tanks at Hanford. And, as you follow the news, you know that Secretary Chu has announced that there are least six actively leaking single-shell tanks, so they're adding to the burden of waste in the vadose zone. And though the amount that is being leaked today is relatively small, we have no assurance that will be the case two weeks from now, two years from now, two decades from now.

The waste is spread throughout the vadose zone all the way to the groundwater. There are twelve single-shell tank farms at Hanford. They are shown in brown in that graphic. Every one of those twelve single-shell tank farms has at least one, and in most cases far more than one, leaking single-shell tanks over the past many decades.

This is a one-volume, one-copy--I see some groans, so people do know what this is. This is the final Tank Closure Waste Management Environmental Impact Statement at Hanford. We ended up getting three in the mail. One was, believe me, sufficient. This document does detail potential environmental and human health risk in the future caused by waste that's in the vadose zone at Hanford, including leaked tank waste. The Department of Energy has been fairly clear that their intent is to leave most of this waste in the soil where it is. They do express a strong preference for landfill closure of the tank farms, although in the EIS, the final one, they do acknowledge it may be necessary to remove or immobilize some of the waste.

But, as we just had this discussion a few minutes ago, leaving this waste in the soil does nothing to change the fact it is, in our view and many others', high-level waste. As Suzanne mentioned, the active leaking out of a tank does not in any way remove key radionuclides, does not result in any kind of immobilization of that. So we're deeply concerned as well about leaving the leaked tank waste in the subsurface.

Another waste stream of concern at Hanford is nearly 2,000 capsules of cesium and strontium. Cesium and strontium was removed from the Hanford tanks as long as 40 years ago to remove heat from the waste tanks at Hanford. It's stored currently underwater in a water-filled basin just adjacent to Hanford's B Plant. The canisters represent the largest concentrated source of curies at the site, about 100 million or more.

In the past there's been a number of discussions about what to do with these. There has been consideration, can we direct disposal of these canisters into a geologic repository. There's been talk about blending it in with the high-level waste stream at the vitrification plant. In recent years it seems there has been more and more discussion by the Department of Energy about storage on site, allowing the radioactivity to decay and then sometime in the future shallow land disposal burial at Hanford.

Doing that, though, ignores the fact again--you know, if you look at a process to reclassify waste, the cesium and the strontium are some of the key radionuclides you would pull out of that waste stream in order to immobilize that in a geologic disposal facility. So this is, you know, the actors that you would pull out. And we also want to make sure that these eventually go to deep geologic disposal.

One other waste stream let me mention briefly that I'm not sure the Board has heard about. You would be hard-pressed to find it in very many of the documents at Hanford that talked about cleanup. Back in the 1980s DOE made some vitrified glass logs for the West German government, and these logs were intended to be a heat source in studies of a deep geologic disposal facility in Germany. Those logs never left the Hanford site. They're stored in casks in the 200 West area and have several million curies of radioactivity. This is a waste stream as well that we want to see eventually leave Hanford and go into a geologic disposal facility. We believe it's high-level waste under our interpretation; we believe it would be as well under many others.

Finally, I recognize that the Board has interest in the spent nuclear fuel at Hanford. In our opinion and I think many others, the spent nuclear fuel is stored safely at the canister storage building and, we believe, can be stored safely for several decades to come. Eventually, though, we do want to see this waste as well leave the site and find a home somewhere in a deep geologic disposal facility.

So thank you again for your time and the opportunity to come and speak with you, and I'd be happy to try and answer any questions. I'm glad those really tough ones about reclassification went to Suzanne first.

PEDDICORD: Peddicord, Board. So, Mr. Niles, is the list of the four topics the State of Oregon priority in terms of the order to be addressed (inaudible)?

NILES: I did not put them in an order of priority. I would have to think about it a moment. You know, we didn't even address really the waste that's in the tanks, and that would be our first priority of dealing with that 56 million gallons of waste. But in terms of issues that I thought the Board would find relevant, those are some of the issues that we have here, yes.

FRANKEL: Frankel of the Board. So I am in complete agreement with you about the leak plume under the tanks being high-level waste and a concern, but I don't think we heard any viable approach for dealing with it. Is there any possible idea or concept for remediating those plumes that are going all the way down to the water table? And it’s a huge thing.

NILES: It is a huge issue. And, you know, the issues I gave here were mostly policy issues. That is certainly a policy and a very big technical issue. It has only been in recent years that the vadose zone at Hanford has really drawn much in the way of attention and scientific study. Ernest Moniz, as you know, the nominee as Secretary of Energy, back when he was, I think, undersecretary of the Department of Energy, referred to the vadose zone at Hanford as virgin territory, unknown territory. We really didn’t understand what was going on there.

There was a focus a few years ago to begin shifting and looking at alternatives for what to do, how to immobilize or retrieve some of the waste. It kind of fell victim to some of the funding cuts of a few years ago, and we’re really not very far along in terms of coming up with viable solutions. We don’t have a solution to offer to say this is what you should do, only that this needs additional study because we have concerns about this waste and it is high-level waste.

GEPHART: Any other--yes.

ZOBACK: Mary Lou Zoback, the Board. This kind of came up briefly yesterday, and it hasn’t been talked about. Have radionuclides gotten into the Columbia River? All I remember is someone saying that there was ten times more uranium coming from fertilizer than there was from Hanford.

NILES: There is radioactive material that’s entering the Columbia River. If you go back to the operational years in the ’40s, ’50s, ’60s, there were huge amounts of radioactive materials getting into the river and could be detected in shellfish up and down the Oregon and Washington coastline. Since the shutdown of the last--

ZOBACK: Coastline?

NILES: Of the coastline all the way--

ZOBACK: Of the river or the ocean?

NILES: Of the ocean.

ZOBACK: Oh my gosh.

NILES: Of the ocean. There was that much volume of material going into the river. When the last single-pass reactor was shut down in 1971, that dramatically reduced the volume of radioactive material going into river.

ZOBACK: Were they actually putting the effluent from the power plant directly into the river?

NILES: Yes.

ZOBACK: Ah, geez.

NILES: It was a single-pass design that carried (inaudible). So there are small amounts of radioactive materials and chemicals entering the Columbia today.

ZOBACK: Even today.

NILES: It's pretty closely monitored. The State of Oregon had an environmental monitoring program on the Columbia River specifically for Hanford that went from the mid-1960s till the mid-1990s and basically shut down because at that point they'd been measuring zeroes year after year after year. And a few years ago we did an analysis, separate sampling, just to verify that assumption. So there is small amounts going in. They are quickly diluted. The concern we have is in the future if a whole lot more gets into the river.

ZOBACK: I guess this is another question related, and I'm not sure who it's for. I'm actually a seismologist, so a lot of this is way beyond me, but the reason you have those hills out there are from earthquakes in the past. And I think there was discussion about buildings and their structural safety, but I just think about all the underground pipelines and the joins in all the pipelines, and a lot of those pipelines are awful old now. And when they were talking about pumping all the waste from all the tanks into that treatment plant, I just thought about miles and miles of underground pipelines. Has anyone looked at that from the safety--from strong shaking and soft material which would amplify this shaking?

NILES: Well, I would add that the concern we would have as well is the integrity of the tanks themselves and that you could have a dome collapse. You could have just a larger damage to the tanks, which could really exacerbate the problem with leakage. Beyond that, I am not a seismologist and can't answer those.

ZOBACK: Suzanne, where is the State of Washington on seismic concerns?

DAHL: They've done a couple of looks at the tank farms as far as different ground motion events, and there is definitely the concern that if you--I think the concern is when you start thinking about the most probable earthquake or the one that the Waste Treatment Plant is designed to, and it's a one-in-two-thousand-year reoccurrence interval. But if you had that type of ground motion at that plant, you would also have that type of ground motion at the tanks and pipelines that are now, you know, 40, 50, 60 years old. And so our concern is, while we need a safe operating facility, we also need to realize that the waste is currently sitting in tanks that probably would have equal problems, if not greater problems, withstanding the same event.

ZOBACK: And no option--if you needed excess storage immediately, no option.

GEPHART: If we may go on here, since we're a little bit tight on time, but any of the folks that are on these panels, please see them afterwards during the break and ask questions there. They'd be happy to be available.

Very quickly, our next speaker is Steve Hudson. He is the newly elected--shall I say that?--newly elected Chairman of the Hanford Advisory Board.

HUDSON: Thank you, Roy.

I should begin by saying, I am also from south of the Columbia River. I am an Oregon resident as well. And people, when they ask me what I'm doing these days after retiring from teaching college English for 39 years and I say I'm a member of the Hanford Advisory Board and now the Chair, they look at me askew, because they know I'm a rhetorician and a grammarian, although I do explain that as an undergraduate I was a chemistry and math major, and my son is a professor of physics at Penn State, and my daughter and her husband are both environmental chemists at Cal State Fullerton. So many of the topics today delight me even if I don't really understand everything you're talking about.

I want to just give you very briefly and pretty compactly a bit of insight into the Hanford Advisory Board, because clearly the issues that the Hanford Advisory Board deals with are well within the purview of this particular committee.

For the Hanford Advisory Board, the most important technical issues associated with the eventual disposal of high-level radioactive waste and spent nuclear fuels are those that fail to adequately address the health, environmental, and economic conditions and needs of the Hanford community. And when I speak of the Hanford community, I talk about that community that extends all the way from the Idaho border to the Pacific Ocean, from the Canadian border to the California border. Because we all are members of the Hanford Advisory Board, we represent those communities of peoples, those interests.

In effect, the most important issues for the HAB, for the Hanford Advisory Board, are those issues which allow the best combination of actions to be taken, the best balance of alternatives. Now, for clarity--and let's begin by noting that because the Hanford Advisory Board's mission is to provide the TPA agencies--the DOE, the EPA, the Washington State Department of Ecology--with advice on major high-level cleanup decisions, its response to issues, and its response to issues that are raised by the TPA membership and by our own stakeholders, we do not typically or even usually address technical issues. We don't write about technical issues.

Now, that said, it does not mean that when we discuss various kinds of alternatives that the HAB advice is not shaped and molded by technical discussions, for certainly such discussions do take place (inaudible) and say the Tank Waste Committee, the River and Plateau Committee, the Health and Safety Committee, as one might expect. But such topics are also addressed from time to time in the Budget and Contract Committee and in the Public Involvement Committee where inevitably, after we have had a public meeting, somebody will say, “How do you deal with a question like ‘Why don’t you just do this?’” And we are trying to find answers that would be credible for the constituents that we often have to deal with.

And while I should also note that there are a number of HAB members who would be comfortable in discussing many of the topics you raised this morning--that is, talking and discussing the chemical and structural roles of bismuth borosilicate melts with regard to the vitrification of high-level radioactive waste and similar topics--we certainly have people on the HAB that are, in fact, able to do so. Discussions such as that, however, rarely occur in advice. And because they are not showing up in advice, I do not like to speculate about what the HAB may or may not have said about a particular kind of resolution.

In essence, I think it’s important to realize that the Hanford Advisory Board is less concerned with ranking the technical complexities of high-level waste treatment alternatives than with how those alternatives impact and mirror core HAB values and principles. For example, when writing advice, the Hanford Advisory Board will consider whether or not a proposed technical solution protects the broader environment and ensures that the solutions arrived at do not harm anything during cleanup, that those proposed technical solutions provide for the efficient vitrification of Hanford tank waste and the disposal of the tank waste safely and permanently, because, as you've heard from anybody on this panel today again and again, vitrification of Hanford's waste and the subsequent disposal of the vitrified high-level waste in a deep geologic repository is one of the most critical components of the Hanford cleanup process. And if the technical solutions develop and deploy new technology, the Hanford Advisory Board would expect that those technologies must do so without impeding cleanup.

Now, of course, the Board will also address with equal concern--and these are the kinds of issues that you're probably not typically involved with--concerns about: Does the solution protect worker safety and health? Does the solution protect the Columbia River? Does the solution protect and restore the groundwater? Does the solution involve the public? Now, for the Hanford Advisory Board, we devote a lot of time to making sure that the public has a conduit to provide their ideas, their concerns to the decision makers. And as what Todd Martin, a former chair of the Hanford Advisory Board, advice allows the public to inform decision makers about what they need to care about.

And essentially that is one of the main obligations of the Hanford Advisory Board.

So we involve the public because that is good practice; we involve the public because it is a good basic prerequisite for environmental justice; and we involve the public because it represents fair and democratic decision making. That is, if we wish to have public support for the decisions we’re making, we have to make sure that they are provided with information that is broad, inclusive, open, and accessible.

Now, one of the things that I did when I first became a HAB chair was to read through the various pieces of advice, and over 20 years the Hanford Advisory Board has produced 250-plus pieces of advice. And I have to admit to you, when I read through the advice, I was far more taken with the quality of the writing and the language and the various ways of expressing particular issues had changed over time than I was with the content. So when I had to read it to prepare for this presentation today, I had to look at the content. I didn’t find that quite as interesting as my first read.

So, in reading through those 20 years of advice, what I noticed--and it’s very important--one, the high degree of consistency. From 1994 to 2013 the Hanford Advisory Board has held essentially to the same concerns and issues that they wish to be resolved. Over those years the changes have been the early 1994 positions and using phrases like, “We don’t care what you do out there, just get on with it,” kind of the colloquial. Today, if I read the advice, it’s far more--it has a stronger sense of urgency; it has a strongly focused sense of, “This is what needs to be done.”

And I’ll flip ahead, because I know we’re really short on time.

In essence, if you go through those pieces of advice, clearly the principle and goals are familiar, especially the need to address all waste streams; clearly the need to address all processes, facilities, and products and a need to secure vitrified high-level waste in a deep geologic repository.

However, it should also be noted that, at least Hanford Board advice about high-level waste, because of that consistency, shows that this reflects not only something about the nature of the Hanford Advisory Board, but it also reflects something very, very much about our constituency, about what the public is interested in and what the public would like to see happen. And, as I said, one of the 1994 statements was to get on with it, to get the cleanup done, while remaining--it is important, I think, that we remain sufficiently patient to avoid embracing short-term technical solutions which fail to produce quality, long-term results.

And, as I said in the beginning, the most important--the most important technical issues for the HAB are those issues which allow the best combination of actions to be taken, the best balance (inaudible) to take place and to, in fact, allow decision makers to get on with it.

And I thank you.

GEPHART: Thank you very much, Steve, for allowing me to nudge you a little bit. You're an example to my next three speakers. We're doing our best. I'm going to nudge folks a little bit quicker, because we do have some other schedules coming up--my apologies--so you'll feel a little bit of a push.

Our next speaker is Pam Brown Larsen. She is Executive Director for the Hanford Communities and member of the Hanford Advisory Board. Pam.

LARSEN: Thank you, Roy.

I am going to skip through some of the prepared comments, because I think that a lot of this has been addressed already in your meeting. But I do want to welcome you today on behalf of the Hanford Communities. It is an association of the cities of Richland, Pasco, Kennewick, Benton, and Franklin Counties and the port of Benton. Those entities came together 19 years ago to work together on Hanford issues, and I've been Executive Director for those 19 years. Also, to bring a sense of immediacy to the concerns of people in this region, keep in mind, the City of Richland draws its drinking water from the Columbia River just south of the Hanford site, so we pay a lot of attention to what's going on.

You have had discussions about the tanks, our 1,900 canisters of cesium and strontium, the 2,300 metric tons of spent nuclear fuel, but I also want to draw to your attention that on the Hanford site we have 570 tons of commercial spent fuel at Energy Northwest in dry storage, and we have 124--and that may not be a current number--decommissioned submarines.

Hanford is in effect an interim storage facility, because we have no place to send our high-level waste that is by law destined for a deep geologic repository. And I want to point out that there are financial consequences to Hanford because of the fact that there is no place to send this material. Funding for guards and guns that protect spent nuclear fuel comes out of the cleanup project, and this is a significant amount of money each year, tens of millions of dollars.

High-level glass that will be produced by our Waste Treatment Plant must be stored until it can be shipped; therefore, funding will have to be pulled from cleanup efforts to design and build a facility to store this material. We're calling it a temporary storage facility, but it's being designed so that it can be expanded if needed, because there is no place to send the high-level glass. One of the consideration in the country now is whether interim storage could include high-level vitrified glass, and we're very hopeful that that would be a possibility. We believe that there should be some compensation to our community and others who are interim storage sites. And I'll go into this in just a bit.

In regards to the path forward, we support the recommendations made by the Blue Ribbon Commission to establish a new entity dedicated to implementing the nation's high-level waste storage program. We support the licensing, construction, operation of a permanent geological repository for high-level waste, and we are encouraged that there are communities in this country that have asked to be considered. We believe that the Nuclear Regulatory Commission should complete the evaluation of the Yucca Mountain license application and that public hearings should be held as required by law.

In regards to the future of the Hanford site, Hanford encompasses 586 square miles. Nearly 90 percent of the site will be remediated in the next few years. However, the highly radioactive tank waste will require decades of work to solidify and encapsulate. Our community has requested 1,640 acres of land just north of the City of Richland to develop an energy park to attract new green manufacturing jobs, and there is a strong interest in new missions.

While we believe that there should be some quid pro quo for communities hosting interim storage, we do not seek monetary compensation as the nation struggles to reduce the deficit. We do ask that Hanford be given consideration for new future missions. And we believe that our future lies not just with the Department of Energy's Environmental Management program, which will be engaged for years in dealing with tank waste, but with other DOE programs.

I would like to just briefly address some of the questions that have been raised. There were questions raised about the waste incident up to reprocessing, which is referred to as 3116 of the Defense Authorization Act. When we were approached about whether Hanford should be included in that discussion, we pointed out that there is within the Tri-Party Agreement a path forward for dealing with tank waste, closing tanks, and closing tank farms that has been vetted in this region and that we think that should be the path forward. It was pointed out that because this material is RCRA material, that that may not be adequate. And so we have asked that there be something written to put into federal law that validates the Tri-Party Agreement process that we have already chosen.

Also, as has been pointed out, there are not just tanks, but there are pipes that are potentially leaking; and we concur with a statement that these leaking T-farm tanks are the canary in the coal mine. There is going to be more. And so we emphasize to those who have authority that we need tank waste treatment as soon as possible. It's extremely important to our region. And one of those alternatives that is going to be considered is the possibility that some of the T-farm tanks, based on process knowledge, meet the definition of what material can go to the Waste Isolation Pilot Plant. If that is acceptable to the residents of New Mexico, we would really like to see that alternative pursuit.

And, finally, there was a question about concern about leak tanks. I also want to point out to you that during the years of operation at Hanford, the highly radioactive waste did go to the tanks, but over 450 billion gallons of liquid were poured into trenches, and a lot of chemical and radionuclides are therefore in the ground between the surface and the vadose zone. We're very pleased that a pump-and-treat facility has been put on line, a $120 million facility that we benefitted from stimulus funding. That facility is going to operate for many, many years. We think that's the right thing to do to get those contaminants captured before they move towards groundwater and the river, but it is a significant problem for us in the long-term.

Thank you very much. And I do have an issue paper that I forgot to provide. And so, Roy, that's copies of that. So I'd be happy to answer any questions from a local government perspective.

GEPHART: If I may exercise moderator preference, because of the time, if anyone would like to speak to Pam, please do so afterwards. We're just going to sort of keep moving on a little bit.

Our next-to-the-last speaker is Gary Petersen. Gary is the Vice President for Hanford Programs under the Tri-City Development Counsel.

PETERSEN: In the interest of time and safety, both yours and mine, I'm not going to walk behind that (inaudible).

Let me point out, too, in full disclosure, I'm going to pass this around as I talk, because I want Al to talk too. I'm not going to repeat the numbers, but in the interest of full disclosure, I am one of the three people who brought suit against NRC, DOE, and the President of the United States relative to Yucca Mountain. We were later joined, thank heaven, by both the Attorney General of Washington State and also Savannah River. So I am a part of that lawsuit. We hope the court will rule here shortly. And I want to raise up and talk about this issue both personally and on a broad basis, and I want to start by making it very personal.

I was born in 1940. Those tanks started to be built in 1945. And the Blue Ribbon Commission has now said that there will be a place for this waste come 2046. At that time I'll be 106 years old. My predecessor, Sam Volpentest, lived to 101. I don't anticipate being that lucky. I also want to point out that I take it personally because I live in North Richland, and I drink the water from the Columbia River, and I have since 1965. So when we talk about the safety of the river and the radionuclides going into the river, I take it very personally.

Let me raise up the issue, though. At Hanford, as Pam said, we have all types of waste. We have commercial waste, the 570 tons from Energy Northwest. We have the Trojan Reactor. I'm passing around a picture of the submarine reactors. Incidentally, in that stack there are a variety of pictures. When we talk about 124 Navy reactor cores, they are both submarine and cruiser missiles. And very shortly over the next few years we're going to be receiving eight reactors from the aircraft ship Enterprise. And so we have it all. We also have a very small Washington State mostly medical low-level waste repository out there as well.

The issue in part for me is, I deal with Congress. I deal with them on a regular basis. And I'm talking about not just once a day or once a week, but very often. The issue is that we don't have enough money to clean up all of these weapons complex sites. That's not just here. That's Savannah River, that's Oak Ridge, that's Paducah. Everywhere you're concerned with, we have an issue with cleaning up all those sites.

Senator Murray has stated very often that we don't want to rob from one site and give to another, nor do we want to rob from within a site and give to another. In other words, there are three DOEs on this site. We've have twelve DOE manages in the last eight years, and it's very hard to keep a consistent, attentive program going when you have that kind of turnover both at headquarters and here. And you have three DOE site managers, all of whom report to the top.

And so one of the things I want to express is, we have the law. Currently we think that we are breaking the law with Yucca Mountain. We have the law. Russell Jim did an excellent job of outlining where that law rests. What we don't have is we don't have the funding to do it. And I know what sequestration means; I know what the impacts are currently. When we have 2,000 of our staff go on furlough and another 300 to 600 laid off, there is no way that you can meet the milestones that we've got in front of us unless something is done.

So my request to the Board--and I'm trying to be short--is that you pay attention to how we actually go forward when money is in the way. And so I leave with you the message: it's personal, I think those tanks were not meant to live until 104 years old, and so we need help. We need your assistance to move this whole program forward.

With that, I was short.

GEPHART: Gary, thank you very much. And I would give my apology for those that I have been pushing just a little bit on the time, but thank you for helping us.

Our last speaker before a quick break is Al Boldt. Al Boldt is representing the non-profit public interest group Hanford Challenge.

BOLDT: Well, the previous speakers have stolen almost all of my thunder, so this ought to be pretty fast.

We have nine reactors, 100,000 tons, have processed most of it, a thousand tons of spent fuel. 2,000 tons of spent fuel, I want to say here, is what's critical. It's in about two-foot-by-13-1/2-foot-long containers, multiple canister overpacks, about half-inch stainless steel. Biggest thing difference on these is, the contents are spent fuel, uranium metal fuel clad and zirconium. Some of them are hollow; the bulk of them are shattered, broke, in pieces being stored in a basin for twenty years and contain uranium hydride that was formed in the water. This field is pyrophoric, and I'm just making that statement. The previous

Yucca Mountain (inaudible) contents will not be pylophoric.

This material will ship to your new repository about 2048 schedule, either needs new criteria or requires treatment to the old criteria. Out of that spent fuel is also associated with it. In the basin we've got .2 cubic yards of spent fuel fines. This is stuff that would pass either an eighth-inch or quarter-inch mesh, really fine, really bad pyrophoric, and other stuff that's diluted with dirt.

The treatment of this has been deferred for a number of years. They're going to do a technology selection in 2015 just to decide what to do with it. It's to be shipped to the--it's still out there on the banks of the Columbia River. Supposed to ship it to T-plant, decide what to do for treatment. This is still high-level waste. The plan is that the sludge is lower-level waste, will be classified as remote handled TRU and go to WIPP.

The 100,000 tons or 98,000 tons we processed went through four reprocessing plants (inaudible) the process, and the tank farms would go to uranium recovery operation from the early plants. We took out strontium and cesium to get the heat out so we could get more waste in the number of tanks we had. We concentrated the supernate, got it hot, put it back in the tanks, let it crystallize; so we have an extra sludge, salt-cake, and supernate. In amongst this was a number of tank transfers managing tank waste, so we got a somewhat mixed inventory. 67 of them leaked. Mention we have recovered the strontium/cesium.

Now, the EIS, that four-foot-tall stack of documents that were shown, was issued December without preferred alternatives for some of the critical tank waste treatment operations, and no records of decisions obviously were deferred also.

As you've seen, we retrieved the wastes, then the "empty" tanks. Empty is--a number of cases studied--what I'm saying is one percent of the residual in the tanks, one percent of the tank contents, the tank farm infrastructure that you mentioned, all of the pipelines that are buried over the tank farm, miscellaneous underground tanks, and the vadose zone are treated for disposal. The retrieved wastes are separated into three waste classifications for treatment and disposal.

Now, the disposal of our failed melters, which is another high-level waste here, I projected twelve melters based on our System Plan 6. The tank farm closure, which is this combination of vadose zone contamination and stuff we left behind, is about two percent of high-level waste inventory.

Now we go down the rabbit hole further on how do we change this from high-level waste. We go to the NRC, and they make a determination that this residual inventory after treatment is reclassified as “waste incidental to reprocessing”. I want to point out that high-level waste, low-level waste, and waste incidental to reprocessing are specific terms defined, and they’re called the Federal Register. Means something to a lawyer. So that’s why we call it low-activity waste. It’s not a legal finding. Low-level waste is also defined by source in the regulations. The NRC makes this determination. There’s three rules there. Basically it’s got to be safe to the environment.

For further discussion and enlightenment, there’s an attachment. The “Legal Bar Against Reclassifying High-Level Waste” at Hanford is on this attachment. The discussion you started entering into is by no means resolved legally.

Our retrieved waste that we separate, again, there was no preferred alternative and no records of decision. We separate three fractions (inaudible) TRU after twenty tanks, both contact and remote handled. NRC has to reclassify this high-level waste. The vitrified high-level waste for disposal at the National Repository, that’s the easy one. The low-activity waste we’ve been talking about, the (inaudible) Waste Treatment Plant will process about 30 percent of that waste, the total waste. We didn’t select an alternative or the waste form that they want to go ahead with. The current Waste Treatment Plant and the one-third of the waste that's LAW has a provisional classification as "waste incidental to reprocessing" by the NRC. That provision is, if you change the waste form and a couple other little nits in the provision, it says come back, it's no longer LAW.

So the NRC's waste classification says it's glass (inaudible). That's what their--

GEPHART: You have to be wrapping up pretty quickly.

BOLDT: Okay. As was mentioned before, we have some other materials, the capsules, a couple thousand of them. Probably not mentioned, the WESF Basin has had damage to the concrete walls behind the liner. They're looking at potentially putting the stuff in dry storage in the future; in 2017 we'll decide what to do. The future repository has to decide whether they're going to take this overpack material that is a water soluble source, just another criteria for the new repository.

We have the 34 German logs, and they're currently in eight steel storage casks. These storage casks have (inaudible) life of 40 years. We need to recertify or replace them in 2037, eleven years before potential shipment to the repository.

There is also a second attachment on here that goes into the discussion of the LAW waste, the indecision on what to do about alternate waste forms, just more detail of what you’ve heard.

GEPHART: Thank you, Al.

All Board members, all staff, all that you have seen on the screen, we have electronic copies, so those will be forwarded to you so you have all the information that has been provided.

And for the speakers, I thank you very much. If there is anything else that you wanted the Board to see or to read that you didn’t present, feel free to give it to me, give it to the gentlemen who are up here, and we will assure you that the Board will receive that.

We have about ten minutes before our next session, so coffee, tea, restrooms. Let’s go. Thank you very much.

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

EWING: Please, if you could take your seats. In particular, if you can find a panel member, bring them in. For the balance of the afternoon, we’re going to shift gears a little bit, and the presentations will cover wider ground.

The first this afternoon is by Bill Boyle from the Office of Nuclear Energy, Department of Energy. He’ll be giving us an update on the potential for direct disposal of dry storage containers currently in service in nuclear power plants.

BOYLE: Thank you for this opportunity. And as Chairman Ewing just said, I’m glad there was the break right now, because we’re making a fundamental break from all the talks that preceded today. I’m not going to talk about glass. I’m not going to talk about DOE defense wastes or anything in tanks. We’re going to discuss commercial spent nuclear fuel in dry storage at the power plants today. As two of the speakers, Ms. Larsen and Mr. Petersen, said, there is an example of that right up the river here that we didn’t see yesterday on the tour.

So what I’m going to talk about so that everybody--we’re all speaking the same language here, it’s the direct disposal of dual-purpose canisters. Well, what are the two purposes of the dual-purpose canister? They have been designed and licensed by the Nuclear Regulatory Commission designed by vendors licensed by the NRC. The first purpose is the storage of spent nuclear fuel, and the second purpose is for the subsequent transportation of that spent nuclear fuel.

Bear with me for a second while I read this slide. The rest of my slides after this are all technical, but this is a technical presentation that does not take into account the contractual limitations under the standard contract. Under the provisions of the standard contract, DOE does not consider spent fuel in canisters to be an acceptable waste form, absent a mutually-agreed-to contract modification. To ensure the ability to transfer the spent fuel to the government under the standard contact, the individual spent fuel assemblies must be retrievable for packaging into a DOE-supplied transportation cask.

So this is my way of telling people that there is a contractual issue related to the direct disposal of these dual-purpose canisters. I've alerted you to it, and I'm not going to speak about it anymore. I'm not an attorney; I'm not a contracting officer. It's just to let people know that there is--the DPCs are entangled in a contract. The standard contract that's referred to is the contract that the government signed with each of the power utilities where the utilities were charged the mill per kilowatt hour, give the money to the government. That's the contract that's being referred to. And the government's view, not only the Department of Energy but the Department of Justice, is: Go read the contract; we don't have to take the DPCs. So that's an issue for others to look at.

What my group is looking at is: Let's pretend that the contracts never existed. Let's just look at the existing DPCs and ask ourselves, Can we dispose of them? They weren't designed for disposal, but now we're looking at them after the fact and asking ourselves, Could we do it? What are the challenges?

So for the remainder of this talk I'm going to focus on what is a dual-purpose canister, show some information about them, get to the fundamental question of can we dispose of them as is or do we need to take out the spent fuel and repackage it, and then a brief description of our ongoing research and development.

So this slide has various information and pictures from one of the vendors of such storage systems in the United States, NAC International, and this figure in the middle tells us what we need to know. I refer to them at DPCs, dual-purpose canisters. This diagram refers to it as a transportation and storage canister, and it's this cylinder in the middle that's steel. Here's another example. This is a picture of that cylinder in the middle. Each of these channels would get a spent fuel assembly, and then a lid is put on this, sometimes bolted, more commonly welded. And then that's put inside another sleeve, if you will, of concrete, which you see down here.

So this is the dual-purpose canister. Here it's in its storage mode. Eventually, when it comes time to transport, this DPC comes out; it's put into a different transportation cask; and then it's transported to wherever it needs to go. What remains behind are all these concrete cylinders. And, essentially, they should be clean. The DPCs shouldn't leak; there should be no activation products.

These are big, these concrete shells, so big that they’re typically made on site. There is no factory that produces these, which would be the general preference, you know, have somebody set up and mass produce them. But they’re so large, they’re typically produced right at the reactor sites.

So this was one of the vendors in one of the modes, vertical. Another thing, the storage works for both pressurized water reactor assemblies, PWRs, and also boiling water reactor assemblies, BWRs. For those who aren’t reactor experts, the PWR assemblies are typically bigger. That’s why you end up--whether it’s PWR or BWR, you get about the same amount of material. So in terms of--it only takes 37 PWR assemblies to equal 87 of the BWRs.

Here is an example of horizontal storage. You can look down here at the right-hand side. The only horizontal system is called NUHOMS®. It comes from another vendor, Transnuclear/AREVA. But, similar to the one I showed on the previous slide, they’re very big. You can always look at the humans in the photos and get that impression.

And, finally, there is a third vendor in the United States. This diagram on the right was very similar to the first one I showed with the DPC inside the concrete oversleeve. This diagram here shows--this provides for below-grade storage, helping to mitigate aircraft crash hazard.

Now, this slide is courtesy of AREVA, one of the vendors. I could show a similar slide for the other vendors. The main point to get out of this slide that, as time has gone by, the number of assemblies in the canisters has gotten monotonically larger. And the reason for that is, the customers for these dual-purpose canisters are the utilities. And they want bigger ones, not littler one. And why do they want bigger ones? We'll use the 32 as an example, because it's not a prime number like 37. It's much more productive for the utilities to load one 32-capacity DPC than to load eight 4-assembly DPCs. It's just that much more efficient for them. They have a preference for large DPCs. It's their choice. That's what they buy. And, like I said, this is specific to the AREVA products, but NAC International and Holtec® would show a similar trend. They only get bigger with time.

And it's this bigness that gets at the fundamental question to dispose or repackage. It's the bigness. Big things are more challenging to handle the transport than little things. For a given heat output per kilogram of material, the more kilograms you have, the more heat you have coming out. And, similarly, with respect to criticality, whatever amount of fissile material you have per kilogram of material, the more kilograms you have, the more fissile material you have. So it's the bigness of the DPCs that pose the fundamental challenges with respect to disposal.

Now, this slide I phrased in terms of the pros and cons of direct disposal. I could have turned it around and said the pros and cons of repackaging, you know, you just have to change the words around, but the issues are the same. And, in short, the pros of direct disposal of the existing DPCs is essentially you're close to done. All you have to do is pick them up at the power plants, transport them to a repository, put them in a waste package, you're done. You're not opening them, you're not cutting them open, you're not unbolting them, you're not handling them. All of that handling and repackaging costs time, money. It would all be done safely, but you also are running the risk of accidents, you're pulling an assembly out, you drop it, and things like that. So the big pro of direct disposal is, you don't do any of that, and you're close to being done already.

I've already discussed the cons of direct disposal of the existing dual-purpose canisters. It's essentially all related to their large size, the amount of material they have in them. They're thermally hot, they're harder to handle, they require bigger underground openings, which can be more challenging, if you will, and it also--for long-term disposal we cannot analyze the criticality the same way the storage and transportation people do because of the long time frame involved. We have to do the analysis a different way, and so we’ve got to do research and development on that.

So I’ll deal first with the big size, and these first three sub-bullets give you some metrics of how much things weigh. For example, the largest waste package considered anywhere in the world by far was the Yucca Mountain Naval spent nuclear fuel, and that was 74 metric tons. And if you look at what a DPC would weigh in its waste package and a transfer cask as you’re moving it underground, it will weigh 150 metric tons.

Well, as this picture shows, cranes can lift heavy objects, but the challenge with a repository, if you’re considering a vertical shaft, is actually the great depth. If you’re looking at 2,000 feet, the lengths of the ropes themselves become--you have to lift the ropes as well as the package. It’s easy enough to go on line and go to manufacturers of mine hoisting equipment, which they start off with the opposite problem that a repository looks at. A repository generally is looking at, the heavy weight starts with all the ropes coiled up and then lets them down. Mines start with, the ore is loaded at the bottom and they try to lift it up. And if you go check the skip capacities of mine hoisting equipment, it’s nowhere near those numbers that I’m showing there.

Now, these bullets say the Germans are looking at it, that maybe they can solve getting it down a shaft, but I don’t know that they can retrieve. There’s requirements for retrieval but, not that I’m aware of, that retrieval must be done the same way you did emplacement. But, having said that, that’s the most easily understood form of retrieval is just undo what you did.

And vertical shafts, because of the great weight of these items, would pose a bit of a problem. But the good news is, there is potential ways around it. If you’ve got enough property, a ramp at a shallow grade--one or two percent works--this is the approach the French are taking for their repository. They literally have the shafts start in the next apartment; right? You know, they need a lot of space, and so they started next door, and down they go. If you’re limited by space, you can corkscrew down in a shallow ramp. So as long as there is no requirement to use shafts, I think the large size perhaps people can work around. The French also looked at, in addition, if you’re challenged by real estate and you can’t do a shallow-grade ramp or corkscrew, they even looked at a cogged funicular railway.

But other technical issues related to the big size include--these aren’t insurmountable, but everything else being equal, large openings underground take a little more work than small openings, and these would have to be bigger openings. And also sealing big openings is perhaps more challenging than sealing a small opening.

And here, for post-closure performance, we also have issues with respect to the heat output. These have a lot of material, they would be hot, but there are ways around that. You can just wait, you can ventilate, but there are ways to get around the thermal problems. And, as I mentioned also, the fissile material amount, you cannot do criticality calculations the way they were done for storage and transportation. Because of the long time frame involved, other things can happen.

And so we'll probably have to do work on what's called burnup credit, which, for the non-reactor experts, gets down to--it's related to the discussion this morning where Chairman Ewing engaged with Peter Swift. Burnup credit is: Don't make overly conservative assumptions about what you're analyzing; analyze what you actually have and find out what your challenges really are.

There have been presentations to the Board on this topic. As a matter of fact, some of our original work on this topic was encouraged by a former Board member, Andy Kadak. We were doing systems studies, looking at smaller packages, and he essentially asked, "Well, why don't you look at the existing packages as well?" And so we took on the challenge.

So this slide is just to show you covers of some reports we're doing. In order of the challenges, the technical challenges, people have look at this before all the way back to the 1990s. The Office of Civilian Radioactive Waste Management contractor issued a report on direct disposal. The next M&O contractor, management and operating contractor, they did as well. Electric Power Research Institute has looked at it. And the consensus is, in a rank ordering of the challenges, it's probably criticality, thermal effects, operations in descending order.

There is another challenge here that's not related to disposal, but it's more to storage. The concept when these storage systems were developed was, they'd be loaded, they'd be put in, they'd be removed, transported, and disposed. But because we do not have a repository in the United States, there is now discussions of, well, let's remove them from the power plants, put them in interim storage, perhaps transport them later, and it's all this handling, the putting in and taking out, putting in, taking out, transporting.

The certificates of compliance--for example, the NUHOMS®, the horizontal systems issued by the Nuclear Regulatory Commission--it states, "There shall be no undue galling, gouging, or scratching," which the utilities actually have to demonstrate before they're allowed to load with spent fuel. But they demonstrated on a one-time basis what we're talking about here is multiple times; and if it got gouged, galled, or scratched, would it call into question the ability to actually store it before you even got to disposal. So that’s other work we have to look at as well.

So my last slide, it’s neither good nor bad. There are pluses with direct disposal. There are definite challenges. We’re doing the ongoing R&D to provide information to decision makers in case they want to go down the path of direct disposal or not. That’s my last slide.

EWING: Okay, thank you.

Questions from the Board? Yeah, Paul.

TURINSKY: Paul Turinsky, Board. Have you found (inaudible)?

BOYLE: No. Historically, the one that--the technical reason that caused people to say, “No, not right now,” it was the criticality. As you go back and you look at the reports done by the TRW group in the ’90s or the BSC group in the 2000s or even in the EPRI report, that’s the biggest--that’s why I ranked it as the top. That’s the one that--over the course of geologic time, you know, they lose their shape, they clump, water gets in. All of a sudden it becomes a more difficult problem, particularly if you don’t take account for the burnup credit. You know, it’s really there, if you will.

EWING: Mary Lou.

ZOBACK: Mary Lou Zoback, Board. Given the graph you showed for the AREVA canisters with the--and you said all of them have the trend to make them increasingly larger--and it seems like your analysis right now, really looking at the technical challenges for as big as they are now, should the utilities be told to not use anything bigger than now? I mean, why are we going to allow them to go down a path that is not going to be--

BOYLE: Okay. It is subject to a contract; right? I don’t think--

ZOBACK: Well, I know, but we’ve got to solve the problem.

BOYLE: I’ll get there, I’ll get there. I don’t think the government can go to the other party in a contract and tell them what to do. The government could enter into good faith negotiations and say, Hey, these are problematic for us; what would it take for you to do four 8s? My colleague, Jeff Williams, works for Monica as well, we do do studies on that sort of thing, different systems, if you will. And we are doing that work.

But to the best of my knowledge, no one has engaged with the utilities yet to find out what would it take. My supposition is, the government might have to offer them a whole lot of money to do this. And the challenge becomes, in order to load those eight 4s instead of one 32, you’re using their pool and their crane a lot more. They need to use that crane and pool for power generation activities and the running of the plant; and if it were to be used for other purposes, it impacts their ability to run the plant.

And this was actually covered, if you will, in two recent reports, one by Electric Power Research Institute and one by the Government Accountability Office, in response to suggestions, get the spent fuel out of the pools and into dry storage. And both groups within the last year issued reports that highlighted this issue that in order to do that, to get it all out of the pools as much as you can and into dry storage, you'd be using the crane and the pool for activities other than the utility really wants to use them for.

So the government could go to them. I don't know what the price would be, but it might be more than anybody is willing to spend.

ZOBACK: But in the end, what the utilities want is for this to go somewhere; right?

BOYLE: That is true. That is true.

EWING: Bill, I have a question. Rod Ewing, Board. You listed in your pros and cons the impact on geologic disposal perhaps restricting the options.

BOYLE: Yes.

EWING: But you didn't discuss it in the presentation really, so what would be some of the restrictions?

BOYLE: Okay. For example, if your geology is such that you want to rely upon a backfill, you'd have to look at would the high heat output be bad for something like bentonite, and there is a reason why those countries that are choosing to use bentonite don’t go with things this hot. Like, for example, Sweden is disposing of spent fuel four assemblies at a time, not 32 or 37. So it would be the heat effects on not only the rock itself, you know, can the rock--does it have a high enough thermal conductivity to get the heat away from the item itself, because there might be thermal limits on the packages themselves that you put down, but also the materials that you’re counting on to work, particularly if you have backfill.

EWING: So backfill would be an issue. But jumping to another type of geology, say salt, which has a high thermal conductivity, so at first blush that’s a positive--but if you have a hot package weighing 50 to 100 tons in a material that deforms plastically, wouldn’t it sink?

BOYLE: People have looked at that. I know that is one of the issues that people are concerned about with salt. I think I’ve heard some of them say, based on their look at it, that’s probably not as big a worry, but it’s something we would have to look at. Each of the geologies, plus or minus, may have their own considerations.

Like, take bedded salt, for example. If you can’t have a vertical shaft--well, I’ll put it another way. If you had a vertical shaft with horizontally-bedded salt, it’s much easier to think of the seal system for that penetration, it's just a cylinder, right, a right circular cylinder. If you spiral through it on a shallow ramp or you come through it on a shallow ramp instead of a circle, you have an ellipse and cross-section, it's a longer distance of the seal for a given thickness of salt. So there are challenges, each of the geologies.

EWING: All right. Other questions? Lee.

PEDDICORD: Bill, a couple things. As you've looked at direct disposal of canisters like this, to what extent have you looked at the issue (inaudible)?

BOYLE: I think some of them do. I think in the--

PEDDICORD: If you can count on it; right?

BOYLE: Right. And it's something that would have to be looked at. I think people do know that. And, again, whether--I don't know if any of the ones with failed fuel currently got the certificate from the NRC, but it's something people would have to look at.

PEDDICORD: I forgot to say, this is Peddicord from the Board. So the question that comes to mind then as well, too, in your list of pros and cons, if you can accept failed fuel in such canisters (inaudible) NRC (inaudible) direct disposal, that becomes a plus that you would not have to repackage (inaudible) failed fuel. Another thing that some of our staff colleagues have identified is, by doing the direct disposal, reducing worker dose significantly. And you might want to put that on your (inaudible).

BOYLE: Time, money, worker dose, even non-radiological accidents. So, again, back to the pro column, you’re essentially done; you’re not doing much more. And every time you do more with things like this, there is dose involved and also non-radiological hazards and time and money.

PEDDICORD: Also, on the criticality question, are there not both internal and external--and I’m talking about (inaudible) package strategies you could utilize to minimize criticality (inaudible).

BOYLE: Oh, yes. And the Office of Civilian Radioactive Waste Management, when it was working on the TADS--transportation, aging, disposal system--there were to be internal to the DPC, if you will, itself the TAD criticality controls.

PEDDICORD: And, finally, one last question. Comparing Slides 4 and 5 of your presentation, just to kind of help me understand, in Slide 4 you show the vertical canister (inaudible), which is the middle container, as you pointed out, and you go on to the next slide, the NUHOMS®, where this is being stored horizontally. But what is the kind of shielding that allows the workers there to be that close to the package containing that many elements?

BOYLE: I am pretty sure that the big object that we’re looking at there does not stay in. It's providing the shielding. The spent fuel is actually inside that. That's a transport device.

PEDDICORD: (Inaudible) package (inaudible).

BOYLE: Yes. And then they shove it in, and then it's that concrete structure that provides the shielding.

EWING: Other questions? Staff?

All right, Bill, thank you very much.

So the last speaker for the day--and we've certainly saved the best for last--is Peter Lyons, Assistant Secretary for Nuclear Energy, Department of Energy. And he will be giving us an overview of the administration's response to the recommendations of the Blue Ribbon Commission on America's Nuclear Future.

LYONS: Thanks, Rod. And it's good to interact with your group again. I found it fascinating to listen to the presentations today. But, as Bill noted in his talk, his talk was pretty much a complete break with what you heard earlier. Mine's going to be a complete break as well. At least Bill's talk probably had the word "technical" in it, so it matched your charter. I don't think my talk has that at all. What I'll be doing is really giving you a policy talk, and I'll apologize for the lack of technical. But that's the way it will be.

I was asked to describe the administration's strategy for basically the response to the Blue Ribbon Commission. You've had other briefings in the past on the BRC recommendations. I certainly don't want to talk through this again. You're well aware that it starts with consent-basing moves to the importance of the new organization and talks about the importance of access to the waste fee along with a number of other very important recommendations.

As you probably know, the outgoing Secretary, Secretary Chu, spoke very positively about the Blue Ribbon Commission, which he had chartered. You're probably also well aware that the nominee for Secretary of Energy, Dr. Moniz, was on the Blue Ribbon Commission; and he was asked in his confirmation hearing just last week to comment on his degree of support for the BRC. And I think it's fair to say that it was off the charts. He indicated a very, very strong interest in moving ahead with the recommendations of the Blue Ribbon Commission.

After the BRC submitted its report, though, in January of 2012, there was an effort within the administration to essentially develop a response to that; and that would then become the administration's statement of their views--the overall administration's--this is multi-agency--of their views on the BRC recommendations. And, as such, it becomes a basis for administration discussions with Congress as hopefully we move ahead with legislation and also a very clear statement, I think, of the importance that the administration places on moving ahead with steps on the back end of the fuel cycle.

The administration's strategy dealt with three large primary areas, which I show here. These are also not dissimilar to what the BRC focused on. And, in general, with very, very few exceptions, the administration's strategy pretty much endorsed what the BRC said, sometimes with small variations or very important variations or key points; but, in general, very strong agreement.

The administration's strategy starts with the importance of consent-based siting, recognizing that the current path we've been on, which Secretary Chu and I have defined as unworkable, was anything but a consent-based approach. And if one looks around the world or within the country at the current situation at WIPP, I think it's very, very clear that a consent-based approach has a far higher probability of success than what we have been on.

In terms of a system design, the BRC and the strategy talks about key words like phased, adaptive, and staged. I'll say more, but it talks about a pilot interim storage facility, moving to a larger consolidated storage facility, and the importance of geologic repository, of course, as you're very, very well aware.

And then it goes into the importance of both the governance and funding questions with endorsement--and this is now from the administration--endorsement of a new organization to take over these responsibilities as well as the importance of providing mechanisms for funding. And I'll be saying quite a bit more about this as we go ahead.

A couple of key points, which I'll try to reemphasize on a few of the subsequent slides. For each of those system elements--the pilot, the consolidated, and the geologic repository--the strategy makes it clear that, as far as the administration is concerned, subject to guidance from Congress, we think that all of those facilities could be considered for defense and civilian waste. And for some of the discussion that you had earlier today, that ability to potentially move defense waste early might become extremely important.

In addition, the strategy makes clear that--at least, again, from our perspective, subject to what Congress eventually passes--we think all of these facilities could be co-located. And at least we think that giving a preference in the selection procedure to facilities that were willing to be considered for co-location could be a very positive step for the country.

In terms of the implementation that the strategy lays out for the interim storage facilities, I think there's been a lot of discussion of these different dates. We think it’s possible to assume--assuming we have legislation by 2014, we think we could have a pilot facility open in 2021 that would focus on servicing the shutdown reactors--probably could take quite a bit more than that; that’s only about 3,000 metric tons--and would depend on how Congress chooses to define what the parameters of a pilot might be. But we think it would be possible by 2021, a larger facility by 2025. So we’re looking at dates that are reasonably soon and, we think, can be real targets if we can get the legislation fairly soon.

And that last bullet down there I already emphasized, what we think is important to consider, servicing both the environmental cleanup and defense sites as well as the civilian.

You’re well aware of the locations of the shutdown reactors. There’s already been comments about the Trojan site somewhat south of here. Several other sites are south of here, but then spread across the country. And there are some hints that there will be additional sites. Kewaunee will be shutting down May 7th; you probably have heard that. Crystal River is probably shut down permanently now, Crystal River, of course, down in Florida. So you could add a few more sites here that may be in this category of shutdown reactors in the not-too-distant future.

The strategy as it addresses geologic disposal goes through what it believes is a reasonable time scale of the operations of the geologic disposal, allowing very substantial time to move through a consent-based process, then, of course, along with a characterization design, licensing steps. Maybe it would be possible to do this faster, and that might depend on which particular sites might come forward and express interest in this. I sometimes hear people say, “Well, gee, you just delayed Yucca Mountain by 50 years.” Well, as someone who has had a great deal of experience in Nevada, you’re well aware that 1998 was not exactly a reality. And in my humble opinion, counting on any date for Yucca Mountain is not very likely to lead to success. And we can go into that if you want, but as someone who grew up in Nevada and conducted--I directed the research at Los Alamos on Yucca--I have some pretty strong feelings on the degree of opposition in Nevada.

A comment that’s made here is that, while the strategy talks about one each of these various types of facilities, we certainly recognize that when we talk about a consent-based process, you may have restrictions, requirements placed in the process of the consent process that could require that you need more than one of some of these facilities. The strategy talks about one, but it certainly doesn’t intend to preclude the possibility that you’ll need more.

I wanted to give you at least a flavor, because I don’t think you’ve been briefed on it, a fascinating study that we asked Oak Ridge to lead. They involved a number of other national laboratories. And essentially the question was: If one looks at the existing inventory of used fuel across the country today and if you had capabilities to reprocess today or if you wanted to save it for reprocessing, would that make sense to look at the current inventory and ask whether disposal, saving it for research, or recycling it makes the most sense?

And they looked into things--which I guess I was aware, but the study certainly brought it home--that if you look at the existing inventory of used fuel across the country, it’s a tremendous number of cats and dogs, all kinds of enrichment levels, all kinds of burnups, all kinds of configurations. And if you imagine trying to come up with front ends to reprocessing systems that would handle all those different mods, their conclusion was, it doesn’t make sense. Furthermore, you’re generating 2,000 tons of the stuff a year, so it’s not like you’re running out of it if you choose to reprocess in the future.

Out of that came, again, what to me was a fascinating conclusion. Their recommendation was that 98 percent of the current inventory should be viewed as moving directly towards disposal, saving some for R&D that would relate to Monica’s programs on possible future closed cycles and some, particularly the Naval fuel, that was viewed as having a possible strategic interest to the nation in the future. But, coming up with the statement that 98 percent of what we have today, in their view, ought to simply be viewed as moving as directly as possible towards disposal.

Going back then to the administration’s strategy, the implementation aspects of that, I’ve already noted consent-based process figures very, very prominently--absolutely no argument--across the administration that it has to be a consent-based process, although the details of exactly what’s meant by a consent-based process probably are going to be debated in Congress. And I’m leading up to the point that there’s many areas here that will be defined in legislation that will be needed in order to move ahead in this area.

But consent-basing, strong agreement; new organization, extremely strong agreement. We did contract with Rand Corporation and asked them to look at different organizational structures that might be used for looking into the future. Now, you would be quite correct in pointing out, there have been multiple studies in the past looking at alternative management structures as well, but this was another new study from Rand and certainly a very, very thoughtful study available on our website. I don’t think it’s any great surprise that the bottom line was, there’s no one organizational type that is guaranteed of success. They indicated that a government corporation or an independent government agency appeared to have the characteristics for success, but the features like the independence, the leadership, the longevity of the leadership, the continuity of the organization may be far more important than the details of exactly how you structure that organization.

Funding also was considered in the strategy, but I’m going to come back, assuming I haven’t bored you too much, with a few comments on what the administration proposed in their budget last week as it was released that actually put some teeth on this. But the administration’s strategy when it came out in January recognized the importance of three different areas. One was to maintain some component of the funding that was subject to ongoing appropriations. The view there was that Congress will and should demand, as should the administration, some annual oversight of the progress being made by this new entity, and that by having some level of appropriations, that would give some degree of oversight to the Congress.

But it also recognized the importance of reclassification of either the fees or the spending. Again, you’re probably very familiar--and I certainly don’t want to go into it, but you’ve got a situation now where the fees are mandatory and the spending is discretionary. And those two sides of the budget simply don't offset each other. And that's where we have been for now probably a couple of decades on this, and, if anything, it's getting worse over time. You need to reclassify either the fees or the spending in order to get them both on the same side of the ledger and be able to talk about offsets. And then, finally, access to the nuclear waste fund. And I'll come back in a minute and show you how the administration addressed all of these points in their budget proposal that came out last week.

I'm going to skip through several slides that go into some of the ongoing R&D in the program that Monica and Bill and Jeff direct. But on this one I did want to note that, particularly in the area of storage R&D--because I think this is of strong interest to you--that second bullet, we've been working on a competitive basis to select teams to come up with a demonstration to provide data on, frankly, what happens on high-burnup fuel in storage. This also is part of a multi-university program--happens to be led by Texas A&M--where we have also asked that they study with several partners to try to gain a better understanding of what can happen--what are the degradation mechanisms that could affect used fuel in long-term dry cask storage and, in particular, to do it for high-burnup fuel.

What's noted here in that second bullet is, we're in the final steps of the procurement process. Yes, we are. And it was announced today that EPRI will move ahead--they were selected to move ahead with a cost-shared program. This will lead to highly instrumented casks. It will involve a demonstration site. There will be a research plan that will be developed as pretty much the next step in this. That will go out for public comment, and we will certainly invite the NWTRB to comment on the research plan; because as we look at virtually any of these options looking into the future, there is going to be a need for dry cask storage for significant periods of time. Between the university program and this actual set of measurements, we're hoping to provide you and the country with far more information on what happens--hopefully nothing--but what happens in dry cask storage and how long can you reasonably consider using dry cask storage.

I think this is one I'll skip through fairly quickly. It's already been commented today by some of the other speakers that we are already involved in these strategy endorses, that we move ahead with planning to the extent we can--there's a limit to what we can do without legislation--but starting to plan for aspects of the transportation program. And that would include reactivating some of the work with the state and regional programs to try to begin to recreate some of the capabilities that were being nurtured earlier on in this program.

In terms of transportation R&D, I think this is another one that I'll skip over, but also within Monica's program.

In disposal R&D, again, under Monica's program with Bill and Jeff--Jeff Williams--we're continuing to try to develop a greater understanding of alternative geologic media. This certainly includes salt, where arguably the U.S. is one of the leaders, maybe the leader along with Germany. And I'll comment briefly on how, in addition to studies at Sandia, we're crafting various international agreements to try to get a better understanding of alternative geologic media that might be proposed in the consent basis. Noting here the interest in continuing work at WIPP, I have to say, not from the standpoint of selecting WIPP, but from the standpoint of using WIPP as a generic salt experimental bed and continuing work, much of that is being done jointly with EM.

Also, Monica's team is cranking up a borehole disposal R&D program to try to look at that as a possibility for the future.

In addition, I mentioned the work with the international partners. We've certainly tried to nurture this, and Monica has been taking a very strong lead in trying to expand the different international cooperative ventures that we have. Again, we have a great deal of expertise in salt, and we do some of that jointly with the Gorleben in Germany. But we recognize that, for example, if it’s granite, Sweden and Finland are doing outstanding work in that area; France certainly; Switzerland to a lesser extent; outstanding work in clay-based systems. So there is MOUs; there is joint programs; we’ve reactivated collaboration with all of those entities. We have an MOU with ANDRA. And I think that’s highly appropriate, given where we are in the current program.

The strategy concludes with the recognition that we’ve got to have legislation. You’re well aware of the limitations within the Nuclear Waste Policy Act, and virtually everything I’ve described here is not going to happen without changes in the Nuclear Waste Policy Act.

You’re probably also aware that Senator Bingaman last year worked to pull together a bill with a number of his colleagues. He did introduce the bill, but in some of the final negotiations he was the only sponsor of that bill. That bill died in the last Congress. Now Senator Wyden, who has taken on the leadership of the committee that Senator Bingaman had with Energy and Natural Resources, as Senator Bingaman retired, Senator Wyden took over that leadership. Senator Wyden has spoken repeatedly about his efforts, working, again, with several very influential colleagues who hold key positions on the appropriate committees, is working towards legislation. He has made it quite public that they started with Bingaman's bill but have worked to identify some of the sticking points that led to different concerns within Bingaman's approach. He has indicated that they may be within a month or two of providing that legislation for review. I'm certainly eagerly awaiting that. And, just in general, I'm very, very gratified to know that there is a group of senators, who recognize this importance and led by Dr. Wyden, are looking towards real progress in this area.

I wanted to switch ever so briefly to comments on the budget. The budget was released last Wednesday. I'm not going to talk through these numbers at all. They're in there. Let me just note that, number one, it's an austere budget, as you can tell by the bottom line. Number two, we worked very hard to protect several key initiatives within our program. One of those is small modular reactors, which may or may not be of interest here, but certainly not to discuss. The other is fuel cycle R&D--again, Monica's program--where we are working diligently to try to maintain funding to move ahead as we can with an existing legislation on different aspects in preparation for moving ahead on the Blue Ribbon Commission recommendations.

Again, I won't talk through this in any detail, but you'll note the first bullet up there under Planned Accomplishments is to continue activities that support the administration's strategy. And then a number of other aspects listed there; some of them I've already talked about.

But I wanted to close--at least I think that's my--yeah, that's my last slide. I wanted to close with this slide. Within the administration's budget were some very, very specific proposals. I guess you could say there has been some of the predictable responses, but there has also been some bipartisan statements that recognize that what the President has done here is to really try to put teeth on the administration's strategy that he proposed.

So the budget--and this is laid out in multi-year--the budget goes for ten years. And laid out within that ten years is $5.6 billion over those ten years to move ahead on this program, to move ahead with the construction and operation of the pilot interim site, as well as substantial progress on the interim storage site and on the geologic disposal. $5.6 billion over ten years is a very substantial number.

In terms of details of the funding, I gave you earlier what the strategy recommended. That was in January. Now what the President has done is to say, okay, I agree that we ought to have annual appropriations in order to give Congress and the administration some degree of annual oversight of the progress. But the statement now is that there will be ongoing discretionary approps up to 200 million, but above 200 million and reflected in the budget now is to move to mandatory approps.

So, again, I described earlier how you've got to either change the fees or the approps so you get them lined up on the same side of the ledger so they can offset. So now the proposal is to go to mandatory appropriations starting in 2017--and this is reflected in the ten-year budget--tapping into the nuclear waste fund as you continue to move ahead with program costs. This is an expensive business. That's why the 5.6 billion. But if this proposal will be accepted by Congress, this is now putting the administration on record as supporting the ability to tap into the nuclear waste fund with mandatory appropriations. That's a very big difference.

In addition, I'm missing one bullet up here, which is also very important. You're, I think, well aware that every year the utilities sue the Department because we didn't take their waste. Well, okay, we didn't take their waste. That's obvious. And every year they win. We have now paid 2.6 billion to the utilities, and this is growing by an average of 400 million per year. But these awards are paid out of the so-called "judgment fund" of the Treasury. That judgment fund is not subject to OMB or congressional oversight. That is a mandatory payment. And in the past that has never been counted within the budget, at least the budget looking forward. It's always put in the budget looking backwards, but by then it’s too late in some sense.

So what the administration is doing and have built into their budget is a forecast of the future liability payments in order to try to make the point to everyone that, folks, this inaction is really costing us, it’s costing the taxpayers, and that those liability payments should be viewed also as an offset towards progress into the future.

This may not sound like a big deal, but it is, folks, to actually recognize that we’re going to lose these suits obviously, and we’re going to plan on losing them. Count the liabilities then as an offset looking into the future. So another extremely important point.

And then the very last element down there, which should also interest you greatly, one of the BRC recommendations was to point out that Yucca Mountain is being done under site-specific disposal regulations. And the BRC pointed out, that’s not a really good way of looking into the future, folks, and then the EPA needs to move ahead with generic disposal regulations. So the President’s budget not only funds, it provides the authority to the EPA to move out with the development of generic standards.

And I’m guessing that last one resonates with some of you.

I didn’t bring a watch up here. I hope this isn’t too late.

EWING: No, you're fine.

LYONS: In any case, thank you, and I'll take questions if you still have any time.

EWING: So, Pete, thank you very much for a wonderfully informative presentation.

And we do have time for questions, so, first, questions from the Board? Yes, Lee.

PEDDICORD: Peddicord from the Board. Dr. Lyons, I agree. Thank you for a very interesting (inaudible) information. Two questions come to mind. What is now the administration's position in (inaudible) this new entity (inaudible), however it's defined, in terms of it (inaudible) an R&D mission towards disposal, and what might be the breakdown between R&D (inaudible) the new entities, assuming it has this responsibility, and what you're currently doing in the fuel cycle R&D (inaudible)?

LYONS: The BRC recommended and the strategy concurs that the new entity should focus on the disposal mission but that the research on separations, possible closed fuel cycles--that's R&D--that should stay within the Department of Energy at last for the foreseeable future. And Monica's program, in all of its elements, is working towards providing information to future decision makers as to whether at some point in the future the country may wish to move towards a closed cycle. But certainly the agreement is, the first thing we better do is demonstrate that we can move ahead with a repository system, which, of course, would be required, closed cycle or not.

PEDDICORD: Let me drill down just a little bit more into the question. In spinning off what we were discussing with Bill Boyle (inaudible) possibility in this issue of (inaudible) fuel and so on, my (inaudible) requires some research and technology development. Is that going to be something then that (inaudible) because this is very much related to the disposal mission (inaudible)?

LYONS: Congress may provide us guidance on that. At least my view is that, to the extent R&D is required specific to the disposal mission, it would be done within the new organization.

PEDDICORD: A second question, if I may as well, too. Now that (inaudible) under the consent-based approps, you have communities stepping forward to express interest. So until new legislation is in place, how does that progress? Is it something your office handles, considers, responds to; or are these (inaudible) until (inaudible) some activity is taken by Congress?

LYONS: Well, a number of organizations across the country are talking with us of their interest, and certainly a number of them have very strong interest in finding ways for us to move ahead with site-specific funding. Under the

Nuclear Waste Policy Act, at least most interpretations would say I could probably move ahead on consolidated storage and go partway; certainly couldn't move towards actual construction or operation.

Again, my view is that it's quite a mistake to do anything site-specific until we have legislation. We have right now quite a split between, I think, the House and the Senate on this. And I am concerned that if I undertook site-specific activities, I would be exacerbating a divide between the two houses. My view is that we're far better off to wait. Even though I could move a little way, I can't move very far. I think we're better off to wait until we have a new legislative framework that takes the place of the Nuclear Waste Policy Act and makes it clear what the congressional intent is. I think we're far more likely to have a successful outcome that way.

This is certainly debatable, Lee. I'm in debates frequently on this. That's at least my view is we need to wait, and we need to see what the legislation is and then move out.

PEDDICORD: Thank you.

EWING: Other questions from the Board? Staff?

LESLIE: Bret Leslie, Staff. Dr. Lyons, I have a question in terms of the consent-based approach. The framework for interactions between states and affected units of local government is set forth in the Nuclear Waste Policy Act. Do you foresee that the consent-based approach is specified in legislation, or is it kind of a generic statement we should use a consent-based approach? And if it’s the latter, how do you determine what those principles are to define what consent-based would mean?

LYONS: Well, first, yes, Congress may tell us. On the other hand, there has also been a lot of studies in the past, looking at what would go into a consent basis. We would certainly draw on that. We would try to find opportunities for public input on how this would be constructed. Although we are--well, I feel very strongly that we should not do site-specific work.

We’re quite interested in working with, let’s say, national organizations that are interested in helping to define what some of these parameters might be, for example, ECA, NARUC. Those would be examples--there’s several others--of organizations that I’m more than happy to work with to help us at least provide ideas and suggestions on what might go into a consent basis, along with several other aspects where I think they can provide important information. But I think it’s at least completely obvious that it has to include states, tribes, and the communities.

And, frankly, we can point to some rather substantial examples within this country where it’s had strong local support and no state support and has fallen flat on its face. So I have no desire to repeat that, and I want to move ahead. To me, that takes all three of those entities.

EWING: More questions? Staff? Board? Yes, Jerry.

FRANKEL: This is Jerry Frankel of the Board. I'm new to the Board and don't know much about politics, and I should indicate that what I know is from the able tutelage of the staff who are here. So thank you for that.

But I just don't have a lot of confidence in our legislature coming together to pass a bill on this soon. So where does it leave us if they can't come to an agreement any time soon and you want to start with some planning? Is there an alternative in case the law isn't changed soon?

LYONS: I don't see the alternative. I fully agree with the Secretary, past Secretary, that Yucca Mountain is not workable. I've spent a good fraction of my life working on Yucca Mountain, and I'd like to see some progress. And, to me, that progress means admitting that it's unworkable and looking into the future.

In the Senate we have Senators Murkowski, Alexander, Feinstein, led by Wyden; so you've got the chairman and ranking member of the Appropriations Committee and the Energy and Natural Resources Committee. That is an extraordinarily powerful combination. My most earnest hope is that legislation, if it can come forth, supported by those four, would be very powerful and quite likely to move ahead in the Senate. I think the House, from what I can see, will be quite a challenge. From anything I've seen, I see the Senate as leading on this, ecstatic to have House leadership as well; but at least I'm not aware of groups of representatives working together on this. But a bill originating in the Senate, if it can be passed by the Senate, presents some opportunities for perhaps consideration by the House.

EWING: Last call. Questions?

Pete, again, thank you very much for your time and the presentation. It's very helpful.

LYONS: Thanks to all of you for what you're doing.

EWING: So we're at the end of the day, but we have still an important part of the program, that is, public comment. I have one person listed, Robert Smith, and I'll ask if there are others after Smith.

Robert Smith.

SMITH: My name is Richard Smith.

EWING: Oh, sorry.

SMITH: By way of introduction, I am retired from the Pacific Northwest Laboratory, worked there for about 40 years in the nuclear area, including the initial (inaudible) storage program where I was involved in the design and planning for the system performance of that facility. I have also been a member of the Hanford Advisory Board for the past ten years, but I want to be careful to say that what I'm going to say this afternoon should not be construed as any consensus opinion of the Board. It's my own personal view, and you can take it for what it's worth.

We've heard a lot about high-level waste today. And one of the problems I've had for years is that the current definitions of high-level waste don't really speak to protection of human health and the environment. It's somewhat of an arbitrary definition (inaudible) came from there--it's high-level waste--and without any characterization of what that means, what that stuff is, and how you might protect the environment from it.

So basically what I'm suggesting is that I think it would be worthwhile to fall back and say, well, what would be a good, solid, science-based approach to defining what high-level waste is and thereby being able to better establish what the criteria for treatment and disposal are. The current definition would allow you to classify as high-level waste stuff that was really low-level waste and have to treat it and dispose of it in the very expensive fashion as associated with high-level waste.

So I would like to see your group, or anybody else for that matter, to suggest to DOE that they engage the national academies to develop this question: What makes sense for a good technical, operable definition of high-level and low-level waste? I've searched the literature to (inaudible), and I can't find the technical bases I was looking for. So if all you do is say, well, why don't you get a committee, a national (inaudible) look at this question, that would be a major step forward.

The present definitions have led us into all kinds of sort of strange machinations, like the creation of the "waste incidental to processing" thing, and other questions about, well, a lot of this stuff in the tanks may be TRU; how do you deal with that? What is it? Is it really TRU, or is it really high-level waste, or is it something else? And how do you package and treat that stuff, and where can you dispose of it? I'm just trying to erase some thinking on this area, because I think it has given us--the present definitions have given us poor service in the recent years.

That's all I had to say. Thank you.

EWING: All right, thank you.

Any other comments on (inaudible) section?

Carol, I know you--

JANTZEN: If there is somebody else behind me, they can go first.

EWING: No, you're next.

JANTZEN: Okay.

EWING: Identify yourself again.

JANTZEN: I'm Carol Jantzen from Savannah River National Lab. I just wanted to correct two statements that I heard this morning that were incorrect. One was the response to Mary Lou Zoback's question about square melters versus round melters. We did not choose a round melter because it was the same shape as a waste tank. We chose it because we did convection modeling. You remember in my talk I spoke about the fact that melters that started in 1994, 1995, which was us and West Valley, you know, nobody had done this before. So we depended on natural convection. We hadn't come up with the airlift coffee pot thing, and we hadn't come up with the bubbler designs yet, so we were depending on natural convection.

There were many, many studies done, theoretical studies, of how fluids behaved, how the natural convection behaved in a round object versus a square object, and the natural convection was better in a round melter.

We also had--the way the electrodes were, there were four electrodes about halfway up the side or down--whether you're coming from the top or the bottom--that cross-fired, so there were four around the circumference at regular distances so that the electrodes could properly cross-fire and maximize those natural convection currents. Also, at that time, with natural convection, you found crystals forming in the corners of the melters, because the corners were colder and they were more stagnant. And so until the bubbler technology came along, a round melter was preferred to a square or a rectangular shape. And to get around that, West Valley made theirs an inverted prism; okay?

So that's the story of the square versus the round peg.

Now, the other comment was about the total system performance license application. It was said that it was based on the PCT test. It was not based on the PCT test. All of the different durability tests that I showed you up there, which included monolith tests, which included single-pass blow-through tests, which included thermodynamic modeling, was all included in the Yucca Mountain license application modeling.

So I just wanted to set that record straight.

EWING: Okay, thank you.

In a moment I'm going to cut you all off.

PEGG: I certainly want to defer to Carol's memory better than mine on that subject. When I said "a tank", I didn't mean a waste tank. What I've been told is that Dupont, who was the site contractor at the time, charged with designing a first-of-a-kind entity, this waste glass melter, knew how to design tank-based designs. That was a natural choice for this melter shape.

One thing I forgot to mention this morning, though, is an important factor in the WTP melters. When we go from the West Valley, the Savannah River scale, to a ten-square-meter scale, one thing you have to remember is thermal expansion. The LAW melter we saw yesterday physically grows from room temperature to the operating temperature by about this much. What that means is you have to allow for active thermal expansion within all of the refractories and all of the components inside that shell. That's much easier to do if you have a square entity with a sliding wall. And these melters actually have internal to the cavity a sliding wall with a jack bolt system; and as the temperature rises, as you bring it up to operating temperature, those jack bolts are pulled back, and that wall actually moves to allow this things to grow. There's a size limit at which that becomes necessary. A small enough melter you can put in simply a crushable refractory that'll take up that slack. But once you get large enough, this much is hard to design around with the ceramic refractory.

So just thought I'd make that addition.

EWING: Okay, thank you.

Last comment. Roberto.

PABALAN: I've got a question, not a comment.

EWING: Identify yourself.

PABALAN: My name is Roberto Pabalan from Southwest

Research Institute. This morning Bill Hamel talked about lessons learned from West Valley applied to the Waste Treatment Plan. Given that the Hanford waste streams are more complicated and also the waste volumes certainly are much larger, what lessons learned from the DWPF have been applied to the Waste Treatment Plant? That’s one question.

EWING: To whom?

PABALAN: Bill Hamel or somebody from Hanford.

EWING: Actually, if you look at some of the presentations, there were some specific examples (inaudible). Well, Ian.

PEGG: I’m sorry, I missed the question.

EWING: Lessons applied from Savannah River to Hanford.

PEGG: Once again?

PABALAN: What lessons learned from the DWPF were applied to the Waste Treatment Plant?

PEGG: Yes, I’m sure there is a lot better people that could speak to this, but, for example, when Bechtel took over the contract in March of 2001, a lot of the former staff from Savannah River and West Valley were part of that team. So there were a lot of lessons transferred in terms of operating issues, off-gas pluggages, how to respond to them. Most of the melter design really is much closer to the West Valley experience than the Savannah River experience. It’s the same basic technology.

But, for example, the melter shape, the way the glass is discharged, it’s not a vacuum discharge like DWPF, but it is an airlift discharge exactly like West Valley. If you look at the off-gas treatment system, the first stage of operation there is something called a submerged BAT (?) scrubber. It’s exactly like what was used at West Valley. There were lessons learned from West Valley that were implemented into a next generation of submerged BAT scrubber. So, in fact, there’s a whole list of lessons learned from, actually, both facilities, West Valley and DWPF, that were incorporated into the WTP design and flowsheet.

Another example I mentioned this morning is the glass forming chemical system. In Germany and France, in the U.K., they use premade glass as the source of the chemicals to combine with the waste to make a viable glass product. That’s what’s also done at DWPF. But, as I mentioned, the compositional variability made that challenging at WTP. What was selected was what had been used at West Valley, which is raw chemical additives, which you can tune on the fly.

So I think the short answer is: I’m sure not every possible lesson was learned, but you can certainly make a very long list of lessons that were learned from previous facilities in this country and abroad that were implemented at the WTP.

VIENNA: Just a quick comment.

EWING: You have to come forward.

And let me emphasize, Roberto, we're looking for comments, not questions, because we're not sure who's here to respond to questions.

VIENNA: John Vienna from PNL. There is a DOE report on lessons learned from vitrification--I believe it's 1999--that has the lessons from Savannah River, from West Valley, and actually some international experience also. All of that was taken into account during the design of Waste Treatment Plant melters.

PABALAN: Okay, that's it.

EWING: Other comments? All right, I'd like to thank the audience for staying through today, particularly the speakers, by making their presentations and contributing to the discussion, even without being reminded. (Inaudible) direct you to the poster session, new for our meetings. I think that you can buy a glass of wine or a beer and then bring it to the poster session (inaudible). I've had the pleasure of discussing (inaudible).

So thank you all, and we'll see you in the poster session in a moment.

Board members and staff, a reminder, 7:30 at Anthony's Event Center.

SPEAKER: No, Anthony's is the restaurant.

EWING: No, it's Anthony's Event Center.

(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 Spring Board Meeting held on April 16, 2013, in Richland, Washington, taken from the electronic recording of proceedings in the above-entitled matter.

April 25, 2013

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