UNITED STATES

NUCLEAR WASTE TECHNICAL REVIEW BOARD

SUMMER MEETING

Tuesday

June 29, 2010

Hilton Garden Inn
700 Lindsay Boulevard
Idaho Falls, Idaho 83402

NWTRB BOARD MEMBERS PRESENT

Dr. B. John Garrick, Chairman, NWTRB
Dr. Mark D. Abkowitz
Dr. William Howard Arnold
Dr. Thure E. Cerling
Dr. Ali Mosleh
Dr. William M. Murphy
Dr. Henry Petroski

NWTRB SENIOR PROFESSIONAL STAFF

Bruce E. Kirstein
Gene W. Rowe
Carl Di Bella
Douglas Rigby
Daniel S. Metlay

NWTRB STAFF

Nigel Mote, Executive Director
Karyn D. Severson, Director External Affairs
Joyce M. Dory, Director of Administration
Linda Coultry, Meeting Planner

I N D E X

PAGE NO.

INDEX
(Continued)

I N D E X
(Continued)

PAGE NO.

P R O C E E D I N G S

8:00 a.m.

GARRICK: Good morning and welcome.

We have a very, very busy agenda today, and, so, as usual, I will be making a pest out of myself in keeping us on schedule. But, I have to say and admit up front that I think I’m going to be the first violator, because my remarks are probably going to exceed my allotted time. But, we’ll do the best we can.

As many of you know, the United States Nuclear Waste Technical Review Board has been in existence for some 20 years now. I’ve been its Chairman for the past six years. And, our meeting today is the Board’s, I’m told, 129^{th} public meeting, and the fourth public meeting we’ve had here in Idaho Falls.

And, I guess when I think of Idaho Falls, a lot of wonderful memories come to mind, because this is where between my undergraduate and graduate education, I had my first real professional experience. So long ago that some of you weren’t even born yet. But, it was an exciting time, and it’s an opportunity that I would hope most engineers and scientists could have.

I was here in the early Fifties. I was part of a technical support team for the Idaho Chemical Processing Plant. I was the token physicist at an entry level. I was supposed to keep them alert about such things as criticality and other issues of a physics nature about the plant, and part of the start-up team for that plant, we had many, many challenges. And, of course, the whole site was confronted with challenges because between 1951 and ’54, which included the time I was here, many facilities started up and all of the facilities were very much the first of a kind. So, it was an exciting time.

There was the Experimental Breeder Reactor-1, the Materials Testing Reactor that I worked with quite a bit in a Gamma facility and a few other things, the submarine prototype, first submarine prototype A1W, and of course the chem plant. The chem plant during that period went through some very challenging and interesting transitions. We transitioned from the REDOX process where Hexone was the solvent, to the PUREX process where TBP, tributal phosphate, was the solvent. We made major changes in the plant. We went from batch mass limited dissolvers to continuous criticality safe dissolvers.

In fact, one of my first jobs was--and, I knew very little about it, I had to kind of learn as we went along--to calculate the number of dissolutions it would take for a heal to be accumulated in the old batch mass limited dissolver, to where we would run into a problem perhaps of a criticality. It was indeed a challenge for me, and it’s the kind of thing that I would think that every engineer, every scientist would welcome because there's nothing like being a part of a start-up team of a process and of a plant that's very much the first of its kind.

And, in the time I was here, I was fortunate enough to get some good letters of recommendation, and then I went on to starting with the Oak Ridge School of Reactor Technology and my graduate work.

My wife takes all the credit for all the good letters I got because the letters I got from the university, she was, the last year I was there, this was at BYU, she was the executive secretary to the President of the university. And, when I moved here, she was the executive secretary to the Executives of the chem plant. So, she probably ended up typing most of those letters, and, so, she indeed takes all the credit.

But, anyway, it's a privilege to be back, and I always--it's an experience that I'll never forget, even though it was only a short period of time.

Okay, the Board's last visit to INL was three years ago. It was not a public meeting. It was a tour. And, we toured the advanced welding facilities being developed by the lab for the Yucca Mountain Project at the Bonneville County Technology Center in town. And, our last public meeting was ten years ago. So, I think a little background on what the

Board is all about, given that long time span, is appropriate.

Congress created the Board in the 1987 Nuclear Waste Policy Amendments Act. And, the Act spells out the Board's activities pretty clearly. The Board is charged with evaluating the technical validity of all activities undertaken by the Secretary of Energy related to DOE's obligations to manage and dispose of spent nuclear fuel and high-level radioactive waste, and, based on these evaluations, it's our job to advise Congress and the Secretary of Energy of our findings and conclusions, and, of course, our recommendations. And, we do this by way of reports, by way of Congressional testimony, and correspondence, and all of these documentations and representations are on our website, which has a very simple address, just nwtrb.gov.

Now, as to Board members, we are appointed to four-year terms by the President, including the Chairman, if you can believe that, and a list of nominees are submitted by the National Academy of Sciences. The Academy makes its recommendations, or its nominations, based solely on the eminence and expertise of the individual in scientific and engineering disciplines. The Board is kind of a unique federal agency, in that it is the only entity that performs an ongoing independent and integrated technical evaluation of all elements of the nuclear waste management system, including waste acceptance, transportation, packaging and handling, facility operation and design, and waste storage and disposal.

Now, the reason the Board was created is quite clear from the legislative history. Congress created the Board because independent technical peer review is essential to acceptance by the public and the scientific community, for that matter, of any approach developed by DOE for managing nuclear waste.

Now, for the past two decades, DOE’s principal waste management focus has been the Yucca Mountain program, including again transportation, packaging, waste acceptance, et cetera. Accordingly, since our mandate is to evaluate DOE’s technical activities in the waste management area, that has been the Board’s principal activity. But, times are changing. The Secretary of Energy, Steven Chu, has made it clear that the administration does not consider Yucca Mountain an option and has established, at the President’s direction, a Blue ribbon Commission on America’s Nuclear Future to recommend alternative approaches for managing the back end of the nuclear fuel cycle.

In the process, DOE has served official notice to its contractors and employees that it is terminating the Yucca Mountain project. Funding for the program office with responsibility for the repository project was eliminated in the President's fiscal year 2011 budget submitted to Congress in early February. DOE has also applied to the Nuclear Regulatory Commission for authorization to withdraw its application to construct a geologic repository at Yucca Mountain. We should hear about that very, very soon.

As we will hear this afternoon, however, as funding for the Yucca Mountain is being eliminated, funding for research into and the development of alternatives is increasing. Meanwhile, the Board's statutory role is still the same: to evaluate the technical validity of activities of the Secretary related to nuclear waste management.

Now, given that mandate, and as you would expect, the focus of the Board's peer-review will closely track DOE's priorities and will follow the transition of nuclear waste management activities from the Office of Civilian Radioactive Waste Management related to defense waste that would eventually require disposal, and we will discuss issues related to those wastes this afternoon, as well.

Now, as to our Board, and as is our practice at the beginning of our meetings, particularly when it's been this long since we've been in an area, we like to introduce ourselves, and you should be aware that the Board is part-time. The staff is full-time, so they tend to keep us on track and honest.

And, I've already sort of introduced myself. I'm the current Chairman. My background is nuclear engineering and risk assessment, and I spend most of my time serving in those areas. And, thanks to my peers, I was elected to the Academy of Engineering in the early Nineties.

As I introduce the rest of the Board, I want each of them to raise their hand as I call their name, and I'll do this alphabetically. I will start with Mark Abkowitz. Mark is Professor of Civil and Environmental Engineering and Professor of Engineering Management in the Department of Civil and Environmental Engineering at Vanderbilt University. He is also Director of the Vanderbilt Center for Environmental Management Sciences.

Howard Arnold. Howard is a consultant to the nuclear industry. He previously held a number of senior management positions, including vice-president of the Westinghouse Hanford Company, president of Louisiana Energy Services, and engineering manager and general manager of the Westinghouse Pressurized Water Reactor Systems Division. Howard is a member of the National Academy of Engineering.

Thure Cerling. Thure is Distinguished Professor of Geology and Geophysics and Distinguished Professor of Biology at the University of Utah. He is a geochemist, with particular expertise in applying geochemistry to a wide range of issues, such as geological, climatological and anthropological studies. Thure is a member of the National Academy of Sciences.

Ali Mosleh. Ali is the Nicole J. Kim Professor of Engineering and Director of the Center for Risk and Reliability at the University of Maryland. Ali’s field of study and practice are risk and safety assessments, reliability analysis, and decision analysis for the nuclear, chemical and aerospace industries. Ali was recently elected to the National Academy of Engineering as well.

William Murphy. Bill is Professor in the Department of Geological and Environmental Sciences at California State University at Chico. His areas of expertise are geology, hydrogeology and geochemistry. Bill also serves as an administrative judge on an NRC Atomic Safety and Licensing Board Panel.

Henry Petroski. Henry is the Aleksander S. Vesic Professor of Civil Engineering and Professor of History at Duke University. His current research interests are in the areas of failure analysis and design theory. Henry is an accomplished author in engineering and science, as many of you know. And, Henry is a member of the National Academy of Engineering.

We regret that four members of our Board are unable to be here today. They are David Duquette of Rensselaer Polytechnic Institute, a materials scientist; George

Hornberger of Vanderbilt University, a hydrogeologist; Andy Kadak of MIT and Exponent, nuclear engineer; and Ron Latanision of MIT and Exponent, a corrosion expert.

There is one person who I would like to introduce from the staff, and that is Nigel Mote. Nigel? Nigel joined the federal government as the Executive Director of the Board's staff on November 23rd of last year. Nigel is a physicist, who has spent his entire career in the nuclear industry, most of it involved in the management of spent nuclear fuel and high-level waste. He worked for more than ten years at Sellafield, the British reprocessing facility, and before joining the Board, was a consultant for almost 20 years.

Before Nigel joined the Board, the Board was without an executive director for almost 11 months. And, during that time, Karyn Severson--Karyn, raise your hand--of the staff served as Acting Executive Director, and Carl Di Bella--Carl Di Bella, raise your hand--of the staff assisted her as Interim Technical Director for much of the period. The Board underwent a major change in priorities during this period because of unfolding policy changes by the new Administration. They and the rest of the staff, some of whom are also seated at the table, assisted the Board in its redirection, and I want to recognize them and thank them for that work.

Now, to continue with the introductions, we have received a message from Congressman Mike Simpson. We have visited Congressman Simpson a couple of times. He is very cognizant of what the Board is and what it’s all about, and I would like to ask Board Member Dr. Abkowitz to read a statement we received from him.

ABKOWITZ: Thank you, John.

I was part of the delegation that had an opportunity to meet Congressman Simpson in Washington, and we very much enjoyed the conversation that we had at that time, and the ongoing relationship that we have with Congressman and his staff. The letter I’m about to read to you was sent to Chairman Garrick and members of the Nuclear Waste Technical Board from Congressman Simpson, and it reads as follows:

“I’m sorry I can’t be there today to join you in person, but I appreciate the opportunity to welcome you to Idaho on behalf of the State and its people. We appreciate the important work you are doing, and we are happy to have you in Idaho. As you know Idahoans--which is a learned experience for me, I didn’t realize that’s what people from Idaho are called--Idahoans are strong supporters of nuclear energy. Southeast Idaho is proud to be home to the country’s lead nuclear energy laboratory, the Idaho National Laboratory, which conducts critical research on existing and future nuclear technologies and nuclear related issues.

In addition, the Idaho Cleanup Project is cleaning up and packaging waste in preparation for disposal at a final geologic repository. Much of the work being done at the INL directly relates to or supports the work of the Board. We value your work as the advisory body to Congress and DOE for activities related to managing spent nuclear fuel and high-level waste, and the challenges you face as we try to move forward on this issue.

As DOE and Congress consider further actions, it is critically important that we understand how decisions made in Washington impact clean-up sites across the country and the work being done at those sites to address the waste. We greatly appreciate the time you are spending to review the activities both in the nuclear research and clean-up fields occurring in Idaho. We recognize how important it is that the country come to an agreement on a long-term, scientifically sound geologic repository, both for the future of nuclear energy, and to ensure the commitments laid out in the Idaho Settlement Agreement are met. We appreciate your work on this complicated and sensitive issue.

Please accept my sincere apologies that I am unable to be there in person today. I look forward to working with you in the future. Sincerely, Mike Simpson, Member of Congress.”

GARRICK: Thanks. Thanks, Mark.

Okay, now to the meeting today. Today's meeting has two distinct, but complementary, parts. This morning, we will be discussing plans for the management and disposition of spent nuclear fuel and high-level waste that fall under the jurisdiction of either the DOE Operations Office here in Idaho Falls, or of the Navy.

Most of the spent fuel and high-level waste is on the INL site, but some of it is in Colorado at the Fort St. Vrain site about 50 miles north of Denver.

The quantities and characteristics of that spent fuel and high-level waste are well known. The plans for managing these wastes, that is, the plans for storing, handling, packaging, transporting and disposing of these wastes were well in hand before the decision to terminate Yucca Mountain. Any alternative to Yucca Mountain, whether it is wait-and-see, another repository, recycling, or some combination will require many years to put in place.

So, an obvious question is whether the existing and planned activities for storage of the spent fuel and high-level waste currently located in Idaho are technically capable of extended storage, and if so, for how long?

The Blue Ribbon Commission will develop recommended strategies for dealing with the back end of the fuel cycle. The first draft of their recommendations is due just over a year from now, and the Commission's final report is due six months later. The BRC is seeking input and deliberation at the present time. And, once the BRC report is issued and adopted, owners of spent nuclear fuel and high-level waste will have to develop new plans to implement the new practices. Today, we will hear about the efforts of the owners of the Idaho wastes to assist the BRC and what they are doing to ready themselves to implement the new policies.

The Department of Energy's Office of Nuclear Energy has a modest Used Nuclear Fuel R&D program underway now, which may be expanded greatly starting in the next fiscal year. Much of the R&D could have relevance for the spent fuel stored in Idaho. Our first speaker this afternoon will discuss that program. The next two speakers will address studies of the entire fuel cycle viewed as an integrated system. We will cap off the afternoon with two speakers, each of whom will address their organization's version of a small, modular nuclear reactor. These systems appear to have some unique cost, time, and simplicity-of-operation advantages. Our particular interest is in how they could impact waste management.

Following the two presentations on small, modular reactors, and the Board's questions and discussions with presenters, we have scheduled time for public comment, which is always an important part of our meeting, and it is to the

Board. If you would like to comment, please enter your name on the sign-up sheet at the table near the entrance to the room. Linda and Wendy are there to help you do this. And, by the way, we also have some other people that can assist you on that matter. If you haven’t jotted down your name, please do so, and add your e-mail address, if you like. If you prefer, remarks and other material can be submitted in writing and will be made part of the meeting record. These statements will be posted on our website along with the transcripts and overheads from the meeting. I understand that one or two of you individuals plan on doing just that.

Now, some of you have asked about questioning during the course of the meeting. We do have sort of a pecking order with respect to that, and a time element is involved that determines how far we can go. First, the Board members will ask questions. Then, time permitting, staff members will ask their questions. And, beyond that, members of the public will be called to ask their questions. Frankly, we rarely get to the point where staff members can ask all the questions they have, but we have another mechanism to allow for people in the audience to question our speakers. You may write down your questions and give them to one of the staff members, who will carry them to the appropriate Board member, and then we will read the question if time permits. And, of course, we may have more time today because the Board is short several Board members.

Now, I should note that in these meetings, we as Board members candidly express our views and opinions. We want to continue to operate in that open and free fashion. However, it should be noted that the candid comments of individual Board members are not necessarily official Board positions. When a Board position is stated, we'll try our best to clearly label it as such.

As usual, to minimize interruptions, we ask that all of you and all of us turn off our cell phones, or at least put them on the silent mode. I also want to remind everyone that it is very important that you identify yourselves, if you are speaking, and speak into the microphone. These microphones don't all have the same pickup capability, and we are very particular about developing a complete record of our meeting. If you are making public comments for the record, please give us your name, your affiliation, and any relevant information that would identify your remarks.

By the way, I want to express our gratitude and thanks to Idaho and the Navy for an outstanding tour that took place yesterday that Board members and staff people attended. I have nothing but very excellent comments on how complete and thorough and how professional that tour was. So, we thank you very much.

So, with these preliminaries out of the way, I'd like to move quickly into our formal meeting, and ask Rick Provencher to lead off. Rick was named the new manager of the DOE Idaho Operations Office barely a month ago. Previously, he managed the highly successful Idaho Cleanup Project for some six years. I would like to ask Rick and each speaker, for that matter, as they come up to just introduce himself or herself, and say what their role is in their respective institutions to save time and not get too many long introductions.

Thank you. Rick?

PROVENCHER: Good morning, everybody.

I'd like to welcome you to the Idaho National Laboratory and to beautiful Idaho Falls. My name is Rick Provencher. I am the Department of Energy-Idaho Manager. My training is in health physics from Colorado State University, and I've been affiliated with the cleanup program for many years, close to 20 years here in Idaho at the Mound site in Ohio and West Valley prior to that. And, prior to West Valley, I was with the Nuclear Regulatory Commission for four years. So, glad to be here and glad you're here this week getting up to speed on our status relative to our spent fuel program and high-level waste.

I've got a briefing here this morning that's somewhat of an historical overview, sort of a geopolitical snapshot of the experience we've had in managing our spent fuel and high-level waste. So, if we can get that on the screen?

Idaho was on the ground floor of spent fuel and high-level waste management.

The Idaho Chemical Processing Plant was built in the 1950s to manage government fuel. Reprocessing and calcination of liquids began in the 1950s and continued until 1990s to 2000s.

When reprocessing was ended, the plant focus became spent fuel storage, preparation for shipping; solidifying remaining liquid waste, and preparing high-level waste for removal.

Idaho has spent fuel from many different sources: on-site reactors, naval reactors, commercial reactors such as Fort St. Vrain, core debris from Three Mile Island, from foreign research, and from West Valley.

The total amount of fuel that we have is about 350 metric tons of uranium in all those categories.

The experience that we had relative to spent fuel reprocessing and calcine operations was done for the purpose of isolating and accumulating the highly enriched uranium that's located in the spent fuel. And, that was used as driver fuel at the Savannah River reactors during operations activities at that facility.

The liquid waste, as I said, was calcined, and we have over 4,400 cubic meters of calcine in safe storage at the INTEC facility as we sit here today. And, the reprocessing activity allowed us to manage very efficiently the spent fuel that was building up here at the Idaho site. And, through the Eighties, from a geopolitical standpoint, the regulators and the site was pretty content with how operations were going.

Then, in 1992, with the discontinuance of the Cold War, the decision was made at the time to stop spent fuel reprocessing. The Savannah River reactors shut down, so there was no further need for the product that was coming out of the reprocessing activities, and there was no sense to continue to generate the high-level waste here if there was no further use for the product at the time. So, that was kind of the state of affairs at that point.

Also, in parallel with that experience, there was controversy back in ’88 relative to the opening of the WIPP facility, and due to the delays relative to opening WIPP, the Idaho governor took action to stop the Rocky Flats transuranic waste shipments into the State of Idaho at the time, and that began a kind of a domino effect relative to activities between us in the State of Idaho to resolve some of the issues that they saw relative to how we were managing the waste here at the Idaho site.

Back in 1990, that discussion extended to the Fort St. Vrain fuel and also the Navy spent nuclear fuel that resided here at the site. And, it all culminated in an Environmental Impact Statement that was issued in 1995, as well as the Idaho Settlement Agreement that was issued in ’95.

And, subsequent to that, the Idaho Settlement Agreement has become the driving force behind the cleanup. You know, it was beneficial for us to have that from a DOE perspective, in that it allows us to request the funding that we need and have a clear and strong regulatory driver for the funding to move forward and continue the cleanup progress here at the site.

There was not unanimous support for the Settlement Agreement after 1995. In ’96, there was an effort to put forward a ballot to the citizens of Idaho to kind of overthrow the Settlement Agreement. And, that was put out to vote, and it was unanimously voted down by a margin of two to one. But, there was a faction here in Idaho that was not supportive of the things that were identified in the Settlement agreement.

So, that being done, the Settlement Agreement was still in effect, and again, it provided us a driving force to proceed with the various activities that we needed to conduct here to progress with the cleanup work.

At about the same time, the Chem Plant, we changed the name of the Chem Plant to the Idaho Nuclear Technology and Engineering Center. And, again, the focus shifted to more efficient means of storing, safely storing the spent nuclear fuel that we have, and securely storing that fuel.

We had about 1.8 million gallons of liquid waste at the time. About half of that was calcined before the calciner was shut down permanently. And, it was decided at the time that it was not worth the upgrades that were needed to the off gas scrubbers to the calcine to continue to permit that and operate that facility. So, it was shut down.

A lot of effort went into cleaning up the underground tanks there. Certainly, a lot of cleaning and flushing occurred in those tanks, and evaporation of the liquids that were in those tanks. And, we were kind of in that mode for a while until we got the 3116 legislation about three years ago, four years ago. And, Idaho really moved forward with that legislation to be the first site to close our underground tanks under RCRA authority and under that legislation.

So, to date, we have cleaned, closed and grouted seven 300,000 gallon underground tanks there at the INTEC facility and four 30,000 gallon tanks. We have four that remain, and about 900,000 gallons of the sodium burn waste, which I know you will get a briefing on as part of your agenda. That work is currently actively ongoing, and the plan is after we complete the processing of that sodium burn waste, we will close the remaining four underground tanks out there at the INTEC facility. So, we do have an end in sight out there, and we're hoping that by the end of 2012, we'll have that part of the mission behind us and well on our way to cleaning and closing the final underground tanks.

In terms of the Settlement Agreement, we believe we've been responsible stewards to the citizens of Idaho in following through with the requirements and the commitments that were made in the Settlement Agreement. And, as part of that, there was one remaining contentious issue between us and the State relative to the buried waste, which is called out in the Settlement Agreement. And, bottom line, I won't go into the details of that, but the bottom line is we resolved those differences a couple of years ago where we agreed to an amount of buried waste that the Department would exhume out at the Radioactive Waste Management Complex, exhume that amount of material, in addition to the, you know, above ground transuranic waste that Advanced Mixed Waste is currently managing for us. And, by doing so, resolved that issue that was voiced by the State of Idaho relative to interpretation of the Settlement Agreement.

So, to date, we're well on our way to moving forward with that exhumation work at the RWMC. We're exhuming the buried targeted waste and in process of shipping that waste to the Carlsbad facility, the WIPP facility. So, it’s going very well. The one more contentious area out at the RWMC was the Pit 9 facility, and we are progressing very well in moving forward with the exhumation of that pit. They’re building a tent over that facility now, with the plan to complete exhumation of the Pit 9 area by the end of 2012. So, we’ll be happy to see that when that is completed.

Also relative to the Settlement Agreement, we’re focused on meeting the dry storage requirement. There’s a 2023 date in the Settlement Agreement, where we’re obligated to move all the spent fuel from wet storage into dry storage, and as I said, we have achieved that for the EM fuel. We’re in the process of supporting the Navy in the transfer of their fuel, and we also have the ongoing operational fuel that continues to be generated out of the Advanced Test Reactor, but we’re in the process of moving that, once it’s gone past its thermal decay, into dry storage as well.

We’re focused on finishing the liquid waste processing there, and also on treating the calcine. One of the more recent things we’ve done, driven by the Settlement Agreement, is issued a Record of Decision, which basically selects Hot Isostatic Pressing technology as the solution to treat the calcine here at the Idaho site, and ultimately disposition that material. So, we’ve got a lot of work in front of us to complete that activity, and then comply with the Settlement Agreement requirement to make the calcine road ready by 2035.

Overall, we think we have done well in implementing the Settlement Agreement requirements. There was about 102 milestones in total, when you roll everything together. We've completed 46 to date, and we were only late on one, but we have subsequently completed that, and that had to do with transuranic waste back a few years ago.

We think this performance that we've experienced has improved the trust and confidence in the Department of Energy between us and the local citizens and the State of Idaho, because we are following through with our commitments. And, you know, we view that as a necessary requirement as we look to build the lab here at the Idaho site. So, it has certainly provided us with a good foothold to pursue other mission activities at the Idaho site, and we're pretty proud of having achieved this to date.

With that, I will discontinue my remarks and, Mr. Chairman, open myself up to questions.

GARRICK: Thank you. Okay, questions, please? Henry?

PETROSKI: I've got a question. This is Petroski of the Board. On your Slide 4, you make a statement that the "Liquid waste was calcined, tanks never leaked." Was there ever a determination or an expectation of how long those tanks would have continued to not leak? In other words, did you have a lifetime in mind for those tanks?

PROVENCHER: Well, as you know, the tanks were stainless steel tanks in a concrete vault. So, it kind of distinguished the design and configuration of these tanks from some of the tanks at the other DOE sites, which were carbon steel, single wall tanks without a concrete vault that they're contained in. So, you know, certainly the design life is a lot longer than what you may experience at some of the other DOE facilities.

In terms of an exact number, in terms of the number of years, I can't say what that is. But, you know, as we went into those tanks and cleaned them, flushed the tanks--we put video cameras down in the tanks and we saw that they were holding up pretty good. There were corrosion coupons placed in the tanks as well, so that was continually monitored. But, it looked like, you know, that the tanks could have survived many more years in their current configuration.

PETROSKI: Could you quantify that at all, many more years?

PROVENCHER: We probably could. I can't do it right now off the top of my head. But, we could certainly get you that answer.

PETROSKI: Okay, thank you.

GARRICK: Mark?

ABKOWITZ: Abkowitz, Board.

Rick, I wanted to ask you a question with regard to the ’95 Settlement Agreement that requires spent nuclear fuel removal by January 1st of 2035. In light of recent developments, the prognosis for when that might take place has changed. Has there been any conversation yet with the State over that particular consideration, especially given that it’s beyond your control, to a large extent?

PROVENCHER: Yes, we’ve had many conversations with the State in that regard. You know, up to now, there’s been other drivers in the Settlement Agreement that have kind of kept our focus, mainly the consolidation of the spent fuel to the INTEC facility, and then the transfer of that fuel into dry storage, and we continue in that mode right now in the process of seeing what evolves out of the Blue Ribbon Commission. And, at that point in time, be prepared to implement those recommendations relative to what to do with the fuel here.

The good news is we’re getting it into dry storage. It’s safe and secure, and we think we can afford, you know, the one or two years before we get a recommendation from the BRC to help, you know, define the future in terms of what to do with that fuel.

GARRICK: Thure and then Bill?

CERLING: Cerling, Board.

With respect to the Idaho Settlement Agreement, it sounds like you made real good progress on your various milestones, and I'm just wondering is there any milestone that's coming up fairly quickly that looks like it could be a problem, especially with respect to the change in the DOE operating procedure?

PROVENCHER: Well, the next series of milestones we're focused on are related to calcine. Issuing the Record of Decision back last year was one of the milestones. We've got that behind us. And, now, we have to issue a Draft Part B permit for the design of that facility to the State by the end of 2012. So, that's kind of the next one on the horizon, in addition to the ongoing transuranic waste milestones, we're just trying to get the TRU out of the state. But, that's going very well.

So, there is an effort to submit that Part B permit by 2012. There's a lot of activity going into that between the EM staff here and the contractor supporting them. You know, certainly there is a question out there relative to what is the ultimate solution in terms of the repository for that material, and how you with complete confidence and surety know that the waste form you're going to put that material into is going to satisfy that requirement. And, I think, you know, part of the solution to that is just dialogue with a Board like yours relative to the unique nature of our high-level waste, so you can factor that into your regulatory planning and path forward, as well as with the Blue Ribbon Commission. So, as that solution is defined, we can ensure that the unique aspects of our waste, which is very unique relative to other waste across the Department, is factored into that, and, you know, the ultimate repository or destination for this waste is considerate of the treatment that we’re planning to perform.

GARRICK: All right, Bill?

MURPHY: This is Bill Murphy of the Board.

Are there any permanent geologic sites for disposal of waste at INL or have there been considerations of developing permanent waste disposal facilities here?

PROVENCHER: In terms of high-level waste?

MURPHY: Or low-level waste.

PROVENCHER: Yes, we have several low-level disposal areas here on site. As you know, the Radioactive Waste Management Complex is a disposal facility operated for many years. The ultimate plan there is to once we exhume the buried waste, cap that area in accordance with the Record of Decision, so that will remain. We also have silos out there that are basically tubes in the ground that house remote handled low-level waste there on site, and those are going to be permanent disposal in those areas.

Then, we also have the Idaho CERCLA disposal facility operational out there, which is taking basically all our low-level CERCLA waste, and disposing of it in that lined cell out there next to INTEC. And, then, we have other non-radioactive pits and disposal areas out there also.

MURPHY: So, these are all low-level waste facilities and they're all for locally generated waste; is that right?

PROVENCHER: Yes, all locally generated.

GARRICK: And, they're all near the surface?

PROVENCHER: Aside from the stuff that, you know, was shipped here historically from out of state, yes.

MURPHY: Has there ever been consideration of development of a high-level waste repository at the site?

PROVENCHER: Not that I know of. EM is currently pursuing an Environmental Impact Statement for greater than Class C waste, and I believe that will be out on the streets here shortly for draft, as a draft for public input. But, Idaho is mentioned in that as one of the alternative sites. Again, it's not deep geological disposition, it's not high-level waste. But, that's the only other one that I can think of that Idaho is being considered for.

MURPHY: Are you aware of any technical impediments that would make permanent geologic disposal unlikely or impossible at Idaho?

PROVENCHER: I don't think we know enough technically to answer that question.

GARRICK: Howard?

ARNOLD: The Settlement Agreement and other activities seem focused on cleanup and getting rid of things. But, ATR, for example, can continue to operate indefinitely, as far as I understand the design and operation of the plant. And, I'm just wondering, do you have running room to think of new missions, new reactors? For example, an EBR-3, or something that might result out of the mass reactor programs, would extend you beyond these time periods? Do you have room to think about that?

PROVENCHER: Yes, certainly. That's part of our, you know, long-term strategy to look at, on the lab side, to look at research and development opportunities. Right now, we're focused on a lot of materials and fuel development work that are being done in the test reactor, you know, with the view of supporting the next generation of nuclear reactor. I think there's also room for discussion on, you know, different types of test reactors that we could help support in the future as well.

ARNOLD: So, you're not precluded from that?

PROVENCHER: No.

GARRICK: Ali?

MOSLEH: Mosleh, Board.

You mentioned that your current focus is on meeting the spent fuel dry storage requirements. And, in light of the fact there's a number of uncertainties regarding kind of the future disposal, how do the uncertainties in fact make your decision, or the requirements that you're following regarding the dry storage?

PROVENCHER: Could you expound on that?

MOSLEH: Yeah. Just the key thing is with respect to the statement that you're focusing on meeting the requirements for the dry storage. Do you anticipate changes in those requirements in the next two, three years as we see the result of the Blue Ribbon?

PROVENCHER: You know, one of the issues we've had on the back burner for a while is, because the amount of storage locations that we have out there at INTEC is limited, it's finite. We continue to receive fuel in from domestic and foreign sources, in accordance with the Settlement Agreement, and at some point, we're going to run out of space. So, one opportunity to help manage that has been the discussion surrounding the swap with Savannah River, which was envisioned to send some of our fuel there, some of their fuel back up here.

In the process of doing that, we would actually send more fuel down there by volume than they would send here, which would create some free space for us. I recognize that's kind of caught up in the whole debate relative to H Canyon at Savannah River, and whether that's a viable option for the Department to pursue. But, that is one element to that storage picture that would certainly give us relief. Without that, at some point in time, we'd probably have to look at additional dry storage capacity here at the Idaho site.

GARRICK: Okay. Well, the trouble with being a nice guy and letting the other Board members ask the questions, I can't get my questions out. But, I'll burden a future speaker with mine. We'd better move on, and we appreciate it very much.

PROVENCHER: Okay, thank you.

GARRICK: Thank you.

Okay, Susan, tell us a little bit about yourself.

BURKE: Good morning. Thank you, Mr. Chairman. Thank you for having me here. My name is Susan Burke. I work for the Idaho Department of Environmental Quality, and I am the INL coordinator there, and my charge as coordinator is to oversee compliance with the 1995 Settlement Agreement, as well as managing other issues that we have with the INL.

Today, I'm going to give you just a brief overview of that Settlement Agreement in regards to the spent fuel and the high-level waste.

The 1995 Settlement Agreement is between Idaho, DOE and the U.S. Navy. The agreement actually settled a lawsuit that Idaho had with the DOE, and Rick mentioned some of that earlier. We're the only state with a court order requiring nuclear waste to be removed from the state by specified dates. It's that continuing jurisdiction by the courts to assure that the Settlement Agreement remains on track and is met.

And, there are a number of interim requirements in the Settlement Agreement based on getting the waste prepared to be removed from the state, putting is also into a safer form while it's here.

And, as the Settlement Agreement states, all the spent fuel in Idaho is to be removed by January 1st of 2035. And, we often talk about the fuel needing to be removed from the state by 2035, but in preparing this presentation, I noticed it's the one date in the Settlement Agreement that says January 1st. So, we might as well talk about 2034.

In the spent nuclear fuel area, as was mentioned, the spent fuel needs to be transferred from wet storage to dry storage by December 31, 2023, and that condition is well on its way of being met, and the State has every reason to believe that that requirement will be met on time.

There's only a limited amount of fuel that can come into the INL each year. I think it's 20 shipments that can come in on a yearly basis, and as Rick mentioned already, those come from various sources.

There's an overall cap allowed for spent fuel in the State until a repository or interim storage facility is opened and accepting waste from INL. So, when that 55 metric tons heavy metal cap is met, no more spent fuel can come in. And, as it gets, you know, as that level goes up and there isn’t a repository looming in the future, you know, that cap may be met and no more fuel can come into Idaho under the Settlement Agreement.

There’s no commercial fuel that can be sent to INL under the Settlement Agreement, and in the Fort St. Vrain spent fuel area, there’s also an agreement with Colorado that that fuel be removed from the State of Colorado by January 1, 2035. The provision is that the fuel would need to come to Idaho first, to be treated, packaged, and then as well removed from Idaho by that January 1, 2035 date. So, there has to be time in which the fuel can come here, be treated, be packaged up to be removed. But, the Settlement Agreement says that the Fort St. Vrain fuel cannot come to Idaho until such time as there’s a permanent repository or interim storage facility available and accepting INL spent fuel. So, there’s a lot of Catch 22 there in how we’re going to get the Fort St. Vrain fuel dealt with.

The Settlement Agreement added on an addendum a number of years ago for the Navy spent fuel because of the unique situation of that facility in our State, and I think you had a tour of that facility yesterday. The spent fuel here pre-2017 is to be out of wet storage by 2023.

After 2017, the spent fuel is limited to being in wet storage for six years. That was the amount of time the Navy said it needed for that process to take place before it was moved into dry storage.

There's a continuation of the annual limit for spent fuel to come into Idaho, that's Navy spent fuel. That's 20 shipments a year rolling average. And, after 2035, the limited amount of spent fuel from the Navy in the State is capped at 9 metric tons heavy metal. So, again, for that to take place, there needs to be fuel moving out of the State.

This agreement with the Navy, or this addendum to the agreement provides for an operation of the Navy's facility beyond the 2035 date. So, this allows our relationship to continue with the Navy as to how their facility will operate in regards to the spent fuel.

In the area of high-level waste, we have sort of a unique statement in our Settlement Agreement. And, I'm probably not going to be the one around in 2035 to figure out exactly what this means, but you can read the actual language up there. So, the high-level fuel is supposed to be in this form to get out of the State. And, you can note that it's to a permanent repository or an interim storage facility. I think the spent fuel is stated similarly, so that the State's position is that it needs to get out of Idaho, whether that out of Idaho goes directly to a permanent repository or there’s some kind of interim storage before that, as long as it’s out of Idaho, that meets our settlement agreement.

On the high-level waste, I think it was already mentioned the waste is to be solidified. That’s in process. The solidified waste is to be put into a form to be safely transported out of Idaho. So, again, guessing that that form is also going to be appropriate for a final repository, we think the direction the DOE is heading right now with the HIP process would meet that requirement and would put the waste in a very safe form available for transportation out of Idaho.

And, then, there must be a viable place for the waste to go. So, those are the conditions, or how we look at the conditions of it being what we call “road ready” in 2035.

Remedies for not meeting the Settlement Agreement include no incoming shipments of spent nuclear fuel if the interim requirements in the agreement are not met. And, if the fuel is not removed by the 2035 deadline, then there’s a $60,000 a day penalty assessed against DOE provided for in the Settlement Agreement.

In addition, in the Navy addendum, the requirements that their spent fuel be in the wet storage for that limited six year period also is protected with a remedy of $60,000 a day penalty if that’s not met.

The State expectations for the Settlement Agreement are that DOE continue to meet interim requirements, which they are doing to date; that the DOE remove the spent fuel from Idaho, again, it’s to a repository or an interim storage facility; that the DOE have the high-level waste ready to be removed in a manner, in a form that it can go out of the State by 2035; and that the DOE continue to provide appropriate funding to the INL site to meet all of these requirements.

Finally, I just want to express why the agreement is in place, and why we care about meeting these requirements and having the fuel and the high-level waste out of here, is we have a very unique feature underneath the INL site and underneath a great portion of the southeast part of Idaho. We have the largest aquifer in Idaho in that area. It’s the only source of drinking water for that number of people in that area. They have designated it through EPA as a sole source aquifer because it is so vital for providing that drinking water, as well as a lot of agricultural use is made of that aquifer. It covers over a 10,000 square mile area, and it contains about that one billion acre feet of water. I didn’t hear anybody mention being exactly from back East, but they tell me that the size of the aquifer is pretty equivalent to Lake Erie.

So, that is our reason for pushing on the Settlement Agreement. And, with that, I'd be happy to answer any questions.

GARRICK: Thank you, Susan. Howard?

ARNOLD: Arnold, Board.

A little calculation in my mind about the $60,000 a day. It seems to me that isn't enough to really make the motivation. It's got to be good will on both sides.

BURKE: Probably correct.

GARRICK: Just as a matter of curiosity, has the State ever been challenged that they can't have their cake and eat it too? They can't, on the one hand, be the national center for the development of nuclear energy, and on the other hand, be as unaccountable for the waste as this sounds like they are?

BURKE: I'm not sure what you mean by unaccountable.

GARRICK: Well, unaccountable in the sense that the waste is somebody else's problem, not Idaho's.

BURKE: You mean as far as a final repository and final solution?

GARRICK: Final disposition, yes, yes.

BURKE: I think the facility here in Idaho is fairly unique in that it's a pretty clear area of cleanup and a pretty clear area of the National Lab, and the two are fairly separate so that there is both support for the National Lab continuing, and providing the work that it does here in Idaho, as well as hoping that the cleanup continues and that that part of the site eventually is done and cleaned up and no longer operating because the cleanup is complete on that side of the fence, so to speak.

GARRICK: I have a question here, and that is does the Settlement Agreement require payments to Idaho annually prior to 2035, and if so, how much?

BURKE: No, the penalties don’t go into effect unless the spent fuel is not removed by that January 2035 date.

GARRICK: Okay. Other questions? Yes, Bill?

MURPHY: This is Bill Murphy of the Board.

You showed the lateral extent of the aquifer here. How well characterized is the vertical extent of the aquifer? Does it have a bottom? Is it all in the Snake River Plain basalts? Does the velocity or the water quality diminish at depth? Is there a depth to it, are you aware?

BURKE: There is, I think it’s something around 400 feet below the site. But, I understand that’s very basalt material underneath the ground at the INL, so there’s a lot of pathways for anything to reach that 400 feet, as well as a unique feature of the aquifer is that it moves towards that middle area and actually comes out of cliffs, then down in the Twin Falls area, the center part of the State. And, so, anything that would get into the aquifer in that area would continue to move through the aquifer. Timewise, I'm not sure, there's a lot of studies out there about that. It is well documented. I just don't have all the facts and figures of it here.

MURPHY: Thank you.

GARRICK: Any questions from the staff? Anymore questions from the audience? Good, thank you very much, Susan.

BURKE: I agree.

GARRICK: Okay, Kathleen?

HAIN: Good morning. I'm Kathleen Hain of the Idaho Cleanup Project, and we're here today about the spent nuclear fuel that is currently managed for the entire Idaho National Laboratory site. And, first up?

Basically, DOE-Idaho has responsibility for approximately 290 metric tons heavy metal of spent nuclear fuel. That's approximately 11 percent of DOE's inventory. That fuel is stored at the Idaho Nuclear Technology and Engineering Center, visited by the Board yesterday, usually referred to as INTEC. It is also stored at the Fort St. Vrain site, which is actually at Platteville, Colorado. You were told it's about 50 miles north of Denver. That was a commercial reactor site, and the fuel is in an NRC licensed independent fuel storage installation, ISFSI.

There is also fuel at the Advanced Test Reactor in the canal. The reactor is currently operating and does generate fuel, and at the Materials and Fuels Complex. Fuel is actually being treated by electrometallurgical process at the complex.

Idaho continues to receive domestic and foreign research reactor fuel. This year, we’ll get five shipments, one from the University of Wisconsin, three from California and one from the on-site reactor. ATR continues to generate fuel.

Now, what’s unique about Idaho is the variety of fuel that is managed here. Fuel has approximately 220 attributes. These attributes are things like size. I have research reactor fuel that weighs less than two pounds. I have the shipping port sea module that weighs more than half a ton. Cladding, I have aluminum, stainless steel and zirconium fuels. I have fuels that are beryllium matrix, carbon matrix. The Fort St. Vrain is carbon matrix. Fuel condition is from totally intact to having been sampled for research purposes, to having been totally crushed. Different enrichments and different times in the reactor.

For the public, this is just a picture of TRIGA fuel. TRIGA is the type of fuel that I receive from domestic and foreign research reactors.

You’ve already had some discussion of the Idaho Settlement Agreement. It was prefaced on the programmatic

EIS, Environmental Impact Statement, for fuel and the remediation of the site. And, all the activities that are currently in the baseline for management of fuel were covered in that EIS.

I'm not going to go through again all the details of the Settlement Agreement. But, for fuel, the next milestone is the 2023, have all fuel in dry storage. And, when it comes to the Colorado agreement, the idea is that the fuel would eventually come from Colorado to Idaho for packaging, but that cannot occur until fuel is leaving Idaho to go to a repository.

We're going to continue to safely manage the fuel on the site while the national spent nuclear fuel policy is developed. That policy is going to include recommendations from the Blue Ribbon Commission.

And, then, the Idaho Cleanup Project is going to respond to those new policies. At the moment, we have provided several management alternatives to both DOE headquarters, and to the General Accounting Office. Examples of that are increasing the cask pad storage. Yesterday, the Board got to see the fact that I have casks that are no longer licensed for road transport, are on a cask pad. They are monitored, and I have fuel stored. There are casks that come out of NRC licensing that can be used for storage. There are 24 positions on that pad, and I'm using six of them.

Modular storage. You got to see the Three Mile Island facility, which is modular storage. NuHOMs type container can be bought fairly inexpensively, about $5 million for the first one that has to do with all the design and criticality. Then, you can replicate them at a million dollars a piece. So, those are two ideas that we have provided.

Yesterday, we went on the tour. What I’ve done in the presentation is put the descriptions of the INTEC facilities at the back, to stay on schedule, and I’m going to spend a little bit of time on the authorization basis and the non-INTEC facilities.

The authorization basis is basically the agreement between the contractor given responsibility for a nuclear facility, and the Department of Energy to ensure that we have safe operations, and in this case, safe storage.

Three Mile Island license is being extended. It will require extension in 2019. We will submit the application at that time. All the other facilities currently have an authorization basis that runs through 2035. And, that authorization basis assumes that we maintain and surveil those buildings.

Now, the authorization basis itself contains a description of the facility, basically, the as built configuration. It contains a description of material that is going to be stored in the facility, the attributes of the design, so that we maintain minimal risk to the worker, to the on-site worker, and to off-site public.

The analysis includes both normal operations, abnormal operations and postulated accidents. It goes through nuclear criticality, radiation safety, fire protection, how I transport things to and receive, how I then store, and emergency preparedness.

In addition, we look at all the natural hazards, seismic hazards for this site, where Idaho site stands with its probabilistic, seismic, hazard assessment. We just finished the ten year review. We did make the decision that the document needs to be updated because there has been over the last ten years a fair amount of new information generated about the seismic characteristics of the Snake River Plain aquifer. But, the basic conclusion concerning the seismic events on the site has not changed.

Flooding, we do not have a river that flows across the Idaho site. We do have two ephemeral streams, Big Lost and Birch Creek. The Big Lost actually flowed this year because we had a fairly wet spring.

Weather related. Snow load is one of our big issues. We do have a fairly heavy winter. And, wind, including cyclonic storms.

We look at all the permit conditions, clean air, clean water, RCRA. We look at analyses to comply with safeguards and securities. When it comes to fuel storage, safeguards and securities is an area where we are expecting change. The attitude toward safeguards and securities continues to become more conservative, and because the fuel is also cooling and will no longer be self-protective, there will be increases in safeguards and securities between now and 2035.

We also identify safety significant systems. Each safety significant system is assigned to a specific federal individual who has responsibility to make sure that it's maintained, and that's one way we make sure that there is accountability for safety.

I mentioned before that I have NRC licensed facilities. The Idaho Cleanup Project basically has three NRC licensed facilities. The Fort St. Vrain facility in Colorado. It is an air cooled facility. The fuel stored in that is carbon matrix. Part of the St. Vrain fuel had been received in Idaho at the time of the suit by the State of Idaho. So, the facility is not full, but it will be maintained. It holds right now approximately 15 metric tons. It was constructed in 1989, licensed in 1991. We are in the process of a 20 year license renewal. We have responded to all of NRC's requests for additional information, and now we are waiting for them to come back after reviewing that material. The surveillance and maintenance of all the NRC licensed facilities is actually defined by the license, and we maintain those licenses with the same rigor as any commercial holder of a license.

Basically, where fuel is currently being generated and stored, the Advanced Test Reactor is operating. Fuel comes out of the reactor. It is stored in the canal until it is cool enough to transport to INTEC and be placed in the CPP-666 storage basin. ATR fuel is the fuel that is the largest population by piece count on the site, approximately 4,000 items. Each of those items has a fairly low metric ton heavy metal, maybe .00 something. It is being considered as a candidate for reprocessing at the Savannah River Site’s H-Canyon, because it is aluminum clad, it’s small, it’s easily transported. Basically, there are two commercial casks that can transport ATR fuel, and where the ATR fuel is currently in the licenses, the net cask recently designed what is referred to as the BEA cask.

And, right now, the ATR facility is undergoing a change to its authorization basis, which should be completed and then approved. Rick Provencher is the approving authority for that safety basis document.

This is just a picture of the canal. You can sort of see why we call it a canal, just a straight shot from the reactor.

The Materials and Fuels Complex is currently processing fuel through the electrometallurgical process. Basically, that fuel is sodium bonded. Fuel has come from the Hanford Fast Flux Test Facility, is currently stored in the Hot Fuel Examination Facility, which is a shielded hot cell. That facility will be treated in the next few years. There is fuel in the CPP-666 basin, basically the CBR-2 fuel, which will also be processed through the electrometallurgical treatment process. Plans are to start moving that fuel in fiscal year 2011.

The process itself produces a uranium product, and a ceramic high-level waste, and a metallic high-level waste. The ceramic form has not yet been created. It comes from the eutectic salt that is part of the process, but it has been tested on a bench scale. And, the metallic waste form is sometimes referred to as a hockey puck and it is stored in the underground vaults at ATR, at Materials and Fuels Complex.

This is an example of the vault storage where both fuel and that metallic high-level waste form is currently stored.

Now, when I was giving you the list of NRC licenses, there is one license in that list which hasn’t yet been built. And, that is for the Idaho Spent Fuel Facility, that's what the ISFF stands for. The license itself is--the facility design itself is NRC licensed, and it can be built with the current package. We made the decision not to go to construction until we had a final idea of what fuels this facility would be packaging.

The mission of the facility is to both examine and characterize fuel, do any stabilization that might be necessary, possibly to provide some interim storage for that fuel, then to package that fuel in a standard DOE canister, and then to store the canistered fuel until it can be loaded out for transport to an off-site either repository or interim storage site.

Now, the kinds of changes that may come from a new policy would be to provide non-canistered storage, to provide for treatment of fuel, treatment being put it into a canister. For fuel not currently assigned to Idaho, the one that has been suggested is the Oak Ridge HIFR fuel. The current design would have to have some changes to accommodate this fuel because it's bigger, in terms of storage space, than what the current design holds. Any decision to receive Oak Ridge would have to go through a formal evaluation of impacts, including the fact that it's not listed as an acceptable fuel under the Idaho Settlement Agreement. And, then, the current design provided load-out for trucks. It did not provide load-out for casks being transported by rail.

It has always been considered a good idea to have multiple transport modes.

And, we have not ruled out reuse of existing facilities. While we have a standard lone design, it is a modular design, and elements of that design can be applied to current facilities. The advantage of building off of a current facility, the rate limiting step in the movement of fuel is always the packaging it into the cask, moving that cask and then unpackaging from the cask. So, you can move fuel more rapidly into canistering if you're able to, say, build off the back end of the 603 fuel storage facility.

This is just a schematic showing that to date, we have taken fuel from wet storage, put it in 603. The picture here is the 666 storage basin. Those fuels have moved up to the 603 irradiated spent fuel facility. The next picture is a canistered fuel going into storage. The plan was to take the fuel in those canisters into the Idaho Spent Fuel Facility. That picture on the bottom is the architect's rendering of the design. Above that, we show that fuel has been dry transferred into the Three Mile Island fuel storage modules. Dry transfer systems are available, so that I do have that way of moving fuel. And, then, geologic disposal at some point, and the idea that there are casks available right now for the transport of fuel uncanistered. The casks for transport of canistered fuel is not currently available.

So, we look at aging management. In order to ensure that all of my fuel will be safe through 2035, we have focused in the current contract on the movement of fuel into dry storage. We are putting an emphasis in the next contract on the assurance that all of the current spent fuel storage facilities will be safe.

We're doing life cycle studies. We have done these for the NRC licensed facilities using the NRC methodology. We are going to apply that methodology to the other facilities. We have already determined some refurbishments for existing facilities. The one that I often focus on is 603. The crane system in 603 is 1950's vintage. It works just fine for what it was designs to do, which is receive and lift a basket. But, it doesn't have the manipulative capabilities to remove a single piece of fuel from storage.

We have a design in place. We are going to fund refurbishment of that crane so that you have the end effect for manipulation that will allow you to pull a single piece of fuel. That will allow you to send fuel to reprocessing if that becomes part of the path forward, or to repackage fuel in a different arrangement should that be the best way to send it to an off-site storage facility.

We're going to be doing all the life cycle analyses using the NRC methodology. That way, across the Idaho site, we will have used the same methodology, and we hope we have comparable results.

The rest of this presentation is just a quick review of the storage facilities you saw yesterday. I'm not going to read these lists of attributes. Just a picture to remind you we have storage right now in the 666 basin, basically Navy fuel, EBR-2 fuel, which is a sodium bonded, and ATR fuel. In the next two years, I'll receive approximately a thousand pieces of ATR fuel from the canal into the storage configuration.

The Irradiated Fuel Facility, which was 603, basically this is the oldest of the dry storage facilities. You look down on the storage array, and that array continues to receive the domestic and foreign research reactor fuel.

Underground storage vaults. Very effective for storage of fuels that are too long for the storage in 603, or have a specific problem with, say, criticality analysis because here, each one is separate. And, there are two generations of vaults, and we have space here for other fuels.

The West Valley Cask continues to store fuel, and then the cask pad. The two casks that are circled on this picture, which are the 125B casks, are actually currently in 666. They are storing miscellaneous cans of fuel. Those casks will be moved to 603 by the end of 2012.

And, then, just facts again on the cask pads, and then Three Mile Island, which is the NRC licensed facilities, modular storage, moved into that facility using dry transfer. This facility will be relicensed in 2019.

And, that's my presentation. Questions, please?

GARRICK: Thank you. Howard?

ARNOLD: Arnold, Board.

That last slide was appropriate. You showed some NuHoms, the same as are being put in on many commercial reactor sites. It seems to me we have an opportunity here on a DOE site to learn about long-term storage, since the U.S. program envisions, or requires long-term storage now that we have no immediate repository. We can have an opportunity to learn about the long-term behavior of these dry storage facilities for commercial units as well as government units.

I don't think there's much doubt that it will be safe from now until 2035, or whenever. The question that comes to my mind is what shape will the contents be in at that time period? Can they then be handled and shipped and, again, after they're shipped, handled again? And, I see opportunities to do work on that to answer those questions.

HAIN: Yes, and we currently provide research opportunities, as well as our own required monitoring of the casks on the cask pad of the NuHOMs containers, and of the underground storage vaults. We have corrosion coupons in all three storage configurations. We do monitoring for hydrogen.

We look at temperature. We look at pressures in all of these. And, we have provided researchers with the opportunity to instrument our storage facilities, and we continue to provide that opportunity, working in some cases with NRC, and in some cases with the laboratories.

ARNOLD: NuHOMs, of course, is only one of several different types. Some are free standing, vertical, and so forth. It seems to me there's an expanded opportunity to try other things that the commercial reactor sites will be using.

HAIN: Yes.

GARRICK: In that connection, and given that there's quite a bit of instability now in what the long-term policies are going to be, as well as the long-term resources for storage and disposal of fuel, is Idaho doing any studies of different scenarios, depending on what the policy ends up being? Because the evidence is pretty strong now that we may not have a repository for 50 years, and you've done some very good work here for a very temporary situation.

It's very temporary when you've got to get rid of all of the stuff by 2035. In the kind of time we've been talking about, that's practically tomorrow. But, it seems to be becoming increasingly clear that nothing much is going to happen for a long time, and I would be very surprised if we had a repository within 50 years, given where we are.

So, what studies are you doing to accommodate the uncertainty associated with policy, and the possibility that the storage requirements are just going to be dramatically extended?

HAIN: To date, what we have done is provide basic cost and schedule information to a number of scenarios. Because Idaho has experience across a range of dry storage configurations, and has the design for the Idaho Spent Fuel Facility, which would canister fuel with the idea of canister long-term storage, the first step was develop some scenarios, the next step was to provide some very basic schedule and cost data. Now, the agenda moves forward with looking at some things besides what has been currently being used in Idaho. So, just step by step, moving forward, looking at alternatives and determining which ones will be best to research.

GARRICK: Ali?

MOSLEH: Mosleh, Board.

You mentioned some activity or research ongoing regarding instrumenting the casks?

HAIN: Yes.

MOSLEH: So, those are ongoing?

HAIN: Yes.

MOSLEH: What are the objectives to kind of see performance or other mechanisms?

HAIN: What we have been looking at, just from the standpoint of the safety basis, was hydrogen generation and corrosion. Then, we've had researchers that have wanted to do long-term trending of temperature and pressure, as well as different ways of looking at corrosion. So, basically, it's the idea we have opened the opportunity to researchers to come up with their research projects, and then to use our casks. What I have funded has focused on the corrosion, hydrogen and temperature and pressure necessary to make sure that my current condition is safe.

GARRICK: This is Garrick, Board.

What metrics do you use to measure your progress towards achieving the terms of the agreement?

HAIN: Well, what has been most recent is because we were meeting the requirement to have all Idaho Cleanup Project fuel in dry storage, the metric was pieces of fuel moved into dry storage. When it comes to the metric of having all fuel out of Idaho, the metric that had been developed as part of the Gold Chart was once again, fuel canistered and fuel removed. At the moment, those metrics are basically not being status, since we are neither canistering nor moving fuel out.

GARRICK: Okay. Any other questions? Yes, Carl from the staff.

DI BELLA: Carl DiBella, Board Staff.

I noticed in Rick Provencher's presentation that the Chemical Plant was shut down in ’92, basically because the market dried up for the highly enriched uranium product from that plant. However, one option being considered now, according to your talk, is reprocessing ATR fuel, which is also HEU fuel, and presumably one would recover HEU, highly enriched uranium, from that. That implies there is a use for that now. What sort of uses are there for that?

HAIN: There is an agreement between the Savannah River site and the Tennessee Valley Authority on receipt and use of the uranium. I am not personally cognizant of the specific details, but I do know that in making the decision to process through H-Canyon, that that is a milestone to be achieved, is the negotiation with the Tennessee Valley Authority.

ARNOLD: If I could just comment, I think ATR fuel is probably a lot easier for them to deal with because it’s aluminum.

HAIN: Yes.

ARNOLD: Probably the answer to the question.

HAIN: H-Canyon can only process aluminum clad, yes.

GARRICK: Doug?

RIGBY: Two quick questions. Rigby, staff.

Two question. Number one, you know, we’re talking about maybe research for long-term safe storage. As I understand, you know, you’re doing the NRC licenses that extend for 20 years. You can maybe anticipate you need to renew for another 20 years. Other than that, do you have any incentive to look for doing research longer than, say, 20 or 40 years?

And, then, the second question comes to the transport criteria, you need a criteria that you can use to know that your package, your fuel inside the package will be safe to transport. In your mind, are you clear on that criteria so that then, you know, you could go ahead and document that it would be safe to transport?

HAIN: When we were focused on transport to Yucca Mountain, the criteria for packaging the fuel in a canister was developed basically by Yucca Mountain with the idea this was how DOE fuel would be received in the standard canister. So, in terms of transport and storage, it was meeting the requirements of the repository.

One of the reasons that we have not pushed forward with canistering at this point until we're certain as to what the criteria for packaging will be, is it is actually easier to make adjustments to the Idaho Spent Fuel Facility before you build it, and to make sure that whatever the characteristics of the canister are, and the characteristics of the fuel to put it in that canister, that's why we have the Gold Box where we say we will characterize and stabilize as necessary. At the moment, we can only say our goal is to meet the criteria that is set by the disposal facility so that our material is receivable. But, we aren't doing any particular research into those aspects.

Now, we do have here in Idaho the National Spent Fuel Program. The National Spent Fuel Program has been very active in looking at all of the research and development necessary to assure that DOE assigned fuel will be acceptable at the repository. They are currently looking at their long-term research plan to determine what changes have to be made. Up until now, the focus as been on welding, stabilization, other aspects of fuel aimed at the receipt criteria for Yucca Mountain. The National Spent Fuel Program is now saying okay, with the change, how do we reformulate our plan to go forward? That effort is not yet concluded. It's still being worked on.

When it comes to the reasons for doing long-term storage research and development, because I represent the Idaho Cleanup Program, our focus has been on shorter term storage until it could be sent to the repository. But, the Idaho National Laboratory as a whole is interested in the nuclear future for the country, and any nuclear future may involve long-term storage. So, just from a standpoint of having a viable nuclear future, we are interested in long-term storage.

GARRICK: Any other questions?

(No response.)

GARRICK: Anybody from the audience? Yes, we have a question. Please state your name and affiliation.

BRAIXFONE: Beatrice Braixfone, Snake River Alliance. And, Kathleen, I know I know the answer to this, but 1995 was a long time ago, and I can’t remember.

You said that INL has responsibility for approximately 290 metric tons. And, in Susan’s presentation, there is the bullet, overall cap of 55 metric tons. What two different things are those numbers referring to?

HAIN: Okay, when I talk about Idaho site responsibility includes material at Fort St. Vrain, because we’re responsible for that.

BRAIXFONE: But, that’s not very much.

HAIN: And, I say right now, the 55 was a receipt, I think, and this is what was already here.

BRAIXFONE: So, that Idaho’s inventory could go up to 345, less what’s at Fort St. Vrain?

HAIN: Yes.

BRAIXFONE: Okay, thanks.

GARRICK: Any other questions?

(No response.)

GARRICK: Very good. We’ll take a 15 minute break.

(Whereupon, a brief recess was taken.)

GARRICK: Our next speaker is Ron Ramsey, and I’ll ask him to introduce himself.

RAMSEY: Good morning. I'm Ron Ramsey. I'm the current project manager for the Calcine Disposition Project.

I'm going to present this in two parts. One will be background. And, then, the second part will be status.

And, I thought I'd give you deep background. My guess is, looking at the schedule, you have people who will address the various parts of the tank waste program that EM manages. But, I thought I'd give you just a summary to introduce it.

We have high-level tank waste and then we have other tank waste. The principal interest of us here is high-level waste, or at least that's mine. The high-level waste tanks, or Generation 1, consisted of a number of tanks. They have since been emptied. So, all tanks that contained what we define as high-level waste have been emptied and grouted, and that portion of the project is complete.

The second generation is what happened to that waste. That waste was solidified into deposits what we call calcine, and they were placed in the calcine bins. And, these bins are to be emptied and the calcine is to be treated via HIPing, and we'll get to that and what that means, then packaged suitably for interim storage, transportation and final disposal.

Finally, we have other residual tanks containing what we're just going to call other tank waste, or we refer to generically as sodium bearing waste tanks. They're salts, and these are second, third and other processing wastes. These tanks are also to be emptied, and they're to be treated via steam reforming on our site. That project is nearing completion, that is, the construction of that facility for that capability.

These are the tanks that have been used. We have three small 18,000 gallon tanks. They're still available. They once process high-level waste. They no longer do so. They contain runoffs, residuals, other kinds of materials. But, they're still in use.

We have four 30,000 gallon tanks. They're all closed. Then we have eleven 300,000 gallon tanks. Ten have been used, one is in reserve. Seven of those have been closed. Then, you can see the numbers of liquid waste. The top line includes principally high-level waste, and some minor amounts of sodium bearing wastes were processed through there, and you can see about 7.7 million gallons in the first run. In the lower area, we have the sodium bearing, and that's the residuals for that, less than a million gallons.

This is just in case you were going to ask me the question. I have not memorized this, so you can peruse that at your leisure.

Calcine is the material we used principally for high-level waste. The very last run, we actually did some sodium bearing waste. But, the value of this technique in calcining is that we get this vast volume reduction.

Historically, most of the waste at the other sites were put into not as good a grade of tanks as we did. They were developed during the war. They had to get up and running very fast, and they used iron tanks, not quite as good as ours. While ours aren't doubly contained, none of our tanks have ever leaked. They are stainless steel, and that allowed us to keep the high-level waste processed waste in an acidic fashion.

And, in fact, as we emptied the tanks for cleaning and grouting, and we lowered cameras down in there, you could still see chalk marks from 60 years before when the tanks were being constructed. They're very clean. So, they were cleaned out with a hydro ball. Most of the heals were removed, and then they were grouted. At any rate, the value to us is that we were allowed to keep it in a very good condition. I said the tanks have never leaked. There have been some leakage in the lines, and that resulted in some enforcement orders with the State. But, what we generated was a solid material, which is, we believe, it's very safely handled and managed today.

The calcine that we have at our high-level waste is RCRA material, and we've put that in our documentation. Our bin sets, where they're stored, we have seven bin sets. Six of them are utilized, one is extra, has never been utilized. And, we’ve been granted a RCRA Part B permit for storage, and the understanding with the State is it’s not of fact appropriate RCRA storage in the sense that’s usually required, but we’re granted this because we’re making progress under our agreements with the State to go forward. The permits are ten years in length and up for renewal.

We’ve had two calciners in the history of the site. The first one, ’63 through ’81, was the calcine waste facility. It gave a grand effort and eventually it was retired. And, then, ’82 through 2000, we ran the new waste calcine facility until it was shut down in May of 2000. I actually helped fund the last run. We started up again, it was about ’96, ’97 for the final run. The calcine are required to shut down periodically because of the harsh conditions under which it operates. The nozzles tend to simply wear out. And, so every couple of years or every couple of campaigns, you had to stop and replace some of the equipment.

Calciner itself is a fluidized bed reactor, a rather neat technology, looks kind of like a Franklin stove, and it has jets that go into it, and you settle a bed with, oh, what did we use, we used I guess alumina to set up the bed, and then we added the materials, and it burned oxygen and kerosene, and then other chemicals we added included calcium nitrate and boron oxide. And, then, we closed it and that was it. So, we generated about 4.4 thousand cubic meters of calcine.

This is just a picture of what the bins look like. Almost every generation was designed slightly differently over the years. But, those are the six in operation. The chart simply shows you the calcine solids storage facility, we call them bins, and the number of bins in each. The first one was radically different. There’s 12, but you only see four sets there. They were nested inside, so they had concentric containers within them. The others were separate bins, and they looked more like silos. And, that’s within a concrete containment. The structure itself was bermed. Some of them were almost entirely covered by dirt. The others are a little more than halfway.

I took this out of the geological repository EIS just to show how do we compare. You can see Hanford has assuredly the most high-level waste, Savannah River the second, and we’re a poor third.

There’s a picture of what several of the bin sets look like. I think if you went on the tour yesterday, perhaps you drove by there. The tanks used to be set up fairly nearby.

So, to finish the story, we would pump the fluids from the tanks. They would go to evaporators, and then the evaporators would go to the calciner. The calciner would flash off the water and then precipitate the material into a dry solid that looks something like comet, or what's your favorite, Tide laundry detergent. And, then, pneumatically, it was transferred to these bin sets where it sits today.

These bin sets are very sturdy. We believe they could last more than several hundred. The design parameters were in fact 500 years. However, we're required to get these into a road ready condition by agreement with the State.

I put this in here because people often wonder how we work out here. I'm not sure how we work, but this is my boss, Mr. Cooper, and then we have this huge group here, it's called Tank Waste Disposition. Actually, that's not quite right, but you know, you get names and then you forget to change them after a while. We're the Calcine Group, and this is my immediate boss, Mr. Jensen.

So, what's our mission? Well, it's the safe and efficient management of all materials within our custody, and particularly high-level waste, protection of the Snake River aquifer, and for the calcine project, it's to have the material road ready by target date specified in our Settlement Agreement with the State by the end of calendar year 2035.

What are we doing? We're going to design and construct a processing facility, and we're going to use the

IWTU, which is designed to treat and manage the sodium bearing wastes. We’re going to use that facility to the maximum practical capability.

We’re going to retrieve and transport 4,400 cubic meters of calcine from its current storage in the bin sets. We’re going to treat it in one of two ways. We can--our ROD says we will use HIPing, and HIPing is a super-compaction method. We could do it that way, depending on what the final requirements for a disposal site are. But, we will build our facility, we will modify the IWTU to contain and be able to apply chemical treatment, which will eliminate RCRA characteristics. That’s based on our prior experience with Yucca Mountain. No RCRA, so we’re prepared to meet that if required.

We’ll package the resultant material in canisters. At this time, we were considering using the DOE standard canister for spent fuel. It was designed here and was designed to be used for our fuel as opposed to Savannah River, which will hopefully have processed all their aluminum fuel. They had at one time intended to send their CATS and DOGS here for packaging.

Anyway, that was the grand scheme of spent fuel some several years ago. We’re not certain that this will be the package we’ll use, but we’ll say that that’s it for the time being.

We're going to store--we may need to do interim storage, since we have nowhere to go, and then we'll perform our RCRA based closure on existing high-level waste facilities and clean closure on the new facilities.

These are our drivers. I've given you some predecessor documents that don't necessarily impact calcine. These earlier documents were largely to do with tank waste leakage, et cetera. Nevertheless, they formed the foundation of the work that succeeded it, and the court order of '93 became part of the activities that led to the general EIS for the site in '95 for spent fuel and high-level waste, and resulted in the settlement agreement itself.

There's also the Federal Facility Compliance Act, which drives us into RCRA. And, then, we have our own EIS that was completed in 2002.

We achieved CD-0 for this project in June of 2007. We published an amended Record of Decision that chose HIPing at the end of 2009. And, that met a Settlement Agreement milestone, by the way.

We are now working toward CD-1. We have a separate agreement with the State on our site treatment plan, and we have agreed to meet CD-1 by the end of this calendar year.

And, then, below, you see the other Settlement Agreement milestones. We need to have submitted a revision to our Part B permit in December of 2012, and this is the ultimate milestone in the project, have everything road ready by target date of the end of calendar year 2035.

Well, we've been doing this for some years. We've been thinking about calcine, or high-level waste, even longer than this would indicate. It was considered in the '95 EIS, of course, and we were planning a path forward easily the last 15 years. But, here's the process that we've gone through in the last decade.

We've done more than 20 alternatives and we did a down select to about 12 in the first EIS for high-level waste in September of 2002. Another disposal option was added, and that was direct disposal in 2003.

We went down to 13 alternatives. Well, that was 13, and we did a down select to about four in '06. In 2009, we realized that direct disposal was not viable, and, so, it was eliminated. We had our last down select from four to the one in November 2009, and that resulted in the issuing of the ROD that selects HIPing.

The selection value was multiple. The alternatives, all of the alternatives that were analyzed, by the way, resulted in little impact, so they were all good in that area, in that arena. None of the alternatives result in appreciably different impacts on historic, cultural or natural resources. Any of the waste treatment alternatives that got the material out was considered good.

We did estimates of life cycle costs, these alternatives that we evaluated. HIPing was evaluated with RCRA treatment and without, and there was direct disposal, and the principal, in fact, the only current approved method for EPA for treating high-level waste is vitrification.

The thing about vitrification is the cost, and we used a life cycle method, which included more than just the impacts to the site for construction and operation. We used what are the total costs to the government for packaging, transportation and interment. And, a principal parameter in that regard was simply how many canisters did you generate and send to the repository. Now, of course, this modeling was done against Yucca Mountain, which no longer is the case.

So, we did the cost evaluation, and then I did a normalization against the least expensive, and, so, you can see how the cost ranged. So, the cost for utilization--these are ranges, by the way--so, the cost for HIPing became rather attractive.

HIPing is Hot Isostatic Pressing. The technology was developed more than 50 years ago, and is well established in American industry for some 30 years. The notion that we have is to produce a robust glass ceramic waste form that will meet the same requirements as the borosilicate glass that’s utilized at Savannah River. We believe it’s going to result in large life cycle cost savings and final disposition, and we believe it may be attractive for other waste management purposes.

So, how does it work? Another great invention in the U.S. patented in ’41. Batelle has used it for bonding fuels in the past. It consists of a pressure vessel with an electrically heated furnace, and the components are placed in a sealed can. And, while the temperatures can go up to 2,500 degrees C, we’re going to use temperatures around 1,000 degrees C, maybe 1,100.

Pressures in the HIPing device can be utilized up to 30,000 pounds per square inch. We’re going to use around 7,000 for our conditions.

The vessels themselves are made to strict codes. Their failure rate is less than a tenth of a percent. And, since we won’t be approaching the boundaries of its capacities, we would expect none of that in our operations.

We’ve done proof of concept testing thus far, and that’s what led us to select this technique for handling the material. We have two major calcine types. First, let me say in spent fuel, the Idaho site has a sampling, at the very least, of every fuel type there is. Depending on the way you count them, we estimate some 220 types of fuel.

But, the primary fuels that we have used has to do with the cladding, and that’s alumina and zirc cladding. So, they generate the two major calcine types we have. And, they're different in their reactivity with the recipes that we have utilized. So, there is a spectrum of ability to be matrixed as we wish it to be.

So, we have used surrogate calcines. We've developed them in a manner similar to the way the calcine is doing. We have very good data on the contents of our calcines, so, we have added the metals that are of concern to us. And, we have been utilizing a recipe developed by a single contractor, who has aided us in this effort for the last several years.

The objective of our testing is to find the recipe that meets two standard tests. The TCLP, this is method 1311 utilized by EPA, toxicity characteristic, leaching procedure, it's a destructive analysis where you chop up your sample, you put it in an acid bath, you let it sit overnight, and then you do an analysis of the leachate. And, you look to see if you have, in the leachate, any of the listed materials that define the toxicity characteristic as defined by EPA.

The other is the product consistency test, and it's an ASTM method. At any rate, the point is is that we have done some testing, and, thus far, the results have been attractive.

Just for some little detail, the numbers that were selected on the data I'm about to show were done on a baseline average. The maximum constituency, that is, there's always a range of what our averages were. And, then, we did the transition between the two.

This is for alumina, and with the addition of the chemicals for this treatment to matrix the metals of interest, we were able to condense this material to about 60 percent of its formal volume. That's very attractive also.

This is the data for zirconia. You can see it's not quite as good. The data ranged from as low as 7 to as high as 33 percent, depending on the methodology. But, at any rate, let's say it's 20 percent, or so, at this time. So, we have some work to do. We'd like to maximize this capability.

So, this was a chart prepared by my predecessor to show the value, for instance, against vitrification. Whereas, we reduced the volume, the volume for vitrification certainly increases. We're able to super compact, and that's of great value to us. And, more importantly, that means we send less canisters to whatever the final disposition site is.

This is just a schematic of the IWTU, and the notion of how we're going to try to put the treatment capability within the facility. So, after the first phase of its life is over, my project will inherit it. We'll investigate it to make sure that it's as we expect it to be. There will be some degree of D&D, where we'll have to do some cleanup, and then remove equipment that’s no longer of use, or occupying space that we require. And, then, we’ll insert the treatment system that we plan to use. We’ll also be required to build a load-out facility on the end, and we’ll have to build storage, interim storage as well.

This is just a schematic of how the process would work. Pneumatically, we would transfer the calcine from the bin set to hoppers, then they’d go into feed blenders. These are the feed hoppers. And, this is the can that would be compressed. The can itself would come here for preliminary heating. Among the things we’re considering is just what we may or may not drive off in the heating process, and then capture appropriately in absorbers. There may be some residual moisture in the calcine. We suspect it’s very little. The calcine bins are very warm. We suspect they drive off, have driven off all moisture. But, nevertheless, we’ll do heating to make sure that no residual moisture resides here.

And, then, we have two other metals that we are concerned about, and, so, our testing, part of our testing will be to decide whether we shall remove mercury and potentially cadmium from this process, or we believe that the recipe that we develop is adequate to contain it and leave it in matrix. Otherwise, if it’s not, we’ll drive it off and it will go to an appropriate absorber and be treated as a waste as well.

After this process, it goes to the HIPing device, and there, it undergoes the pressure, isostatic, that’s pressure from all directions, just as if you were to take it to the bottom of the sea, and it also undergoes heating as well. And, then, that would be the final product.

The can itself would be reduced. Our initial objective was to be able to put three of these in a 15 foot stand canister or two into a 10. So, that would mean it’s a two foot diameter by roughly five foot. And, the original can would be roughly two and a half feet diameter by something like eight feet, and compressed to that reduced volume.

This is the schedule we’re working on. It’s certainly not final. We’re debating and arguing all the time on how to improve our schedule. So, that’s what’s represented by the give and take here. We’re still talking about it. But, the objective, of course, is to finish ahead of our Settlement Agreement milestone date.

So, what are our challenges? The challenges are always cost and schedule, and particularly this cost retrenching environment. So, our project requires constant monitoring, and we will be adjusting as necessary.

The technical challenge for us is maximizing the loading efficiency. That’s one. Another is dust and fines from the material itself, the feed product. The high heat environment and the high radiation environment. Heat and radiation, of course, is a challenge for us because much of our material will be electronically controlled. I’m sure you’re aware of the high radiation just fries your electronics.

Most of my career here, more than a decade has been managing the spent fuel program, and where we have our caves for fuel manipulation, we have cameras, they’re video cameras. And, over the weeks and months, you can see the video just graying out and then finally you have to replace those cameras.

So, part of the challenge for us is to build this facility so that we have good visual of our working materials and of the equipment itself, and access to it. We’ll do that either with windows and power manipulators, or we’ll use video cameras, so that regular routine required maintenance will be easy to achieve. Things will wear out, parts will suffer. Ideally, we will use plug-in, plug-in and play. It will be able to easily remove by a hand manipulator and then replaced. And, then, those things that just break down that surprise us, we’ll want easy access to.

So, we’ll have to make it, the facility has to be designed so that we can do these things reasonably well, and that is a challenge. To meet that, what we would like to do is utilize, to the best extent possible, mockups and modeling.

And, in my career, every time we used mockups and modeling for spent fuel activities, you think that's pretty simple to handle fuels, but we have had a number of challenges over the years. And, when we did these processes, we were successful. So, we, and our management is supportive of doing this. The problem, of course, is always how much can you spend and where will you apply it.

So, what's our strategic challenge? Is meeting the treatment, packaging and receipt standards of some disposal area without knowing what it is. So, we're going to be listening to the recommendations of the Presidential established commission, and certainly the experts without House and DOE. And, we expect we'll be hearing something from you.

So, here's pictures of--this is a schematic of how it appears. It's a little bit larger. And, here's an example of after compression utilization.

I'll just point out the two things that we look for in our testing is the one successful recipe that will work for everything. We may end up needing two recipes. That's a challenge, because that means more work. You'd have to sample the feed, and you'd have to have a testing capability. But, the contractor that we're utilizing, they're hell bent on developing a single recipe that allows us to reduce that requirement.

And, then, finally, we need a can that collapses uniformly with integrity every single time, so that it doesn't leak and contaminate the inside of our work area.

And, that's it. Questions?

GARRICK: Okay, let's start with Henry?

PETROSKI: I was going to hear you say that you are interested in using full-scale mockups, and you said modeling. What does the modeling consist of? Are you talking about computer modeling or are you talking about something else?

RAMSEY: Well, we could certainly do that. Most of the technology that we will employ, you can buy down at the farm equipment stores just down the street, this is a farming community, hoppers, feeders, blenders, mixers. The challenge is is that they haven't been used in this environment. That's a challenge. The other is switching very good, well done technology, HIPing, and doing the same.

So, yes, we would use computer modeling to decide does this make sense. Orientation, for instance, we're going to try to put about ten pounds of good stuff in a five pound box here at the IWTU. So, modeling and computer use will help us design and orient our equipment to maximum extent feasible.

The mockup itself has the value in that when you lay your train out, you can see just how easy is it to be accessible for PMs, for routine maintenance, and for repairs when they actually break down.

PETROSKI: And, that's not a computer model?

RAMSEY: No, that would be--

PETROSKI: Tangible?

RAMSEY: It would be a tangible. There's another value to it as well, should we do a full-scale. I'm not certain we'll do a full-scale, but should we do it, the value of it is that it's now a training facility as well, and it also houses extra parts that we could use for replacement if necessary. I'm not going to try to oversell this, but in my mind, when we prove this technology and it's successful, I think it will be attractive for other wastes in the future. So, I suspect this facility will have a longer lifetime than we're making it for.

PETROSKI: Now, when you say you may not go to full-scale modeling, does that mean you might just skip a mockup entirely?

RAMSEY: No, sir. We will certainly use elements of mockup.

PETROSKI: Good.

GARRICK: Bill?

MURPHY: This is Bill Murphy of the Board.

You point out on Page 25 that the HIP process produces a glass-ceramic. I'm curious the extent to which you've characterized the phase changes that occur in the HIP process. What is the mineralogy of the product, and has that been investigated, and has that material been considered in the context of ultimate disposal?

RAMSEY: Well, the fact is we've utilized a contractor who has done considerable work in this arena. They call their material SimRock, and it's proprietary. So, they don't let me see the chemical formula as of now. What we have decided to do, however, is we've utilized their expertise to do our proof of concept, and we're ready to go forward. We did our selection. They issued our ROD. And, our contractor has issued two statements to the world. One was a request for interest in this capability, and they received some 20 notices from other companies, and now they have released an RFP. So, we will own that formula. Come see me next year, and I'll tell you what it is.

What it is, of course, is a ceramic, and that's a matrix. And, you know, there's two ways you can, the matrix either cages the items of interest, and they're metals in our case. We believe all the organics are gone. They were blown off in the calcining process. We have never been able to find organics in our analyses of the calcine. So, matrices for ceramics, they either cage the material or they use the--

well, crown ether theory, where, you know, you have unbonded electrons that just grab the metals, just like your hemoglobin does, or crown ethers do.

GARRICK: Yes, I’m going to interrupt you with some breaking news. The NRC Licensing Board this morning released a 61 page opinion denying DOE’s motion to withdraw the license application. Mark?

ABKOWITZ: Well, I can’t top that.

RAMSEY: If you’d like, we can all go have drinks now.

ABKOWITZ: Abkowitz, Board.

I just wanted to get some clarity on the context of your presentation. The agenda suggests that you’re going to talk about the description and status of the Idaho high-level waste, but your presentation seems to be exclusively focused on the part of that that’s been calcined. Can you speak to the other roughly 900,000 gallons of liquid waste and what’s going to happen with that?

RAMSEY: I think my colleague follows me on that topic. Is that right? Yes, sodium bearing waste, Mr. Shawn Hill will follow on that. May I defer to him?

ABKOWITZ: So, that’s the remainder?

RAMSEY: Yes, sir.

ABKOWITZ: Okay, thank you.

RAMSEY: What I attempted to do was show the general program as it evolved over the last 15 years from tank waste to several kinds of discussions. My project is calcine.

ABKOWITZ: Okay. But, the sodium bearing waste is considered high-level waste?

RAMSEY: It depends on who you're speaking with. We define it as the first-run raffinate, and that is the bulk of the calcine that we have treated. Second, third, and other wastes comprise what's sodium bearing waste. They are principally salts.

GARRICK: Okay. Thure?

CERLING: Cerling, Board.

If you consider the entire process, what about sort of where are the other volatile radioactive wastes, tritium, carbon 14, xenon, iodine, that sort of thing?

RAMSEY: Well, the expectation is that they will be bound in the matrix. And, where they're not, we'll trap them. I'm sorry, my specialist isn't here today, but my belief is we will trap them, either in exhaust after heating, or they'll be bound in the matrix.

GARRICK: Howard?

ARNOLD: Arnold, Board.

It seems to me you're putting emphasis in the reduction in volume. But, to me, the important issue is related to the one that Thure just asked, namely do these things really retain the bad stuff? And, what kind of leaching takes place, and so on and so forth in the repository environment?

RAMSEY: Well, the full intent is to lock up the materials that define it as hazardous according to EPA. We believe the majority of the radionuclides will be within that as well. Everything else will be trapped in the treatment process.

ARNOLD: And, you will have tests to prove all that?

RAMSEY: Well, that’s the point, and right now, the tests we’re utilizing are TCLP and the product consistency test. And, as I say, I won’t say it’s foolproof at the moment, but the preliminary results are very attractive.

GARRICK: Okay, go ahead, Ali.

MOSLEH: On the volume reduction, you state in the 70 percent range. What are the variables that, what contributes to that range?

RAMSEY: What contributes?

MOSLEH: Yes.

RAMSEY: Just the super compaction.

MOSLEH: I see.

GARRICK: As a followup to that, the earlier literature I read on this when it was announced that Idaho was going to do this, they were talking about volume reductions considerably less than 70 percent.

RAMSEY: Oh, that range, that includes non-treating, so, no, we won’t achieve 70 percent. That’s the range for nontreatment as well as treating with chemicals.

GARRICK: So, what was the real driver in the Record of Decision? Is it the volume reduction? Is it a specific activity that could be handled? Is it the density of the material? Why was this really chosen from a technical standpoint? That volume reduction doesn’t seem to be very important. It’s just a matter of real estate.

RAMSEY: Well, the importance really is in the number of cans that you generate.

GARRICK: Yeah, but if you take it to the limit, it’s still a matter of real estate.

RAMSEY: It is.

GARRICK: And, you have to trade that off with the cost and the problems associated with getting it to that form.

RAMSEY: Well, there’s a couple of things. One, don’t short-sell the notion of reducing the volume of final mass. The modeling we used for most of my career here has been a cost, we used the formula that was provided by RW. And, the cost to the government to inter a can, a can being spent fuel or high-level waste, for most of that period was $660,000 a can. The cost, they had re-estimated it just before they went out of business, and they did not release it in their documents, the cost was then approaching a million dollars a can. That’s the cost to the government.

So, we employed that in our assumptions when we were looking at the lifecycle cost. That’s one element. One element is is that we believe we can do it cheaper. Another element is the simplicity of treatment as well as compared to what is required for the vitrification process.

When I joined DOE in ’91, the Savannah River facility was well underway, and it was I guess some five years later before it was up and running. The original estimate for the Savannah River facility was $1 billion. It was some $3 billion before the facility was complete. It’s up and running, does a good job, and it’s doing what it’s required. But, nevertheless, it was quite a--it was a technical challenge, particularly in glass pour. All the fuels, even though all their fuels that they’re processing are aluminum, they do have a variety of fuel types. That changes the chemistry, it changes the pour.

I remember sitting in my office and listening to the cursing across the hallway each time a pour was fouled up. Now, they’ve got it pretty well handled. They’re doing it reasonably well.

The Richland facility, I believe was originally estimated to be 3 billion. Do you know what the cost is estimated to be today? It’s a little over 12 billion.

So, the simplicity, the capability that we think we have, the ease of handling, the least likelihood of failure, these were elements that contributed to our selection choice.

It’s attractive for those reasons.

GARRICK: Was the scenario analyzed just putting the calcine in a waste package similar to the Yucca Mountain proposed waste package?

RAMSEY: Well, it was to be generated for a package here that would fit their needs. We have always planned here to use the standard canister for our spent fuel. So, we would use, there’s four dimensions, gives you four different cans, there’s an 18 inch inner diameter, a 24 inch inner diameter, and a 10 and a 15 foot length. Those dimensions handle all the fuel that we manage here at the site, and probably within the complex.

When I was working on the facility that would have managed, handled, packaged and stored that fuel, we had entertained some, more than ten years ago, the notion that it would be a good idea to put our high-level waste in that same canister. So, that’s an alternative we’re considering. We have not made that decision. We’re considering others as well.

Nevertheless, the point being those cans would have been loaded together in a particular cask, shipped to the mountain, and then they would have been stored and placed into the final package.

Have we changed our thinking since the TAD arrived? We have not entertained that, no. The TAD, by the way, is not a shipping vessel. So, loading it here would have required a very large cask for utilization.

GARRICK: Okay, we're running a little behind. We'll take one more question. Yes, Bruce?

KIRSTEIN: Kirstein, Staff.

Can you provide any details on the HIPing recipes with respect to what those additives are or will be?

RAMSEY: SimRock. Sorry, no, I don't have that, and I suspect I'd have it--if I did know it and told you, I suspect I'd be in court tomorrow.

KIRSTEIN: Thank you.

GARRICK: Thank you. Thank you very much.

Okay, Shawn Hill is going to talk to us about the description and status of sodium bearing wastes and plans for its storage, transportation and final disposition.

HILL: Good morning. My name is Shawn Hill. I'm currently the Deputy Federal Project Director for the Sodium Bearing Waste Treatment Project. As Ron spoke earlier, he will be using the integrated waste treatment unit to perform the HIP process. We will also be using the IWTU and the reason for the name, Integrated Waste Treatment Project, is that we built the facility in such a way that we could complete sodium bearing waste treatment, and then reuse the facility to go and perform the HIP process and the calcine disposition project.

A little background information. As Mr. Provencher talked earlier, we started the fuel processing in 1952, early Fifties, continued that reprocessing through 1991, which is a three step solvent extraction process. The solvents typically were nitric acid based and dissolved the fuel that way.

The first cycle, raffinates, were again processed in the calciner, new waste calciner, and converted to the calcine that Ron is working with currently.

They also talked about the tank farms, the 300,000 gallon tanks, of which there are eleven. The first seven were the ones that contained the high-level first raffinates, first cycle raffinates, and those were calcine. Those tanks have been cleaned to a heal and both the tank and the vaults are now full of grout and closed. So, we have four tanks left. Those four tanks contain the 900,000 gallons of sodium bearing waste. There are three tanks that are in use, they’ve got approximately 300,000 gallons each, one tank is empty.

Calciner, new waste calciner, I think we’ve covered quite a bit now, and the bin sets. Waste management, decon activities, cleaning up of these first seven tanks, plus cleanup of the reprocessing facilities. We’ve got a lot of decontamination solutions that are high in sodium and, hence, the sodium bearing waste name.

According to the Settlement Agreement, of those many agreements that we had in there, the one that applies here is DOE shall complete treatment of sodium bearing liquid high-level wastes by December 31, 2012. And, so, that’s what started this project.

This is a picture of the tank farm. This is during close out of the seven tanks and tank farm grouting. And, the artist’s rendering of the integrated waste treatment unit. To the left, which is the south, the short part of the building is the off-gas part of the building. The center taller portion houses the treatment cells, three foot engineered concrete cord walls, lots of shielding, lots of rebar. And, then, just to the north of that, or to your right, is the mechanical building, which includes the control room, some HVAC, UPS power supplies, and all the utilities, which are fed into the building. And, then, all the way to the right, the building is the product storage building. That’s where we will have interim storage for this waste once we’ve finished this campaign.

The project is currently approximately 70 percent complete on construction. This picture was taken I believe, let’s see, we’ve got wires coming across, so this was taken within the last three weeks. URS Construction is working hard to get this closed out so that we can start turning systems over, which we have, and that’s what I’m here for, is the commissioning and testing portion of this, so that we can get all these systems tested, if they work properly, and then we will go into the run.

The current schedule is to have the majority of construction complete by September of this year, and then we will continue testing and turnover through readiness reviews, and we believe we'll hit CD-4 and project turnover about the August 11 timeframe, leaves us about 15 months, 16 months to complete the campaign.

The technology that we're going to use is steam reforming. We'll have a fluidized bed. It's going to destroy all the nitric acid in this cleanup solution, destroy the nitrates and organic materials, and produce a dry solid mineral product, and then the gases out the stack will be mostly waster vapor, carbon dioxide and nitrogen gas.

Waste flow, we talked about the tank farm, we've got those three tanks in there, they've got steam jets which are able to transfer the waste over to the new waste calcining facility, which is the last calcining facility that Ron was speaking of.

In the basement, there are two blend and hold tanks. The project will install two pumps over there so we can recycle and then take the waste and pump it in an underground double contained line to the integrated waste treatment unit, and to the waste feed tank there.

For the process overview, I'll go over this really fast because there's another slide that shows all this. But, basically bring it into the waste feed tank. The waste feed tank has a 30 gallon per minute waste feed pump attached to it, which recycles water. And, then, we'll take a slip-stream of two and a half to three gallons a minute into the first fluidized bed reformer, which is the DMR, or denitrating mineralization reformer. Reduction reformer, the solids come out of the bottom of that, go through an auger grinder, so there's no chunks, and then they are nitrogen pulsed to a product receiver cooler, and from the product receiver cooler, fill canisters, and I'll talk some more about the canisters a little later.

The gases and vapors from the DMR, exit the top of the DMR through a process gas filter, metal filter. Any solids from carry-over are collected, and then there's a nitrogen pulse that drops that material to the bottom, and then it can also be taken over to the product receiver cooler and put into canisters. The gases that get through the filter go to the second reformer, carbon reduction reformer, another fluidized bed steam reformer. From there, an off-gas cooler because the carbon reduction reformer operates at about 950 C, and then through an off-gas filter, and then when it leaves the off-gas filter, goes through blowers, HEPA filter, granular activated carbon beds, and to a mixing box, and then out the stack.

Here's the process flow. As I said, the waste feed tank is about a 1,500 gallon tank. It's for batch feeding. So, we will take waste from the tank farm, mix it and blend it the way we want in the NWCF, and batch feed to the waste feed tank. The pump recirculates 30 gallons per minute, a slip stream is applied in through nozzles into the DMR, or denitrating mineralization reformer.

The product off the bottom goes to the receiver cooler and down to the canister fill station, and the gases go through the processed gas filter into the carbon reduction reformer, through off-gas cooler, off gas filter, and then out through the HEPA filters and gas beds.

We use steam and nitrogen as fluidizing gases in these beds. The first bed contains coal for the process, and the second one is a carbon material.

The canisters that we will load out of here are two feet in diameter approximately and ten feet tall. Similar in construction to RLCs, or removable lid containers that DOE-Idaho is currently using to transport RH-Tru off-site to WIPP. And, we are expecting somewhere between 650 and 700 of these canisters. They will be placed into concrete vaults. The vaults are four by four array, and will hold 16 of these canisters. And, then, the vaults will be stored in that product storage building that I talked about earlier for interim storage.

This is the interim storage facility, the product storage building. These vaults when they're loaded weigh in excess of 300,000 pounds, and they will be transported on air pallets and a tugger assembly. The concrete that's poured there is super flat. It was laser leveled, it's flat within an eighth of an inch in 20 feet. And, that's where these things will be stored until such time as final disposition is determined.

Speaking of final disposition, as we discussed earlier, sodium bearing waste was determined to be not high-level waste in Idaho. It was other than or incidental to waste processing, and, so, our path forward was to ship these to WIPP in these removable canisters, in a 72-B container. But, for us to go to WIPP now, they will have to change the record permit, and there are talks there if that's the way we go or not. Of course, if it is determined at some later date that this is high-level waste, then we'll be dependent upon the BRC to determine where we're going to send this, and what we'll do with it.

And, that's all, Mr. Chairman.

GARRICK: Thank you. Thank you very much. Bill?

MURPHY: This is Bill Murphy of the Board.

Do you know what the mineralogical composition of your product is at the end?

HILL: I will have to say also that that's a Thore Technologies treatment activity. It is, but I'm not sure how much I can say other than the beds are carbon and coal, and there will be an alumina of some type used as a bed material. But, it is proprietary.

MURPHY: Thank you.

GARRICK: Howard?

ARNOLD: Arnold, Board.

If this stuff is determined to be high-level waste, then you've got to go through a process similar to the glass or the HIP result, or whatever. I mean, you've got to characterize it as how it will behave in a repository.

HILL: That is correct. So, if we are not able to process this and send it to WIPP, or a similar place, then it may have to undergo further treatment in order to meet--

ARNOLD: You'd have to then put it through the HIP process, or something.

HILL: That is a possibility, yes, sir.

GARRICK: And, furthermore, if it turns out that this is high-level waste, then all the to-do about volume reduction of the high-level waste is kind of a moot point.

HILL: This is actually about a five times reduction from the liquid to the solid.

GARRICK: Yes, but it's still relatively low activity.

HILL: Relatively low activity.

GARRICK: So, all I'm saying is that I don't see volume reduction as a significant parameter.

HILL: It's purely content.

GARRICK: Purely content, specific activity, and the quality of the material.

HILL: Yeah, leachability.

GARRICK: Yeah. Any other questions? Yes, Bruce?

KIRSTEIN: Kirstein, Staff.

What is the status of the equipment design or process design of the figure on Page 7?

HILL: Actually, the project is about 70 percent complete. The design is complete on the major processes, and the facility, all these tanks, these six large vessels are already constructed and in the facility and we are working on connecting that pipe right now.

KIRSTEIN: Okay. And, one last question. Is there an additive thrown in with the waste form clear up in the upper left-hand tank, such as a clay, or what do you add in there?

HILL: That was the proprietary information I was speaking of earlier, but it is an alumina based.

GARRICK: Any other questions?

(No response.)

GARRICK: Any questions from the audience?

(No response.)

GARRICK: Very good. All right, thank you. Thank you very much. Okay, John?

MC KENZIE: Good morning. I’m John McKenzie. I’m the Directory of Regulatory Affairs for the Navy’s Nuclear Propulsion Program.

Dr. DiBella reminded me, in preparing for the talk this morning, that it’s been six years since we’ve given a public presentation to the Board. So, I’ve included a little bit of background on who we are and what we do.

We are unique in that we’re a joint organization of the Navy and the Department of Energy. Our mission is deceptively simple. It’s to take nuclear power, provide the Navy the capability to use it to safely and reliably power its war ships.

In order to provide the Navy that capability, there is a whole breadth of activities that we are involved in, many of which we needed to create when we were stood up in August 1948. Nautilus went to sea in January 1955. It’s less than seven years to invent or develop materials, create operator training programs, design and construct and test the prototype here in Idaho and design and construct and test the Nautilus.

After Admiral Rickover, who was then Captain Rickover in 1948, retired after 34 years of service, the President saw to sustain the processes and procedures that had served us and the country so well by an Executive Order.

Congress subsequently codified those authorities and responsibilities, and those are set forth in the footnote.

The director of the program is Admiral Donald. He’s the fifth director of the program, and under the Executive Order, the director is jointly nominated by the Secretary of Energy and the Secretary of the Navy, and serves an eight year term.

This chart shows the breadth of our activities in a different manner, and I’ll talk for a few minutes about those related to spent fuel. First, the nuclear powered fleet, that’s really the focus of our day to day activities. 82 nuclear powered warships. That’s 54 attack submarines, 14 ballistic missile submarines, four guided missile submarines, ten aircraft carriers, that makes up over 45 percent of the major combatants of the United States Navy.

In addition to the reactors on those ships, we operate four training reactors, two in South Carolina and two in New York State as part of the training program that we develop in order to take sailors and junior officers, after we give them the theory, provide the opportunity to take theory and apply it in practice before they get assigned to their first warship. There are six shipyards that construct or service nuclear powered warships. Four of those shipyards do reactor servicing. Those four shipyards are the Portsmouth Naval Shipyard in Kittery, Maine; Norfolk Naval

Shipyard in Norfolk, Virginia; Norfolk Newport News and Newport News, Virginia; and Puget Sound Naval Shipyard and Intermediate Maintenance Facility in Bremerton, Washington.

The fuel removed from the reactors by those shipyards is all shipped by rail to the Naval Reactors facility here in Idaho. At the Naval Reactors Facility, all of that fuel is examined to compare the performance that did occur during operation in the warship, to the predicted performance when that fuel was designed and installed, and in that way, improve our modeling and design capabilities.

The design space for Naval reactors is unique. The fuel that we develop needs to fit in a warship, and operate safely and reliably in a wartime environment. The picture is a shot that occurred during the shock test of the USS Theodore Roosevelt. The reactor was operating during the shock test. There was a crew on the ship, and the design requirement is that there be no interruption of power. The Roosevelt passed that design.

We do similar shock tests with submarines, but those pictures aren’t quite nearly as interesting because you don’t get to see a ship.

The consequence of this design space is I end up with a fuel which is compact, rugged and extremely effective in retaining fission products from escaping from the fuel. A measure of the effectiveness of the design is the fact that sailors assigned to nuclear powered warships receive less radiation exposure than the average American citizen, including us here in the conference room.

As I mentioned, all fuel removed from nuclear powered warships is shipped by rail to Idaho. The picture on the upper left is our current shipping container. It's designated as the M140. The walls of the container are 14 inch thick solid stainless steel. The container weighs over 350,000 pounds, it's certified to meet NRC requirements for transportation. Since the late 1950's, we have shipped over 800 containers from the shipyards around the country here to Idaho. Currently, we're shipping about eight containers in a normal year.

The picture on the lower right is of the expended Core Facility in the Naval Reactors Facility. That's the area where we unload the fuel from the container, and place it into a water pool. As I mentioned, all fuel is examined to compare its performance to predictions. That technical feedback has allowed us to extend the life of naval spent fuel. The fuel in the Nautilus lasted about two years. The fuel in today's submarine, today's attack submarines, will last the life of the ship, about 33 years. That extended fuel life allows us to minimize the time the ship needs to be in a shipyard providing a more effective platform for the Navy, and also serves to minimize the amount of spent fuel that we generate.

Speaking of the amount of spent fuel, there are various ways to measure inventory. The next two slides provide two measures, the metrics of the size of the Naval inventory as it's compared to the overall national inventory of spent fuel.

First is the statutory measure, metric tons of heavy metal. Work and numbers here come from the work that we did for the repository license. The statutory limit for the repository was 70,000 metric tons. 90 percent of that was set aside for commercial fuel. 10 percent was set aside for defense fuel and high-level waste. Naval fuel was set aside was 65 metric tons. That's less than one-tenth of a percent of the inventory originally targeted for the Yucca Mountain repository.

An alternate measure is the number of canisters that you'd end up putting in the repository once it was opened. Because we use highly enriched fuel, the typical Naval canister has fewer metric tons of heavy metal than a canister of commercial spent fuel. We had project for the purposes of modeling in the license application that there would be 400 canisters of Naval fuel. That still represents a small fraction of the overall inventory that was planned for the repository.

The current inventory of Naval spent fuel in Idaho is about 25 metric tons, and we're in the process of moving that into dry storage consistent with our commitments in the Idaho Settlement Agreement. These two pictures taken from the License Application illustrate some of the hardware for that packaging. On the left is a basket. Fuel is loaded into the baskets, and then the baskets are loaded into stainless steel canisters. The canisters are seal welded and evacuated, and the design of the system is intended to allow it to be in emplaced into the repository without any further direct handling of the fuel.

The picture here on the left is the area of the expended core facility where we do the packaging of the canisters. Once a canister is loaded, seal welded, vacuum dried and then backfilled with helium, it is lifted into an overpack. The picture on the upper left shows us moving an overpack with air pallets. The prior presentation talked about moving very heavy things with air pallets. It in fact can be done and it's very interesting to watch. The overpacks unloaded weigh 175 tons. The picture on the lower right is a photograph of our overpack storage facility. We currently have 32 loaded overpacks in storage.

Our obligations include shipping the fuel from Idaho, and we've made good progress in creating an infrastructure to execute those shipments. The photograph on the left here is our newest shipping container, is the M290 shipping container. It's 30 feet tall. It weighs 260 tons. And, like our other shipping containers, we will be taking that to the NRC to receive a certificate of compliance from the NRC. We took delivery of the first article of that earlier this year.

The picture on the right is the rail car which moves that canister. It is the first rail car designed to the American Association of Railroad's new specification for spent fuel rolling stock. That rail car has been taken to the test facility in Pueblo, Colorado. The testing has been completed on it, and we'll be taking that design to AAR for certification for general interchange service in August.

It turns out that in addition to using this container for shipment of the loaded spent fuel canisters, it will serve as well for moving aircraft carrier fuel from aircraft carrier servicing at Newport News here to Idaho. Currently, the aircraft carrier fuel is too long to fit into the M140. This will allow us to put the aircraft carrier fuel into the shipping container without any intermediate disassembly, and relieve us of a choke point which currently exists in our servicing activities at Newport News.

Looking forward, we have a couple of construction projects in progress or on the drawing board for storage of spent fuel. The expended core facility that I made reference to is on the left. The overpack storage building is the blue building toward the right. Immediately above that are two expansions. The first expansion will become operational later this year. That will expand our ability to store overpacks from 54 to about 122 overpacks. Again, that will be available for service later this year.

We have in detailed design a second expansion of overpack storage, as well as a cask shipping and receiving facility. The cask shipping and receiving facility is specifically designed to support loading and unloading of the M290 casks. Both of those are expected to be available for use in 2015.

Prior speakers well covered the Idaho Agreement, and I guess I'll not spend too much time elaborating on that. I'd like to follow up on Dr. Arnold's question on the $60,000 a day penalty. It's important to keep your commitments, and certainly good will and sustained trust is a reason for keeping your commitments. And, it's our intention to do that.

But, for us, beyond the $60,000 a day question, is the obligation to suspend further spent fuel shipments to Idaho in the event we fail to meet one of those commitments. If we were to suspend those shipments, that impacts the Navy's ability to service nuclear powered warships, and it quickly becomes a problem in supporting fleet operations. We experienced that in the Nineties during the litigation of the lawsuit from Idaho. So, we're keenly focused on ensuring that we meet commitments, and we're also directly engaged with the Blue Ribbon Commission as they go through their work and deliberations to ensure that as they plot out a path forward, that path forward includes a credible path for defense wastes, including spent nuclear fuel, so that our ability to meet those commitments is unaffected.

That ends my prepared remarks, Mr. Chairman. I'm ready to take questions.

GARRICK: Okay. Questions from the Board? Yes, Howard?

ARNOLD: Arnold, Board.

I just wanted to respond by saying you could end up being stuck like commercial reactors where they have to keep it on site, and I don't see how you'd do that.

MC KENZIE: That is a possible outcome.

ARNOLD: I can understand why you don't want to.

MC KENZIE: Storage at shipyards would be problematic. During the 1990's, as part of the litigation, we did temporary storage at the shipyards in shipping containers. Eventually, you run out of shipping containers, and at that time, we approached Idaho and Idaho was willing to give us some relief to do limited numbers of shipments in order to continue to support the national defense. Because of space constraints in a shipyard environment, it would be very difficult for us to create interim, as is discussed today, spent fuel storage at the shipyards.

The Secretary of Energy was asked in March during Congressional testimony if he could guarantee that the commitments made in the Idaho Agreement, including the Navy commitments, would be supported, and his short answer to that was yes. So, we're depending on the Blue Ribbon Commission and the Secretary and his actions to keep us out of that situation.

GARRICK: Any other questions? Yes, Bill?

MURPHY: This is Bill Murphy of the Board.

For the license application for Yucca Mountain, were there data presented on the stability of the waste forms in a Yucca Mountain type environment?

MC KENZIE: Yes, sir. Not all that in the unclassified portion of the license application. It was a classified supplement that went along with it.

MURPHY: Can you say anything about that in a general audience?

MC KENZIE: I guess I can say that we concluded that Naval spent fuel as a waste form was well suited for geologic disposal.

GARRICK: That's probably right. Any other questions? Questions from the staff?

(No response.)

GARRICK: I think the combination--oh, yes, yes.

DJOKIC: But, what about an aircraft carrier?

MC KENZIE: Our fuel design is not quite developed to the point where we can deliver a life of the aircraft carrier design. An aircraft carrier design life is on the order of 50 years, and we’re not quite there yet. We still plan in our aircraft carrier designs for a mid life of fueling. That includes the fourth class, the newest aircraft carrier class, which is currently under construction at Newport News.

GARRICK: We need to say it--and repeat the question so we have it on the record.

DJOKIC: I see, I’m sorry. I wasn’t sure how--my name is Denia Djokic from U.C. Berkeley, and my question was what was the life of the core in the aircraft carrier?

GARRICK: Okay, thank you. Thank you.

Any other questions?

(No response.)

GARRICK: The combination of your thorough presentation and hunger pangs for lunch have allowed us to be right on time, and we thank you very much for your presentation.

MC KENZIE: Thank you, sir.

GARRICK: We will now adjourn for lunch.

(Whereupon, the lunch recess was taken.)

AFTERNOON SESSION

GARRICK: Good afternoon. I hope everyone had a good lunch. We at the Board ended up at a very distinguished restaurant named Denny's. But, it was okay. They were very nice to us.

All right, it's time to move on, and the first talk this afternoon is going to be on DOE-NE's Used Nuclear Fuel Disposition Program, and we're pleased to have Pat Schwab here to tell us all about it.

SCHWAB: Good afternoon. Thank you for inviting me to speak to you today. My name is Patrick Schwab. I'm the Acting Director of the new Office of Used Fuel Disposition, R and D. We just are in the process of standing up this new office. Next slide?

I'm going to start at the level of the Office of Nuclear Energy, and then drill down through the organization into the Office of Used Nuclear Fuel Disposition. I'd like to start with this quote from Dr. Miller, because it expresses his optimism for the growth of nuclear energy in the United States. However, this optimism should be tempered because the nation does not yet have a complete fuel cycle. We don't have an open fuel cycle, and we don't have a closed fuel cycle. I think that's the problem that's facing us here today.

I'm going to discuss the Office of Nuclear Energy's work on the back end of the fuel cycle, and I will start with the mission statement for the Office of Nuclear Energy, and I want to, in particular, focus on the last phrase, “research, development and demonstrations.”

Our office is distinct from some of the other offices in the Department of Energy because we do not have any design, build and operations of large scale, industrial scale, facilities. This is distinct from some of the other offices, like the Office of Environmental Management. You heard from them this morning. And, we heard about their large industrial scale facilities, like the sodium bearing waste treatment facility.

We heard from the Office of Naval Reactors this morning, and they have industrial scale facilities that they operate. The Office of Nuclear Energy is basically a research and development organization. This is reflected in our budget. Our total budget is just under $1 billion. Compare that to the office of Environmental Management budget, which is six times larger. The reason is that they design, build and operate industrial scale facilities. And, their budget is about $6 billion.

Our budget request for FY ’11 is a little over 900 million. And, as you can see, most of that is in research and development, and the rest of it is in infrastructure, mostly here at the Idaho National Laboratory.

The Office of Nuclear Energy has four stated objectives. These are the objectives that Dr. Miller has approved. I'm not going to spend any time, except on the third one. This is where this Board's interest lies. Develop sustainable nuclear fuel cycles. And, we have just been through an Office of Nuclear Energy reorganization, and we reorganized our organization along the lines of our mission needs, of course. So, we have an office that's devoted to this specific objective. It's the Office of Fuel Cycle Technologies.

One of the main activities, one of the most important activities of this Office of Fuel Cycle Technologies is to report to the Blue Ribbon Commission. Their interim report is due a little over a year from now. And, one thing you might not know about this Commission is that they are really very, very independent. Vince Gocroft (phonetic) and Lee Hamilton are not people who are going to let DOE Headquarters set their agenda. They are setting their own agenda and we are supporting them.

In fact, on July 7th, one of the subcommittees, the subcommittee on disposal, is having a meeting in Washington, and I have not been invited. I haven't even seen the agenda. That's how independent they are from the DOE Headquarters.

There are two other subcommittees that they have formed. One is the subcommittee on fuel cycles and reactors, and that subcommittee is going to have a meeting here in Idaho Falls July 12th. And, I understand that Pete Miller has been invited to speak at that meeting, and he is planning to come here and speak July 12th here in Idaho Falls.

Remember, I’m discussing the objective of sustainable nuclear fuel cycles and the office devoted to that is the Fuel Cycle Technologies Office. And, this Fuel Cycles R&D Office has these technical areas, but once again, I’m going to drill down through this very quickly and just focus on the last one because I think that’s where the interest of this Board lies.

I am the Acting Director of this office, and we recently reorganized and our organization reflects the missions, and this is one of the missions, and we have this Office of Used Nuclear Fuel Disposition R&D, and here’s our mission statement.

I want to point out that the Office of Used Fuel Disposition does more than used fuel. We also have, it says used nuclear fuel and waste generated by existing and future nuclear fuel cycles. That means high-level waste, and anything else that may come out of the advanced reprocessing system.

We tried to call it the Office of Used Nuclear Fuel and High-Level Waste Storage, Transportation and Disposal, Research and Development, but the name was too long, and that's why we shortened it to Used Fuel Disposition R&D. And, just like I did before, I'm going to focus on this phrase, "Scientific research and technology development." The office is not engaged in any design, construction or operation of storage facilities or disposal facilities or handling facilities for transportation. Our mission is to conduct scientific research and technology development.

In about three months, the Office of Civilian Radioactive Waste Management will cease to exist, unless the courts decide otherwise. And, at that time, it's probable that the missions from the Office of Civilian Radioactive Waste Management, RW, the missions of storage and disposal might be transferred to this office. If that happens, we will need a new mission statement.

Now, let's take a look at the budget for this office. It goes from 9 million in FY '10 up to 45 million in a budget request in FY '11. It looks like a huge increase. However, remember, that the Office of Civilian Radioactive Waste Management has a budget of about 200 million in FY '10, and a budget request equal to zero in FY '11. So, two point are clear. One is that the total DOE expenditures on the back end of the fuel cycle, the total expenditure is going down, not up.

GARRICK: One point is clear. You're not building anything.

SCHWAB: That's true. We are just starting, in FY '11, we're really starting to take up the slack from the decision to terminate Yucca Mountain. That's what this $45 million is for.

Now, the House Energy and Water Development Subcommittee asked the DOE a question for the record about the breakdown of this $45 million budget request, and this is our answer on the record. Transferring science programs from RW to NE is 12 million. We've got this line is, in particular, of interest to this Board. The RW science program close-out costs. That includes records retention. I understand this Board is very interested in making sure that the DOE retains records from the Yucca Mountain work, and that's what this budget line is for. And, I wish it was coming out of somebody else's budget instead of mine, but Dr. Miller has made it very clear that we are going to retain those records, and if we have to pay for them, we will.

Other transfers of RW functions, as RW is dissolved on October 1st of this year. Technical work will be transferred from RW to NE. The standard contracts, these are the contracts between the utilities and the Department of Energy for picking up their spent fuel from the reactors and taking title to that spent fuel. These will be transferred from RW to the Office of General Counsel.

The fee adequacy report, as required by law, is a report that goes to Congress every year, is required to come from the Department of Energy, that responsibility will be transferred to the office of General Counsel. And, of course, litigation support, who knows how long the litigation will go on, that will not come to the Office of Nuclear Energy. That will go, of course, to the Office of General Counsel.

The records retention that I mentioned before from RW probably is going to go to the Office of Legacy Management, LM, and the funding will come from Office of Nuclear Energy to the Office of Legacy Management because they don't have their own funding.

Collaboration. We're standing up a new office. I'm collaborating with anybody. When you're standing up a new program, you've got to understand the requirements before you start out and decide what you're going to spend your research dollars on. So, part of my job is to listen, and I'm certainly going to be listening to this Board, but I've been fortunate that the Electric Power Research Institute initiated a program on collaboration. So, I'd like to publicly commend EPRI for this effort. They have brought together representatives from EPRI, of course me and DOE-EM, NRC, cask vendors, utilities, NEI, National Laboratories. EPRI called them all together into one committee, and I'm very pleased that they did so, because then I don't have to do it. And, we sit and talk about what they would like us to spend our research dollars on.

We're also interested in what the foreign countries are doing. But, collaboration is a very big part of standing up this new program. In fact, when I start talking about next year, what we're planning to do in FY '11, the first two bullets on this page are a direct result of that collaboration effort from EPRI. The storage of LWR fuel to 100 years or more. Now, the NRC has licensed two ISFSIs out to 60 years now, and they're starting to think about another 40 year extension. So, that would take it out to 100 years. But, the utilities and the cask vendors cannot at this time say with absolute certainty that their systems can be licensed by the NRC for that extra 40 years. So, that's a high priority item for my new office's research.

It looks like long-term storage is likely to be the reality for a long time, and we need to take a look at the corrosion processes that might go on inside these dry cask facilities.

Also, the utilities continue to push their burn-ups higher and higher, and there's some limitations on the NRC licenses on burn-ups. So, that's another item, high-priority research from this Office of Used Fuel Disposition.

And, we're always, the national labs and private companies are always developing new fuel cycles, new types of reactors, new waste forms, and the task of this new office will be to take a look at those and see what will be the storage requirements for those new reactors and new fuel forms.

We're not going to sit and wait until after the fuel has been generated before we start to think about how to store it. That's not going to happen anymore.

We'll be evaluating concepts for distributed, regional and centralized storage. In some cases, it might make more sense to do a vault type storage instead of dry cask storage. We are not doing any site specific evaluations of any kind.

Transportation. We have not started any activities on that in FY '10, just because we didn't have enough funds in FY '10, but we will definitely start it up in FY '11. Storage and transportation go hand in hand. They're going to be linked inside our new organization, because it doesn't do any good to store something for 100 years if at the end of that period, you cannot transport it. It may not leak out of your storage facility at the end of 100 years, but it still has to meet the transportation regulations. The fuel still has to be intact and robust enough that it can meet the transportation regulations. So, storage and transportation go together.

And, disposal. A complete fuel cycle will require geologic disposal, period. We will continue to see new fuel cycles and new reactors developed on paper. And, many of these have the potential to reduce the heat load or volume of the high-level waste maybe as much as 50 percent. But, they will not ever reduce these parameters down to zero. So, therefore, geologic disposal will always be required, no matter what reactor you're running and no matter what fuel cycle you're running.

And, the new office is establishing the technical bases for a variety of potential disposal environments, including granite, clay, shale, salt, deep boreholes, and none of these investigations will be site specific, not at this time.

And, I want to mention again on the collaboration, we're having a working group meeting the end of next month, and I've invited this group, and Carl DiBella has already sent me an e-mail and said he's going to send somebody from the staff. So, we are listening. We're interested in what requirements you think you want to submit to us. We want to make sure that our research program gets going in the right direction.

And, I'd like to close with one more thought. Yucca Mountain may or may not be an option anymore, based on the decision from ASLB this morning. But, we in the Office of Nuclear Energy are starting up some new programs, and as

Yogi Berra said, “It ain’t over ‘til it’s over.”

I don’t know if Yucca Mountain will be reborn. I don’t know if the Office of Nuclear Energy will be tasked to create a second repository, or what will happen. But, I do know, “It ain’t over ‘til it’s over.”

Thank you.

GARRICK: Thank you. Questions from the Board? Yes, Mark?

ABKOWITZ: Abkowitz, Board.

Pat, I enjoyed your presentation. You certainly have a very ambitious program laid out, and it looks like you’re focusing on a lot of things.

I guess my question is with the budget details that you’ve laid out, and the number of activities that you’re initiating, I guess I’m trying to get a better understanding for just how much progress you can make given the fact that you have scarce resources to sprinkle over so many different things. Can you comment on how you intend to manage that program? Are you going to be using primarily in-house people, or contractors, or how does the rubber meet the road?

SCHWAB: The Office of Used Fuel Disposition has one campaign, and we call them campaigns in this office, so I’m the Acting Office Director and I’m also the Federal Campaign Manager, so I direct the contractors at the national labs through the campaign. Maybe you know Mark Peters and Peter

Swift?

ABKOWITZ: Sure.

SCHWAB: Mark Peters is the contractor lead in that campaign. He's called the National Technical Director.

Now, as far as the federal employees are concerned, we recently advertised and offered positions to over 20 federal employees from RW. And, over 20 employees have accepted those offers. So, the Office of Nuclear Energy is going to open up an office in Las Vegas, populated with roughly 20 people from the Office of Civilian Radioactive Waste Management. And, so, we're going to have enough feds. In fact, one of those feds is going to be the new Acting Director of this office. And, I'm not going to continue as the Acting Director. I'm going to be Senior Advisor in the Office of Used Fuel Disposition.

Does that answer your question?

ABKOWITZ: Thank you.

SCHWAB: Thank you.

GARRICK: Howard?

ARNOLD: Arnold, Board.

I know you said you aren't being site specific, and I understand why. But, you showed a truck heading off somewhere with a canister on it. There has to be some kind of general planning for dealing with stuff at the end of the storage period. There has to be some facilities somewhere to put it into final disposal capsules, and so on and so forth. Are you going to do generic thinking about things like that?

SCHWAB: Yes, sir. We're going to be doing a lot of generic type research about a site. Our research is not going to get out in front of the recommendations from the Blue Ribbon Commission.

ARNOLD: Yeah. The other point I guess I'd want to make is that we are committed to long-term storage, period. So, no matter what you find in your R&D program, it's going to happen. So, we have to have contingency plans for things that we worry about. I mean, you aren't going to be able to say 20 years from now, long-term storage is a non-starter, we can't go on, because it's a given. So, the question will be we must have contingency plans for dealing with results, you know, things that may or may not go according to plan.

SCHWAB: Yes, sir, I agree. If the current storage ISFSIs, or vaults, or wherever, if those turn out to be impossible to relicense again when they get near the end of their 60 year life and we, the NRC, turns down the license application for an extra 40 years, then we need to understand why the license was rejected, and then take action from there.

ARNOLD: Yes, you need to be able to deal with it at that point.

SCHWAB: Yes, sir. But, we first have to understand why the license is rejected.

MURPHY: This is Bill Murphy of the Board.

On Page 20 of your presentation, you suggest that you will evaluate the technical bases for granite, clay, shale, salt and deep boreholes. Is there a technical basis for this list, or is there some other basis for this list, or how extensive might that list be?

SCHWAB: It can be expanded. I said including granite, clay, shale, salt and deep boreholes. It could include more.

MURPHY: Was there a technical basis for this list at this point?

SCHWAB: No, sir.

GARRICK: Henry?

PETROSKI: Petroski, Board.

On your Slide 12, you talk about conducting scientific research and technology development. As I understand research and development, as it was originated, in history and government a century or so ago, is you end up with a product. That's what you're developing. And, that necessarily involves at least consideration of design. You repeatedly in your presentation denied any affiliation with a design effort. What does technology development mean in this context that you've circled?

SCHWAB: We can develop certain technologies without a specific--without going to a specific design.

PETROSKI: Could you give an example, please?

SCHWAB: When I say a specific design, I mean a specific cask that is ready to be marketed, or a site specific disposal site. We can do lots of development of stainless steel canisters and study their corrosion in various environments.

PETROSKI: Can you do that without having a specific design in mind?

SCHWAB: It would be a lot better if we had a specific design. If we had a mission to go and do a real project, then we could do more specific development. That is absolutely true. But, our research and development is, at this point in time, we have to be generic because we cannot get out in front of the Blue Ribbon Commission.

GARRICK: Just to make the afternoon a little more interesting, isn’t that a bit of a cop out? I mean, can’t you consider different scenarios and provide the Blue Ribbon Commission--you might discover in this kind of analysis that you found some information that’s critically important to establishing policy, which is the primary thing that the Blue Ribbon Commission will do. It just seems to me that the impression that’s being given is that we’re going to go to sleep until we hear from the Blue Ribbon Commission.

SCHWAB: Well, that’s not what I meant to convey, sir. We’re considering options, but not specific designs.

GARRICK: Now, for example, let me give you a specific example. I'd like to know what serious analysis is going on to ferret out what we learned from the Yucca Mountain project. I mean serious analysis. You spent $13 billion and a lot of it was very good work, a lot of good science. It's the most active program in the last two decades with respect to waste management, and yet we hear absolutely nothing about anything being done to that information base. And, that did contain some very useful R&D--I'm not picking on you, Patrick, but I know you can handle it.

SCHWAB: Can I take your question back and get you an answer? I don't know the answer right now.

GARRICK: But, it just seems to me that there's a gold mine there somehow, and yet I just don't see much being done. I know people are saying that it's in a different geologic medium and the ball game changes completely. But, some of the challenges don't change. Some of the challenges of how to build engineered barriers, some of the challenges of how to calculate and determine the source term, there's some real basic fundamental issues, and one of the things that this Board has never been happy with, even with Yucca Mountain, was the source term analysis. The corrosion model, yes, it was some very good work done there, but that's only half of the game.

The other half of the game is that once you penetrate the package, just exactly what kind of mineralization processes are going to take place? What kind of degradation models adequately represent what's going on? What kind of physical chemistry takes place? Very little to nothing was done in that arena.

So, you know from Yucca Mountain a lot of where the holes are in taking on a giant project like a deep repository. And I just think that sometimes, the reason we get bad policy is because we, the scientists and engineers, don't do a very good job of providing the policy makers with good technical information. It seems to me there's great opportunity now to do that, not after we've heard from the BRC, but while the BRC is deliberating.

SCHWAB: Yes, sir, I agree with you.

GARRICK: Okay.

SCHWAB: Can I give one example?

GARRICK: Yeah, I superseded by colleague here. I want Ali to ask a question. But, give the example, and then we'll go to Ali.

SCHWAB: Modeling the geology, especially the heat transfer through rocks, we have a great model for Yucca Mountain, and we're going to use that to build a more generic model that should be able to handle a variety of different geologies. And, we should be able to predict how the rocks will react to an injection of heat better with these new models.

And, let me make one more point, if I may. The best way to transfer that kind of information from the Yucca Mountain program to future programs is by retaining the people. I mentioned Mark Peters and Peter Swift. We're retaining them. We're hiring 20 people from RW Las Vegas office. We're going to try to maintain continuity that way. I personally didn't work in RW myself, so I'm not one of them bringing that much experience, but we are bringing the right people to work on this new office.

GARRICK: Great. Ali?

MOSLEH: So, actually, my question very much relates to what you just said. The line item that you have in your FY '11 budget regarding transfer of science programs from RW, is that mostly bringing people but not specific activity? What are the types of research or programs that--

SCHWAB: I would like to say that we're still working on that. Okay? We have idea. In fact, there's a meeting going on today at Argonne with Mark Peters and Peter Swift, and they're today making recommendations on how to spend these dollars on disposal. And, they'll make those recommendations to me, and I'll probably approve them because they know more about this than I do. But, this is the breakdown that is on the record today, because this is what we have given to the House Energy and Water Development Subcommittee. I don't have anymore detailed breakdown at this time.

MOSLEH: But, the same generally applies to the research to be--

SCHWAB: That’s correct. That’s correct. We haven’t got down to that level of detail for FY ’11 funding yet. It’s still a long ways to the start of FY ’11 in the budget process.

GARRICK: Mark?

ABKOWITZ: Abkowitz, Board.

If we could go to Slide 10, please? I wanted to pick up on John Garrick’s comment about lessons learned from Yucca Mountain. And, one of the things the Board kept trying to get DOE’s attention was with respect to the concept of system integration, both integration between science and engineering, between preclosure and postclosure, and there’s several other examples as well. And, I’m curious as to the extent to which that background is influencing the way in which these six different enterprises are intending to work and interact with one another, because it’s very difficult for me to understand how a Used Nuclear Fuel Disposition Program can function without being very integrally involved with separations and waste forms, advanced fuels, and some of these other programs. You can’t work on one without understanding how it influences the other, and I’d like you to comment on that, please.

SCHWAB: We are integrated. This is the second level of drilling down. Let me back up.

ABKOWITZ: For example, do you have an executive committee, or some type of regular routine function which the program directors from each of these six programs are engaged in with one another on a routine basis?

SCHWAB: Maybe I should go to my one backup slide. This is our new organization, new org chart developed by Pete Miller. He’s up at the top. And, then, there are five offices under Pete Miller. This is the Office of Fuel Cycle Technologies, Buzz Savage. And, here’s the Office of Used Fuel Disposition, and there’s two offices here, Office of Systems Engineering and Integration, Office of Fuel Cycle Research and Development. So, they come together here at Buzz Savage’s level.

ABKOWITZ: Abkowitz, Board.

I appreciate that. But, we saw org charts from the Yucca Mountain project that were equally as impressive.

SCHWAB: I talk to the guys in these offices all the time.

GARRICK: Okay. Yes, Doug Rigby, you have a question?

RIGBY: Doug Rigby, Staff.

This is related to a number of the comments that have been made. It seems to me, you know, my time looking at things, that the front end drives a lot of this. The interest is in types of fuels, types of reactors, a lot of these kinds of things. What do you think of the idea of the back end maybe starting to drive things? In other words, you're looking at geologies, certain waste forms that might dovetail well with geology, since final disposal probably we're worried about tens of thousands, millions of years, so if there's particular geologies and waste forms that are more ideal for such a long time, then you can start looking backwards. Okay, is it--would it be ideal to age some of the fuel for a while, and then for these particular ideal waste forms, maybe there's particular new fuels, certain kind of reactors, everything else can almost then fit best what the end result is. You know, the back end sort of driving some of the earlier decisions. What do you think of that kind of an idea? Is that ever discussed?

SCHWAB: Yes, looking back of the past 40 years, with twenty-twenty hindsight, I think it's fair to say that we should have paid more attention to the waste disposal issue a long time ago. And, I think that message has been received by a lot of people in the industry, and certainly in Washington, we have, now that the Secretary has decided to terminate Yucca Mountain.

There has, in the past, been this attitude that well, we're going to--we'll build a fuel and we'll run the reactors and then hand the waste off to somebody else.

That’s not going to happen anymore.

GARRICK: Yes, Howard, go ahead. And, then, Carl DiBella.

ARNOLD: This is sort of a rhetorical repeat of what I wanted to say earlier. We don’t look at long-term storage as an R&D opportunity to see whether it’s a good idea. It is now committed. It is the world we are in. So, the R&D ought to be addressed at what do we do with the stuff after it’s been long-term stored. That’s my point. Not a question. I’m sorry.

SCHWAB: Thank you.

GARRICK: Carl?

DI BELLA: Well, I’m not sure if this is going to come out as a question or a comment. Could you put up Slide 14 again? This is sort of a followup on that top line, the science programs, a followup on the question of Dr. Mosleh. I’m not familiar with all the science programs in RW. I tend to work in the materials science area and I’m familiar with those. Most of those programs have been terminated, cancelled within the last year, some within the last months, or so. And, the people are gone, both the people at the laboratories in two cases that I’m thinking of, who were doing the programs, as well as the two people with capabilities in the material science area that were part of RW. They’ve transferred to Hanford and to Oak Ridge respectively. And, the people at the laboratories I'm sure have found new work.

So, how does one transfer a program that doesn't have people to carry it out anymore? Are they going to hire new people? I'm sure you know that this dilemma exists. How do you address it?

SCHWAB: You're right. We're losing a lot of good people. They're transferring to other activities at the national laboratories. Some are--at some laboratories, there may be layoffs. So, not all the good people are gone, and we're going to be picking up as many as we can, and, programs like the behavior of the variety of metals in a variety of geological environments. Corrosion is a big deal. We're going to be studying corrosion over long periods of time.

You know, in the past, our interest has been on corrosion up to 60 years. Now, we have to think about 100 years, 200 years. The Chairman of the NRC, Chairman Yasko, said 300 years. We've never looked at corrosion for that period of time for our storage facilities.

DI BELLA: Well, in a repository environment, maybe a million years.

SCHWAB: Yes. A repository environment is even longer, sure.

GARRICK: Yes, Nigel? And, that will be our last question on this subject.

MOTE: Nigel Mote of the Staff.

I'd like to come back to your R&D objectives, but this time I'm going to be--reprocessing and recycling. As John Garrick, the Chairman, said, he, in the 1950s and 60s was involved in the early work on reprocessing. Not much has changed since then. We know we can dissolve fuel. We know we can separate the uranium, plutonium and the waste products. You are embarking on an R&D program focused on recycling, but we're trying to understand where recycling may go if it's going to be different from past experience. Can you tell us what are the objectives?

In the discussion this morning, again, John Garrick said that if it's a matter of saving real estate, we're not sure of the real estate. If it's a matter of disposing the heat in a different way, that's something that we think we can do. If it's a matter of maximizing the recycling of the products, at this point and for the foreseeable future, there's plenty of uranium at relatively cheap prices. So, if you have an R&D program, is it focused on price, availability, maximizing recycled, minimizing repository volumes?

As I think Henry Petroski said, with an R&D program, presuming you have some objectives that you're trying to understand and trying to reach. Can you help us understand the targets of the investment program that's coming up in recycling and reprocessing?

SCHWAB: That’s a real tough question. First, let me go back to this slide. This is the office I was focusing on. You’re asking me a question about systems analysis and integration, and the separations in waste forms. These are other parts within the Office of Fuel Cycle Technologies. Okay? There are lots of different kinds of separations, processes, that are being investigated at the national laboratories. We’re looking at all those, and various kinds of waste forms that could come out of those. For example, people are proposing thorium based fuels, and deep burn graphite based fuels. And, we are looking at all those.

Now, are you--is your question related to what’s the ultimate goal of the R&D program? Is that where--

MOTE: Yes, it’s presumably the objective is to make it more economical or make the product more readily available or have a better waste form. But, presumably, there’s a target that the R&D is focused on, and I’d just like for you to help us understand what is that target, because it will help us understand how we should be reviewing what’s going on in terms of understanding where it may have an impact on the future fuel cycles in the U.S.

SCHWAB: The R&D program, as specified in the Office of Nuclear Energies, R&D roadmap, is a very long-term R&D program, and the R&D program is designed to do research for decades.

MOTE: Is its objective to reduce the volume of waste going into a repository? I assume there's one objective--

SCHWAB: No, we haven't specified that objective.

MOTE: Is that objective to move the product more readily suitable for recycle?

SCHWAB: The objectives are not that specific no.

MOTE: So, it's more generic R&D program focused on--not to meet--

SCHWAB: Yes.

GARRICK: It sounds like this topic may need more corridor discussion, and I think we've taken as much time as we can allow. And, we appreciate Patrick's patience and tolerance of our barrage of questions.

SCHWAB: It's my pleasure, sir.

GARRICK: But, we'd better move on. Thank you very much.

Our next speaker is going to talk about simulation of advanced fuel cycles, Steven Piet.

PIET: Congratulations. You're in the minority of people who get my name right the first time. Thank you.

GARRICK: Oh, thank you. That's probably the only good thing I've done today.

PIET: I have to ask the Board, you've incurred a risk by coming here today because you're at risk of death by power point. So, I'm going to try to make this as interesting as possible, and hope that you give us some good questions at the end.

We're in the systems analysis part of the fuel cycle program that Pat mentioned are performing. So, you're going to see a few things in my presentation that overlap his, but we're looking at it from a total systems perspective. We ask ourselves if we develop the tools, some of which I'll talk about, what future might we want? How are we going to get there? How do we get started? How do we look through all the different options and combinations of options? And, as Pat said, the Fuel Cycle Technology Program is an R&D program. We're in what is called a discovery phase. There's different phases that have been established, and we're in the discovery phone right now. And, therefore, we are looking at various parameters, uranium, some dealing with proliferation, some dealing with waste management, and so forth, but there are no hard objectives.

How can we get there? And, I'll show you some simulations of what can occur between here and there. And, some of these tools we haven't used quite for this purpose, but we can look at issues like contingency plans that came up before. We have the ability in some of these simulations to say I can go down a certain path, you assume, however, that something goes wrong.

The VISION model is one of the tools that we use. We model the entire fuel cycle starting with energy demand, uranium, conversion, fuel fabrication, reactors, wet and dry storage, and I use these terms in a generic sense. So, even if it’s a sodium reactor or an HTGR, so wet means actively cooled, but wet fits better on the viewgraph, so bear with me. Packaging, separation, different waste categorizations, different disposal options, grouting, what might go from where to where, what reactor sends material where.

But, we stress that it’s a tool. George Fox said in 1979 that all models are wrong. Some models are useful. So, you have to always look at the output of a model and consider is it useful. What is it telling you? So, I’ll show you a few others.

We have not looked in this program at the non-commercial wastes. That’s outside of our scope. But, we do try to take a comprehensive view of the commercial fuel cycle and all the various options.

So, I’ll show you some of our capabilities, and give you some examples. The user tells the model what you want to specify in terms of energy demand for the next 100 years or 200 years. We call that fuel composition, we call it fuel recipe, you name it, we put it in. You could have different reactive charts. We don’t try to model individual reactors, but rather, types of reactors. And, sometimes you have options, often times you have options where reactor types are working in synergy, or at least they're intended to.

Different types of storage, different types of separation, different options of where separation products go, and routing matrices between the reactors and separations. And, all these parameters can be changed year by year in the simulation if the user so desires.

When we model the United States, we can also do worldwide, but when we model the United States, we start our simulations in the year 2000 with 86 gigawatt electricity generation. That's the 103 reactors we had then. Uranium oxide is the fuel. Light water reactors, we generally assume that lifetimes are extended to 60 years. We can change that, but that's our typical assumption.

We start with the amount of uranium oxide that's in storage. No separation capacity, and, therefore, there's no routing to be done because it gets as far as this and stops.

What are the challenges in thinking about a fuel cycle option, any fuel cycle option. As Pat said, we have not completed any fuel cycle option today, open, closed or anything in between. You, therefore, have functions in a complete fuel cycle that we do not have today.

In this graph, what we have function-wise, today, for the U.S. is in green, and functions that we may want in the future are in red. You see that half the diagram is red. The point being that if you're going to build a new fuel cycle, you have to consider what functions you want in that fuel cycle, and what sequence, and what manner they come on line. And, it's not trivial.

If we don't set up those steps in a correct order, and what the option is, the model chokes, things get backed up, somewhere, typically it's separation, but it can be anyplace, depending on what it is you're doing. So, as you're looking at a complete system, you not only have to decide what you want, but in what sequence are you going to bring those functions on line.

Over the last several years, in what is known as the Global Nuclear Energy Partnership Program, we tended to use these assumptions for a lot of the simulations. I'm not going to walk through all of these, but just to give you the sense that what you have to decide is capacities, what type of reactors you may want, when do you want to bring different technologies online. Do you have phases in which you bring the technology on, but you can strain its rate of development? So, fast reactors, for example, we would have the first test reactor in 2022 in these scenarios. And, then, you have a decade where you throttle back the growth of fast reactors. You don't have to do that. That's one of the instructions we were given.

You can change how long material stays in storage. You have to decide what size separation plants you're going to build, when you're going to build them. And, each one of these can change dramatically. One parameter can change how the whole system functions.

This is a simulation, year 2000 to 2100 of once through fuel cycle. We assumed in these calculations the repository opened and started taking fuel here. We would not do that in doing the simulation today. The Y-axis here is the radiotoxicity a thousand years after reactor shut-down, and it's calibrated to 1.0 in the year 2000.

In this particular simulation, way down here at the bottom is the toxicity of material that's in reactors. You have ten years of storage in this simulation, wet storage, a minimum of ten years of dry storage, and all of this goes into one or more repositories.

Depleted uranium, low level waste, fuel fabrication for the light water reactor in these particular categories are so small you don't see them on this graph. So, you have a growing inventory of material, but it's a relatively simple looking graph.

This is a case where I have a light water reactor and I start to build fast reactors in this case with a transuranic conversion rate to a .5, which means for every atom of transuranic material that I produce, I consume half of that. We've run the calculations with all kind of different options. This is just one example.

The first thing to point out, this is the same as before. This area called reduction is material that does not get created. So, you've reduced, in this scenario, the total amount of radiotoxic material by a factor of 2. You didn't make it. Some of it you consumed, some of it you never made in the first place.

The other thing to point out here is I've got more colors. Well, that's because I've got two reactor types, I've got a separation type. I, therefore, have more cooling types. And, so, now I have transuranic material in more places. Now, this is a fast reactor. This is the wet storage for the light water reactor. We assume with these calculations, that we're building separation plants so that we can work off the backlog of material in dry storage, so that eventually goes to zero.

So, it's a more complicated diagram, but, again, this is material that is not made, or it's eaten up, and the transuranic material that goes into the repository is so small, you don't even see it. Why? Because you're taking the transuranic material that dominates this particular metric, and you're recycling it.

Now, there's two valid ways of expressing the result I just showed you. They are both valid, and strangely enough, some people pick on and some people pick the other. But, they're both technically valid. One way of expressing the result is that the toxic inventory requiring deep geologic disposal has dropped by factor of 300 to 1000 relative to the once through fuel cycle. Why? Because the only thing that goes is an assumed processing loss rate. The penalty, however, is that there are new types of waste that are generated, and I'll come to that in a moment.

The other equally valid way of describing the result is that the total inventory in the system has dropped by a factor of 2. One of the things that's key is that we assume that used fuel from a fast reactor gets recycled quickly, and I'll show you something about what happens if you don't make that assumption. The faster you do things, the larger this number becomes.

And, finally, we'll talk some, the last part, I'll talk about what we call the active or in service inventory, and what and how you can extract value from it.

So, sometimes, you'll hear people talk about this number, and sometimes, you'll hear about this number. They're both valid. They're just different ways of describing the same result.

Now, this is the envelope of radiotoxic inventory for once through. This is the curve for the recycle case I showed you a moment ago. And, this is what happens if I change the delay time for fast reactor used fuel from one year to ten year, everything else is the same. My inventory in the whole system increases by this much.

So, the longer you have time lags in the system, you have material held up in various parts of the system, that means it’s not producing value. It’s not getting consumed. It’s not getting used. It’s sitting someplace. And, so, you have to specify the time lags to know how any given set of technologies is actually going to work. It’s not enough to say I’ve got technologies. But, when do the technologies come on line, and what are their time lags.

You sometimes hear people say that recycling transuranic material or uranium is just a way of holding it up rather than admitting that you have to dispose of it. Now, we choose to look at it by saying, well, there’s all kinds of different options, and that we find that the longer you can keep a given material in service, transuranic material, uranium, zirconium, cladding, whatever it may be, the longer you can keep it in service, the more you can extract value from it, and the more you reduce consumption of ore. And, any time you dispose of material before the value is exhausted, you’re consuming new virgin material. So, waste minimization involves how can I remove or decrease how much new material I have to dig up out of the ground.

Now, I mentioned there’s different types of waste.

And, the Board asked some questions a moment ago about how to look at this as a system, and this next set of cartoons or diagrams is from a study that I had the fortune of reading that involves people from a separation campaign, a fuels campaign, as well as systems analysis. We call it the Losses Study. And, I'll explain what Losses mean in a minute.

You start with radioactive materials that are in service. Today, if I want to take materials out of service, I have to meet some waste acceptance criteria, WAC. In theory, I can go to deep geological burial, for low level waste. South Carolina, Utah, Washington State have these sorts of facilities in operation. Of course, the nation has none of these in operation. In fact, nobody has one of these in operation. And, this material is characterized primarily by very long-term toxicity and high heat. This is low heat and low long-term toxicity.

Well, we're systems analysts, we look at options. So, there are options associated with new fuel, or putting aside uranium for eventual use. But, I can't go from here to there without the material passing some impurity limit. The point being now is that all of these, this and all of this, these are all products, the way this team looks at things.

I can't take material out of here and take it anywhere without it meeting some set of criteria. If I have more waste getting up into this, I can violate those impurity limits. If I have more transuranic material getting down into here, if I choose recycling, then I'm certainly not producing waste that might qualify down here.

So, the losses of waste material to fuel, or fuel material to waste, is why we call them the Losses Study. In other words, do you want dirty fuel and clean waste, or clean fuel and dirty waste. That's a series of very complicated trade-offs. And, just to show you one technical example, generally, in the different separation options we're looking at, the separation of actinides from lanthanides is chemically difficult.

The lanthanides are actually, if by themselves, quite pure, they'd be down here. As soon as I start putting much in the way of transuranics down here, I mess this up. On the other hand, the various fuel types are generally not very tolerant of much in the way of lanthanides. So, the more I can tolerate lanthanides here, I get less actinides there, and vice versa. So, this is all interconnected.

There's more and more thinking and work about recycling zirconium, for cladding, or graphite in HTGR types of reactors. There's been some work done on fission product targets.

And, finally, we've done some thinking and we do work some with the used fuel disposition campaign, to at least talk about options that might exist with regard to low heat, high longevity waste; or high heat, low longevity waste.

Okay, remember, we have examples around the world of this type of waste disposal, and this type of waste disposal. This type of waste storage, perhaps disposal, but not here. So, as we're looking at this whole integrated system, all of this is interconnected, and every one of these decisions impacts the ability of every one of the other ones.

We've looked, for example, what are the different options? These are the different parts of used fuel. We're studying more cases, more different fuel options this year. These are potential criteria for non-high level waste.

So, transuranic material. If I want to take it out of service, my only two options are to recycle it as fuel, or it becomes high-level waste. If you fill out the whole graph, this is where we are today. You see yes's, maybe's, no's. The point is if I want to avoid high heat, high longevity waste, or high-level waste, I have to get greens everywhere. We're not there. But, this is how we're looking at the overall system.

In conclusion, it is a system. One decision impacts all over the place. You have to account for all the facilities, all the mass. There's advantages in reducing ore consumption by using materials as long as you can. And, there's this inherent trade-off between clean waste, clean fuel.

Timing matters. I can’t tell you how any new technology will change any of the metrics that I’ve heard before without you telling me or one of us making assumptions as to how we’re going to deploy that technology. There’s no such thing as equilibrium. It’s an always changing system.

Recycling can lead to more types of waste, but there seems to be options and precedents what to do with many of them. And, that’s what I call high heat, low long-term, or vice versa. So, it’s a complex system and we’re trying to analyze those options. Everything is on the table, and these are some of the tools that we have used to get as far as we have.

Thank you.

GARRICK: Thank you. That’s very interesting work.

I have one question before I let the Board get into the act. Who is your customer?

PIET: Department of Energy.

GARRICK: Department?

PIET: Department of Energy.

GARRICK: Well, who within?

PIET: Ultimately, Buzz Savage.

GARRICK: Okay. And, what are they doing with this information?

PIET: They would be better off answering that question than I am. Most of this is work in progress, and, so, we're connected with the various other campaigns. We're exploring options. I'm an engineer and my job is to do technical analysis, lead teams, analyze options. How and when or if options will be narrowed, on what basis, I'm afraid that's above my pay grade.

GARRICK: All right. Howard? Thank you.

ARNOLD: Arnold, Board.

I have no quarrel with what you've done here. I do want to point out that you've made a baseline assumption that there are fast reactors.

PIET: Only this example, sir.

ARNOLD: Oh.

PIET: We do lots of calculations--

ARNOLD: I'd like to see the example that has only light water reactors in it.

PIET: We've done--I don't have that with me, but we have calculations like that. I can continue to recycle as long as I want, as long as the fuel and separation technology exists. I can reprocess or recycle, as I prefer to call it, in a thermal reactor with additional fissile support. I do not necessarily need a fast reactor.

ARNOLD: Yeah, my own bias from looking at past studies is that in thermal reactors, it's a loser's gain, but you don't gain enough by reprocessing to make it worthwhile.

But, that’s just my own view.

PIET: One of the things--believe me, some of my colleagues, and I see a few in the back, I could bore you for quite a few hours if you’d let me. And, I’ve done that on occasion. But, different sets of options have different characteristics. If I really care about uranium utilization, I’d better go to a fast reactor. If I want to recycle and eventually consume material, I can do that in almost any type of reactor. So, if you’re going to start narrowing down options, you’ve got to tell me, or somebody has to decide what your objectives are. But, besides those objectives, I can tell you which sets of options tend to get you there.

ARNOLD: Well, with the light water reactor only option, that place where you said impurity limits becomes an issue, you know, things like build up a U236, and so forth, but you’re right, it would take a detailed discussion to get into it.

PIET: But, this does feed into some of the R&D. For example, the fuels campaign is taking these sorts of observations and saying well, if the lanthanide attack on cladding is a problem, it sets the impurity limit for the lanthanide, maybe I put a coating between the fuel and the cladding, therefore tolerate a higher degree of lanthanides. That’s the type of thing that’s on the table and being looked at.

GARRICK: Okay, other Board members? Yes, Mark?
ABKOWITZ: Abkowitz, Board.
First of all, I'm pleased to see that this work is going on. I don't know if you were keeping track of the Yucca Mountain deliberations, but the Board was recommending to DOE for quite some time to develop a systems approach to preclosure, and finally, the TSM model came into being, and by virtue of the fact that that existed, the Department discovered some serious hand-off problems between the surface facility design and other components. So, really, it's good to see that this is happening when it is.
I'd like to go to Slide Number 4, if I could. And, want to explore two or three of the things that you've stated in Slide 4 so I can get a better understanding of how the model is constructed and its fidelity.
The first one is the question of material balance. Have you gone through the painful excruciating process to make sure that everything is in material balance?
PIET: Yes.
ABKOWITZ: Okay.
PIET: I'm quite a fanatic on that.
ABKOWITZ: Okay. My understanding is that it's difficult, if not impossible, to even understand what the material balance equations would be for fast reactors, because no one that we've talked to has actually been able to

produce such flow sheets. So, could you tell us the secret of where you're getting this information?

PIET: We spent a lot of time talking to our colleagues and asking as many tough questions as we get away with asking, is the short answer. In terms of the reactor physics part of that, my colleagues here and at Argonne in Chicago, we get from them the reactor physics. There, the material does balance. It's the way the calculations are done.

In terms of the separation matrix down here, what are these? These are matrices, and we force that we don't lose mass. And, so, when they say oh, 99 percent here and 98 percent there, if it doesn't add up to 100 percent, we say well, if you don't tell us where we're going to have 100 percent, we will assume it goes to a catch-all category. So, we, shall we say, have that dialogue and force the numbers to add to 100 percent.

ABKOWITZ: So, you would be willing to share your process flow sheets with the Board for the fast reactor types that you've been testing?

PIET: We can certainly do that. But, remember, these are not process flow sheets. They are, at this level of modeling, a matrix. This is what comes in to a separation facility and this is what comes out, and which of the various mass streams it goes to.

ABKOWITZ: Right. Maybe I was using the wrong nomenclature, but that’s what I was interested in.

PIET: In terms of all the detailed chemical steps, that’s beyond what we model at this level.

ABKOWITZ: No, no, well, I’m interested in what goes into the black box and what comes out of each process.

PIET: Right.

ABKOWITZ: Okay. Let me now move on real quickly. I know there are other members here that want to participate. Reactor types, are you working from the detailed data of the individual assemblies at each reactor facility, or have you grouped them into some aggregate?

PIET: Aggregate.

ABKOWITZ: Okay. And, at what level of aggregation are you working at?

PIET: Actually, fleet average for a given type of reactor.

ABKOWITZ: Okay.

PIET: I can change burnup, I can change all the various parameters. We can model any type of reactor. Remember, to this particular model, and this is only one of our sets of tools, for this particular model, it’s what goes in and what comes out. The detailed reactor physics is also part of systems analyst. This is where we get that data from elsewhere. The only type of reactor we can’t model right now is a thorium based, because the model doesn’t know what it means to say I can only make as much fuel as I have thorium based fuel. Right now, none of those algorithms are there. We're working on those, but that's not our top priority. So, if it's a uranium or transuranic based fuel, we can run the simulation.

ABKOWITZ: Okay. Let me quickly ask two other questions. The first one has to do with is there any plans in the future to add an economic analysis component to this? Because, you know, at the present time, it's kind of like all the costs are equal, but obviously, we understand there may be very different costs involved.

PIET: There is in systems analysis a cost database we've had externally reviewed by people in and out of the program. Unfortunately, those pesky Europeans have hired away one of my colleagues, David Shopshire, who developed that. And, so, we have not replaced him, so we're a little blind right now in the economics.

ABKOWITZ: But, that's another piece of information that the Board could have access to?

PIET: That's a public--I'll warn you, it is a thick report.

ABKOWITZ: That's why we have Staff. Sorry, Guys and Gals.

PIET: I believe the most recent version of that is September of last year.

ABKOWITZ: Okay. And, then, finally, lastly, if we could go to Slide Number 8? I was just curious if you could describe why you chose the criteria you did for the Y-axis, because I'm more familiar with seeing things like mass as one way of trying to understand what the system requirements will be under different scenarios. And, you looked more kind of at dose, I guess, as your criteria.

PIET: The model, we can calculate heat, we can calculate dose, we can calculate volume, we can calculate mass. Each one has its own sets of assumptions built into it. Given the time involved, I picked this because when I talk to friends and relatives, neighbors, I find that how toxic material is is what they respond to the most. So, I picked that. But, we are multi-lingual in the sense that we speak all of those different parameters, and calculate those, and I keep dreaming up new ones, or someone else dreams up new ones, and I drive some of my modeling colleagues crazy every time I do it.

ABKOWITZ: Okay, thank you.

GARRICK: Yes. Do you feel you have a very good handle on the effective burnup on these cycles? The trend is certainly going to higher and higher burnups, and there must be a threshold, particularly for light water reactors, above which it's uneconomical to be thinking about doing some of these things. Do you have a good handle of that kind of information?

PIET: That’s not something we have looked at. I’m aware, I’ve seen some of the reports in the literature done by industry and others, and some of them indicate the optimum is 70, 80, I couldn’t give you the range off the top of my head. We’re at 50, roughly, now. I will tell you that the choice of metric, of course, does matter. For this metric, this graph would not look one bit different if we go from 50 to 70, or 50 to 80. It just won’t change. Mass would change a little bit. So, it depends on which parameter or sets of parameters you care about. But, in terms of do I have a crystal ball? I don’t know. Again, there, I only know what’s been done by some of the industrial examinations of the economics. So, I have to duck the rest of that.

GARRICK: It seems to me--I’m sort of a “scenarios likelihood consequence” guy. It seems to me if you really did do this, together with embedding in it an economic model for different scenarios and explain the pros and cons of each scenario bracket, or each set of scenarios that you’ve enveloping, that this is the kind of information that would be not necessarily the sly, the totality of what you’re doing, and it would be extremely useful to Boards like us, to the Blue Ribbon Commission, and what have you.

That’s why I asked who was your customer, because I was really interested in what motivated this, because I do believe that this is the type of thing that we need much more of. And, I don't know what kind of budget you have, I don't know what kind of range they've given you to do this type of work, but as Mark said, until we started pushing in the Yucca Mountain Project for a total system model for the preclosure operations, it was very difficult to get a handle on just exactly where the bottlenecks would be, what could really be the drivers in making the program a smooth and operate throughput as well as possible.

Because there's so much consumption of energy in the safety side, that sometimes a throughput and economic side just gets neglected beyond what it should be, and beyond the point of where you avoid problems downstream. So, this is some element of it, and I can imagine some forms of it could really be very useful.

PIET: This cost database that I mentioned that Shopshire and other colleagues have worked on, they've been very careful to try to be comprehensive and very careful to try to indicate ranges of uncertainties.

GARRICK: Yes.

PIET: Because if I were to go back to that other diagram that talked about mass was, every one of those-- every one of those has a cost, and every one of those costs is uncertain. The uncertainties are non-trivial.

GARRICK: Yes, I'm very aware of that, and I think that’s something we need to see a great deal more work in.

Yes, Ali?

MOSLEH: Is technology readiness and uncertainties associated with what’s feasible or not an aspect of your analysis?

PIET: In terms of this particular computer model, its ramification is when do we or someone tell us to assume the technology is available. So, it manifests itself in that fashion. But, this is only one part of systems analysis. And, so, in other parts, we used to have reports to Congress every year that talked about the sets of options, and technology readiness was one of the parameters, one of the many parameters that were reported. So, that’s something that we consider. The time scale now, as Pat mentioned, are long, in which case the existing technology readiness is perhaps not as important.

MOSLEH: So, no way to translate to a time parameter in your simulation?

PIET: Not in, I would say, a systematic fashion. I mean, in theory one could do that. But, when we’ve tried that in the past and we’ve talked to various experts on various technologies, we say well, how fast can, you know, what’s the soonest I could deploy such and such a technology? And, every time I ask that question, the answer is how much funding am I going to get between now and then? And, they don’t know and I certainly don’t know. So, it’s very hard to turn the issue of technology readiness into something quantitative in this sense. You have to make a whole bunch of additional assumptions, and so far, we haven’t seen the value in doing so.

MOSLEH: You can do sensitivity analysis?

PIET: Oh, yes, all the uncertainties and the economics and all that stuff, yes.

GARRICK: Okay. We’re running slightly behind, not too bad yet. Thank you very much. That was very interesting.

Okay, Emory Collins. He’s going to talk to us about views on practical approaches to recycling used fuel.

COLLINS: Emory Collins, Technical Advisor in Nuclear Science and Technology at Oak Ridge National Laboratory. I’m going to talk to you about some views of our senior technical staff and practical approaches to recycling used fuel.

About a year and a half ago when the announcement came out that Yucca Mountain was to be postponed and then cancelled, some of our laboratory managers asked a group of us to put together our collective thoughts, those of us with expertise and experience in the advanced fuel cycle operations.

And, so, this began with a White Paper study and as we completed that and sent it out to a number of interested parties and received comments, review and comments back, we incorporated those into the study and we also, one of the comments was that we didn’t have a strong enough cost analysis basis, and, so, we recruited our expert economic person, Kent Williams, to join us, do an economic analysis, and add that to the study. And, the bottom line was that we published the study as an ORNL report in April of this year.

First, we took a look at the situation, and as so many other people have recognized, the current situation is that public perception has become increasingly favorable for nuclear energy because it is a large economical source of clean energy, with very low carbon emissions.

The problem, of course, is the unresolved nuclear waste disposal issue, and how much that is of a major concern. Of course, the plan up to this point has been safe disposal, would be transportation to, emplacement in a geologic repository. But, as we found out with the experience of Yucca Mountain, finding an acceptable site for a geologic repository is a much greater social and political problem than had been anticipated.

Everyone recognizes that continued used fuel storage is not a permanent solution, and, so, we’re afraid that the situation may be a deterrent to the public acceptance of nuclear energy.

So, why not consider fuel recycle as a practical solution? Certainly, the base recycling technologies have been deployed in other countries, and advanced research and development studies in this country over the past 30 or 40 or 50 years have developed a number of improvements that can be deployed, particularly in the last ten years.

And, so, we think that an advanced fuel cycle approach could be deployed that would give us proliferation-resistant recycle facilities. We have a unique opportunity to process older fuels first, and I'll talk more about that in a few moments, and we could incorporate more complete recycling of used fuel components if we focused our research and development so that we could minimize the eventual impact of the geological disposal of radioactive materials.

Let's look at this issue of recycling more of the components of used fuels. And, first, I'll have to apologize, I'm using used fuels and spent fuels interchangeably here, they're the same. But, this is the composition in mass of the existing inventory in the United States, consisting of about two-thirds of pressurized water reactors used fuel and one-third boiling water reactors. And, as most people recognize, the majority of material is uranium, the fuel cladding and hardware and very little of it is the highly radioactive fission products and transuranium elements. On the average, about 3 percent.

Now, if you look at that situation in high burnup, more recent fuels, this number will increase to about 5 or 6 percent. Otherwise, everything looks pretty much the same.

If you look at the breakdown of the fission products and transuranics, about three-fourths of it are fission products. Of the transuranium elements, the vast majority, 85 percent, or 85 to 90 percent is plutonium, the rest is mostly americium and neptunium and very little curium.

And, so, the current industrial treatment is performed in other countries, just to recycle the plutonium. Uranium is separated in the process and in some, recycled as a demonstration, but not nearly all of it. We feel that additional components could be recycled, all of the uranium, including the other transuranium actinides, possibly zirconium from the fuel cladding, and possibly some valuable gases rare earth elements and noble metals out of the fission products if we focused our R&D program.

Now, the need for a geologic repository will still be there, but the methods that we’re recommending we feel can delay the need and minimize the capacity needed and significantly reduce the hazard of the waste that will be disposed.

One of the things abou8t recycling uranium, of course it can be re-enriched and sent back to light water reactors, but is to send it directly into heavy water reactors, such as the CANDUs. In some of the analysis that have been made to date show that the CANDUs, because of their more rapid turnover, could actually handle, the 18 Canadian CANDUs could handle from 2000 to 2800 tons per year of recycled uranium, which is more than what we're generating right now, or equal to it. And, on top of that, the U236 penalty, which is there for all recycled uranium, is much less in a heavy water reactor.

Now, they are currently not doing this, and they would have to certainly license that, but AECL has sponsored over the last three or four years, a uranium reuse study, international study, and it's my understanding that they plan a demonstration in the Chinese heavy water reactors in a few years from now.

Zirconium recycle. We just began a project to investigate this after meeting with and discussing with an industrial consortium, which included a zircaloy manufacturer. And, the concept here, we would take the contaminated hulls from removing the fuel, and subject them to a metal refining process, in which the zirconium is volatilized and purified from the other volatile components, and then decomposed into a metallic form in a net shaped form.

The residual alloying agents and radioactive contaminants would be returned to the spent fuel process plant for disposal as waste.

The purified zirconium will, of course, be radioactive to a certain extent. However, the zirconium 93, which is the radioactive component, is not really a significant radiological problem because its half-life is over a million years and it’s Beta emission is only about 90 kilovolts. This is not much more difficult than handling zirconium itself, because it’s pyrophoric nature, and so it requires some controls there.

Now, what about cost of recycle? Is it really an impediment? As I mentioned, we got our cost expert to look at four cases, one the direct disposal of fuel in which the waste is 100 percent; the current recycle of plutonium only, which is only about 1 percent, so 99 percent is still waste; and the advanced recycle methods where the uranium, all the transuranics, zirconium and some selected fission products, which could reduce the mass of waste requiring eventual geologic disposal down to about 5 percent. And, we recognize the advanced reactors will come on and they’ll have some new requirements, probably stainless steel cladding, and things of that sort. We could see some increase there.

But, we got, from the standpoint of cost, they looked at the comparable levelized costs of electricity from nuclear energy in terms of mills per hour for each of these cases, looked at the front end cost, the reactor cost, the storage cost and the disposal cost, and the recycling cost, if it’s there, and as you can see, the reactor costs dominate very much.

And, the reason for that, even though recycling facilities are quite expensive, you’re aware that $25 billion for the Japanese Rokkasho Plant, but those plants serve many reactors, and so it’s the reactor costs that dominate. And, a fuel cycle cost in every case are less than 15 percent.

And, then, when we looked at the front end fuel cycle costs and the back end fuel cycle costs, and compared the individual cases, we did not find that the fuel cycle costs differed by any great significant amount. Now, this held true even for the future when we expect to see some breeding materials from depleted uranium and thorium resources, and those will require more expensive reactor and fuel designs.

Looking now at proliferation resistance, which is also a barrier to beginning recycle, and, looking back again at the same used fuel mass components. And, what we can see here is that the plutonium is a chemical element, and that plutonium can be separated. It’s not the only fissile material in used fuel. The uranium has some residual fissile material, but, of course, it’s very dilute and it requires re-enrichment, so it’s not of a concern. Plutonium, on the other hand, can be fashioned into a weapon, and so it has to be protected. It can be chemically separated by any number of different ways, and most of these ways are well known in the chemical industry, not just the PUREX process, not just solid abstraction, but various methods such as ion exchange, and other things that can be deployed on a smaller scale.

So, it was our conclusion that the fuel itself has no intrinsic safeguards characteristics, and that physical protection and other proliferation resistance means are necessary to prevent diversion. And, that holds true whether or not you're just going to continue to store the fuel, whether you're going to have direct disposal, or whether you're going to treat it in recycling.

Now, engineered safeguards can provide some adequate proliferation resistance. Look at this chart here, which is the radiation barrier. The radiation goes from a standard PWR fuel assembly versus time, and of course you see that the radiation barrier is provided by the presence of short lived and intermediate lived radioactive fission products, but that barrier decays with an exponential rate. And, used fuel older than several decades become more vulnerable to diversion and theft. Now, just where that point is is rather arbitrary, but the safeguards experts have studied that. They have established for their attractiveness level in the past a level of about 100 r per hour at a meter distance. It's my understanding that they are not satisfied and they're going to increase that, which means that the fuel could become more vulnerable at an earlier age.

But, the point is here is that vulnerability can be eliminated if the fuel is recycled before this point is reached, because you will re-establish, and then we can work within this range here, and we'll always have a radiation barrier in stored fuel.

The second thing that we can do for proliferation resistance is to put our recycled facility in a co-located and integrated plant, a physically safeguarded plant, such as the MOX plant that we're building down at Savannah River right now, which would contain all of the storage, disassembly, separations, fuel fabrication, and recycle, and a place that's physically safeguarded with fissile material predominantly entering as spent fuel large, heavy and easily accountable fuel assemblies, and leaving in the same fashion, and deploying effective monitoring and surveillance of the waste and people that are exiting the plant.

Also, the inventory of the material in process, that is, that material that's been separated from the radiation barrier, the fission products, would be minimized. And, in fact, plutonium doesn't need to be completely separated. I'll talk about that in the next slide here. We do feel like, though, that the use of near-real-time monitoring and accounting of fissile material is necessary to maintain the location and movement of the material.

We can go another step. No separated plutonium. Plutonium doesn’t have to be separated from all the components, just the neutron poison materials, which are xenon and the lanthanide fission products. The industrial plant can be designed to prevent plutonium separation from uranium and other things. And, in fact, uranium is the largest component, and that is one of the safeguards people have said would be the most deterrent, although none of them are real deterrent.

But, if you compare current recycled PUREX methods, they do have the capability by using a partitioning contactor bank that has a stripping section and a back scrub section, they can effect, by simple arrangements, ratios of the flow rates into the system, they can affect either a complete or a partial partitioning of uranium and plutonium.

But, a plant could be designed that didn’t have this back scrub section, and that would be automatically ensured that uranium and plutonium couldn’t be totally separated. And, other techniques that we’ve demonstrated developed at Savannah River could enable us to control the amount of uranium and, therefore, that would be a method of what you normally hear as COEX or NUEX or some of the new flow sheets that are coming out.

We can go a step further than that and add back in the fission products that would give the radiation barrier back to the recycled fuel, but that’s going to increase the fabrication, transportation and handling operations, make them more expensive. So, we feel like that an economic and a benefit analysis really needs to be done before that step is taken.

In any case, the physical protection requirements are still going to have to be applied, because plutonium can be separated. And, the recycled fuel transportation costs are not decreased there.

Now, let me spend just a minute to talk about time factors, because time factors are something that we can take advantage of, as well as protect against. The chart that I’ve shown over here is a bar chart, and basically the exponential decay of relative decay heat coming from used fuel where the white color is the short lived fission products, the red color is the intermediate lived cesium and strontium, and the blue color is the long lived transuranic elements.

Now, as you can see, after about ten years, most of the short lived fission products are gone. Most of the radiation barrier then is applied from the cesium and strontium. That gets even less out to 100 years. So, we have the opportunity in this country to deploy something like a fifty-fifty concept, where we process the fuel at about this point in time, and we store the high-level waste for another 50 years within the separation facility, which is a practice that's actually being done in France.

So, our waste would look like this, and if we recycle most of the plutonium and the transuranium elements, this isn't there. And, the decay heat would be about 10 percent of what we had at the beginning. So, the future impact of high-level waste emplacement into a geologic repository would be greatly lessened.

In addition to that, some of the volatile radioactive emissions are lower, notably the 11 to 13 year half-life tritium and krypton 85, such that capture and storage likely will not be required. In current plants where they process at about five year old fuel, the krypton and tritium are released, as well as some of the other fission products, volatile fission products. That would probably not be allowed in any future recycling plant.

So, if you can utilize the time factor at about a 30 year time factor, the krypton 85 reduces to a level that can be released according to the EPA 10 CFR 40 limitations.

And, finally, because we're processing now without the short-lived products that they're encountering right now in current reprocessing, the separation processes can be made much more simple and less costly.

Another thing that we can benefit from by the longer time is the transmutation pathway, which centers about the isotope plutonium 241 with a 14 year half-life. If one continues to irradiate, you will find that the capture will go on up the chain and produce larger and larger quantities of the heavier elements of their neutron emissions and more difficult to handle. That occurs when you have longer radiations or processing in periods that are short relative to the half-life of P-241, and you would have the transmutation pathway following this to the heavier elements.

If, on the other hand, you allow the fuel to decay for two or three half-lives of plutonium 241, this will go to americium 241, and that will transmute by a different pathway in the green boxes, producing predominantly lighter plutonium isotopes following this pathway here. Unfortunately, this americium 242 does split in its decay pathway, and, so, you still get a small amount of B-242, but the ingrowth of that is very slow. So, the net effect is that you minimize the heavy element generation.

So, what we concluded was that there is an optimum age of about 30 to 70 years, 70 years being the insufficient radiation barrier, the shorter than 30 years being more difficult in processing and more environmental releases. So, somewhere in this range, which we have the opportunity to do now, we can maximize safety, reduce environmental effects, lower the cost, and maintain adequate proliferation resistance.

Now, if we take the oldest fuel concept first, we can carry this out for a very long time, somewhere, if you look at the scenario here where we visual, we get our first plant started in the year 2030 and build up the rate of reprocessing, and it is a continuous level, out to the end of the century, and we find that the age to begin with is well over 50 years, and at the end of the century, it’s still slightly under 50 years.

So, there’s one more time factor that I like to talk about, and that is the time required to implement industrial recycling is not an overnight process. We put together a little scenario here, which visualizes over the next 50 years, a rather mild growth in nuclear reactors, and we assumed that we would get a decision to treat used fuel in the near future. At this time, of course, we have no treatment capacity. We’re generating over 2000 tons of spent fuel per years, and we have 64,000 tons in storage. That situation has shown that based on world-wide experience, the design and construction of a plant like this would take 15 to 20 years, so we wouldn’t have the first plant until the year 2030. At that point, it would likely not have the capacity that we need to match the generation rate. This is typical size of current recycling facilities.

And, so, we would have to add a second plant in another ten years, and a third plant, and only at that point, did we equal the recycling capability and capacity to the generation. And, that is the time that we would cap the growth of used fuel and the need for additional storage space. Now, any faster growth of reactors or any slower decision will extend that and raise this number.

Now, we concluded that time and sustainability are the strongest factors for deciding to recycle fuel. We know that nuclear energy is expected to grow in the United States and Europe, Japan, Russia, we know that it’s growing rapidly, or expected to grow rapidly, in countries such as China and India, possibly in the UK and other countries.

The question then is at what time will the availability of low-cost natural uranium decline? We know that that will happen at some point, but we don’t know when. If we believe that nuclear energy is to be sustained beyond the availability of natural uranium, then there’s going to be a need for breeder reactors and industrial-scale recycle capability.

Therefore, we think that the strong consideration for implementing fuel recycle are this future need for breeder reactors, to utilize the tremendous potential energy in the fertile materials, the uncertainty of when in the future that natural uranium will become unavailable, and the multi-decade process that’s required to implement industrial-scale recycle at the capacity needed.

So, in conclusion, are summary. Our analysis concluded that the cost of implementing fuel recycle will be an insignificant change to the cost of nuclear electricity. Our analysis showed that. We think that engineered safeguards can be used to provide adequate proliferation resistance. We recognize that continuing delay will likely occur in locating and operating a geologic repository. And, we also recognize that continued storage of used fuels is not a permanent solution.

We think that if there is no decision, the path forward for used fuel disposal will remain uncertain, with many diverse technologies being considered and no possible focus on a practical solution to the problem.

However, with a decision to move forward with used fuel recycling and to take advantage of processing aged fuels and incorporation of near-complete recycling can provide the focus needed for a practical solution to the problem.

That’s all I have. I’m glad to answer questions.

GARRICK: Thank you. Thank you very much. Questions from the Board? Howard?

ARNOLD: Arnold, Board.

I was trying to find the slide. There was one here that said it’s lower cost to let it sit longer. There was a slide that claimed that you reduce cost by longer storage.

COLLINS: Reduce cost by longer storage?

ARNOLD: Yeah, it was less cost. Okay, I presume that what you mean is the cost of that particular recycle step, because the overall cost would involve--yeah, that’s the one, the bottom point there.

COLLINS: Yes, this is basically that the plant design can be much simpler.

ARNOLD: Okay. But, not the overall system.

COLLINS: Yeah, you’re not dealing with the purification cycles that you have currently. Simple, one-step separation will do the job at this point.

ARNOLD: Yeah, you’re not really claiming, if I look at your cost table, you’re not really claiming that recycling saves money. You’re claiming that it adds a small increment to cost?

COLLINS: We’re saying that the predominant cost of nuclear electricity is the reactor cost, and the difference between the various no recycle and recycle is a very insignificant cost.

ARNOLD: So, I take the first two columns in your table, UOXL WR and UOX MOX LWR, there’s a significant cost increase. It’s only if you go to the next two steps, and particularly the breeder reactor, that you start to get back close to the original cost.

COLLINS: Right.

ARNOLD: I’m just restating what you’re saying, but unfortunately, the only thing we could look at now is the first step, you know, from the 62 to the 83, and that really is a bad--

COLLINS: That's where we are today.

ARNOLD: Yeah, that's a bad scene for people who want to do reprocessing, because you'd got to then postulate either a new recycling scheme which recycles the pig, the squeak and the tail and everything else, or you have to go to breeder reactors?

COLLINS: Right, and what we're advocating, of course, is advanced recycle is the way to go. And, we know this is going to take us 20 years to build a plant, so we have time to focus our research and employ as much of this as we can.

ARNOLD: But, even advanced recycle is still considerably more expensive than the original case.

COLLINS: It's only 3 or 4 percent of the difference in the cost of--

ARNOLD: I'm looking at--oh, yeah, all right. Except, you know, I always am skeptical in the cost of facilities that haven't been built yet.

COLLINS: Right. That certainly could be made greater if you hit the wrong decisions.

ARNOLD: In fact, if I could just digress a moment, there was a British physicist named PMS Blackett, and he was known as the Blackett of the pi factor because he said every time somebody came in with an estimate of what something would cost, and it had never been done before, he used pi in his mind, he multiplied by pi. And, if you actually look at the history of a number of projects, it turns out to be not that bad a number.

GARRICK: Any other questions from the Board?

It's a very interesting presentation, and we appreciate it. Unfortunately, the Board has had an opportunity, some of the Board members at least, to examine this material pretty carefully, so I think we're pretty comfortable with what we're seeing here.

So, I think we'll excuse you, and get us back on schedule and take our break now.

(Whereupon, a brief recess was taken.)

GARRICK: As a former reactor guy, I've been looking forward to these two presentations all day. So, John, let's hear it.

RAWLS: I'm John Rawls, Chief Scientist at General Atomics. I'm pleased and delighted so many of you have stuck around all day. I hope we make it worth your while.

I had the honor of speaking for a number of us at General Atomics had been working on a novel concept for nuclear power. It is a high temperature gas cooled fast spectrum small modular reactor that we call EM squared, for Energy Multiplier module. It's not advertised as on the market next week. This is really a long-term effort in which we're in the very early stages, and accordingly, we've set the bar point high. We're trying to make significant progress in all of the areas we regard as the real impediments to the greater use of nuclear power in the United States.

Economics being first and foremost, I'll report some positive interim developments on that. It looks like we can make some savings there. The focus of this session of course is about waste, and so we'll talk about that. The bottom line there is that it looks like we can reduce the requirements for repositories and defer their need. I don't think any nuclear approach can eliminate the need for repositories.

Despite being a fast spectrum reactor, it has some very fine attributes in the area of proliferation resistance. We'll talk about that. Lessens the need for enrichment services, and we don't need to have any chemical separations for the fuel cycle.

It addresses the nation's energy security needs in a direct way, not only for nuclear supply of electricity, but for process heat applications, which is comparable in terms of its energy demand to electricity.

It also doesn't need water cooling at the site, which allows it to be built in many places that present nuclear plants can't be built. And, something that usually doesn't make this list, human dimension. The U.S. gained the leadership in this area both domestically and in the military applications because the best and brightest worked on it, and those people, there are a few of you still around, you serve on panels, but what I don't see is the young, the best and brightest going into this field. And, we're trying to energize an initiative that would be nationwide to produce the technology that the nation would be proud of moving forward in the nuclear arena.

So, I'm making all these claims, I'll at least explain to you roughly how it works so you'll understand what we're talking about. The basic concept is breed and burn in situ. I show here, the geometry is not really accurate, but it's suitable for the purposes of description. It's a cylinder with suitable reflective services around the core. A portion of the core is fissile materials, it's enough fissile material to make initial criticality. That burn spreads into adjacent areas. I'll don't call it a blanket because it's really interspersed with the starter in an intricate way. This is composed of fertile material, a number of different fuel possibilities present themselves.

But, as the fertile material is bred to fissile material, the reactivity increases, and the geometry is designed so that the k effective is basically flat for as long as possible. And, that’s the trick in the design.

There are a number of advantages to having a flat k effective. Control is easier. We can control actually without any in core control rods. These are control drums that have reflective and absorptive sides that rotate to control re-activity of 3 percent, or so. It has advantages for safety, has advantages for proliferation resistance. I won’t go into all those things.

But, the predictions we made were we could run for more than 30 years with a maximum excursion of only about 3 percent in k effective, without touching the fuel. There is no fuel added. There is no shuffling. So, when we’re at the early stages of this, and took this to DOE almost exactly a year ago today, DOE top management, they got excited about this and said let’s have a top level review.

I wrote to all of the national labs into a major peer review, and Argonne set themselves up to do an independent nuclear analysis, with all the latest fast reactor codes, and I was pleased to discover that they actually got a somewhat longer burn and a somewhat lower k effective. So, the neutronics of this has been validated.

There are lots of technological issues. We’ll touch on a couple of them as we go along. So, here is a point design that captures this basic concept. It’s a 500 megawatt thermal helium cooled design at 850 degrees C. That will yield 240 megawatts electric, 48 percent net efficiency.

The nominal case is we have a starter of LEU and a surrounding material blanket, if you like, not really a blanket in the conventional sense, of DU. But, actually, a variety of fuel mixes can be used, but that’s the simplest to talk about. 30 year core life without refueling or shuffling. Then, the end of life core can be used again to start another core, if you can take out a fraction of the fission products. This doesn’t need to be high purity reprocessing. It’s simply a remanufacturing, and several processes have been identified that are candidates to achieve that kind of fission product removal.

Underground sited. This scale was chosen so that the physical size allowed it to be factory manufactured and transported to the site, which is a significant potential cost reducer.

For the aficionados, this is a little bit more about the nuclear core. I don’t want to talk about this in detail, but do want to point out what the nature of the fuel is. The fuel is in the form of a plate. The plate is about the size of this note paper sitting in here, five by eight inches. It’s about a centimeter thick. It’s uranium carbide, which it leaves enough room for fission products and expansion of the material over this 30 year life, and it’s clad, if you like, is the plate, the plate is a silicon carbide material, which is done extremely well in fast irradiation data. Nobody has done the irradiation data out to 30 years worth of life, but it’s dead flat at the temperatures we’re looking at. No further expansion.

And, we actually have a spectrum, by virtue of using a uranium carbide fuel and silicon carbide plate, in which there’s a fair amount of carbon in the system, and that moderates the spectrum a little bit. But, there are very few multi-MEV neutrons, very little transmutation takes place in the core. You do have a high DPA dose, but very little transmutation, and that embrittlement and growth of hydrogen and helium in materials is responsible for much of the material swelling.

Now, one differentiator here with other approaches is that in contrast to a pin or a particle fuel, a plate is a very poor pressure vessel. So, as the gases from fission products build up, we have to vent them. Thus, an extra complication. So, every one of these plates, these plates fit together in a frame like a set of CDs in a holder, and those frames are built up in the core. Each one of these is porous and connects to plumbing in the silicon carbide, and all the other structure is silicon carbide, to allow the gases to escape the core.

There’s some advantages in that, in addition to being able to have the material survive. The cesium goes out at these temperatures. So, the worst case release scenarios are more attractive.

Here's a nominal fuel cycle. First generation, one begins with a starter. This case is about half LEU mix and a depleted uranium mix. It could be used nuclear fuel. I'm trying not to say spent, but I have a hard time not saying it. Those work equally. I don't have to take fission products, by the way, out of the spent nuclear fuel. I do have to convert it to a carbide. I have to do some chemistry.

The run for 30 years, in accordance with the diagram I showed. The discharge is suitable for starting up another reactor, in fact more than one reactor, if one takes out about half of the fission products that are made in that. The comment was made you never reach an equilibrium. After about three of these cycles you reach an equilibrium in a fast reactor. You never do in a thermal reactor. But, all actinides have about the same fission process in a fast reactor, not exactly the same, but they all burn, so you will eventually reach a nuclear equilibrium. You may not reach a chemical equilibrium, or a thermal equilibrium, or other things, but in the neutronics, you reach an equilibrium.

So, in principle, one can reuse this fuel multiple times. You never have to put in any more enriched material. Enriched material only goes in the first time. So, it's a better utilization of uranium.

I define fuel utilization in the conventional way, but it's the fraction of heavy metal atoms that are mined that actually fission in the process, while it's used as fuel. But, that classically is only about a half a percent in LWRs. You can't basically get above the .7 percent U-235 content of natural uranium.

DOE, and this comment was we don't really have an open fuel cycle, we don't have a closed fuel cycle, that was made. They've actually set an interim goal of 10 percent as an acceptable goal for fuel utilization, meaning there would be significant progress.

This EM squared design, even in the first generation, gets better than 1 percent because there's high burnup, stays in there much longer. And, you reuse it, you would think that would go linearly, but in fact, the output, the end of life core from generation N supports more than one core for generation N plus 1, so it goes exponentially. And, after a few cycles, it's not to be sneezed at, cycles are 30 years long, so it's hundreds of years. You eventually get to this kind of utilization.

Then you begin to tap into what was referred to as the enormous energy content of the fertile fuel we have. The U.S. inventory of DU is equivalent to five times the world's proven oil reserves. So, if one can get decent fuel utilization out of the existing either the waste product of the front end of the nuclear fuel cycle, DU, or the back end, the used nuclear fuel, we really don't have to worry about the price of uranium, or availability of uranium going forward.

Now, on to the waste. This chart deals just with quantity of waste, volume or tonnage. I've got the mass. This particular chart. As a function of the number of years of operation, for continuously operating site with 1.2 gigawatts electric, so that might be a single--it would be five of these little EM squareds, which are 240 megawatt electric. LWR generates all these little steps, or each little fueling cycle, every 18 months or two year fueling cycle of the third of the core coming out, and adding up over 400 years to 12,000 tons in that one site.

You do better with a reactor that has high burnup, because the fuel generates more energy. You do better if you have higher efficiency. This is about 50 percent higher efficiency. So, that gives you a bump even at the first cycle. If you reuse the fuel multiple times, you get another linear increase in this ratio, and you do even better yet, and this is the case I happened to plot, if the spent LWR fuel is used as fuel, because what's the change in the net waste in the nation due to this sites. And if I'm using up somebody else's waste, I count that as a negative in this population, and I get about a 30 to 1 ratio there.

Well, mass and volume aren't the only things. Maybe not the most important things. By the way, all these little steps, there's a big step at the end, and that's because I've said at the end of 12 cycles, I'm finished with that core. So, I have now put all that, that core has now in its entirety gone into waste. Whereas, these intermediate steps, I've just taken out the fission products, because I reused the fuel. Also had a slight waste that went into every step here in the manufacturing process.

These are a bit more profound, and I should have plotted this a different way, I didn't realize this until I looked at it today, but here, the implications for the decay activity and the decay energy after one cycle, what I should have done, the dark is actinides, the lighter color is fission products. What I should have, was showed this on the same chart with LWR and done it on a per unit heavy mass, per ton of initial heavy mass. That's the way it's usually plotted. But, I can tell you what the results are.

The fission products are better, particularly the early times, EM squared, because the cesium has gone somewhere else. It's still in the system, but it's not in this waste stream. It was captured separately in a gas stream, not the core. It's not entrained in the complex waste. So, the early times are better. At late times, it's dominated by samarium 151, the spectrum is a little different for a fast reactor and a thermal reactor, but you wind up with about the same fission product mix, a little bit more technetium 99 in the fast reactor, as it turns out. And, it's only a few watts per core for the fission products after a couple hundred years.

The actinides, if you only run one cycle, aren't very different. It's a different mix of actinides, but it's roughly the same radiological burden. If you can reuse the actinides multiple times, you can reuse the core, then those numbers go down linearly per unit energy produced. It depends on how you plot all this stuff.

Perhaps the most evident difference is that you're simply taking the waste and leaving it in the reactor longer. You're not taking anything out after two years. You're waiting 30 years before you take anything out. But, hopefully, after 30 years, you're reusing that multiple times.

So, waste doesn't meet a repository need until its finished with however many cycles it's going to go through. And, there's R&D to find out how many cycles that is. But, it's certainly postponed decades, maybe centuries.

Proliferation. Some of the advantages are--we actually don't even have any fuel handling technologies in here. Some of you may ask well, how can that work? How can you have a reactor that sits there for 30 years and you never touch it? I suggest you ask Mr. McKenzie here, because most of the reactors built in the U.S. work that way. They just happen to be on ships.

Avoiding chemical separation, I wasn't going to talk about that today, but we could. The fuel that's discharged with its actinide content winds up being quite self-protecting, though it's not immediately useable by somebody who grabbed ahold of it. Reactor is below grade, which makes access to it more difficult. And, the low access reactivity, you can't just take a portion of this reactor, take out the fuel and put in a breeding section. It won't be critical anymore. It doesn't have enough excess reactivity. It can't be used as a fuel fabrication facility for unpleasant purposes.

The economics, these are what we say--this is data from the latest MIT study. This is what we get from using the same code that's used on the next generation nuclear plant NGNP, studies for cost studies. I don't tend to believe those codes. But, I tend to believe that the cost would be less on a per unit energy produced basis. This has far less materials. It has far more factory labor. It has a shorter construction time correlated to those two things. It has a smaller facility footprint. It has higher efficiency. It doesn't have shut-downs for fueling or shuffling. Has simpler control mechanisms, doesn’t have complex control rod drives, and so on. And, a more esoteric matter, the fuel is bankable because it lasts the life of the--like any other structure, and you can turn it into an operating loan, which reduces the cost of money. Right now, fuel is an operator expense.

There is a report you can get from DOE of the usual heft from the national laboratory review of this concept, and it was generally supportive of the reactor physics and of the goals set out and the reasonableness of the goals. I spent most of the time talking about all the development programs that need to be carried out to convince yourself that this would really work. And, the principal issues are material life, fuel chemistry. After 30 years, you’ve got most of the periodic table in that. So, it’s an active chemical system. And, the fission product transport, do we really get those gases out of the system? Can I make welds that will last 30 years, seals that will last 30 years without getting too much of that stuff in the coolant. And, people are now mapping out the research programs and getting started on some of these things.

GA took encouragement from this report, and has committed a lot of money to taking some of these technologies to the next stage. We’re actually building representative fuel elements, representative structural elements. We are also studying the plant end. Our notion for a power conversion system is a generator that operates not at synchronized to 60 hertz, but operates much faster to make it smaller, get rid of all the magnetics, make them very small high frequency, and then have a converter, solid state converter at the end. That's kind of a modern thing. That's the way the Navy is doing their new power distribution systems, for example.

So, in summary, I think this program, we're at a very early stage, shows some promise economically, shows some promise for waste, shows some promise for proliferation. And, hopefully, we'll start to see the involvement of the kind of talent this country needs to see in its nuclear forays in the future.

That's it.

GARRICK: Thank you. Okay, Howard, why don't you start?

ARNOLD: Okay, Howard Arnold, Board.

Looking at your Slide 11. The one I'm looking at is comparative--yeah, that's it. I was surprised to see that the cost advantage from an ALWR was entirely in the capital cost, and that the fuel cost is higher in yours. What's the reason for that?

RAWLS: We have to buy all the fuel at day one.

ARNOLD: Excuse me?

RAWLS: We have to buy all the fuel at day one.

ARNOLD: I see. So, this is up front cost?

RAWLS: This is 30 year--normally, it’s shown as 40 year levelized, because we run for 30 years, so we re-massaged this data. But, the difference is we have to buy all our fuel at day one, so you think that’s a big fuel advantage, but when you actually discount the dollars, it’s a disadvantage.

ARNOLD: So, really, what you’re saying is you’ve got a thing that’s going to be cheaper from a capital cost standpoint?

RAWLS: Yes. Now, this analysis did not factor in this. I run this by a few people and they buy it, and that will change actually, the differential on the fuel. The fuel costs will go down here. I’ll be able to treat that like a--right here, it’s treated like a construction loan cost. If you treat it like an operating cost, in which it’s a bankable asset, you’re getting revenues from that fuel. That reduces that number.

ARNOLD: Okay. But, it all boils down to a claim that--

RAWLS: If you didn’t have inflation and you just added up how much fuel you had to buy, this has to buy a lot more fuel. But, it delays it. This has to buy all the fuel at day one.

ARNOLD: Yeah, okay.

RAWLS: So, discounted dollars turn out to be higher.

ARNOLD: But, the capital cost, again, I come back to that, you project about half for the ALWR cost.

RAWLS: If I count fuel the way it’s counted in the normal ways of thinking, normal ways of doing the accounting, our cost per kilowatt hour is down by 30 percent. Our cost per kilowatt is down by 40 percent. So, the capital improvement is better than the electricity cost improvement. And, as I say, I don’t tend to believe those numbers. I just believe it’s going to come out that way from these attributes. If we can make this work, it’s going to be cheaper.

GARRICK: You know, it seems that about every few years, small modular reactors come back into the picture, starting way back with the Army package power reactors. And, then they fade. Is it this particular reactor type that makes it exciting this time around? Because, in general, the feeling is that nuclear has its best application when you make them big, and have a need for a great deal of energy. But, smaller amounts, maybe there’s other ways to go.

RAWLS: I participated in many discussions of this point, and there’s certainly no consensus. The feeling is for LWRs, the bigger the better. And, I think if you look at, for example, the small modular LWR cost, they’re higher per kilowatt and per kilowatt hour. They have advantages for capital formation. If somebody can’t risk the company on one plant, they can risk a billion, but not 5 billion, they have advantages. And, for some utility commissions where your cost isn't the most important thing, because you recover it, that may be the right answer.

But, if you're competing on a low basis, price really matters, and the bigger the better. I think you can make a difference if you can also shrink the balance of plan. So, that's why we're pushing to try to get the power side of this down. It's typically a lot bigger than the core.

I watched with interest the movement of the steam generators that San Onofre just imported, 570 tons each, took them two weeks to move it 15 miles up the coast. That was interesting. A lot of the costs that are added to your system, they punched a 28 foot hole in the wall to get it in there, that sort of thing.

ARNOLD: And, of course, you're claiming you'll never have to do that.

RAWLS: I'm claiming?

ARNOLD: You're claiming you'll never have to replace that module?

RAWLS: No, I would have to replace the steam generator module, but I can do it on a truck.

GARRICK: Why is the concept associated with underground installation?

RAWLS: I'm not sure that's the right answer. There's a desire to avoid the aircraft impact, question from the NRC, our new licensing reactors, and this does that. For a small enough plant, you can protect it with above ground structures. I'm not sure, I can tell you the original suggestion.

This came from Edward Teller papers in the late 1980s, and it actually triggered what Terra Power does, they were going to be on the session today, and the guy, I visited him a couple weeks ago, and he actually had surgery today, otherwise, he would have been here. They took off also on the Teller paper just like we did. There's a sodium cooled metal clad, completely different technology. Teller's original suggestion you will not like as a waste management scheme. He put it underground so that at the end of life, you could just pull the rods and melt the core. That was his waste remediation program. I don't think anybody is advocating that.

GARRICK: Well, I was just curious if there was something peculiar about this design, if putting it underground offered an advantage. I'm aware of Teller's arguments and the flaps that went on many decades ago about underground construction. I just wondered if there was something here that was different--

RAWLS: It's argued that it's a proliferation advantage. I think the right way to do the proliferation side for a vessel you don’t have to touch, is seal the vessel and make the breaking of the seal an international incident that’s reportable, it’s reported by satellite, the IAEA is notified, so on and so forth. I don’t think it has to be underground. That happens to be the concept that’s currently being represented here.

Most people want to avoid the discussion about aircraft collisions. But, I think there are other ways to do that. You can break up airplanes with modest sized structures if the thing you’re protecting is small.

GARRICK: You noted some disadvantages, and it looked like one of the areas might be materials.

RAWLS: Whether materials are going to live long enough?

GARRICK: Right.

RAWLS: Whether the fuel chemistry will be benign enough. After so many elements appear in the soup, I worry that new reactions will take place that will cause transportation of materials, segregation in the fuel, it’s no longer homogeneous, things I just don’t understand that are perhaps related to small temperature gradients in there that come from chemistry that we don’t know about because it’s never been pushed. You can, in principle, investigate all that without using the unstable isotopes, and that’s something we’re actually trying to set out to do.

GARRICK: My final question is what’s your estimation of the deployment time of this concept?

RAWLS: I don’t have one. We presented this to DARPA and they wanted to do it in 18 months. We presented it to DOE and they wanted 18 years. So, we could use the same chart, we’d just have to redo the little scale.

ARNOLD: Geometric mean or--

RAWLS: I think DOE is a lot closer.

GARRICK: I’m thinking more from the standpoint of the development. How long is it going to take to develop this concept?

RAWLS: The biggest problem is getting accelerated live data on the materials. There’s no U.S. facility that allows that to happen, and there are impediments to doing it at offshore facilities of various types. I can go through that if you like. So, what we’re going to have to do is build a test reactor that’s probably smaller, high power density, that gets accelerated life. And, we’ve actually talked to people at INL about doing that. But, we’ve got to get further down the road with samples tested and ATR, hyper, and things like that before we even contemplate that.

GARRICK: Because I remember many, many, many decades ago, similar excitement about homogeneous reactors, for example, but nobody could solve the chemistry problems, because you could have continuous reprocessing and had lots of very desirable features, and it could be at any size and what have you, but the materials killed that project, the chemistry.

RAWLS: Well, there's some advocates. Steve Koonen likes it, Pete Lyons is a big fan, Pete Miller wants to spend money on it, but Pete Lyons is an advocate. So, I think it will get a fair test in the technology department. If you serve six more years, maybe we'll know whether it's real or not.

GARRICK: Well, that's not going to happen. Any other questions for John. It's very interesting.

ARNOLD: Arnold again.

Talk just a little bit about that turbine, the high speed turbine, please, and what development opportunities exist there.

RAWLS: We're actually--before I do this, I started a program for the Navy, it's called EMALS. It replaces the steam catapults on aircraft carriers with electromagnetic catapults, and we had to figure out how to store enough energy electromechanically to do that as opposed to use the steam header from a nuclear reactor. And, in order to get the weight down and the size down, we had to go to higher speed motors than what were out there, with high power. You can make high speed motors, you know, the dentist's office has very high speed motors, but if you want megawatt class high speed motors, you get into combinations of mechanical, thermal and electrical stress that are quite challenging programs. We made good progress there. We kind of apply the same technology here.

And, the power electronics to go along with that has really improved, so that you can very inexpensively on a dollars per kilowatt basis, take say a 400 hertz output, convert it to sync to the grid, and a 400 hertz machine would be one-seventh the size of the 60 hertz machine. So, we think that the cost eventually would come down to the cost of materials, and making it smaller is going to be the right answer. You push combined stresses, it’s a challenge, but it can be done.

GARRICK: Very good. Outstanding. Thank you. Okay, Otis Peterson is going to talk to us about novel small reactor technologies and their potential impact on spent nuclear fuel and high-level radioactive waste disposal, et cetera.

PETERSON: All right, I’m here to talk to you about a very special reactor, a mini reactor, which is built to fill a very special niche in the marketplace. We are designing this system to be small enough that it can actually be transported completely, the entire core, and to do that, we need to be able to put that core into a standard transport cask.

So, to be transportable, the core needs to be completely sealed, and we want to make this thing small enough it will fit into a standard transport cask. And, so, searching the industry for the largest cask that's available, it roughly about five feet, and inside diameter, a meter and a half, and so that's what we are designing around.

This reactor would produce 25 megawatts of electricity. It would be designed to last for eight to ten years. We are well along with what would be considered the scientific design of that, which is being engineered by Los Alamos. By making these things very small so that you never touch the fuel, you don't have to have any infrastructure on site where this reactor is installed. As a matter of fact, you don't even have to have any infrastructure within the nation in which this reactor is being installed. We want to make this thing safe, simple and very economical so that it can fit into many operations in many places in the world. We want to produce power for less than 10 cents a kilowatt hour anywhere on the globe.

So, you can see here a typical installation where we would have a vault, which is underground, two vaults actually, one into which we would place an operating reactor, which would last for, as I said, the order of eight to ten years. When that's close to being burned out, finished, we would load another one into the sister vault next door, and we would just switch from one to the other, leaving the first one in here for a few years, that length of time to be determined, to when it’s a little easier and safer to remove. And, then, we’ll pick up the entire unit, which is here, disconnect it from the piping, and so on, and take the whole thing back for refurbishing, refueling, and everything, back at a central location.

So, what we have shown is the coolant for this will be liquid metal, to make this thing small, we don’t want to have to have a pressure vessel, so we are using liquid metal. In this case, we’re going to use lead bismuth eutectic, which is safe to use and transport because you can drop it into water, or expose it to air, and you do not get sodium fires. It’s a little heavier, but you end up with a total system which is very safe and secure.

The lead bismuth would be piped out of there, sent through boilers to make steam, and you would end up then with electrical production in a standard manner. While we have no interest in redesigning the energy conversion equipment, but we want to make sure that the energy conversion process is well separated from the nuclear process, so that they do not feed back onto each other in any fashion. The rotating machinery is outside the radiation field, so that it can be maintained, replaced, or whatever might be required for that equipment.

The specifications are shown here, the details that you may have interest in for the nuclear engineers. We want to, as I said, produce roughly about 25 megawatts of electricity over a period of time of about eight to ten years. I already said that this thing is roughly one and a half meters in diameter, and it's about two and a half meters high, easily fit into a standard transport cask, put it on a rail car or heavy transport, and away we go.

The structural material will be stainless steel. The fuel is to be uranium nitride, which will be encased in stainless fuel pins within the reactor, and then we will have lead bismuth already encased in that chamber. There will be a primary lead bismuth cooling loop which will be completely contained. There will be a secondary loop and a heat exchanger within the total envelope of one and a half meters by two and a half. And, that secondary loop will be coupled to the outside world and eventually end up in the heat exchangers or boilers, as you might want to call it, to produce steam for the power conversion.

To keep things small enough that we can fit into this cask for shipping, we need enriched fuel, and so we're proposing to go to the limit of low enriched fuel, which is roughly 20 percent. I mean, we'll stay just under that. But, this is where I expect this become interesting to this Panel, because now we're going to be dealing with spent fuel, which is no longer only 5 percent or 1 percent, 5 percent maximum, only 1 percent enriched. And, so, there is where we get to the point where it becomes interesting for you people.

So, as I stated, to keep this size small and still have a nuclear reactor that can work for a reasonable period of time, we need to have fuel enrichments on the order of 20 percent. And, to meet the certification requirements, that we have a fuel which has been demonstrated to have a certain burn depth. Uranium nitride has been operated up to about a 6 percent burn, so we’re assuming that we can operate to probably about 5 percent.

So, if we start with 20 percent enrichment, and we can only burn down 5 percent, that still--of course, what burns is obvious the 235. So, we end up then with spent fuel which still has an enrichment of roughly 15 percent. That is valuable material. The original fuel at 20 percent enrichment is probably worth about $10 million a ton. So, we would end up then with fuel which the spent fuel still can be worth of the order of $7 million. We need to retrieve that value to make this reactor economically viable. So, we need a method of recycling this fuel so that we can retrieve the economic value, which is there.

So, our bottom line is that for the first time in the commercial world, we actually have spent fuel which has value rather than spent fuel which we have to spend money on if we want to recycle and reuse or, you know, try to minimize the use of new ore or whatever. So, there’s a real driver now for looking into what is the best, the most economic way to make use of spent fuel out of a commercial reactor.

So, I’ve already said some of this, you see, we still have 75 percent of the initial economic value is still retained in that spent fuel. We need to get that back. That should be a reasonably straightforward process. We can calcine nitride to get to the oxide fuel that already has been demonstrated many different separation processes, and been demonstrated for that. We need to make this process as simple and cheap as possible so that we can keep this operation going.

The first stage of PUREX supposedly can separate out the fission fragments which are the nuclear poisons that we don’t want to be recycling, and therefore, allow us to recycle the actinides which is the major fraction of that. And, so, if we then end up with material which is roughly 15 percent enriched, you know, we clearly can just dilute that three to one and we have 5 percent, and we have something we should be able to sell back to the big boys, the nuclear industry that already exists out there.

So, we think that this really is the first time in the commercial realm that there is a real economic justification for reprocessing, recycling, and we would like to see this proceed.

And, so, since I'm speaking to the Department of Energy, I wanted to point out the places where we think that we all need help to do this. And, that is that we really need to optimize those reprocessing technologies. And, not only that, but to do that in the region where the enrichments are higher than the normal 5 percent that people are presently dealing with. And, so, that's a different type of reprocessing than we've been used to. But, then, again, this is a small scale because these reactors are not going to hold more than a few tons of, probably in the order of about 5 tons of fuel per reactor. And, so, we're not talking about the same scale of operation that the present commercial reactors are operating at. But, we need to develop the designs and the facilities, and particularly the procedures for handling these higher enrichment fuels.

We also need to look at the techniques for treating non-oxide fuels, because almost everything out there obviously is dealing with the oxides. And, we actually think that the future, and this is essentially reinforcing what we have heard several times earlier today, that there's no need for separating the actinides from each other, that we should be able to keep all the actinides together, take out the fragments which are poisons, and then send the actinides as a group back through the reactors to make sure that we extract all of the power and value that's stored in those.

And, all of this, of course, needs a regulatory framework to be able to do all that work here in the United States. And, so, that’s my story.

GARRICK: Thank you.

PETERSON: We’re changing the paradigm and proud of it.

GARRICK: Well, it isn’t that we don’t have experience with reprocessing highly enriched fuels, because we do. But, we don’t have experience with this particular--

PETERSON: Yeah, and it’s not necessarily available to the commercial world.

GARRICK: Right. But, I don’t know that that should be such a difficult challenge. What was the real driver for this concept?

PETERSON: Well, actually, it started out as a technical novelty, which got attention and got us going. But, it turns out that by exposing the world to this concept of a reactor which is totally sealed and sent out as a cartridge, as it were, a black box that you don’t need infrastructure to support, turns out to have been a very strong driver in the commercial world.

Kim Jones, who is in the audience back there, has developed a market between 100 and 200. He’s collected letters of intent to purchase this device when we, you know, start making the first ones. And, so, there is a real market out there that needs to be addressed. And, so, that is the important thing that Hyperion is selling, is actually having that packaging, as it were, of nuclear power.

GARRICK: What are some market examples, what kind of applications do you envision, what made up most of this 100 or so?

PETERSON: Well, many of those places, those markets, are places which are off the grid or on the periphery of the grid. There was comments made at the ANS conference a few weeks ago that it’s easier to get a site to put a nuclear reactor in than it is to get a site to put a new extension of a grid. The amount of money that’s invested in putting in, you know, big grids is really competitive with putting in new reactors.

But, there’s lots of other places, you know, obviously remote communities are a perfect example for this, islands, things like that. Military bases are--they want to have stand lone power supplies, there’s well over 100 U.S. military bases that need the order of 25 megawatts or more.

The heavy oils, you know, the oil industry, presently to get to free the heavy oil, the bitumen that they try to get out of the ground, they send steam down to melt it, and they burn the equivalent of one-third of the oil they get out of the ground just to generate the steam to free the oil in the first place. So, you know, we can, if we can supply them nuclear power, not only do we lessen the amount of CO2 dumped into the environment, but we increase their yield by 50 percent.

So, you know, we've got--there are just lots of applications, and, you know, you can't afford to put a gigawatt system up in the oil stands in Northern Canada, but you could put a whole bunch of these up there, and at the end, pick them up and take them home.

GARRICK: But, it's still more or less a base load concept, isn't it?

PETERSON: Yes, absolutely. It definitely is base load, but on a small scale.

GARRICK: Right.

PETERSON: That's all. The scale is different.

GARRICK: Yes, go ahead.

ARNOLD: Arnold, Board.

One of your arguing points is the value of the fuel as it's being reprocessed. But, that's simply you're getting your money back that you put in in the first place.

PETERSON: Right.

ARNOLD: You put in too much in the first place.

PETERSON: Correct, absolutely correct.

ARNOLD: So, you have a carrying cost of three times the--

PETERSON: Right, the financial--

ARNOLD: So, you know, the economics, I would still have to question. A technical question. Why nitride fuel? I know it was going to be used in one of those space electric vehicles, but why nitride?

PETERSON: Yeah, when I was on that other viewgraph, I forgot to point out that again, we're trying to, since this is very small, we're trying to improve things to our benefit as much as possible. We intend to operate at 500 degrees, which is a little high for oxide. Nitrides are much better when you go to those higher temperatures. And, so, that's the reason for going with nitride. We also can bond the fuel to the cladding again using our lead bismuth eutectic to do that, I mean, thermally bond of course. So, that those things all make it a nice complementary package.

ARNOLD: I was wondering if Los Alamos is trying to use of the fuel they made for that.

PETERSON: No, they'll have to make more. But, they would be happy to have the business, at least for the first couple of loads. Then, they'll be out of it.

GARRICK: Are you getting most of your lead bismuth data from the Russians?

PETERSON: A lot of it, but there's a lot of other places which either are using it or testing it. Los Alamos themselves have been using lead bismuth over on the accelerator for cooling their target. And, so, there's quite a bit of experience with lead bismuth, but the predominant amount is overseas.

GARRICK: Any questions? Anymore questions? Questions from the Staff?

(No response.)

GARRICK: Anybody from the audience want to challenge this fascinating concept?

PETERSON: Yeah, let's make life lively.

GARRICK: No, it's very serious business. Thank you very much.

All right, according to our schedule, we are at the public comment part of our meeting. And, I have two names here of people that want to make public comments. One is Abby Johnson. Is she here?

JOHNSON: Hello. I'm Abby Johnson. I'm the nuclear waste advisor for Eureka County, Nevada. Eureka County is one of the ten affected units of local government under Section 116 of the Nuclear Waste Policy Act, and we have participated in the Yucca Mountain Oversight Process since the mid 1990s. I've been involved in the repository issues since 1983, either professionally or personally, or both.

I'm here to advocate for this Board's timely role in gathering and compiling lessons learned for the Yucca Mountain Repository Process. We could call it lessons learned, the prequel, or lessoned learned so far, or lessons from the first 50 years.

The Nuclear Waste Technical Review Board has been a leader over the years in providing a forum where all parties have discussed key issues. Your transcripts and related documents are a record of the process, and the evolution or devolution of the repository program. And, you have always been open to public comment.

It is evident that the Blue Ribbon Commission deliberations would benefit from Yucca Mountain lessons learned. To paraphrase one of today’s speakers, the optimum processing time for lessons learned is now.

Although the Board’s focus is technical, it has wrestled with institutional, management, systems and policy issues which have been as daunting as the technical challenges, and should be a focus of the Blue Ribbon Commission’s work.

I would hope that if the Board convened a lessons learned meeting, that you would invite panels for the range of perspectives and roles that have been active observers over the years. Consider the obvious participants, but also the observations of self-servingly, the affected unit of local government, the states of Nevada and California, the public interest groups, the media, and former TRB Board members whose past investment of time and intellect should be recognized and whose ideas should be invited.

I encourage the Board to do this in a timely fashion so that the transcript, and should you desire, related report could inform the Blue Ribbon Commission process and their draft report. Providing an open and accessible forum to discuss and compile Yucca Mountain lessons learned so far would serve scientists, scholars, engineers, decision makers, and the public who will face the challenge of nuclear waste disposal into the future.

Thank you for considering my request.

GARRICK: Thank you. Thank you very much. And, we will certainly consider your request.

Judy? Judy Treichel?

TREICHEL: This was going to be the first meeting where I was not going to say anything, because it was Idaho and you were hearing from people from INL, I've never been to INL, I don't know much about it, it was really interesting. And, then, Dr. Schwab stood up and started talking about the new used fuel disposition campaign that's part of the Nuclear Energy Office of the Department of Energy, and it just flared up all those old horrible issues.

And, in his presentation, it was so clear that nuclear fuel disposition or disposal of nuclear waste is sort of like this unattractive step-child that comes at the very end of a long, long family tree, and in fact, the last slide that he had did show it as the last line of a long and busy family tree. And, it's just kind of taken as a re-occurring annoyance.

And, on one of his slides, it also pointed out that part of what they would do, the used fuel disposition campaign would identify alternatives, which sounded a lot like the considerations that are being done by the Blue Ribbon Commission. But then on a later slide, he said geologic disposal is required, period.

So, it's like we do lip service to alternatives. We talk about these things, but then when it comes to it, you've got to slam it home in a repository. And, I'm not sure that there should be a repository or there shouldn't be, but there should certainly be a discussion about alternatives for what happens to nuclear fuel.

And, I also think that it's interesting on that same slide, somebody asked if there was a technical basis for coming up with the disposition possibilities, and that they would look at granite, shale, salt and deep borehole, when in fact in the Nuclear Waste Policy Act, there's a provision for sub-sea bed. I'm not advocating that. I have no position on that at all. But, it's actually in the Act, whereas granite is prohibited. So, it's just sort of an interesting kind of list.

But, then, he got to the point where he was talking about the Slide 16, very famously showed that EPRI was the one, the Electric Power Research Institute, that put together a collaboration, and in this collaboration, there was EPRI, two parts of DOE, there was NRC, there was NEI, the utilities, the national labs. And what’s missing here? If we have to have any sort of a lessons learned, as Abby was just talking about, the public is completely missing from this entire thing.

And, there’s also missing--I mean, this is so bad, I come out agreeing with Dr. Garrick, we made a great point that there should be research done on source term, and there was another comment made from the Staff that maybe you ought to look at what’s to be disposed before you start figuring out where and how to dispose of it. And, come from the back end forward, instead of all the exciting stuff about new nuclear power plants, new nuclear energy, all of that sort of thing, and then oh, yeah, we’ve got this awful thing called disposal.

And it’s just never going to be solved with this campaign or any other, because by the time you get to announcing what your new solution is, you’re going to have people like me, and there’s a whole lot of them out there, who will be all set up to oppose anything that comes along. And, we finally have gotten pretty good at it.

So, if you want to have something that makes any kind of sense, that goes anywhere in the future, you’ve really got to start out from the very beginning doing the kinds of research that needs to be done, and starting with the public involved right off the bat.

And, lastly, I guess I'm the only person in the room that will say if nuclear waste is a really big problem, why don't we even consider stopping to make nuclear waste.

Thank you.

GARRICK: Thank you, Judy. Any other comments from anybody?

(No response.)

GARRICK: I want to thank the public comments. They're very thoughtful and very provoking, and we appreciate it. It's the highlight always of the Board's meeting.

Does anybody have any other business to take up, either the Board, the Staff or the participants?

(No response.)

GARRICK: Hearing nothing, I will officially adjourn this meeting, and thank everybody for excellent presentations and an excellent day.

(Whereupon, at 4:50 p.m., 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 Summer Board Meeting held on June 29, 2010 in Idaho Falls, Idaho, taken from the electronic recording of proceedings in the above-entitled matter.

July 12, 2010

____

Federal Reporting Service, Inc.
17454 East Asbury Place
Aurora, Colorado 80013
(303) 751-2777