NUCLEAR WASTE TECHNICAL REVIEW BOARD

MEETING OF THE PANEL ON THE ENGINEERED BARRIER SYSTEM

IDAHO NATIONAL ENGINEERING LABORATORY (INEL) ACTIVITIES FOR DISPOSAL OF DEFENSE HIGH-LEVEL WASTE AND SPENT NUCLEAR FUEL

O'Callahan's Convention Center
Shilo Inn
Idaho Falls, Idaho
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BOARD MEMBERS PRESENT

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Dr. Donald Langmuir, Chair, Panel on the Engineered Barrier System
Dr. Garry D. Brewer, Member
Dr. John J. McKetta, Member

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Dr. Ellis D. Verink

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P R O C E E D I N G S

DR. LANGMUIR: Good morning. My name is Don Langmuir. I am professor emeritus of geochemistry at the Colorado School of Mines in Golden, and I serve as chair of the Board's Panel on the Engineered Barrier System. The EBS Panel instigated today's meeting.

First let me introduce my colleagues on the panel: Dr. John McKetta. Is John here yet? There he is.

DR. MCKETTA: Hi, Don.

DR. LANGMUIR: Professor emeritus of chemical engineering at the University of Texas in Austin. Dr. Dennis Price I think is still having breakfast. He is professor--it's very tough getting service out there with this many of us. He is professor of industrial and systems engineering and director of the Safety Projects Office and coordinator of the Human Factors Engineering Center at VPI. Dr. Ellis Verink, professor emeritus in the Department of Material Science and Engineering at the University of Florida. Dr. Verink chaired this panel until his term expired. He and Dr. Price, whose term also expired, have been serving on the panel and the Board as consultants pending presidential action to reappoint or appoint replacements.

We are very pleased that the Chairman of the Board, John Cantlon, is with us today. His field is environmental biology, and he's a former vice president for research and graduate studies and dean of the graduate school at Michigan State University. He has served as chairman since April of '92. As chairman, he is an ex officio member of all panels.

I'd also like to introduce Dr. Garry Brewer, professor of resource policy and management and dean of the School of Natural Resources and Environment at the University of Michigan. Dr. Brewer chairs the Board's Panel on Environment and Public Health and the Panel on Risk and Performance Assessment.

We have two members of the Board's staff with us at the head table. One is Dr. Bill Barnard. Bill is the Board's executive direct. And Dr. Carl Di Bella, who is a member of the Board's senior professional staff and who assists this panel among other duties. I also want to thank Carl for his as usual excellent job of organizing this meeting for the Board.

Several other Board staff members are with us today. They are seated at the table on the side or at the table in the back. Briefly, they are Russ McFarland, senior professional staff member; and the other professional staff members with us today are Dr. Daniel Metlay, Dr. Leon Reiter, Dr. Daniel Fehringer and Dr. Victor Palciauskas. Also with us today are Frank Randall, a member of our external relations staff; Linda Hiatt, in charge of meeting arrangements; and Donna Stewart, member of the support staff.

We are not frequent visitors to INEL. This is only the second visit by a Board group, our only other being more than three years ago. I think, therefore, that I need to describe who we are, briefly, what we do, and of course why we're here. Our Board was created by the 1987 amendments to the Nuclear Waste Policy Act. The amendments provide simply that the Board shall evaluate the technical and scientific validity of the Department of Energy's activities under the Nuclear Waste Policy Act. The Act itself was passed in 1982 and provides for DOE to develop repositories for high-level waste and spent nuclear fuel by following an orderly process of repository site characterization, approval by the Nuclear Regulatory Commission, and construction. Currently, only one potential repository site is being evaluated. It is at Yucca Mountain, Nevada. Site-specific work for a second repository is not authorized and cannot be under current law until the year 2007 at the earliest.

Board members are nominated by the National Academy of Sciences and appointed by the president. We are not a large Board. More than half the Board and more than half the professional staff are here today, even though this is a panel meeting rather than a full Board meeting.

The liquid high-level waste from reprocessing in tanks at INEL and the greater amount of calcine derived from that liquid waste and stored in bins here are destined for deep geologic disposal in some sort of safe, solid form, in one or more repositories. That material is our--was our primary interest for our last visit. We wanted to know how the waste would perform in a repository and how it could impact a repository. We wanted also to know how much there is, what its composition is, what sort of separation and solidification treatments you are considering for it to get into a proper form for permanent disposal, and how it might be packaged to come to a repository.

We are looking forward to an update on your plans for liquid high-level waste and calcine today, but our primary interest for this visit is really spent fuel, in particular spent fuel owned by the government, like naval spent fuel, in contrast to civilian spent fuel. This government-owned spent fuel is also destined for deep geological disposal in a repository, after appropriate processing and packaging. Our questions are in the same vein as for high-level waste and calcine: how much government-owned spent fuel is there, what are its characteristics, and what are you going to do to make it acceptable for repository disposal? I suspect that all the answers to these questions do not yet exist, but anticipate we will hear your plans to develop answers.

We would also like to know how the part of DOE responsible for storing, processing, and packaging the high-level waste and spent fuel, which is the Office of Environmental Management, and the part of DOE responsible for site characterization at Yucca Mountain, which is the Office of Civilian Radioactive Waste Management, are working together to develop specifications that high-level waste and government-owned spent fuel must meet for disposal.

Also on today's agenda are discussions about the Greater-than-Class-C waste management program. Although this is defined as a low-level waste, it is the most hazardous of low-level wastes, and therefore destined for geological disposal. And there is a presentation about INEL activities on civilian spent fuel storage. With regard to the latter, I want to announce that for our 1:30 presentation today, David Abbot and Norman Rohrig will do a tag-team presentation in place of Kevin Streeper.

We are well aware that the Secretary of Energy announced her Record of Decision on the "interim management" of government-owned spent fuel on June 1st--last Thursday. In this case, "interim management" apparently means the consolidation of government-owned spent fuel to Hanford, INEL, and Savannah River, and its safe storage at these locations for a finite time period. We realize that our presence here so soon after the Record of Decision may leave some to infer that we might have something to do with it or the draft and final EIS that preceded it. Well, we really don't. "Interim management" of government spent fuel is not in our purview. As I've said already, our purview is the next step. We are concerned about waste that might be disposed of with civilian reactor spent fuel in a repository. We would hope, however, that whatever is done during "interim management" will not be incompatible with ultimate disposal.

We want to express our thanks to the Idaho Operations Office and Lockheed-Idaho Technologies for the meeting today and the tour tomorrow. I want to particularly thank Brian Edgerton, Walt Mings, Ron Denney, and Gerry Paulson; I understand that they have been working closely with the Board's staff in arranging the meeting and in setting up tomorrow's tour.

I know that each speaker has much more to say than could be said in his or her topic area during the time allotted. I am concerned that we stay on schedule so as to allow those speakers late in the day their fair share of time. So to the speakers, I say, please stay on schedule; I will help you by letting you know as you approach the end of your time. I will be soliciting questions from the Board, the staff, and if time permits, from the floor, after each speaker. If I don't get to your question or comment, please try to hold it until the public comment period at the end of the day.

If there are no general announcements before we start; if there are, we could address them now. If not, let's continue and start the meeting.

Our first speaker is Tom Burns, assistant manager of the DOE-Idaho Ops Office. The floor is yours, Tom.

MR. BONKOSKI: Now, first off, I'm not Tom Burns, I'm Mike Bonkoski. I'm manager of the spent fuel and high-level waste programs at the Department of Energy Idaho Operations Office.

I'd like to welcome the Engineered Barrier System Panel to Idaho Falls. I will not apologize for the weather, but I can't let this weather pass without comment. When I first moved here about thirteen years ago, I was told by a lot of people here that if you're dissatisfied with the weather, wait five minutes and it will change. Well, they didn't finish that. It does change, but for the worse.

This is a timely meeting of the Panel in Idaho Falls, mainly due to recent and current activities that affect our management of high-level waste and spent fuel. Just recently we completed our spent nuclear fuel programmatic and environmental restoration waste management EIS and issued a Record of Decision on that last week. And you'll hear more about that later. In addition, we're negotiating with the State of Idaho a consent order under the Federal Facilities Compliance Act that relates to scheduling a treatment of high-level waste. And in addition, we have the bill of the week that's being proposed in Congress regarding the repository.

I think we have an interesting array of topics for you today, and if there is any additional information we can provide to you after this meeting, please feel free to ask. Again, welcome to Idaho Falls.

DR. LANGMUIR: Our next presentation is, if I have the name right and we haven't got a problem with the agenda, Steve Gomberg, talking about waste acceptance requirements, the DOE interface.

MR. GOMBERG: I was going to make a comment about the weather, too, but I guess since everybody else will I'll hold my comments until the end of the public comment period.

I have a lot of material and a little bit of time, so what I'm going to do, I guess first I should introduce myself. My name is Steve Gomberg. I'm with the Civilian Radioactive Waste Management Program, team leader of the systems engineering and program integration team. I'll be talking about waste acceptance requirements and the DOE interface. And basically I wanted to cover four areas. The first three, in the interest of time, I will try to go over very quickly, because I think the Board knows most of that information, and then focus on the latter point, the interface, that I don't know if the Board has heard anything formal to date.

For the purpose of overview of the program, some key milestones and activities that we are focusing on at the present time, notwithstanding any bills of the week or anything along that line. We're working at Yucca Mountain Site Characterization Project to make a Technical Site Suitability Determination by 1998; to submit an initial license application by the year 2001 to the NRC; and to begin repository operations by 2010. From the waste acceptance storage and transportation side of the program, we are planning on deploying Multi-Purpose Canisters to the utilities by 1998, and presently there is no monitored retrievable storage system within our planning basis at this time. From the standpoint of second repository operations, there are no activities being conducted to date to investigate second repository. We are required to make a recommendation and an evaluation to Congress no sooner than the year 2007.

Also, I wanted to just put a schematic up. This is what we call an interface diagram. It tries to define the flow of materials into the Civilian Radioactive Waste Management System, ultimately destined for permanent disposal in a repository. In the upper left-hand corner, the civilian reactor and spent fuel storage site wastes and DOE spent fuel storage sites will provide spent fuel which, if acceptable, would be transported into the Civilian Radioactive Waste Management System and ultimately emplaced underground in a repository. There is also the high-level waste and production storage, including that from INEL, which would also potentially come through that waste acceptance gate into the waste management system.

There are three key Statutory and Regulatory Authorities which primarily drive the activities of the program, including the development of requirements, and they are: The Nuclear Waste Policy Act, which defines the development of repositories, authorizes characterization of the Yucca Mountain candidate site, limits waste to be emplaced in the first repository to 70,000 metric tons heavy metal. In addition, the 10 CFR Part 60, the NRC's regulations on disposal of high-level waste in geologic repositories, defines licensing requirements, site criteria, waste package performance and design criteria, and repository design considerations. And finally, the Environmental Protection Standard, 40 CFR 191, which is presently remanded and is being reevaluated by the National Academy of Sciences, establishes allowable releases to the accessible environment. In lieu of a final standard, we are using the remanded standard as a basis to at least help us plan and conduct site characterization activities under that standard until a permanent standard is put in place for Yucca Mountain.

Now, within all of these statutory requirements there are some key waste form considerations that we do impose on waste forms. Primarily from the NRC regulations, the waste form must meet certain waste form criteria. Solidification, consolidation, and noncombustibles are the primary characteristics of a waste to be acceptable within a repository environment. The waste form must be designed to remain subcritical for long time frames. And we are currently looking at excluding RCRA mixed wastes from the first repository.

In addition, the waste form is a key component of the waste package design, and there are specific package design criteria which must be met which in part are incumbent on the waste form. Those include no explosive, pyrophoric or chemically reactive materials, no free liquids. These requirements are established in such a way that these are not in a concentration that would affect the ability of the repository to perform its waste isolation capabilities. We also have to have specific handling requirements to ensure safe handling of the waste and unique identification so that we can track the waste, this individual spent fuel or high-level waste, from its origin to its permanent burial locations and ultimately, in the event of retrievability, would be able to identify those waste forms.

In addition, as part of the waste package design, we must consider interactions. And so these include such things as solubility, reduction-oxidation potential, hydriding, effects of radiolysis, corrosion--there are several others. These were the key that would potentially relate to spent fuel waste forms.

Now, in developing requirements for waste forms, another aspect is some requirements that are incumbent on the Engineered Barrier System or the repository have a component that comes from the waste form, and therefore there may be contributory requirements that we would allocate to a waste form in order for the Engineered Barrier System, for example, to meet its performance objectives. I've called these Performance Allocation type requirements. They're important because the waste form is the key physical interface and those characteristics define the design of the waste handling, transportation, repository subsurface facilities and equipment.

In addition, the waste form performs as part of the Engineered Barrier System and the Total System Performance. There are three key periods that we analyze. The first one is called the substantially complete containment period, from 300 to 1,000 years. The second one is the gradual release period, which is basically from 1,000 to 10,000 years. And finally, the overall releases to the accessible environment. Currently right now are established from up to 10,000 years.

In addition, long-term criticality control must be maintained and geometry and various considerations such as poisons and whatnot that the waste form may contribute are part of the overall analysis and set of considerations.

Now, the way we document requirements within the Civilian Radioactive Waste Management Program is through the Requirements Technical Baseline Hierarchy. The top-level document provides the key functions and statutory sources which provide the initial requirements that then get developed and evolved into what we call the System Requirements Documents. If you'll remember the interface diagram I showed a little awhile ago, there were four key activities or elements that occurred within the Waste Management System, and those four activities are captured in the form of Requirements Documents below the top-level document. The one I want to focus on is the Waste Acceptance System Requirements Document, and there's a little bit of a description on that on the next slide.

Okay, and primarily this provides the full set of requirements for those waste forms currently accepted or planned to be accepted into the Waste Management System, including interface requirements, contractual requirements, quality assurance requirements, training, some of the administrative requirements, requirements on the waste acceptance element. And in addition, it identified waste form criteria, and those criteria develop and evolve to different levels of specificity based on the knowledge of the waste form. Right now we have criteria for commercial spent fuel and for canistered borosilicate high-level waste glass, and we are planning to develop other specifications for such waste forms as DOE spent fuel and other waste forms as may be necessary to accommodate geologic disposal.

Now, within the program currently, we plan to accept for disposal commercial spent fuel, low-level--I'm sorry, light water reactor spent fuel and canistered high-level waste glass. This is the most data that exists. And we're evaluating the applicability of other waste forms for disposal, and those are including right now DOE-owned spent nuclear fuel--and that includes production reactor spent fuel, naval reactor, research reactor fuels--surplus weapons materials, plutonium residues, and Greater-than-Class-C low-level waste. The focus of this presentation right now will focus, though, on the DOE-owned spent nuclear fuels.

Now, just by way of comparison, the projected inventory out to 2030 of commercial spent fuel is around 85,700 metric tons compared to about 2,800 metric tons of DOE-owned or defense-related spent nuclear fuel. Within the first repository planning allocation, as established by the Nuclear Waste Policy Act, we can allocate 70,000 metric tons within the first repository, and that allocation right now allows for 63,000 metric tons for commercial spent fuel and 7,000 metric tons of defense spent fuel or high-level waste.

Now, related to depository disposal, the disposition of DOE-owned spent nuclear fuel includes the provision for safe interim storage and management at the location as determined in the Record-of-Decision until they are ultimately dispositioned. All DOE-owned spent fuel would be stabilized, characterized and prepared for ultimate repository disposal. There is currently a reassessment going on within the Department to look at reallocating within the 10 percent allocation within the first repository planning basis to allow--initially it was 7,000 metric tons of borosilicate glass; we are looking within the Department as far as allowing a reallocation so that the total 7,000 metric tons could include both DOE-owned spent nuclear fuel and high-level waste glass. The ultimate constraint is that it does not exceed 10 percent of the repository capacity. And there are certain considerations, then, for acceptance, including payment of fees, appropriate NEPA reviews, minimizing impacts to the program's schedules, and of course, compliance with waste acceptance requirements.

Now, along that line, there are steps along the way that it would take to qualify waste forms for disposal. Certainly the key part would be characterization. We need to understand the physical, chemical, radiological properties of the waste forms, and one key way to do that, of course, is through characterization testing. Performance assessment would take that information and allow us to model how the waste would behave out into the long term. Consistent with the requirements we would focus on the Engineered Barrier System and Total System Performance Requirements and criticality. Presumably there would also be validation testing to validate that these results were reproducible in the field, if you will. In addition, we would need to analyze the waste forms against the waste form criteria in 60.135 to look at some things such as pyrophoricity, chemical reactivity and those sorts of things over the long term within the repository environment.

In addition, then, this information would also allow us to design Engineered Barrier Systems, i.e. waste packages, and surface and subsurface facility designs. the information would also then be used to allow us to conduct the appropriate NEPA evaluations, to prepare for licensing by incorporating the impacts of DOE spent fuel in the Safety Analysis Report, another appropriate documentation that will be going to the NRC. And obviously all of this needs to be done under the veil of quality assurance requirements.

In evaluating the DOE-owned spent fuel disposition for repository disposal, the approach we've taken is to identify key issues affecting our ability to manage those waste forms within the radioactive waste management system, primarily technical, regulatory and programmatic. What we've tried to do to minimize the amount of work and activities that need to be done are focus on those differences between commercial spent fuel and DOE-owned spent fuel. We do have a lot of information on a large data base on commercial spent fuel, and this will hopefully allow us to reduce the amount of work that would need to be done to characterize these waste forms.

What we would do then is recommend data needs and activities that would allow the ultimate integration of these waste forms into the Waste Management System. That's from the OCRWM side. From the EM side, we want to help provide early guidance to EM given what we expect would be the final Waste Acceptance Criteria and the requirements on the waste form to give EM and their contractors the ability to make decisions, including whether the waste forms are suitable for direct disposal, whether they would need conditioning or treatment, or whether they might need processing of some sort to make them suitable for disposal.

Now, this is the section that focuses specifically on the interface that we've established within the Department within the Office of Environmental Management and the Office of Civilian Radioactive Waste Management. This coordination is facilitated by something called the DOE-Owned Spent

Nuclear Fuel Steering Group. And the Steering Group is responsible for identifying issues regarding waste acceptance through emplacement of DOE-owned spent fuel into a geologic repository and specifically recommending tasks, activities, data information needs for the resolution of DOE-owned spent nuclear fuel disposal issues.

Now, the organization includes membership from both RW and EM. There are co-chairs and members as appropriate. And the Steering Group basically will make recommendations to line management for conducting activities as part of the normal budget development process, hopefully beginning in FY '95 and continuing through FY '96 and out years. So obviously some of this work is very dependent on the budgets that we get from Congress and that sort of thing.

We basically established Task Teams, and the task teams are the groups that provide the general expertise in order to develop the issues and the resolution approaches in order to incorporate these waste forms into the Waste Management System and recommend activities and tasks that would need to be conducted. We've broken up the Task Teams into three basic groups, a Program Team, a Waste Acceptance and Transportation Team, and a Repository Team.

Now, what I wanted to do in finishing up is to go through the key issues that have been identified and are being worked on by each of the teams to show that we are on a very aggressive schedule, we are addressing what I think are the key critical issues in all the necessary areas.

The Program Task Team is primarily focused on ensuring that adequate inventories exist and characteristics exist as necessary. There are numerous coordination activities that go on at that level. We want to ensure that there are approved quality assurance programs, both within RW and primarily within EM, who is responsible for managing the DOE-owned spent nuclear fuel, and that we can identify future materials that may require repository disposal.

The Waste Acceptance and Transportation Team is focused on the interagency agreement and the development of fees/payment schedules, ensuring that safeguard and accounting requirements are met, managing and ensuring that classified information is appropriately managed in the licensing and public process, developing the MTHM equivalence--this is more of an issue with glass waste forms than it is specifically with spent fuel--looking at the types of considerations to transport spent fuel ultimately into the Civilian Radioactive Waste Management System, and looking at things such as standardization with our Multi-Purpose Canister concept which we are applying to commercial spent fuel.

The Repository Task Team, I guess in my opinion, has the bulk of the work. They're trying to look at all the waste form constraints consistent with the characteristics of the DOE-owned spent nuclear fuel, incorporate those characteristics into performance assessments that would help us to determine the ultimate acceptability of these waste forms for disposal, and looking at the key considerations related to waste package and equipment design and long-term criticality control calculations and considerations.

So, in summary, EM and RW have established a close working relationship to develop and control and resolve waste acceptance issues and develop waste acceptance requirements and criteria for the ultimate inclusion of some or all DOE-owned spent nuclear fuel into the Waste Management System.

DR. LANGMUIR: Thank you, Steve. We have plenty of time for questions. Questions from Board members? Dr. Brewer?

DR. BREWER: Yes, this is Brewer, the Board. Steve, could you put Chart 11 back up for us?

(Pause.)

DR. BREWER: Now, I'm not clear this is a real question. In terms of the DOE spent nuclear fuel, you projected 2030 2,750 metric tons of uranium. Is that in the inventory at present? Will there be additions to that? I mean, what is the ultimate number by the year 2030?

MR. GOMBERG: From the commercial side, we know that's pretty much what is in the inventory and has to be dealt with. The inventories of DOE-owned spent nuclear fuel, I think it's on the order of around 2,650 currently in inventory, and if you add potentials for I think it's primarily farm research reactor fuel and additional naval expended cores, there's an additional 100 metric tons projected through 2030. So that 2,750, to my knowledge, is the number that represents what would be in inventory by 2030.

DR. BREWER: Okay, thanks. One additional question, and again, it's curiosity driven. In this wonderful marriage that you've described between the two parts of DOE, I wonder if you could characterize, from your point of view, what the biggest problem or problems, or the biggest difficulties you've got in trying to make this work.

MR. GOMBERG: From my point of view?

DR. BREWER: Yeah.

MR. GOMBERG: Okay. I think the biggest concern that I would have is that we are potentially undertaking an activity that will require a commitment to expend resources to collect the data and to do the analyses necessary to demonstrate under QA controls and other appropriate controls on the activities that DOE-owned spent nuclear fuel is suitable for geologic disposal. So I think getting that commitment that we're willing to spend the time and effort to do those additional things is the biggest challenge that I see right now.

DR. BREWER: So it's a resource constraint, is that what you're saying?

MR. GOMBERG: Yes.

DR. BREWER: Okay. Thank you.

DR. LANGMUIR: Langmuir, Board. Related question. I'm wondering how your plans as a task group coordinated team here play into the licensing schedule that the DOE has set for itself.

MR. GOMBERG: One of the issues that we have raised is to minimize impacts on both the waste management and the EM schedules. And certainly it all developed from the impact that we do not do anything at this point to jeopardize our schedule for submitting an initial license application for the Yucca Mountain site if it's deemed suitable.

One of the issues, then, is that schedule impact and consequences, and what we've been trying to do is two things. One is we have schedule networks that we have developed both for the RW program and the EW program. We're trying to lay those schedules together, and through that assess the potential schedule driven risks that might be identified and obviously raise those and work those as best we can. In addition, we are trying to minimize the types of activities that would need to be conducted, primarily through focusing on those key differences with DOE-owned spent fuel so that we have a realistic chance of conducting those activities. In the event that we don't meet the 2001 license application submittal, we had planned on amendments to the license application. And there are certainly opportunities, although I don't think they've been finalized right now, to allow some additional years to look at trying to incorporate additional waste forms into the repository prior to its operation, you know, under NRC review and approval.

DR. LANGMUIR: John Cantlon?

DR. CANTLON: Yeah, Cantlon, Board. How many different sites now in DOE are there spent fuel that belongs to DOE?

MR. GOMBERG: If I may, I'd probably want to defer that to one of the Idaho or EM people, because I know there's a lot.

MR. EDGERTON: Some of these questions here from Dr. Brewer and the last question I think we'll talk about during my presentation on the overview of the national spent fuel.

DR. CANTLON: Very good, very good.

MR. GOMBERG: Thank you very much.

DR. CANTLON: And following that up--again, if it's on the docket for later, that's fine--the question is, how good are the records on your oldest spent fuel? We have some problems on records on some of the other wastes. How good are the records on the spent fuel? Are we going to hear about that?

MR. EDGERTON: I think the answer is we have some challenges here and some opportunities.

DR. LANGMUIR: Carl Di Bella has some questions.

DR. DI BELLA: Thank you. Carl Di Bella, the staff. I noticed in one of your earlier overheads that you intend to exclude RCRA mixed waste from the first repository. Has it been definitively determined which of DOE's spent fuels and high-level wastes are RCRA mixed wastes and which are not, and therefore which are candidates for the first repository and which are not?

MR. GOMBERG: Okay, right now we are planning, we are looking at the possibility of excluding RCRA, primarily because of the dual regulatory authorities that would potentially be involved and the complications that that would create, and also an additional set of regulations and requirements that really have not been tested for this type of facility. EM--and Brian, you look like you want to answer this to--is undergoing a characterization effort to identify which of their spent fuels are RCRA materials. They've been meeting with the EPA and various other groups, and I think you will probably discuss that later on.

MR. EDGERTON: Touch upon some of the sodium bonded fuels we have, the EPR type fuels. Gary McDannel also has been involved in this characterization study that Steve's referring to. Maybe we can talk a little more in detail about that also later.

MR. GOMBERG: Right now, the fuel that looks like it's our biggest issue regarding RCRA characteristic is our sodium bonded fuel. There are others.

DR. DI BELLA: Another question. You said one of OCRWM's goals is to give early guidance to EM, I guess, in very specific individual fuels and wastes as to what they could do or not do to make things compatible or not incompatible with the repository.

MR. GOMBERG: Right.

DR. DI BELLA: Have there been any instances in the last year where either this new coordination group or just OCRWM in general has given such guidance? Could you tell us what they are?

MR. GOMBERG: I guess there have not been, to my knowledge, specific instances. However, I think EM is also very familiar with the regulations that we need to comply with, and I've been very impressed of their knowledge of our program. I think the biggest challenge that I would say--and obviously we've been working to try to work together to develop guidance--is on the disposition of the N-Reactor fuel up at Hanford. For various reasons, not the least of which is that represents about 80 percent of the inventory of the fuels. We've discussed and through the Repository Task Team primarily have discussed other issues or other challenges that may say that certain waste forms may not be suitable for direct disposal. But until we actually start, you know, conducting some more detailed analyses and whatnot and looking at some of their long-term performance, which we're trying to get underway as soon as we can, it's more a discussion phase than an actual formal guidance phase.

DR. LANGMUIR: Dennis Price?

DR. PRICE: Dennis Price, Board. You mentioned that you intend to recommend data needs and activities to allow the integration of DOE spent nuclear fuel into the OCRWM System. To what extent do you crank into that operational things? And there's generally--my impression, anyway, is that there's a lack of specificity with regards to operations as you cut across all of these things that you showed in your initial diagram of the flow of these materials. There's not much specific information at this time available about operations. How much does that handicap your view of the design and your view of things in general?

MR. GOMBERG: Okay. Two standpoints. One would be from the standpoint as far as ultimate acceptance of DOE-owned spent fuel into the Waste Management System. I tend to break them up, at least in my own mind, into two parts. One is suitability. Are they suitable to meet the broad regulatory requirements that we will be challenged on? And if they are and if we do accept them into the system, what are the key operational design and other considerations that will come into play? But one other thing that we will be able to learn from from EM is the fact that they are currently managing these waste forms safely right now and plan to continue to do so. They're going to look at dry storage and various other things which may have applicability to our program and how we would ultimately handle and operate our facilities. Certainly operations is a key construct of our overall program, and I think as you indicated, we will have more operational knowledge as we have more information and more detail on the repository designs and on the characteristics of the waste forms that would allow us to identify operational constraints as we move through the design and acceptance of the fuel into the system.

Doesn't look like that answered your question, though.

DR. PRICE: Well, no, I really would like to understand specifically how you, from the systems standpoint, are wrestling with the operations and how quick some of these things are really going to become part of your--are you culling out data needs and things and a need for further operational specificity? I'm not sure that operations aren't lagging behind in response to the kind of informational needs that you need to have to do your job.

MR. GOMBERG: Certainly on the slides near the end of the presentation that identified the issues, transportation operations and design and repository operational surface and subsurface design considerations are two of several of the issues that we need to tackle. In the process we're at right now, they're at the Task Team level, where they are developing the specific issue resolution approaches and the data needs that we will need to collect. So from that standpoint, it's somewhat early, so I don't have specificity to lay out to you right now, but we felt they were important enough to raise as key issues and hopefully get some resolution, including the data needs and the information that we would need to design a safe system.

DR. PRICE: Okay, thank you.

DR. LANGMUIR: Bill Barnard?

DR. BARNARD: Bill Barnard, Board staff. Steve, on your 11th slide you indicated that there's 7,000 metric tons of defense waste that's slated for disposal in the first repository. What's the current DOE estimate on the total amount of defense waste that will require disposal in a repository?

MR. GOMBERG: If you take the DOE-owned spent nuclear fuel inventory and then you look at high-level waste from Savannah River, Hanford and INEL, I think the numbers that crop up into my mind are approximately 11,000 MTHM. Now, this assumes that we have a method that's agreeable that will allow us to equate glass or ceramic waste forms to MTHM, but it's around 11,000 under the current Method B, I think is the current method.

DR. BARNARD: Does that include the single shell tanks at Hanford?

MR. GOMBERG: Yes.

DR. LANGMUIR: Langmuir, Board. I had another question related to that famous Overhead 11. There's some mathematics there that is simple, but I wonder, if federal statutes remain as currently they do with regard to commercial high-level waste receipt and disposal, where does the 22,000 MTU that you have left of commercial fuel go? Where does DOE plan to put that up to 2030?

MR. GOMBERG: That's a good question, and we get that question a lot. We don't feel right now that it is appropriate, that we have the information or the data, specifically on the Yucca Mountain candidate site, to necessarily go in 2007 and recommend a need for a second repository. We know we have a statutory limit on the first repository; what we don't know is what the actual physical limit of the repository is, and that's one of the considerations that we feel that we need to be in a better position to understand prior and as part of going to Congress on the need for a second repository.

We issued a report--and I have to admit I do not know the status of the final report, but it was basically plans for the disposal of high-level waste and spent fuel under Section 803 of the National Energy Policy Act. Must be back '93, I think, we issued that report. And the conclusion was basically that until we have a better sense on the physical limitations of the site based on thermal loading and other sorts of considerations and what the actual areal extent of the repository block are that's suitable for disposal. We are not really in a position right now to go to Congress and ask for lifting that 70,000 metric tons, even though obviously by simple mathematics we would exceed that if we were to accept all this waste into repository disposal.

DR. LANGMUIR: Thank you, Steve. We're right on schedule now.

MR. GOMBERG: Okay, thank you.

DR. LANGMUIR: If there are further questions of Steve--he's been very gracious to respond to so many--we'll have time later in the meeting to, I think, ask them perhaps at the round table.

The next presentation is by Brian Edgerton, overview of the DOE-owned Spent Nuclear Fuel Program, status of the programmatic SNF environmental impact statement, and the SNF record of decision.

MR. EDGERTON: Good morning. Again, it is a good morning, we all look outside. I am with DOE-Idaho and also with the EM-37 Headquarters Program for which INEL has a lead integration role for the National DOE Spent Nuclear Fuel Program. I think the presentation I have will build upon some of the discussions by Mr. Gomberg and perhaps further answer some of the questions related to the inventory and the characteristics of the general DOE spent fuel inventory across the entire Department's complex.

I'll talk briefly about the National DOE Spent Fuel Program formed within the Energy Waste Management EM Group. It was established in early 1993. Primary objectives of this national program is to support policy development, undertake a strategic cross-cutting planning responsibility for EM or DOE spent fuel, coordinate that among DOE line organizations directly responsible for the management and facilities for DOE spent fuel, general oversight and program integration, and primarily chart a management course of action for ultimate disposition of all DOE spent fuel, which is the theme of the program and my presentation this morning.

Again, the mission is the safe interim storage and, for the next period of time preparatory to the final permanent disposal of DOE spent fuel, which is the end objective of the spent fuel program.

We have taken somewhat of a systems approach for the management of DOE spent fuel, initially looking at the assurance for existing storage conditions and management, recognizing there has been a very open document here a couple of years ago with the EH vulnerabilities assessment report for DOE spent fuel, reactor radiated nuclear materials, looking at the inventory characterization necessary for that safe existing storage, of course store and transfer SNF, consolidate spent nuclear fuel management for the existing conditions where appropriate, and eventually to deactivate a release facility that's no longer needed.

The middle block, the middle bridge here, for the longer period of time, is to achieve what we call interim storage, and that could be anywhere from 40 or more years, depending upon the schedule and acceptance of some of this material in the first repository or a second repository. Again, inventory and characterize as necessary that spent fuel for the safe interim storage management, stabilize, transfer, again consolidate as necessary, and where appropriate release surplus facilities.

End objective is to prepare for ultimate disposition of this material, appropriate characterization being the Waste Acceptance Criteria we talked about earlier with Steve, to appropriately condition and eventually transfer that DOE spent nuclear fuel and ultimately to release these interim storage facilities as we move into permanent repository disposition.

This builds upon the famous Slide No. 11 we talked about last. I'll talk a little bit more about the relative comparison of DOE spent nuclear fuel to the commercial. These numbers are consistent with what Mr. Gomberg talked about. Currently we're looking at inventory of about 2,646 MTHM for DOE spent fuel. In the year 2035, which is the somewhat arbitrary 40-year planning period that was addressed in the programmatic spent nuclear fuel Record of Decision that Mike Bonkoski mentioned earlier, we're looking at 2,742, just under 100 metric tons additional generation of spent fuel. That compares with the 32,000--I think it's a little lower than the number you had, Steve, but comparable--and around 86, 85,000 metric tons in the 2035 time period. Eighty percent currently on a mass basis and less than three percent in 2035.

I will add, though, that even though it's a small amount of fuel relative to the commercial, to Dr. Brewer's question, I think in my opinion the diversity of fuel that we have to manage compared to maybe 20, 25 types of commercial spent fuel--we have in excess of 90--is probably a very strong challenge for us to deal with here as we work towards conditioning, stabilizing and preparing for ultimate disposition of this material.

Talk a little bit about the distribution, currently, of the DOE spent nuclear fuel. That may be a little hard to see for some of the people in the back. I'll start west and work way east here.

I think as Steve mentioned, the bulk of the spent nuclear fuel inventory for DOE by mass is at the Hanford site, the N-Reactor production fuel, approximately 80 percent. I think you're familiar with, Board, from discussions last year at Hanford on their activities as they move forward for a path to stabilize, to prepare for interim storage, and ultimately for disposition of that hopefully in a repository. Aluminum, stainless steel, zirconium primarily, a very dense material. I call them like logs almost, 30-inches long, 52 pounds per log. Some degradation concerns, obviously, in the KE Basin particularly.

At the INEL we have 261 MTHM currently. The INEL probably has the greatest diversity, definitely has the greatest diversity of spent fuel. We have representatives of almost every type of spent fuel at the INEL currently other than the N-Reactor production fuel. Aluminum, clad graphite fuels, hastlelloy, stainless steel, zirconium, some without cladding, mostly wet storage.

We have a commercial demonstration facility, the Fort St. Vrain, Public Service of Colorado. Approximately 16 MTHM graphite matrix to fuel currently stored there at a licensed facility, modular storage facility. Talk about Oak Ridge with 1 MTHM, small amount, mass and volume, aluminum, stainless steel, zirconium, some diversity of fuel. The Savannah River site, a little over 200 metric tons, primarily aluminum, nickel, some special case commercial zirconium, and then we have some special case commercial fuel, as most people are familiar with West Valley in New York, 27 MTHM.

We do have a diversity of cats and dogs type fuel, if you will, scattered through a number of laboratories. I'll talk about that briefly, associated with some of the special research reactor fuels, university fuels and some commercial examination type fuels.

Again, just to kind of emphasize a point from the preceding slide, by mass, Hanford has approximately 80 percent of the fuel, about 10 percent INEL, 10 percent at Savannah River, the remainder scattered across the complex.

For an interim storage management standpoint, I think other measures we look at, I think of more relevance, perhaps, is the volume of spent nuclear fuel that DOE currently owns. The INEL, based on a volume basis, has over 700 cubic meters out of about 1,300. So over 50 percent of the volume of DOE spent fuel is currently managed at the INEL; Hanford 17 percent because of the high density of their production fuel; Other, 16 percent; Savannah River about 13 percent.

Again, if you've got the hard copies, you can see there's quite a diversity of fuel locations for that "Other" category: Brookhaven; Los Alamos; Oak Ridge; I've mentioned the West Valley, approximately 12 cubic meters; we have a minor amount of fuel at B&W Lynchburg that we're looking at consolidating; some domestic non-reactor university fuels; and of course the Fort St. Vrain is quite a--about 160 cubic meters of spent nuclear fuel located there.

I mentioned earlier the primary theme and mission of the DOE Spent Nuclear Fuel Program is to in a systematic manner manage and move towards ultimate disposition of this material. Very closely allied with the OCRWM program for commercial spent fuel, we hope. This graphically--kind of an artist's rendition--reflects the, if you will, mission profile of the DOE Spent Fuel Program. Over 90 percent of our fuel currently is in temporary pool storage, 10 percent in dry type storage, cask storage or vault storage. We are looking at moving this material into a safe interim storage, the middle block I mentioned earlier for our systems approach. We anticipate primarily dry storage to appropriately characterize and stabilize and consolidate that fuel.

And over time we hope to, consistent with the current repository schedule, begin moving DOE spent fuel that meets Waste Acceptance Criteria, that's been properly characterized and stabilized, for which appropriate fees have been paid, into the commercial repository. As Steve mentioned, there is a systems approach being looked at, starting this month, as a matter of fact, to consider the allocation of high-level waste and DOE spent fuel in that historic ten percent allocation for the first repository for defense high-level waste and spent fuel.

DR. CANTLON: What's that end date out there on the right?

MR. EDGERTON: You aren't supposed to see that. No, that's 2035. That's somewhat of our arbitrary date. We've got this broken line here, recognizing there's quite a bit of uncertainty in that 2035 date. Again, that was the 40-year period that has been considered by the spent nuclear fuel programmatic EIS just recently completed.

Again, to amplify, we're looking at ultimate disposition of this material working closely with the Office of Civilian Radioactive Waste Management. As progress in this area, there's been quite a bit of discussion internally within Department of Energy. We have a recent Secretarial Action Memorandum signed in the end of March that states as part of that Action Memorandum that is our--DOE's--intent, preferred alternative, if you will, preferred option, to move as appropriate DOE spent fuel into the first repository, within that ten percent historic allocation.

We are looking at screening criteria as we go through the great diversity of fuel that DOE owns, looking at what can perhaps go directly into the repository utilizing perhaps a Multi-Purpose Canister or similar concepts, particularly the high-integrity fuel, the special case commercial fuel that's very comparable to the commercial type fuel already slated for the repository. Some of the fuel will quite likely require minor conditioning. A possible example of that would be the N-Reactor fuel, where we have the concerns for hydride surface formation. There may be a need for some sort of oxidation stabilization and canisterization of that material in preparation of it going to the repository or a repository.

Finally, we have a third category that we recognize because of the fuel nature, the degradation, the fuel characteristics. It will require perhaps substantial, fairly intrusive mechanical and/or chemical stabilization. We'll have some discussions later on today, I believe, about some possible technology options that could be used in that category.

Again, as far as the path forward for DOE spent fuel, we are looking at working at very closely with the OCRWM program, looking at particularly the high-integrity fuels--the naval fuels for example, although they're high and rich, they're very integral fuels--the commercial type fuels which we now have in the DOE inventory as primary candidates for the first repository, perhaps direct disposal wherever possible. We're looking at R and D and conditioning technology applications for some of the intermediate fuels, such as the N-Reactor fuels possibly, and the more reactive fuels.

We do have Three Mile Island core debris, the entire core here located at the INEL currently, approximately 83 MTHM. That is indeed core debris, it's not your classic spent fuel that you would see in the commercial side. Very likely we'll acquire conditioning technologies to prepare that material for ultimate disposition in a repository.

We will work with the license application process, the safety analysis process, work through OCRWM with the NRC as appropriate, and in fact there have been some initial discussions, I believe, in March with the NRC to relay the DOE's intent to include DOE spent fuel directly where appropriate with a high-level waste allocation in the first repository. We're showing a 2010 date as the official date. We all hope to stay with that. We recognize a lot of uncertainty on the repository operations, but that's what we're working towards here, and begin accepting DOE spent fuel in that first repository approximately 2015. One of the keys, we'll be working on the Waste Acceptance Criteria with OCRWM, again, for the tremendous diversity of DOE spent fuel.

Again, I'd like to emphasize that we're looking at direct disposition of DOE spent fuel wherever feasible, recognizing that the balance will require various degrees of conditioning, stabilization and canisterization to prepare that material for a repository.

A very simple one-line flow diagram here. We have looked at this at a much greater level of detail. We'll be talking a little later this afternoon, I believe, about some of the integration concepts being looked at at the INEL for full treatment integration of our waste streams, including DOE spent fuel, in a synergistic approach to prepare this material for ultimate dispositions for these waste streams. For DOE spent fuel, we're going to look at, of course, is the material currently stable for existing or interim storage? If yes, it goes directly into interim storage with appropriate characterization. For those materials that require additional stabilization, a good example, of course, is moving into dry storage wherever feasible, moving out of the temporary storage basins where they're currently located, drying, handling, canning, and into a longer term interim storage, both nationally and at the INEL.

As we jointly work with OCRWM to develop Waste Acceptance Criteria, we're going to be looking at stabilization of that material for repository acceptance. There may be a processing involved for some of the fuels, very likely processing involved, either mechanical, chemical, or some combination thereof, as we prepare this material for disposition in a repository or some other final solution or longer term interim solution, recognizing there's a lot of dynamics and discussions and Congressional debate and so forth in this repository versus some sort of longer term interim storage solution.

Talk a little more about how we're conceptually looking at the DOE spent fuel relative to getting it to the repository. From the reactivity, pyrophoricity concerns that were brought up by Mr. Gomberg earlier, we recognize that metal fuels, such as the N-Reactor fuel, will probably require some sort of passivization or conditioning to prepare this for stable long-term storage in a geologic repository. As we mentioned earlier, for RCRA characteristic-type fuel, we have sodium bonded fuels--I think the EBR 2 fuel's a good example--that we have to look at in some manner removing that RCRA characteristic so we can get this material to the repository. There may be some technologies that can very easily remove or leach that material from the RCRA. I think Argonne will be talking a little bit about some of their activities that may be very applicable to some of these RCRA bonded fuels.

Part of the diversity that we are challenged by with DOE is a diversity of fuel condition. You've seen the N-Reactor fuels, some of the photos that are very, very kind of enlightening, I think, to see some of the KE Basin, to say the least. We have fuels that have gone through post radiation examination, we've gotten fuels here such as the

LOFT that have been--the Loss of Fluid Test--here at the INEL that were intentionally breached or failed as part of the research work with the NRC for commercial reactors.

We have what I call the soft fuels or aluminum clad fuels that were used for production reactors for research activities that were, quite frankly, designed at one point to be dissolved, reprocessed. With the phaseout of reprocessing in the DOE in April of '92, we're looking at other approaches. I think some of the processing technologies historically are still quite applicable, perhaps, as to aluminum clad fuels, particularly at Savannah River, and to process those into an established high-level waste form such as the borosilicate glass logs and stainless canisters.

Clearly, some fuels will require additional characterization to confirm a path forward. And that goes back to, I think, Dr. Cantlon's question here about how can we use some of the old records, build upon these records that are 35 or 40 years old in some cases? We've had recent experience with some of our SNAP fuel that's stored at the INEL of retrieving those records, and that's a very timely process as this material becomes less and less accessible. That provides a data base in which we can further characterize or hopefully qualify for a repository or longer term interim storage.

Looking at some of these basic criteria, we've got kind of a rough cut on what we think from the DOE inventory have a path to disposition. Fuel that is likely to be able to go relatively directly we think at this point is approximately 40 percent. This is used in, I think, a mass basis. The N-Reactor fuel, for example, about 23 percent of our fuel. Probably some sort of at least conditioning and passivization. Hopefully not strong, intrusive characterization, but that's still being looked at, as Steve Gomberg mentioned earlier. The aluminum clad fuels, I believe, we're looking still at approach to processing and placed into the borosilicate glass log high-level waste form, about 30 percent. Some of the characterization canning maybe 5 percent by mass. We mentioned the sodium bonded fuel, less than 3 percent, but that will clearly require some sort of conditioning to remove that RCRA characteristic.

I think a strong theme here, and it's been developing over the last year, is a very close I think the word was marriage or coupling of the commercial program in DOE with the defense program and high-level waste program to move this material in a systematic managed fashion into the repository. As Steve mentioned, we have an active Steering Group that's now underway and functioning. We have three key subtasks or Task Teams. As a matter of fact, we have the repository team meeting again later this week here at INEL to pursue the waste acceptance issue, waste acceptance development, and some of the criticality issues associated with DOE spent fuel.

I think the Waste Acceptance Criteria is one of the key issues that we have, the challenges that we have, to work together mutually to look at some sort of approach to build or couple that with the diversity of fuel that DOE now owns. We are currently working with the license application. We are involved with the license application annotated outline to prepare our fuels data for the repository, MTHM equivalence as a basis for fee payments, both for the high-level waste and also for the DOE spent fuel, recognizing the diversity, the research nature of the fuels, the low burn-up and so forth for some of the fuels, high burn-up for some other fuels. There will be some challenges here to get a good basis and then, of course, to apply the resources against that to make sure that to make sure that we are clearly a part of that first repository.

As far as the NEPA integration, we are working closely with RW Yucca Mountain Project Office. The forthcoming Notice of Intent that will come now, I believe, later this month on the repository EIS does include all DOE spent nuclear fuel. The Navy is very actively working with the MPC/EIS that is part of that ongoing NEPA analysis. We recognize that will be an ongoing integration throughout this program for both DOE and high-level waste and commercial spent fuel.

Transportation issues.

The NRC interface has begun working closely through OCRWM with DOE spent fuel. We're looking at a singular regulatory and quality framework. We're using the RWO333P where appropriate for characterization and preparation of our DOE spent fuel for the repository.

You may have missed on that earlier graph, on that flow chart, but we are looking at using external regulatory approaches comparable to commercial for our DOE spent fuel management.

Talk briefly about the Record of Decision that came out last Thursday that is addressing the interim storage management options that we have for DOE spent fuel over the next 10 to 40 years, where best to locate that interim storage management. Secondarily, we're looking at the capabilities, facilities, basically the infrastructure needed for this interim SNF management and R and D activities that may be needed to support this management during this interim period.

I think some of the key issues are that as far as an environmental impact, the impacts of all the options, reasonable options, considered were relatively small impacts between or among the alternatives were equal or even smaller. Overall, environmental impacts were looked at as fairly small, nonsignificant in many cases. Cost is not a significant discriminator. We did look at some conceptual life cycle costs for the various interim management options for DOE spent fuel, primarily driven by how extensively used existing facilities. Obviously substantial cost uncertainties in some of these longer term cost projections. There was a fair amount of overlap among the alternatives. And again, not a clear "winner," if you will, or discriminator.

Talk briefly about what some of the implications might be for the Record of Decision for how we may reallocate where appropriate DOE spent fuel for the interim management. Again, we are looking at a regionalization by fuel type, where Hanford material would stay where it's at. Since they have the bulk of that material, they would work with their N-Reactor for a path forward to repository disposition. Since the INEL has a diversity of fuels, many of the less typical fuels, the nonproduction fuels, the non-aluminum fuels would, where appropriate, come to the INEL for interim management, build upon the existing infrastructure that we have here. In addition, the naval reactor fuel which has been coming here historically would continue to come here for appropriate examination and then interim storage and preparation for disposition. Savannah River would likely continue to receive the aluminum fuel from the foreign research reactors, the university reactors. Some of the aluminum reactor fuel that we have around the complex may be appropriate to consolidate the Savannah River for appropriate processing, again processing for stabilization for the repository.

I want to preface this is potential increases. This is an upper bounding projection of what spent fuel could be allocated at Savannah River. Again, the aluminum clad fuel, what I call the soft fuels, for processing perhaps. From a heavy metal content, roughly 7 metric tons over an existing capacity of 206 metric tons inventory at Savannah River. From a volume standpoint, a fair increase over there, over 100 percent, foreign research reactor, university fuels, some of the other aluminum fuels that are part of the DOE complex now.

Closer to home, again, potential increases that are bounded by the preferred alternative and Record of Decision we'd be receiving, potentially, at the INEL the non-aluminum fuels, the nonproduction fuels, looking at about 163 metric tons potentially increase over the 261 metric tons over the next 10 to 40 years and fairly substantial potential increase in the storage volume required here at the INEL.

I think some of the key background elements of the Record of Decision, it does establish a supporting path for ultimate disposition of DOE spent fuel. The fuel regionalization by fuel type builds upon, we believe, in an optimal fashion, the existing infrastructure within the DOE to responsibly, safely manage this material and prepare it for disposition. A best balance of factors as far as institutional infrastructure, technology application development, balance cost approach, and I think it optimizes the amount of transportation where needed. It also continues to support the DOE and Navy mission defense, national security mission, obviously, for the Navy, examination of fuel research, the reactor support for research safety, medical isotope reduction, and again, a management path for moving towards ultimate disposition.

Clearly, and I think you'll see more of that as we go through this discussion today, we are looking at a parallel mutual management path for both DOE spent fuel, working with the OCRWM program for their commercial fuel program. We hope to integrate with that program without impacting the commercial reactors fuel disposals.

Wherever feasible we are going to model equivalent approaches to how we manage DOE spent fuel. I mentioned earlier looking at external regulatory framework comparable or identical where necessary or appropriate with the commercial reactor program, using the Nuclear Regulatory Commission and code of federal regulations for external management regulations of the DOE spent fuel. Looking at comparable repository performance assessment. We're looking at comparable EBS systems, and wherever possible looking at Multi-Purpose Canister use for INEL fuel, DOE fuel. I think our theme here is to prepare as appropriately as we can for what we call "road ready" staging preparation for our DOE spent fuel to hopefully the first repository.

That concludes my formal presentation. Again, I would welcome any questions. I think we have a few minutes here.

DR. LANGMUIR: Thank you, Brian, we have less than one minute. Does someone have a very brief question that's a pressing question?

John Cantlon?

DR. CANTLON: Cantlon, Board. A number of the countries in the world, France, Japan, perhaps the two outstanding ones, look at spent fuel as a resource, not as a waste. And my question is, is any thought being given to the fact you're looking ahead here 40 years? Currently it's the U.S. policy not to reprocess, but 40 years in the future there may be an energy question about this. Is any thought being given in the handling of these fuels that would essentially make reprocessing or reuse of these materials more difficult? Is any thought being given to that?

MR. EDGERTON: That's kind of maybe a little bit of a trick question. You're of course aware of the Presidential Decision Directive 13, and that's--

DR. CANTLON: I understand that's current policy.

MR. EDGERTON: Current policy is to proceed as outlined here. We are looking at stabilization technologies to reduce volume, to homogenize our diversity of fuel, to better prepare for a Waste Acceptance Criteria and pause our disposition. Some of the technologies we'll be talking about today do segregate fissile material, for example. One could say from a personal standpoint that may be appropriate to hold that material for reuse in a fuel cycle. I personally feel that way. I won't comment or cannot comment on what the DOE's policy is. But we're looking at stabilization of that material currently.

DR. CANTLON: I understand that. My question is, as you look at that stabilization process, there may be alternatives that would make future reprocessing simpler and cheaper, and is any thought being given to the choice of those?

MR. EDGERTON: That's in the back of our minds as we apply what I call a "systems engineering approach." It's a look at not having to duplicate steps, not to box ourselves into a corner as we move down the path.

DR. LANGMUIR: Thank you, Brian. I think we have to go on. We're over the schedule now. There will be time later in the day for further questions.

The next speaker is Al Hoskins. His topic is DOE-owned spent nuclear fuel at INEL, description and current storage challenges.

MR. HOSKINS: Thank you. Again, my name is Al Hoskins. I'm manager of the Spent Nuclear Fuel Program for Lockheed Idaho Technologies.

The first slide talks, as Brian mentioned in his presentation, there are a large variety of fuels at the INEL. I separated here just three of the parameters--cladding, fuel meat, and the enrichment--and within those three parameters there are 23 different combinations of fuels at the INEL. Other combinations that bring in the fuel matrix materials, the thorium content, the variance in thorium content, the type of oxide use, such as the ceramics and so on, will bring us on up to the previously mentioned 90-plus types of fuel at the INEL. We have zirconium fuel, we have stainless steel fuel, aluminum and graphite fuels at the INEL in several different varieties. Our fuel meat includes uranium metals, uranium alloys, alloyed with various metals, including mostly the aluminum, we have uranium oxide fuels, and uranium carbide fuels. We have enrichments that exceed 80 percent enriched fuels down through some that are above and below the high-enriched, low-enriched breakpoint at 20 percent, and we do have some that are very low enriched.

Looking at the various examples of fuels that we have, we do have some commercial fuel. We've been involved with several test programs, some involving the Nuclear

Regulatory Commission, that have brought in commercial fuels for those test programs. On the right we see one of the PWR fuel elements, the classic Westinghouse 15 x 15 array. We have some of that type of fuel in storage with the uranium oxide pellets, the zirconium, and we have also stainless steel clad commercial fuels in these assemblies.

An example of the test reactor fuels, we have the Advanced Test Reactor fuel. The Advanced Test Reactor is one of the several reactors at the INEL. This particular one is using an aluminum fuel assembly. Dr. Fillmore is now holding the dummy fuel assembly that we have for display. It is a curved plate fuel using the aluminum alloy type assembly construction. It's assembled with the holding assemblies on the top and bottom. When we store that fuel, much of this fuel was being reprocessed here at the INEL in previous years, so much of the fuel we now have has actually had the assembly cropped, where they've taken the in box and the lifting assemblies off on both ends so that they did not have that additional non-fueled waste that was brought into the processing picture.

DR. BARNARD: Is that full scale?

MR. HOSKINS: Yes, that's a full-scale assembly there. During the break, we'll move those back to one of the back tables so people can see the display there.

Looking at another of our fuel types is the Fort

St. Vrain fuel. It's a graphite fuel. It uses a uranium carbide fuel meat made into a small sphere. It's what they call a trisoparticle coating with silicon carbide. And those are then pressed into rods and then further placed into a graphite block. This particular wafer, now this is just one cross-section wafer of the actual block. The blocks themselves, as shown here, are 31 inches tall. But that is the assembly for the Fort St. Vrain fuel. We have the first three segments in storage for that particular fuel. The remaining assemblies are down at the reactor site in Colorado.

Moving on to the storage condition, some of the fuels are stored bare and intact. Some have been canned. Much of the test reactor programs actually involve some destructive examination of the fuels, and so some of those fuels, once they followed the examination process, were put into cans and we now have those cans in storage. As I mentioned earlier with the ATR assembly, some of the fuel has had the ends cut off as preparation for reprocessing. Test reactor fuels have been declad in many cases as part of the examination process that followed the tests done in the reactor tests themselves and have undergone destructive examination.

As was mentioned earlier, we do have the Three Mile Island core debris in storage.

Well, let me come back. I was kind of hurrying through some of those. Let me come back and talk a little bit about this. This particular one--and it's not a very good picture because we were trying to move from a video tape under water to a still picture and on to an overhead and we lost some of the clarity--but this shows again, looking at the end of that ATR curved assembly, the plate type fuel. In this case, the end fitting box has been removed, so you're actually looking at the top of the plates in the photograph--it's not very clear--inside an aluminum port in a fuel rack.

This photograph shows the storage of the stainless steel clad EBR 2 fuel, and that fuel is made into small pins. We have the pins loaded into stainless steel tubes and sealed with a lifting ring on the top of the stainless steel tube. Now, those again are the sodium bonded type fuels.

And the last slide talks to some of the more recently canned fuels. We are doing and continuing to do some recanning of fuels into stainless steel cans as part of the interim storage of the fuel.

As Brian mentioned in his earlier slide, we have a total of 261 metric tons of fuel at the INEL. For this slide, I elected to use the number of assemblies or the number of units we have in storage and the volume at each of these sites.

Starting at the top, at the Test Area North, we have a pool--and this was shown on the other slide--is the storage pool. The major fuel in that storage pool is the Three Mile Island core debris. It's currently stored in this pool. We also have in this pool the LOFT reactor fuel. Also at Test Area North, you see the storage pad there. The storage pad includes three--or excuse me, the casks storage on a pad. This is several different types of storage casks. There'll be a little more description about that test program subsequently in the agenda today. But this program was part of an NRC-sponsored program for testing commercial fuel in dry storage.

This photograph has moved to the Idaho Chemical Processing Plant, and this particular photograph is CPP-666, which is our newer storage facility. It began operation in 1984, and it has six storage pools, all stainless steel lined, in a relatively new modern storage facility.

This particular slide has moved from CPP to the test reactor area--I'm sorry, we have not. I didn't recognize it. This is the South Basin or the South Pool or the CPP-603. My perspective was bad on this photograph. The CPP-603 South Basin Pool includes some naval fuel as well as many of the test reactor fuels currently stored in this pool. It's essentially the oldest storage facility in the DOE complex. It began operations in 1951. Also at the CPP-603--and this is reflected with the additional pools at 603--we have the fuel stored on vertical storage hangers. Those hangers go down underneath the floor deck plates, where we have the fuel actually stored in either buckets or actually hung from the hooks down in the storage basin itself. Now, this again is water storage using these hangers.

DR. DI BELLA: Excuse me just for a moment, Al.

MR. HOSKINS: Yeah.

DR. DI BELLA: Carl Di Bella here. I think we're going to visit tomorrow, those people that are going on tour--

MR. HOSKINS: Right.

DR. DI BELLA: --each of those three pools.

MR. HOSKINS: Yes, correct, those will be part of the tour.

This is moved also. Within the CPP-603 facility, there's an add-on facility, if you will, for storage of the graphite fuels in dry storage. This is a dry storage system. You see here the truck trailer being brought down. This has represented the cask used for bringing in the Fort St. Vrain fuel. It's brought to a vertical stature, moved into a cell where the fuel is removed, and put into storage containers and moved on into the storage cell. I think there's a photograph of the actual storage cell here through the shielding window. Again, this will be part of the tour tomorrow. This shows the assembly.

Go ahead, we're pushing time here.

This is an aerial photograph, also at CPP, the chemical processing plant. This is that 603 facility. The graphite storage is on this side, South Basin, Middle Basin, and North Basin. This also shows the storage in dry caissons. Those are a vertical dry caisson down into the ground. And again, the next photograph will show just the top piece of that vertical caisson. We have also graphite fuels as well as several of the shipping port LWBR-type fuels.

This, now, has moved across the street to the test reactor area, and this photograph shows the advanced test reactor pools just outside the ATR reactor. And essentially it's a canal for storage of the fuel while it's cooling, before it's then transferred over to the chemical processing plant for additional storage.

This is keying from the systems engineering slide that Brian used earlier, where he had assuring safe existing conditions moving on to achieving interim storage, and ultimately preparing for final disposition. And as you see, many of our existing storage facilities, many of those are very old and the storage conditions in those facilities are not adequate for a long-term storage in preparation for the final disposal. And so our intent right now is to retire many of the older facilities by use of construction of one new facility in storing of the Three Mile Island fuel, use of

Multi-Purpose Canisters for much of the rest of the fuel, and we will continue to use the new CPP-666 water storage facility for principally the naval fuels and those fuels that are continuing to be discharged out of the reactors that need additional cooling. We have the plans as necessary for doing the canning, conditioning, further characterization that's required as we prepare the fuels to go into the Multi-Purpose Canisters.

The next couple of slides briefly talk to some of our near-term activities. As I mentioned in that earlier slide, retirement of the facilities is one of our goals. The CPP-603, which is again the oldest facility in the complex, is first to be retired. And we have now moved 311 out of 378 fuel units that need to be moved per a court mandated court order by the end of this calendar year. These are being moved to 666. All of the fuel will be removed from the facility by the end of the year 2000. We are continuing to evaluate all of the fuels in the INEL as the needs for conditioning, and then their further storage in Multi-Purpose Canisters.

This slide talks somewhat to the facilities as shown in that earlier depiction. The Three Mile Island storage facility, the request for proposals for a new facility was issued in February this year. We are reviewing those proposals that have been submitted, and our intent is to have the award of bid by the end of this fiscal year. The EA, Environmental Assessment, and the Finding of No Significant Impact from that EA is actually in current public review.

That concludes the slides that I have prepared for this presentation to just give an overview of the INEL. Questions?

DR. LANGMUIR: Thank you, Al.

Questions from the Board? Dennis Price?

DR. PRICE: This can be directed to you, and perhaps to also the previous speaker. In your consideration of fuel to go in the MPC, with the wide variety of fuels and the materials and so forth, what has been, in your considerations, the role of filler for the MPC and ultimately filler in the waste package?

MR. HOSKINS: There's been some discussion or some examination of various fillers. One of the efforts now going on--and we are looking very diligently at combining the high-level waste disposition with the spent fuel disposition and actually using a glass waste form as filler in the Multi-Purpose Canisters around the spent fuel. That would involve some phasing of operations, but it would significantly reduce the total number of canisters that would then have to go to disposal in the repository.

Other filler materials, we are examining the needs and the potentials for using poisoning materials necessary to maintain subcritical in using the high-enriched fuels that we have in storage. So other poisoning-type materials would also be examined. Some of the subsequent talks in the performance assessments and the waste form identification that are also coming up also talk to some of those alternatives that we're studying.

DR. PRICE: How did some of these affect transportation?

MR. HOSKINS: The transportation is expected to be acceptable using a glassified waste around the spent fuel assemblies. The use of the poisons, essentially utilizing the Multi-Purpose Canister, would be NRC licensed as it would be then transported to the repository. So we don't anticipate serious problems with transport.

Any other questions?

DR. LANGMUIR: I had a related question which perhaps we'll hear about later today. Langmuir, Board. If you're going to put glass waste around the spent fuel, perhaps we're going to be talking about the stability of such a combination both physically and chemically. Radiolysis effects on the glass, for example. The boron is a neutron shield of some sort. I'm a geochemist, so sometimes I don't know exactly what I'm talking about on these issues, but obviously there are lots of performance characteristics that have to be addressed on such a marriage.

MR. HOSKINS: That's correct.

DR. LANGMUIR: Are we going to hear more about this today?

MR. HOSKINS: In some respects we will hear about the early planning, some of the early performance assessment work that has been done. We are not completely done with all of the examinations and work that must be done in order to qualify those waste forms.

DR. LANGMUIR: Would you be doing all of that here? Where would that work be done?

MR. HOSKINS: Part of the work will be done here, part of the work would be done--actually, Henry Loo, in his discussion, will talk about our performance assessment where we're collaborating with the Sandia Labs in these performance assessment works. Also the waste form identification and the qualification of waste forms. We involve the other laboratories that are working those sorts of issues.

DR. LANGMUIR: Garry Brewer? Excuse me, sorry, Steve Gomberg.

MR. GOMBERG: Just two clarifications. I know it's something we always discuss internally. Our program right now is currently evaluating Multi-Purpose Canisters for commercial spent fuel, and so the subcontract that M&O TRW is in the process of is geared toward basket material designs, the incorporation of potential filler--although that's, I guess, optional, it's not to be precluded. EM has done some feasibility studies of MPC's with the interest that during this environmental analysis process, if we feel that it's feasible from a NEPA and a programmatic consideration to proceed with MPC's, then they would be ready, of course, to facilitate as expeditiously as possible the standardization of MPC's and to the overall program. Certainly their basket designs would be different and various other things along that line, and those all need to be taken into consideration within the overall optimization of the MPC's within the program. So I just wanted to try to point that out.

DR. LANGMUIR: I had a related question to all of that, and that is, I would assume that quite a bit of thought is being put into the interim storage process insofar as the choice of interim storage mode adds a cost and a complication to the ultimate disposal in the MPC. If you're going to take it out of interim storage and go to MPC, what you choose for the interim storage can make it very difficult, ultimately, to get it in the MPC in a form you'd like to have it perhaps. Is this being considered?

MR. HOSKINS: Yes.

DR. LANGMUIR: Is the interim storage approach that you're using or proposing to use carefully being interplayed with the MPC choices that might follow?

MR. HOSKINS: That's correct. The bulk of the fuels that would go into interim storage, if possible, we will put directly into MPC's. Those that we do not put into MPC's we will put as a priority to move into dry storage so that they are effectively moved one major element closer toward the MPC-type storage and the repository. The interim storage of the naval fuels will include the pool storage in the CPP-603. That fuel is very robust, it does not deteriorate in that type of an environment. So that particular fuel would continue to be stored in the CPP-603--or 666, I'm sorry, 666. And particularly we would be bringing in the thermally hot fuels as they are discharged from the naval reactors and brought to the expended core facility and then on down to the chemical processing plant. And then, since that facility has a finite volume, we would be moving out the, if you will, older fuels, the cooler fuels, on in to Multi-Purpose Canisters.

DR. LANGMUIR: Further questions from the Board? Garry Brewer?

DR. BREWER: This is Brewer on the Board. Are their parts of this system that would be really sensitive to slipping in the schedule, the famous 2010? I mean, are there parts of it because of the age, from your point of view--the age of the facilities--let me reframe the question this way: are there parts of this system which are absolutely dependent on having a repository adhere to the schedule, and are you doing contingency planning in case that doesn't happen?

MR. HOSKINS: At this point, our program is not terribly sensitive to slippage in the repository program. We would intend to store the fuel in Multi-Purpose Canisters, essentially on pads at the INEL, pending that repository. So they would essentially be road ready, but the time frame would not be a serious constraint in moving the fuels.

MR. EDGERTON: I guess I would add there's both a technical answer, which you've gotten, and clearly an institutional or what we call a political response. As far as the de facto permanent disposition, we've clearly got to keep pushing that so that we can continue to responsibly manage the fuel for an interim period of time. There's a lot of impatience on stakeholder standpoints for that slippage, obviously.

DR. BREWER: That's why I asked the question. Thank you very much.

DR. LANGMUIR: Thank you. Bill Barnard?

DR. BARNARD: Bill Barnard, Board staff. Are any of your operations sensitive to funding concerns? I know that you want to retire your 603 pool. Are there any other facilities that it's critical that you retire?

MR. HOSKINS: The answer is yes, we are sensitive to funding issues. We currently have adequate funding to retire the 603 facility as per the schedule shown in the earlier slide. Some of the other facilities that we are intending to transfer fuels out of and retire we have requested the funding, we have indications at this point that we will be getting funding to begin that process. The possibilities exist that some of that funding either would be rescinded or would not be authorized, and that would delay the removal of the fuels. But at this point in time, we do have that funding, like I say, in place for the 603 transfers as shown and requested for the additional transfers.

MR. BONKOSKI: We also have funding for removal of the TMI fuel that's currently funded.

DR. LANGMUIR: Could you identify yourself for the tape?

MR. BONKOSKI: Oh, I'm Mike Bonkoski with the DOE Idaho Operations Office.

DR. LANGMUIR: Thank you. We have time for one very short question.

DR. DI BELLA: Quick one. Carl Di Bella. You showed a picture of ATR fuel, I guess, in a pool in a fuel rack of some sort, and on the top of that fuel rack looked like some red crud or crust or corrosion product of some sort. Was I looking at that correctly? What is that, is that a corrosion product?

MR. HOSKINS: Yes. That particular photograph was taken from video tape down in the CPP-603 facility, and there is some corrosion product in that facility. The storage racks, they are aluminum storage racks, and we are seeing some aluminum oxide corrosion product on the racks themselves and on some of the fuel.

DR. LANGMUIR: Thank you. I think we have to go to the next speaker, who is Gary McDannel, and the topic is DOE-owned spent nuclear fuel at INEL, systems engineering and ultimate disposition challenges.

MR. MCDANNEL: I'm going to be talking about INEL spent fuel and our systems engineering approach towards getting this spent fuel finally disposed. There's some confusion and some folks have different ideas on the definition of systems engineering, and from our perspective, what we're trying to do from a systems standpoint is to look at the end point of where we're headed with this spent fuel, look at the big picture there, identify those requirements that we need to get there, look at some different alternatives to finally get to the final disposition of that fuel, and then finally criteria to evaluate those alternatives against each other and then pick one that seems to be the optimum. So that's our systems engineering approach towards final disposition.

This is a diagram that you've seen before, and the thing I want to point out here--in fact it gets to Dr. Langmuir's comments on what--my only complain about this logic diagram is that it forces some sequential thinking. It forces you to think, first I need to get to interim storage, then I need to get to final disposition. And there are certain things that can be done, for instance, with Multi-Purpose Canisters that can essentially solve the interim storage and preparation for final disposition in one swoop there. But that's what this diagram shows, and really you have to go through those sort of steps, but there are ways to accomplish both of those in one step.

I don't intend to go through every one of these blocks. The main things I wanted to point out here is that one of the things that systems engineering tries to tell you to do is it says, "Do the right things right." And our strategic planning and direction effort here is really trying to do, what are the right things that we should be doing with spent fuel? And there are a lot of factors that go into that and outputs that come out of that. And then we have a lot of tactical planning, where, you know, we identify that we need to get fuel out of our 603 facility and we need some good tactical planning that ensures that that fuel is moved safely from one location to the next. And our end goal here is to get, as Al was mentioning, our fuel finally into an interim storage location that is prepared for the repository and in this road ready concept.

So looking at those objectives, then, and where we're headed, we need to ensure that our operations are conducted safely. We need to make sure that we're doing things cost effective not only in the short term, but looking at life-cycle costs as well. And one of the things we're trying to do there to focus on that life cycle is look at, you know, are there ways to accomplish this interim storage and preparation for final disposition concurrently? Systematic decision making; ensuring that we're complying with our court orders, for instance, to move the fuel out of 603 and other regulatory drivers there. Consideration of stakeholder concerns has been a major focus for us. A lot of what we've heard from stakeholders is to try to minimize the amount of transportation that you're doing and don't just be moving fuel to be moving fuel, and make sure that whatever you do with our fuel, make sure that it's road ready, get it ready to leave the state.

And those have been major drivers in our path forward, and then again focusing on getting this fuel prepared for final disposition, and really trying to do that only one time. If you have to move fuel into an interim storage facility and then move it out of that interim storage, you know, to something that's transportable for disposition, those costs tend to accumulate there, and trying to do that one time is a good cost saver.

Some of our constraints to accomplish our path forward and to move forward. Of course we've talked about the EIS Record of Decision that was issued. We do have a court order to remove fuel from our CPP-603 facility. Brian Edgerton mentioned our Vulnerability Action Plan Commitments that we have from a study that was done a number of years ago. Of course the decision to end reprocessing for uranium recovery is a constraint for us in terms of future options. We've got to meet our Repository Acceptance Criteria, and then these dates and when the repository and license application are coming up are other constraints that impact our approach.

So from a systems perspective, we need to take a look at those requirements and constraints and look at a number of different evaluation criteria. How are we going to determine what the right thing to do for INEL spent fuel is? And so the different criteria we've looked at are: risk, environment, safety and health risk; our costs, and there's three different measures there, your short-term costs, a flattened profile, and life cycle costs. The flattened profile has to do with do you have a lot of facilities that you're trying to build that all come on-line at the same time at INEL and create a huge funding spike that is difficult within the Department to fund those sort of things. So if there's a way to flatten the profile, that's helpful, and of course life cycle. Effectiveness: Does our approach really get us to the in-state stakeholders? How much programmatic risk? How flexible or robust is that option towards future perturbations? I know it was mentioned, you know, what happened if the policy changes on what we're going to do with spent fuel down the road and recovering that and looking at how robust these different options are relative to that? Does it meet our mission? At what stage is the technology and does it properly safeguard our fuel and information?

What I've got here is a list of some of these alternatives, then, that we've looked at. There's many more, and this actually is a subset that comes from a more substantial logic diagram that puts these together. But basically, you know, do we use our existing facilities; do we upgrade those and expand them or look at new facilities? Wet versus dry storage. There's some fuel that, you know, is fine for wet storage and we haven't seen any problems with it, plus it's required for cooling purposes. Do we look at modular or stand-alone facilities? Transportable versus stationary configuration, and different options, then, for final disposition, whether it's to process that or to direct dispose of it. So those are some of the alternatives we've looked at.

From an overall systems perspective, then, some of the critical decision points, again, are this Record of Decision, which significantly impacts how much fuel we're going to have so we know how much capacity we need in the future. Another critical decision point is what is this final waste acceptance going to be and will our fuel have the necessary pedigree to meet that? Will we have MPC's available in the time we need to do that?

So some of the issues coming out of that are: How much existing capacity do we have in particularly dry storage? That's where we would like to head with most of our fuel. And some of those facilities that we do have and have some excess capacity, there are some potential vulnerabilities with that. Environmental Impact Statements that are ongoing. There's one for the Multi-Purpose Canister as well as the repository. Currently the Navy fuel is included in this Multi-Purpose Canister EIS considerations. And then looking at multiple fuel transfers, again not only from a cost perspective but from a safety perspective and stakeholder perspective as well, trying to minimize those.

Then, in order to illustrate how we've looked at those different criteria and evaluated those different alternatives, we'll use this kind of stop light approach here that if it's red it doesn't meet the criteria; yellow; green; and blue is a discriminator if it exceeds a criteria.

And this next chart then shows four of the major alternatives that we've looked at at INEL for dealing with our spent fuel and shows how we've looked at those alternatives and how they've scored and compared one with the other. And without going through a lot of detail on, you know, why is this yellow and why is this green, I want to make sure that we point out that where we're headed with INEL fuel is to consolidate this fuel into transportable dry storage configuration, which basically is the Multi-Purpose Canister approach.

And it's important to take note of this note up here, too, that for those fuels that are going to be direct disposed, this approach of a dry transportable storage particularly makes sense. Where the fuel may be processed down the road, we want to try to use as much as we can existing dry storage facilities or in some cases new dry storage capability where we need to in order to store that on an interim basis. But this is our preferred approach, and it's not blue all the way across the board, it does have some negatives, but that's where we would like to go at INEL.

Some of the pros and cons, then, of this path forward is that it does have lower life cycle cost. One of the nice things about Multi-Purpose Canisters is it's a system that can interim store your fuel, transport it, and ultimately dispose of it. So it's got some real advantages from a life cycle standpoint. And basically because it does this, it accomplishes interim storage and final disposition in one step. It has strong stakeholder support because that fuel is "road-ready." As soon as a repository opens, it's on the road ready to go. The commercial and Navy approach is down this same road, and so we can build upon the experience and expertise that will come out of their efforts. Another nice thing is it does levelize the funding. The Multi-Purpose Canisters is a pay-as-you-go approach, so it levelizes our funding. And it doesn't preclude any future alternatives. You can pull the fuel back out of those Multi-Purpose Canisters.

Okay, the negative side of that is it does create a higher interim storage cost. Those Multi-Purpose Canisters, depending on what the final design is, they're not cheap just for interim storage. But from a life-cycle standpoint, they've got some advantages. But just interim storage, they're expensive. There's a lot of uncertainty in our Waste Acceptance Criteria for the repository. Is it going to accept HEU? Is our fuel going to have the pedigree necessary to qualify it? And then the other negative is that in order to get our fuel into Multi-Purpose Canisters, because of the schedule associated with getting Multi-Purpose Canisters built and designed, it potentially delays our consolidation of a fuel at INEL a couple years. So there are some negative things associated with it, but overall we think it's the right approach.

So our future actions are to look at these existing facilities and try to keep the fuel in those as long as possible unless the fuel is deteriorating in those, and then we need to get it out as rapidly as possible. We need to look at this existing dry capacity and evaluate that cost against new facilities. Which fuels can be direct disposed? And we've already made some attempts at doing that, have an initial stab at that that Brian Edgerton showed. Need to make sure that the DOE fuels are considered in future EIS's. One of the things we're looking at is a privatization approach, which says if we're unable to get the funding we need for some of these facilities, are there ways to privatize that approach so that we can get the funding through the private sector as opposed through the normal system. So we're looking at some opportunities there. Need to integrate this with our critical decision points and also do some more sensitivity analysis with our evaluation criteria.

So overall, this systems solution, when you look at how our path here at INEL has gone forward, and by looking at a systems perspective and looking at this final disposition, the things that it's done and allowed us to do is move into interim storage and get the fuel staged for final disposition concurrently. We're looking at processing of those fuels that are not likely to be direct disposed, and primarily those are those sodium bonded fuels, the Experimental Breeder Reactor fuels. And then integration with other sites, such as shipping our aluminum fuel, which is consistent with the EIS Record of Decision, down to Savannah River for them to deal with there.

This is a listing, then, of some of these disposition challenges that we really talked about. This kind of pulls them together and summarizes them. The primary concerns there, then, in the technical area, are with canisterization of that fuel. How are you going to put that fuel in there? And criticality control, particularly with the DOE high-enriched uranium. From a regulatory standpoint, you know, which of our fuels exhibit a RCRA characteristic that would have to be removed prior to disposal? Safeguards of that fuel. And then concerns with the repository schedule and the impact that that has on us, which Al mentioned is fairly minor, because we will get that fuel in that road-ready configuration. And then interagency agreements and fees associated with getting the DOE fuel into the repository. And then there's a number of other secondary challenges that are each being worked and focused on as well. I won't go through those in detail.

But I will talk about, you know, what we are doing to alleviate those major or primary challenges. In the containerization area, we're looking at the MPC concept, and again, it doesn't preclude future options because the fuel is retrievable from those Multi-Purpose Canisters. Criticality control, there's a number of assessments going on looking at how those DOE fuels would perform in a repository.

The RCRA studies are going on trying to characterize our fuel. And again, as we mentioned, the sodium bonded fuel appears to be our worst case fuel. We also have some issues and concerns with disrupted fuel. The Silver Indium Cadmium control rod is melted in there with the rest of the material and potentially could leach Cadmium. And so there are other issues with RCRA, but sodium bonded is our biggest issue. Safeguards, concern with HEU and with the Navy fuel as well as other HEU.

Really, the major challenge we have is finalizing this Waste Acceptance Criteria. If we can pin the tail down on this thing, getting to that will be fairly easy. But pinning that one down is, you know, a number 1 issue. And then trying to make sure that we don't have to do a lot of rework. You know, we're interested in once we get that Waste Acceptance Criteria, that pins it down and we can go in that direction and won't have to characterize now and characterize later and keep on characterizing.

And then the interagency agreements that are going on and the Steering Committee is working those issues.

Finally, in conclusion, then, I believe our INEL path forward for dealing with spent fuel has evolved, and I think that's been a healthy evolution. It's based on a systems approach to finally reach the end point for our spent fuel. The thing that is really important to happen is that while we look at these alternatives that that doesn't stall us, that we're allowed to continue forward on our path forward where we look at other alternatives and just ensure that we don't preclude those down the road for these future perturbations or changes in policy. And I think our path forward can overcome these challenges.

So that's all I had to say. Are there questions?

DR. LANGMUIR: Thank you, Gary, we have time for a few questions.

John Cantlon?

DR. CANTLON: Yes. As I understand the present Act essentially identifies defense reprocessing waste as the 8,000 metric tons that's allowable in the existing repository. Do you require legislative amendments or something new to make a substitute for spent fuel for the reprocessing waste?

MR. MCDANNEL: Go ahead.

MR. EDGERTON: We have internally looked at that last year within DOE, that exact issue, and we have an internal general counsel position that's documented that says indeed that we can directly dispose of our DOE spent fuel under the current legislation. I know that is somewhat controversial, but we have made that conclusion and are proceeding on that basis.

MR. GOMBERG: It's based, by the way, not so much on the high-level waste part of the definition but the spent fuel part of the definition, which is any fuel irradiated in a reactor. It's not necessarily specific.

DR. LANGMUIR: Question--Langmuir, Board--related to the privatization. That was an interesting thought you posed. I assume that implies you think you could save money by privatizing some of the activities that INEL is accomplishing. Is that a fair inference? How would you go about that and what would that entail? Would that be a savings, do you think?

MR. MCDANNEL: The privatization numbers that I've seen --and they are preliminary--they don't show a substantial savings, but they do provide a way to get those facilities on-line, whereas, you know other options may not allow that to happen. So it may not necessarily be a cost saver, but it is a way to get those facilities funded so that we do have them available and can move forward. Again, those are preliminary numbers, but that's what we've seen so far. And I don't know if some other folks can comment on that, but that's what I have seen so far about that.

MR. HOSKINS: This is Al Hoskins. I just add that as I mentioned on our path forward for the Three Mile Island fuel, the bid proposals that we have are from the commercial storage systems, if you will, the various companies that are out competing with each other in providing dry storage systems for the commercial industry, and we are utilizing that as our standard, if you will, for building facilities that would store the additional fuels. So we are using the private sector wherever they have an expertise rather than trying to reinvent or rebuild, if you will, within the DOE.

DR. LANGMUIR: Now, we're on schedule right now. We're scheduled to have a break. Let's do so and reconvene at 10:30 for the next presentation.

(Whereupon, a break was taken.)

DR. LANGMUIR: Our next presentation is by Henry Loo. His topic is repository disposition evaluation for INEL spent nuclear fuel and high-level waste: performance assessments and criticality analyses, a hot current issue.

MR. LOO: Good morning. I'm Henry Loo. I will be talking about the work that has been completed so far as far as the performance assessment and criticality analysis in conjunction with the final repository disposition evaluation for INEL spent fuel and high-level waste.

Before I start, I thought I would just kind of cover a little bit of an outline of my talk. I'll give a little bit of history, which I think you're going to hear quite a little bit of it this morning. Cover a little bit about what we did in Fiscal Year 1993, and then get into the

'94 performance assessment and criticality evaluation and then cover the results and then kind of indicate, you know, what we are doing currently and the future plans.

I think this slide kind of looks, you can probably see, familiar to the slide that Steve put together. Back in 1992, when DOE decided not to reprocess spent nuclear fuel, one of the things that was initiated was the INEL spent fuel and the high-level waste program. At the time, when we looked at the whole picture, we said, "Well, what do we need to do as far as we've got spent fuel that's in dry storage, underwater storage and the high-level liquid waste in the tank farm and to bring it to final disposition in the mined geologic repository?" One requirement, as Steve indicated this morning, is meeting the performance requirements of the final waste form in a repository environment. So at the time, that's how the performance assessment was initiated, is to make sure that whatever we do in the conditioning and processing and taking care of or managing the spent fuel and high-level waste would have a fairly good chance of meeting the final disposition requirement. That's how the program PA started.

So as far as the performance assessment is concerned, I'd like to go over the purpose, is to really initially assess the performance of the potential final waste form as we see it in hypothetical geologic repository against the requirement of 40 CFR 191 and 10 CFR 60. As Steve noted, at this time, as far as the EPA standard for Yucca Mountain hasn't been established and that we're, you know, waiting for that. If that changes, we will have to change the requirement as well.

The result is to really try to help us to identify the Waste Form Product Characteristics, what the waste form needs to be in order to meet the repository requirement and guide a program as to how we should treat and condition the waste, you know, to do that, at the same time meeting the interim storage requirements. And it was not intended originally when we started the program to support any kind of licensing application at all.

The activity itself involves not just us but, you know, multi-laboratories. We pretty much led the effort in 1993 when we first started. We contracted with Sandia National Laboratory to do the performance assessment, you know, who has been intimately involved with the PA process. Savannah River has also helped us in the past year review the criticality methodology and provide us some information on the Savannah River high-level waste and inventory. Hanford provided information on the N-Reactor, which I realize this is INEL's spent fuel program that we're talking about, but we did as part of the performance assessment include the N-Reactor spent fuel in the evaluation. The RW folks have kindly helped us; the B&W folks; and the TRW Environmental Systems Service also helped us evaluate our criticality methodology when we first started looking at criticality in a little more detail in '94. Lawrence Livermore also helped us when we finished finalizing the waste form based on what we know in respect to the performance do the Waste Form Product Characteristic Document.

After each one of the performance assessments, we also had a technical peer review of a five- or six-member panel on the various expert areas to make sure that we're going down the right path. Some of those members you guys may know of. Dr. Thomas Pigford is on the panel, as an example, and Karsten Pruess, who is with the Lawrence Berkley Laboratory. You know, he's involved in that. That's just a couple names that were involved in the peer review.

As far as the--when we first started--the performance assessment is concerned, the first year, in 1993, we looked at five potential waste forms which addressed the high-level waste that is at the INEL, the calcines, and then two fuel types of that we have evaluated at the beginning. Like Al mentioned earlier, we have over 90 some type fuel. We cannot, you know, do a PA on every single fuel type. So the very first initial performance assessment we kind of grouped them into two different groups, one we called special fuel and one we called graphite fuel, just to give us some idea of how those two fuel types would perform. We did include originally, even in the first performance assessment, all the complex-wide glass in the repository that we have proposed for the repository, you know, that we have considered.

At the same time, as far as criticality is concerned--maybe better to do it this way--we did look at loading, you know, as far as the limit is concerned. We limited the amount of fissile material in each one of the canisters in the first and initial evaluation, and I'll get into that a little further down below. And two of the waste forms that we have considered out of the five, we did consider processing all the spent fuel and removing all the fissile material and then basically just having high-level waste to deal with. And the other option that we looked at was also diluting what we have. You know, take the spent fuels, grind them up, dilute them with depleted uranium before we put it in the ground. You know, it's kind of not a very good way of doing it, but we did look at that, you know, in 1993.

Originally, in 1993, we did not look at a tuff type repository because, you know, at that time, we were directed by DOE to consider other hypothetical repositories for our spent fuel and high-level waste. And what we selected at that time was an igneous rock--you know, a granite repository similar to what Canada is looking at. And also we looked at a bedded salt repository.

As far as the criticality is concerned, what we did, like I indicated earlier, we pretty much limited the amount of mass that is in each one of the canisters. For a bedded salt repository, we're able to put 10 kg of fissile material in each one of the canisters. The reason is mainly due to the fact that the salt would creep and surround each one of those canisters so there would be no more water to get into the canisters, so that's why we were able to put that high loading. As far as the rock repository is concerned, all we could put in was around 700 g. We were a little bit conservative in there, because you actually could probably put probably around 800 gram, a little bit over 800 gram, but we selected to use the 700 gram number. And one thing that we did not consider in the first initial study is any kind of migration of the fissile material from a canister, and then assembly of that material further out in the far field. So based on those assumptions, you know, criticality in the first year, when we looked at it, it really isn't a problem. We're limiting all the mass, you know, in each one of the canisters.

Just kind of for informational purposes--let me kind of put that slide back--as far as the concept of emplacement, we were looking at it in 1993 as the borehole type, which back then the RW folks were considering borehole emplacement on the drift, you know, and then with clay surrounding the canisters.

As a result of the 1993 study, we have a set of recommendations, and based on that set of recommendations, we kind of formulated to FY-94 PA Scope, which included the waste forms, five type of DOE spent fuel, which is fairly consistent with the fuel type that was indicated earlier by Al and everybody else in the program. We looked at the ATR type spent fuel, which is a high-enriched aluminum-type fuel, Fort St. Vrain, which is a graphite spent fuel, and we looked at Shippingport, which is a very robust spent fuel that was high-enriched with zirconium cladding. We thought at that time, because of the nature of the Navy spent fuel, the classification problem, you know, we might be able to get some feeling for using this. We felt that the Shippingport PWR fuel would be fairly low robust, might give us an indication of how the Navy fuel might perform.

DR. REITER: I have a question.

MR. LOO: Yeah.

DR. LANGMUIR: Leon Reiter?

DR. REITER: Leon Reiter, staff. Just a point of information, is it Peach Bottom fuel, is that from the Climax test?

MR. LOO: No, I don't think so. I think the Peach--I guess I'm not that familiar with the fuel type. All I know, it is a graphite-based fuel.

DR. FILLMORE: Denny Fillmore with Lockheed. There are two Peach Bottom reactors. There was a pressurized water reactor and there was a graphite reactor. We have both of those fuels in the DOE community. In fact, both types of those fuels are at the INEL. There were actually two Peach Bottom refuelings. There was a Peach Bottom Graphite Core 1 and a Core 2. I am not familiar with the Climax test.

UNIDENTIFIED SPEAKER: Turkey Point.

DR. FILLMORE: Okay, that was Turkey Point, the Climax test.

DR. REITER: Is that at INEL, Turkey Point?

DR. FILLMORE: Yes, we do have that.

MR. LOO: Okay, and then we do have some commercial spent fuel that is here, the PWR commercial spent fuel, and we looked at that, and finally the N-Reactor spent fuel.

As far as the high-level waste form is concerned, in 1994 we looked at it in a glass-ceramic form, we think we probably will not go that way because of some of the evaluations, system engineering evaluations. But we did look at it in 1994. We did look at the borosilicate glass waste form, and then also, in the beginning of the initial PA study, we looked at the loose calcine, even though we recognize that it doesn't meet the requirement as being a solid form, but at least gives us some reference base that we could compare how the treatment and conditioning will be able to improve the performance of the waste form in the repository.

The type of repository that we looked at in '94 is a tuff repository similar to the Yucca Mountain. And we did look at two emplacement concepts, which is the drift emplacement with 125-ton MPC and then a borehole concept for the spent fuel that we looked at a 25-ton legal-weight truck canister. And I know that since--at this point, I should say, the RW folks have no intention of using that to emplace fuel. But at the time when we started the '94 study, you know, there were still some questions, so that's why we went ahead and put that in there in our evaluation.

As far as criticality is concerned, we considered the consequences and probability of such an event at postclosure and what kind of impact it would have on the total system performance, you know, as far as that's concerned.

Again, we are looking at those two regulatory requirements, 40 CFR 191 and 10 CFR 60. We did include a dose to the public, you know, and tried to get some feel, you know, what are we talking about a dose is concerned to be released to the public.

The next two viewgraphs are fairly straightforward.

It's just a couple of viewgraph examples of what we did as far as in the performance assessment. Like I say, the glass, borosilicate glass in a container we've overpacked that would be placed into a repository all is placed into a Multi-Barrier Waste Package, which is the same concept that the RW folks are doing right now for the high-level waste glass, and then put it into the drift so it is drift emplaced.

And for spent fuel, this is just an example for Shippingport. We're talking about putting 24 elements, as an example, into an MPC and then put in the overpack or the disposal container and then into a repository. And for the LWT, we just kind of put them in the LWT and go into the repository.

From a criticality evaluation standpoint, here's just a real simplified tree flow diagram showing what we did, realizing that some of those tasks were done in parallel and not directly, you know, from one thing and then the other. But this kind of gives a very general, simplified flow diagram showing what we did. First we generated a fault tree of what kind of event could lead to a criticality, and based on that, in conjunction with the site characteristic and the waste package material that we have selected, we kind of see what kind of failure mechanism that would create a criticality situation, and then determine which one of those scenarios is plausible. From then we determined the probability of the event and figure out if it did happen, you know, what kind of fission are we talking about, thermal output, and use that probability in the evaluation. Should we include that in the PA? And if it's so small that we don't have to include it, then it's just basically we eliminate it. If not, then we would include it in the complex PA to go ahead and evaluate what kind of a criticality effect it would have on the performance--what kind of effect criticality would have on the performance.

At the same time, Sandia also developed a dynamic model to kind of take a look at and make sure that how their dynamic interaction with the total system of the repository and make sure that what the assumption that we have made is a reasonable assumption.

I'm going to skip a slide here. The next slide that I skipped just basically shows a little more detail on the task that was done.

And this is what we kind of postulated based on our evaluation that could, you know, for a high-enriched uranium spent nuclear fuel containers. It could have water, highly moderated, which is a water system with a slow reactivity increase which is similar to the Oklo-type situation. And another one that could be a fast reactivity increase with later like a SNAPTRAN experiment that have been done in the past. The other possibility is the low-moderated; you know, pretty much a dry system with a slow reactivity increase like a Fast Breeder Reactor, and then another one is the fast reactivity increase, you know, like some of the LANL experiments that were done and some of the accidents.

In our evaluation to date, we kind of feel that the bottom three are a very unlikely event, you know, due to the amount of water that will infiltrate into the repository and whatnot in comparison to the very top event. So the performance assessment in '94 we pretty much concentrated on the more likely possibility, which is the high-moderated, slow reactivity increase type situation scenario.

As far as the results are concerned, what we find is that the consequences of a criticality, assuming a high moderation and low reactivity, are fairly negligible. And you're talking about a steady-state reactor limiting to about 1 kW because of the fact that the tuff type environment is pretty much atmospheric pressure. If there's any more heat than that, it will pretty much boil your moderator, your water, away and any kind of criticality of event would stop. With that kind of assumption, even if you assume that a reactor 1 kW down there perking away, you're talking about 10^{25} fissions over the 10,000-year time frame. That is, you know, fairly small as far as insignificant with what we've already got there on waste that is placed in the repository that was being under evaluation. If we're talking about

12,000 MTHM, if you assume that is spent fuel with a burnup of 40,000 MWd/MTU, that's an amount of about 10^{30} fission.

But one thing that we did realize that what we have evaluated to date that we cannot show that the possibility of criticality could not be readily ignored as a scenario. We need to evaluate it further and make sure that we understand, you know, any kind of process and possibility a little better.

I do want to point out that in our evaluation there are a lot of uncertainties at this point as to the various processes that we would have a lot of conservatism in there that we need to go ahead and evaluate further, and then by better understanding of those processes, we should be able to reduce the probability of any criticality event to a very low level. Some examples, the container, how long the container would last, what kind of solubility are we talking about with your fissile material versus your neutron absorbers material. Those are kind of the examples that I'm talking about there.

As far as the performance assessment results are concerned, based on our evaluation, together, the high-level waste with the spent fuel, including the INEL, Savannah River and Hanford, high-level waste glass appears to be acceptable for compliance with 40 CFR 191. Now, there seems to be a little bit of problem in some of the emplacement package requirements of the one part per 100,000 per year release rate that is indicated 10 CFR 60.113. Those specific radionuclides, you know, that exceeded the regulation is technetium-99 and carbon-14. The mean release rate exceeded that requirement. That means with all the PA run that we have completed, about 50 percent of the run exceeded the allowable release rate. Same thing with iodine-129 and uranium-238. We talk about there's a 10 percent probability that with all the run that we have completed that we exceeded the release rate. The majority of the contribution of the release is coming from carbon-14, technetium-99, iodine-129, uranium-234 and plutonium-237.

One little qualifier there is that depends on the regulatory periods being evaluation. That little item, that list up there, is considering the 10,000-year period. If there's any kind of change in that, that's going to be changed. If for some reason the NAS panel would recommend that we look into a period of 100,000 years or more, you know, those radionuclides will be different.

Based on the best available information that we have in Fiscal Year '94, carbon-14 inventory in the DOE-owned spent fuel did not violate the requirement of 40 CFR 191. That's kind of a little bit different than what the commercial fuel have. I know that they had some problem, and I guess, Steve, you might check on that a little bit.

And one other thing that is important that we felt is the solubility of the waste elements in the repository environment. That has a very significant impact as far as how much stuff that you could have in the repository.

Some of the open issues as a result of the FY-94 PA analysis include verifying the acceptability of using ORIGEN run ORIGEN2 computer codes to estimate the amount of radionuclide inventory in the slow-cooker. When we make that calculation, we are talking about using ORIGEN run at a 1 kW level, which is quite a bit lower than what is normally used by the code. So we need to go ahead and verify that.

At the same time, we have some ORIGEN run that when we determine what is waste inventory or the radionuclide inventory from the various fuel, they're all based on ORIGEN run, and we're going back to making sure we have included all the impurities. As an example, carbon-14, when they did the ORIGEN runs, they didn't include any kind of impurities on the nitrogen and whatnot. That is the major actor that generates the carbon-14, and so does the other major radionuclides. You know, we need to go back and get that information firmed up a little bit better.

And then validate as far as the neutron absorber material solubility. You know, how quickly could the neutron get dissolved and removed.

DR. LANGMUIR: Henry, could you speed it up, we're over time here.

MR. LOO: Oh, okay. Sorry.

And so the rest of them are pretty straightforward.

And then the activities concerned, PA activities currently, right now we're doing an FY-95 performance assessment for the DOE high-level waste. Because of some of those being an uncertainty and, you know, indicator, open issue that we need to kind of resolve, we selected not to do a 1995 performance assessment for spent fuel. Kind of evaluates different items right now that we're looking at that we're verifying and finalizing in evaluation protocol. And then future plans, we're planning on doing an FY-98 PA, or earlier if funding allows.

That pretty much kind of concludes my presentation.

DR. LANGMUIR: Thank you. We have time for two or three questions.

Dennis Price?

DR. PRICE: On your fault tree analysis, what did that look like? Your top event was a criticality event. Did you come up with a number of cut sets, and what was the minimal cut set if you did and probability of occurrence of that cut set?

MR. LOO: Well, the top event that we were more interested in is, you know, could a criticality occur in the repository environment based on the set of scenarios leading to that event? And, you know, that includes various things that we have looked at--human intrusion, drilling into the repository, and allowing water getting into the repository, as an example. So we looked at the sequence of what could lead to a criticality and then developed a probability. And what we have looked at based on the very conservative assumption of in the 10,000 years, you know, the canister will be breached to allow water to get in. Within 10,000 years, there's enough water that will infiltrate into the repository that will allow corrosion and transport of all the fissile material. All those conservatism, you know, right now we're leading to a criticality number of 10^{-7}, the probability of a criticality.

DR. PRICE: And how many events constitute the cut set that would contribute to that 10^{-7}? Certainly no single point failures.

MR. LOO: No, no.

DR. PRICE: But numerous.

MR. LOO: Yeah, I think we're talking about at least three or four, you know, plus.

DR. PRICE: How many cut sets were in the total fault tree?

MR. LOO: I'd probably have to get somebody to help me a little bit. Jim, do you remember how many cut sets when we did the evaluation?

MR. WILSON: My name is Jim Wilson. I work with Henry on the fault tree. I didn't do a count on the cut sets. I would say it's on the order of 30, though.

DR. PRICE: And the 10^{-7} is the probability of the occurrence of the minimal cut set?

MR. WILSON: No, that's all of them together.

DR. PRICE: That's the sum?

MR. WILSON: Yes.

DR. PRICE: Do you know what the probability of the minimal cut set is?

MR. WILSON: Not offhand.

DR. PRICE: It's certainly much, much lower than that.

MR. WILSON: A fraction of that. Not a very small fraction of that, but a fraction of that.

DR. PRICE: Oh, so the minimal cut set constituted a good proportion of the probability of occurrence?

MR. WILSON: I would have to say probably. I don't remember the exact number.

DR. PRICE: Yes. So if you had 30 cut sets, the rest of them were rather low in contribution?

MR. WILSON: There were three groupings. There was a grouping at a single criticality, there was a grouping at a widespread common cause event that would influence a lot of them--that was the lowest grouping--and there was a grouping in the middle that would be a partial damming that would affect say 10 or 15 waste packages in an area because of a damming effect that gathered the water together around those waste packages.

DR. PRICE: Rather than take time here, I wonder if we could get a copy.

MR. LOO: I think the Board has ten copies of that report.

DR. PRICE: Oh, is that right?

MR. LOO: Yes.

DR. PRICE: I guess I would like to see it.

MR. LOO: I mean, if you guys need another one, we could send you one.

DR. LANGMUIR: We'll have to bring it to a close right now.

MR. LOO: Okay.

DR. LANGMUIR: We're a little over schedule here. Thank you, Henry.

MR. LOO: Okay.

DR. LANGMUIR: The next presentation is by Larry Taylor. His topic is repository disposition evaluation for INEL spent nuclear fuel and high-level waste: meeting waste acceptance criteria.

MR. TAYLOR: Good morning. Looking at the weather, I think I'm going to have to wax my skis to go skiing this weekend.

One of the issues relative to completing a performance assessment is developing a waste package concept of what our waste packages would look like going into the ground. And because of the nature of the performance assessment and developing that Waste Package Criteria, it is necessary that it's an iterative approach using systems engineering concepts. And the idea is that you start with a system design, and because this would have been busy, I've broken this out so that what you see here, from a development standpoint, ties in with this value over here.

Our concern is that we have to meet regulatory requirements and we have to factor into that the geological repository characteristics. Some of that is being done right now by the Yucca Mountain personnel. Along with that we have to look at our DOE fuels, their characterization, and the performance assessment of those fuels within a given repository environment. And then below that we'd look at it from a concept of MPC's, overpacks, and the criteria for those fuels in the package.

Continuing on down, we then have to get into the characterization of the fuels, the individual fuel types, the chemistries, the 'neutronics' of those fuels within the packages. We'd look at material selection. Some of this is going to piggyback on the efforts of Yucca Mountain. There's no point of us having our own development program to look at a materials performance for an MPC if we use a common design with Yucca Mountain, and we would expect to be able to take credit for their work in that area.

Component integration, then, we have to look at the RCRA issues and the 'treatment.' They talked about the sodium bonded fuels having to be investigated and whether they could be buried in a repository. Issue of drying operation, some of our fuels are stored wet. They would have to be dried. To what extent we don't know yet. Accountability issues for HEU right now appears to be fairly rigorous. We're not sure the extent and how we would qualify our fuels in that area, so that's going to have to be investigated in some detail.

Eventually you'll get into the loading/packaging and thermal affects going into the repository. Our wastes are going to be cooler than your typical commercial nuclear fuel package. Storage and transportation issues we have not addressed directly right now, but certainly would have to be a consideration when we look at a waste package ready for road shipment. And then integrating that into the final disposal option at the repository itself.

To meet a lot of these goals and needs, we have started looking and tying in our work to the development efforts that have been going on through Yucca Mountain, and we basically started with their Waste Acceptance Systems Requirements document that was issued, first revision, in

January of '93, and I want to put this in a time perspective, because they're currently working on a Rev. 1 here. But this was about the time frame when we started looking at how can we configure or package our wastes so they would be compatible with system requirements being developed for Yucca Mountain? We used their guidelines but applied them to the "second repository," because at that point in time DOE fuels had not been identified as a material that could go into that first repository, which I think answers one of our Board member's earlier questions.

In conjunction with the completion of the performance assessment, we also captured the nature of the waste forms that would be inside that repository that would qualify for performance assessment. Because this was a second repository, we could get away with it. Normally, your repository operator is the one that writes and establishes the Waste Acceptance Criteria. Where there wasn't a second repository, we had to put on another hat and say, "Okay, we're going to be a repository operator, what would we expect for our waste packages?"

With the advent of the '94 performance assessment and a direction by DOE to look now at a tuff environment similar to what was being studied at Yucca Mountain, we then conducted the performance assessment and wrote a Waste Form Product Characteristics document very similar to the Waste

Acceptance Criteria, but so as to tread lightly and not step on oversensitive toes, perhaps, title change here. But it captures, in essence, the details of the waste form that need to go into a repository that would qualify for the geological characteristics of that repository.

Work that's going on now is as a result of the MGDS License Application Annotated Outline which has just come out. We're now starting to look at--I'm going to skip down here a minute; this is about Slide No. 8. We have extracted from--and I'll have to ask you to refer to your overheads. This is hard to read. It's representative of one requirement of 115 that we are trying to interpret that Yucca Mountain has said, "This is our interpretation of a regulation." This is our interpretation of their interpretation of a regulation, and here are the data requirements that we have to fulfill to try and qualify that particular fuel type. This is one of 115. We're expecting somewhere between 20 and 30 of them will be directly applicable to us where we will have to go out and develop a pedigree for these fuels because none of that exists according to the current standards that are being used to judge spent commercial fuels. So that's what we're trying to qualify in that area.

Our scope in development of the Waste Acceptance Criteria to support packaging our fuels and getting them ready to go to a repository is really an outgrowth of this whole structure that more or less sums up a lot of the concerns that the commercial people are going to have to deal with. And this is the area that we're dwelling on right now in terms of trying to fulfill the licensing requirements and identify how our fuels would meet those criteria.

This is the performance assessment work that's been going on through Sandia. We've been working with them in trying to come up with concepts to combine wastes, looking at the combination of putting HLW into a spent fuel package to try and save volume. Some of those packages right now, I think, are currently costed at about $3 1/2 million per MPC, so it's not a cheap proposition.

Along with that we will have a Waste Product Specification so as we get into preparing these wastes and putting them into a road-ready condition going into a repository that will have the documentation in place that says how these packages will meet Waste Acceptance Criteria. Along with that you'll have a Waste Compliance Plan, Waste Qualification Report, and then the actual production records themselves.

I think an important point that needs to be brought out, I think it's been discussed and alluded to earlier, is that we need to make sure that we don't do something dumb in our treatment or pretreatment and packaging of these wastes that will require us to pull that material back out to requalify it. And along with that, we must also spend the time up front characterizing these wastes before we stick them into an MPC given that we're not going to have regulatory changes that once we've qualified them that now we have to go back and requalify them because we didn't get enough data on them in the first place.

Some of the requirements that are being stipulated in the MGDS License Application are issues such as solubility, oxidation, corrosion, mechanical strength, fire explosions, thermal loads, radiolysis. And most of those criteria have already been established or identified as issues which must be addressed by the wastes going into our waste packages in the Waste Form Product Characteristics document which was issued in 1995. Those others we would have to go back and look at now in more detail because they were not part of the original Waste Acceptance Systems Requirement document as we read it initially.

Along with those issues associated with the MGDS will be those associated with neutron absorbers, criticality, inventories, organics, materials considerations, package labeling, Allowable Void Space. And all of those have some type of a regulatory requirement driving them which we would have to satisfy and meet to get our packages to qualify in a repository.

Henry talked about the evolution of our waste packages going from an individual canister concept where we have relatively low fissile loadings on the order of--that should be 700 grams, not .7, or 10 kg's in salt where we can take credit for water exclusion. We went into the initial study on the assumption that double contingency requirements would be expected throughout the life of the repository, which is 10,000 years.

The original concept, I think, in terms of disposal of wastes in a geological repository was geared mostly towards high-level waste and not towards long-lived fissile products such as Highly Enriched U-235. We had always processed that before, recovered it, and recycled it into the system. When we went to a '94 assumption, because of the number of canisters that this would generate, we've got to say, okay, let's look at packaging them in a large package and putting in fixed neutron absorbers, which were then deemed acceptable. At this point in time, we've more or less focused on Boron-10 tied in with stainless steel, probably in a coded material that would be integral to the internals of that package. There will be some type of a lattice support on the inside. This is the same approach that's being taken by Yucca Mountain for the commercial fuels right now.

Standard configuration for a PWR-type package is 21 fuel elements. I think they're a 17 x 17 array, fairly standard design.

Shippingport, the elements are a little bit smaller so you can put them in a little more dense. You would still have to use Boron in terms of poisoning. We're talking about B-10 enriched material. It would have to be done in a special production run of whatever stainless steel we settle on. This particular configuration results in something like 460 kg of U-235 in a single package. And you have to place a lot of faith and credit in the fact that that Boron will stay there not just for 10,000 years but maybe 100,000 or a million.

Originally, we were considering putting ATR-type elements in there, into an MPC. There would be three layers, 255 total. There is on the order of 235 kg's of U-235 in one of those packages. Now, I guess, with the recent Record of Decision, those ATR elements would probably be packaged and shipped down to Savannah River for reprocessing, so this may become a moot point.

But these are some of the issues that we've dealt with in terms of examining criticality issues and trying to come up with a creative way to put them in a minimal package so that we don't have a long-term effect out beyond 10,000 years.

Fort St. Vrain, they were modeled with as many as twelve. Normal packaging would probably be more on the order of seven per element. These are stacked five deep. They represent, I don't know, 150 or 170 kg's of U-235 equivalent. I can't remember just off hand. Oh, yeah, 37.8. There's 54 percent enriched U-235 in there, so again, it qualifies as HEU.

All of these packages had to be evaluated in terms of presence or the likelihood of water ever entering the packages and how they might behave were the water to get in there and leach the poison away. Certainly one of our concerns has been the potential for differential separation of the adsorber away from the fissile material rather than vice versa. We've discounted, at this point in time, the prospect of a far field criticality. Everything we've looked at has been locally within the package.

One of the key issues that we're working on right now is identifying the specific fuel characteristics that would be necessary to develop the "pedigree" that you have with commercial fuels that we don't have with a lot of our commercial test reactor fuels. If we start with something on the order of 150 fuel types throughout the DOE complex, some 90 plus in storage at the chem plant, it would behoove us to try and group or lump as many of those fuels together from a characterization standpoint and then go ahead and develop the pedigree on those particular fuels.

What we're looking at now is what the cost would be, and it doesn't make a lot of sense to take a couple of fuel baskets that might contain 15 or 20 fuel elements and spend $15 million trying to characterize those fuels if you can lump them together with another fuel type that's very similar and do all of it in one package. So, ideally, we want to cut our fuel types down to a manageable 8 or 10, and even at that we're talking on the order of $10 or $15 million perhaps to qualify each fuel type just to get it to go into a package.

The one key element associated with that is that we now have facilities with modification that would be available to do some of that hot processing. But if neither the funding nor the desire to keep those facilities operational at this point in time and get started on identifying these characteristics of the fuels, characterizing them far into the future, waiting till your 2010 or 2015, and then saying, "Oh, gee, we've got to go out and get this data," we would have a real problem trying to support the fuel characterization requirements to meet the geological repository requirements.

That is in summary what I wanted to talk about today. Are there questions?

DR. LANGMUIR: Thank you, Larry.

Questions from the Board?

I had a more--Langmuir, Board--general question about the INEL's abilities to deal with this. This sounds like a major effort. And it's tough enough when you've got spent fuel, and you need to characterize its performance, as many of the labs are currently doing, looking at how it would dissolve, its radiolysis effects, and how this would represent a source term in a repository. But when you're dealing with potentially several other kinds of forms and you have, I gather, one organization here that's focusing on that as a major effort, how are these several potential forms going to perform and how will they impact the repository source term for releases of radionuclides? I wonder whether you have the resources here, personnel, with the expertise. And I'm talking about hydrologists and geochemists--that's my bias--along with other types of corrosion experts. I know you have people like this around, but I'm wondering what the size of your program is that's focusing on this effort and your perception of how successful it can be in the time schedule you've got to do it.

MR. TAYLOR: I don't know if I can give you a good clear answer to that. We have a dedicated group of individuals that is looking at packaging the different types of fuels. We would be more interested, I think, in characterizing the radionuclide inventory in certain fuels, where we have no record of the actual time in the reactor, what the neutron fluxes were, what the position of the fuel was, such as they have in commercial fuels. We'll have to make some simplifying assumptions in terms of beginning of life, end of life type concentrations of uranium. We'll have to make some extrapolations based on perhaps ORIGEN code runs rather than neutron interrogation techniques. We'll have to look at the fuel chemistries, such as how does uranium carbide perform in a water environment? Because uranium carbide in an HTGR was always running in a dry system, so all of the emphasis went in the development of data relative to uranium carbide in a dry environment rather than a wet one.

A lot of the actual chemistry work associated with the fuels on the performance of those chemistries and extrapolating them to PA results or data sets for use in PA we're probably capable of at the INEL. A lot of the other programs associated with Boron leachability, from stainless steel, the performance of an MPC in a repository environment, we would rely very heavily on the results coming out of Yucca Mountain. And certainly that is one of the key elements in a Steering Group, is trying to determine and define whose ball it is to carry for some of these data requirements.

DR. LANGMUIR: I noticed your Steering Group started in '94. That doesn't give you very much historic--

MR. TAYLOR: No.

DR. LANGMUIR: It's kind of late to start all of this, it sounds like.

MR. TAYLOR: It is, granted. And I think it's a major step that we've been able to finally get DOE and RW to start talking to one another. In the past, it's been kind of you have your program, we'll have our program, and I think we've made gigantic strides in trying to achieve a working relationship with those individuals and getting even the names of the people and who to contact to get some of this information flowing.

Other questions?

DR. LANGMUIR: More Board questions? John Cantlon?

DR. CANTLON: John Cantlon. In your Overhead No. 9 you have a long column of individual requirements that have to be met to achieve this. One of the difficulties when you have that kind of a situation is a sort of falling off in the coherence of the systems approach, getting it smooth running. In other words, it becomes just junked. Are you doing anything in particular to try to be sure that you've got a smoothly running system and not get too wrapped up in the details of regulations that may in fact be quite different in the near term?

MR. TAYLOR: Again, I'm not sure quite how to answer that. I know in the case of neutron absorbers, from a systems standpoint, we've looked at various materials internally where it's certainly of some value, but in terms of getting them qualified in the stainless steel, we've just said, "We can throw those out."

From a criticality standpoint, we've looked at bulk fuel types. In other words, we've characterized HTGR performance inside of an MPC, but you're not going to have one MPC that's going to have ten percent of its volume filled with the cats and dogs of one or two fuel baskets. So you're going to have to look at blending those fuels, and you may have three or four fuel types in one MPC. And that's a detail that has yet to be worked out but certainly needs to be addressed.

But from a criticality standpoint, we've involved-- I think Lawrence Livermore has done some work in support of us recently. We've got our own criticality group, and then we've worked very closely with Sandia and their criticality group in trying to assure ourselves that we're taking the right approach to evaluating criticality. So we're relying on a lot of other groups and individuals across the DOE complex to support us in these efforts.

Some of them, in terms of organics, you can basically forget about from the standpoint you know the characteristics of the fuels, what environment they were in in the reactor, not necessarily their age in the reactor or the irradiation time, but you know how you've stored them since then. Organics are not a problem in that particular case. They may be a problem from a high-level waste glass treatment. And I think Savannah River has been concerned with that in terms of some of the extracted materials that they've tried to use over the years. And I don't know, pyridine, I think, was one of them that they talked about. Is that an organic that is of concern on a long-term basis either from a chemical leaching standpoint, glass breakdown or fire and explosion type hazard? Certainly we're not going to pack coveralls inside of one of our MPC's to take up void vault. That will be excluded.

Yes, there are a lot of things that need to be considered, but not all of them necessarily apply to all of our fuel types. Some of them apply more specifically to certain types than others.

Does that answer your question?

DR. CANTLON: Yeah. Well, I'm really interested in how strong the systems approach of keeping a good, clear, smooth running process as opposed to getting mesmerized on the individual regulatory things.

MR. TAYLOR: We have not tried to go into the nitty-gritty details of specifically--although, to give you an example, the statement on 4.32 under Liquids says you won't put any free liquids in there that will compromise the internals of a waste package. And that's all it says. We have to now interpret that as to what is a free liquid; if there is liquid in there but it's not free, is it a concern to the internals of the waste package?

Other questions?

DR. LANGMUIR: Leon Reiter?

DR. REITER: Leon Reiter, staff. In the previous presentation we heard that in '93 performance assessment they looked at igneous rock and WIPP like, and then in '94 they went to tuff like, and then we heard about the decision that came out and marked the intent to put the spent fuel in the Yucca Mountain repository. So apparently, before, in the '93, they were looking at another solution, another type of disposal, not Yucca Mountain, and the second repository. What was the reason for the shift?

MR. TAYLOR: I think the key was that the regulation as it was being interpreted at that time did not allow for spent fuels to go into Yucca Mountain or into the first repository.

DR. REITER: So it was a legal--

MR. TAYLOR: It was a legal issue relative to the waste type and which repository it could go into. Furthermore, the total of the DOE spent fuels, as I think Brian talked about earlier, we're estimating at about 11,000 metric tons, and we can get 7,000 in. And so it becomes a juggling issue: do you put the high-level waste from Savannah River, West Valley and potentially Hanford, which is just the double shell tanks, or do we put fuels in, in place of some of those and put those in a second repository? And I think those are issues that are still being juggled programmatically at DOE headquarters level. And we're just trying to look at the various issues and the permutations and combinations and how they might affect us or how we might be affected by the decisions they make.

DR. LANGMUIR: Dan Metlay, Board staff?

DR. METLAY: This is a question that probably isn't directed to you, but maybe to Steve Gomberg, and I didn't have a chance to ask it earlier. Now that we have a better sense of what the spent fuel situation is with DOE, and I also understand that the Department's in the process of putting together a revised life cycle cost study, is there anything that you now know that would suggest that the allocation between the civilian side and the defense side is going to be any different in significant ways than what was presumed to be the case back in 1990?

MR. GOMBERG: We are getting ready, I think, or are very close to issuing our total system life cycle cost analysis. I haven't actually read it. From what I understand, it includes commercial spent fuel, high-level waste and defense high-level waste. I'm not sure if DOE spent fuel is in there right now. The differences in allocation that could or would occur I don't think are significant when you look at it from the 90/10 traditional split. I have seen, just like everybody else has, reports in the trade presses and whatnot where copies have been shown that show there are volumetric increases possible. I really don't have the knowledge to comment on that specifically.

One point, I guess, that we didn't bring up. Before 1992, we were expecting to basically reprocess all DOE spent fuel, and that was in either a ceramic or a borosilicate form would be sent to the repository, and certainly our focus was on that. As a result of the president's decision, the EH vulnerability assessments and various other things, we have evolved over time to this particular standpoint. We I don't think have said that we are in a position to accept all DOE owned spent fuel in a first repository. We have said that we are evaluating it to determine if it's suitable and ultimately acceptable in a first repository.

DR. METLAY: But just to clarify, you don't see the 90/10 split changing significantly?

MR. GOMBERG: The 90/10 split I think is based on projections of inventories potentially in a first or second repository, based on numerous assumptions that have to do with repository- and transportation-related costs. My understanding is those numbers are supposed to be reevaluated periodically to redefine that split, but my understanding is there would not be a significant change in that overall split. There could be a relatively small change to accommodate projection changes based on, say, EIA information, energy information, administration information, and whatnot. But not that I would, I guess, right now say was significant.

DR. LANGMUIR: I need to bring it to a close. Several things I need to say before we depart for lunch. First of all, they are prepared for us here in the hotel for lunch. They say they can handle all of us. I'm wondering with the other meeting going on, but that's what they say. They suggest we get the buffet, because it's more efficient. We're do back here at 12:30. There are two hot entrees, soup, salad for $5.95.

Final point, everybody who's made a presentation this morning, as well as those who make presentations this afternoon, need to be here at 4:00 to participate in the round table discussions, a very important part of our day.

So with that, I'll adjourn us for the morning. Reconvene at 12:30.

(Whereupon, a luncheon break was taken.)

A F T E R N O O N S E S S I O N

DR. LANGMUIR: We'll begin the afternoon session. Before we do, I have an announcement. "Please announce"--this is for me--"Please announce regarding the tour"--this has to do with our tour tomorrow--"everyone who asked to be on the tour and pursued their clearance information by the May 19th deadline is on the tour. They were faxed an itinerary on Friday, including those on the waiting list." So apparently everybody who wanted to go is going.

Our first presentation of the afternoon is given by Don Connors, and his topic is DOE-owned spent nuclear fuel: naval propulsion program component--path forward for ultimate disposition.

MR. CONNORS: Hi, I'm Don Connors. I'm representing the Naval Nuclear Propulsion Program today. And I'd like to start off by identifying a little bit what that program consists of. First of all, it's a joint DOE/Navy enterprise. It's an organization that was essentially set up years ago, was made legitimate by an executive order of President Reagan in about 1980, and has been codified into public law now. It's responsible for all of the Naval Nuclear Propulsion Program matters, and I've listed what those are:

There are over 100 nuclear-powered warships right now, and that's a scale down. That's about what it is now. Because in 1987, there were 150 nuclear-powered warships. By the year 2005, there will be about 80 nuclear-powered warships. So we're on a very steep decline, a slope, of reduction as evidenced by the end of the Cold War as required because of the end of the Cold War.

Those 100 nuclear-powered warships have about 120 shipboard/land-based nuclear reactors.

There are two moored training ships. They're ex-ballistic missile launching submarines where the missile compartment has been cut out of them, the ship welded back together, made into training platforms. They're located at Charleston, South Carolina.

There are three land-based prototypes operating now. All three of them are at the Kesselring Site facility near Schenectady, New York. There are no prototypes operating now at the Idaho National Engineering Laboratory. None of the naval reactors' prototypes are operating.

It's responsible for nuclear safety, radiological matters at naval shipyards and basis, two R and D laboratories, and the Expended Core Facility at the Idaho National Engineering Laboratory.

To date, we've had about 4,400 reactor years of operation steamed over 100 million miles, and had about 300 refuelings and defuelings. We've never had a reactor accident or any significant release of radioactivity.

Now, this is a rehash of a couple of other slides you've seen, maybe in a little different form, but brings out the Navy component. The Navy right now has about 10 MTHM of spent nuclear fuel located at the Idaho National Engineering Laboratory. Over the next 40 years, we expect to generate another 55 MTHM, so that would bring us up to a total of 65. This is a small amount in comparison to the DOE fuel, which you've heard talked about, and it's a very small amount with respect to the civilian fuel. But those are the numbers that are listed on that chart.

Navy fuel is classified. And I can only ask you to imagine what it must look like by throwing up a few of the characteristics of the fuel. It's metallic, solid, non-flammable, non-explosive, highly corrosion resistant fuel. It withstands combat shock forces, which are important in a warship, obviously, but they have to withstand depth bomb attacks and so on. So it's pretty shock resistant. I put the emphasis on the "well in excess of 50 g" up there.

It is capable of rapidly changing power levels, and it needs to be in order to accelerate a ship or slow down a ship at an instant's notice. So the fuel system is capable of rapidly accelerating power levels. That fuel system totally contains the fission products that are inside. The only fission products that we ever find in the primary coolant are tramp radiation of the tramp material, the uranium material, that might be in the clad. That's the only fission product that we find in the coolant on a naval reactor. And we have a strong incentive to do that. The Navy people live on the ship right in close proximity to the fuel.

It possesses extremely long operating lives, right now over 20 years. Didn't always used to be that way. The Nautilus had a two-year lifetime. With examinations of fuel at the Expended Core Facility, the development work that's been going on, we've been able to extend that lifetime now up to over 20 years. And that integrity at high temperature clearly relates to an extended integrity at low temperature, the kind of temperatures you'd experience in a storage situation.

The integrity of the fuel we think is evidenced to some extent by the fact that we lost two nuclear-powered submarines in the '60's, the Thresher in 1963, the Scorpion in 1968. Both are lost and on the bottom of the ocean in deep water, one in 8,400 feet, the other in over 10,000 feet. We have sent vehicles down to examine the environment around those submarines, and there's no evidence of any loss of integrity of the fuel. And we think that's an evidence to the high integrity of the fuel system that we've designed.

The fuel cycle for Navy fuel, Navy spent fuel.

It's removed from the ship and up to now has been sent to the Idaho National Engineering Laboratory for examination at the Expended Core Facility. And after examination, it gets transferred the Chemical Processing Plant to DOE for ultimate disposal. It was being reprocessed up till 1992, but reprocessing of Navy fuel stopped in 1992 just like the other fuels.

The shipments to INEL are made in containers like this one. We have a couple of different container designs. This is the M-140 container, which is about 16 feet high, about 10 feet in diameter. It's basically a solid right circular cylinder. The wall thickness is 14 inches of stainless steel, and there's about 17 inches of stainless steel up on the top, including the steel in the protective dome, which acts as a shock absorber in the event of a problem. The only reason I show that is because it's one of the options for the path forward in taking care of Navy spent fuel.

The container itself, the M-140, is designed for complete containment during normal conditions. It's certified by DOE to 10 CFR 71. The design was submitted to the NRC for review, a Certificate of Compliance issued by the NRC. And I would point out in addition to that, no active cooling system is needed on the M-140 container.

Historically, through 1995, we've sent shipments, about 600 of them, to the Idaho National Engineering Laboratory. We had sent all but 27 shipments prior to 1993. The court order in 1993 stopped further shipments, but the State of Idaho and the court agreed that additional shipments were required and allowed 27 more shipments during the pendency of the court injunction, which as you know is still in effect. All of those shipments were by mail--by rail. We don't ship by mail or by air. The containers are dry. They've all been to Idaho, we've never had an accident, and the total radiation exposure to the entire population along all the transportation routes has been .1 of a rem from those shipments.

Now, what's the path forward for Navy spent fuel? The military characteristics of the fuel likely will provide suitable for direct disposal without any processing, without any canisterization or additional work on the fuel. We think it's acceptable the way it is. It's likely to meet the Waste Acceptance Criteria. We don't know what the Waste Acceptance Criteria are, and therefore we have to say it's likely to meet the Waste Acceptance Criteria.

We are participating with DOE right now in the path forward. First of all, when the Notice of Intent came out on the Multi-Purpose Canister, the Navy asked the DOE to become a cooperating agency, and DOE agreed to let the Navy become a cooperating agency in the development of the Environmental

Impact Statement on the Multi-Purpose Canister. We are actively engaged in working the Navy material into the EIS for the MPC. Navy fuel will be included in the license application to the NRC. I understand the license application is probably targeted sometime in mid-1996. At this point, it's not clear when we will include ourselves. We may include ourselves as an amendment to the license. We have one ground rule: not to delay the licensing of the MPC for civilian fuel with the addition of the Navy fuel. So probably follow it by some number of months. The Navy fuel will be included in the repository EIS. There is a Notice of Intent that's in preparation. When that Notice of Intent comes out, you should be able to see Navy fuel is going to be included in the repository EIS. WE've done the leach testing and so on on spent Navy fuel. We have confirmed that it is not RCRA waste. We have EPA agreement on that confirmation. So Navy fuel is not RCRA.

Now, what does it look like for Navy fuel in an MPC? This is a sketch, without revealing any of the classified information on the Navy fuel. But the MPC that I've selected here is the 21 PWR module MPC, and that's supposed to be a 17 x 17 Westinghouse commercial fuel module that's sitting there. And 21 of those would fit into the ports in the MPC. We expect to put the Navy fuel into a container. Maybe the insert arrangement might change, maybe it will not change, but the Navy fuel would fit right into the ports that the commercial fuel will fit in.

The alternates that are being considered in the Multi-Purpose Canister EIS--and now you'll see why the M-140 was discussed earlier. The first and the preferred alternate that is being developed for the MPC EIS is the 125-ton canister design. There is an alternate to that, which is the 75-ton canister design. There's another alternate that basically says, "What if you don't pick the MPC, but what if you instead use existing technology?" Well, the existing technology for Navy fuel is the M-140 shipping container, and we would therefore pick the fuel up out of the water pools at Idaho, put it back in the M-140 that we took it out of when it come in from the shipyard, and send it to the repository and then unload it into whatever unit is designed and developed for disposal in the repository. That would be called the No Action alternative, and it is using existing technology. There's another alternate that is a high-capacity transportation cask. To do that, we'd realign the internals in the M-140 and set it up so that it could handle more fuel and get a higher capacity transport with a modification to the M-140. There are two other alternates which are exactly the ones that are being considered for the commercial fuel, and that's the transportable storage cask using the NAC-STC system or it's a dual-purpose canister using the NUHOMS MP-187 system. So those are the alternatives that are being considered in the EIS on the Multi-Purpose Canister.

I have just one more slide, which shows the comparison of an MPC loaded with 21 PWR modules, commercial fuel modules, and an MPC loaded with typical Navy modules. If we start at the top, we can see that the total metal is about the same, 14 MTTM for the commercial PWR assemblies, 12 MTTM for the Navy modules. If you'll look and say how much of heavy metal is there, there's 10 MTHM in the low enrichment commercial fuel. There's .4 of MTHM in the highly enriched Navy fuel. So with an enrichment of 3.75 percent in the commercial 21 module PWR, you wind up with 364 kg of U-235. With an enrichment--our enrichment ranges from 93 percent to 98 percent; I picked 97 for this chart--we would wind up in an MPC loaded with Navy modules with 360 kg of U-235. So we have crudely the same criticality problem that the civilian unit will have.

Now, that's what I had prepared to identify. If you have any questions, I'd be happy to try and answer them.

DR. LANGMUIR: Langmuir, Board. Clarification on your last overhead, Don, is what does BOL stand for, U-235 BOL enrichment?

MR. CONNORS: That's Beginning of Life. I took the initial loading of a PWR assembly, 3.75 percent enrichment, and wind up with 364 kg. So that's what BOL means, Beginning of Life, before any depletion of the fissionable material.

DR. LANGMUIR: Thank you.

MR. CONNORS: Okay.

DR. LANGMUIR: I have a generic question here, sort of. I don't know, maybe it's not generic. But anyway, I noticed that this fuel is mysteriously secret. I wonder how one gets through a licensing with public discussions of consequences of disposal, license for the MPC Environmental Impact Statement, without divulging what it's made of. I wonder how you'd defend its performance in a repository without divulging what it's made of.

MR. CONNORS: Well, first of all, when we have to reveal classified information, we get the people we reveal it to cleared, set up the necessary controls, and then provide whatever information is necessary. So that's the way we do it, and we've done that with licensing. And one of the reasons I pointed out the fact we have licensed the M-140 container is this is not unusual for us to do. We have had a couple of meetings basically recently with the MPC people on a classified basis, and we just reveal the information that needs to be revealed.

DR. LANGMUIR: A related question. If it is in fact--and I'm pretending I know what it is, I've been given a rumor here from someone near me--if it's metallic uranium, I'm assuming if it's in a repository and there's a breached waste package, you're going to have oxidation, and possibly crepitation and spalling, a behavior quite different than UO2 commercial fuel if it's in the same kind of waste package and it's breached. And I would assume whatever happens to it is going to be different behavior perhaps.

MR. CONNORS: It's different than commercial fuel, let me say that.

DR. LANGMUIR: Yes, but it's performance will be different.

MR. CONNORS: It's zircaloy 4 clad material, we have identified that much.

DR. LANGMUIR: Okay.

MR. CONNORS: It is highly corrosion resistant.

DR. LANGMUIR: The fuel itself or the cladding?

MR. CONNORS: The fuel itself is highly corrosion resistant.

DR. LANGMUIR: Okay.

MR. CONNORS: In addition to the cladding.

DR. LANGMUIR: All right. Remains a mystery as to what it is.

MR. CONNORS: Okay. And I've been successful.

DR. LANGMUIR: Questions from the Board? Bill Barnard, Board staff?

DR. BARNARD: Bill Barnard, Board staff. As I understand, most of the reactor fuel is now in pool storage?

MR. CONNORS: The reactor fuel, the 10 MTHM that's in INEL, is in pool storage either at ECF or at ICPP. I think there's 3 MTHM roughly in pool storage at ECF. The other 7 MTHM is in storage at ICPP in pool storage, mostly in CPP-666.

DR. BARNARD: Could this fuel be put in a dry storage? There shouldn't be any reason why it shouldn't.

MR. CONNORS: It could be put in a dry storage, and we included the option of dry storage in the programmatic Environmental Impact Statement that was just issued. Could be put in dry storage. We have enough room right now in water pool storage. We know how to handle water pool storage. When we need dry storage, we can take the stuff.

Now, our calculations at this point, I mentioned that we ship the stuff dry. We don't need water in the container for cooling when we're shipping it. These are not high-decay heat load units. We don't need water for cooling when we ship it. We've made the calculations, the MPC calculations say 5 years before you put it in an MPC, 10 years before you put it in a transport container, 20 years before you put it in the repository. We're making our calculations at five years and not finding any difficulty in loading. We've done the structural work, we've done the decay heat work, we've done the criticality calculations. We don't see any obvious impediments. Clearly we've got a lot more work to do before it actually becomes reality.

DR. LANGMUIR: Carl Di Bella, question?

DR. DI BELLA: I take it burnup is a classified number for naval fuel?

MR. CONNORS: Yes.

DR. DI BELLA: Okay.

MR. CONNORS: Yes.

DR. DI BELLA: This morning, Henry Loo spoke to us about a recent performance assessment that he had done with INEL where he didn't do it for naval fuel but did it for--

MR. CONNORS: That's right.

DR. DI BELLA: --what he called a surrogate, and I think it was a Shippingport fuel.

MR. CONNORS: He used a Shippingport module, yes.

DR. DI BELLA: Okay. And he concluded that it passed the performance tests that are in 40 CFR 191. But he also said the waste form would not meet the requirements of 10 CFR 60 as far as the release rate is concerned, and actually, I read that the waste package, according to the models that they used, wouldn't meet the 1,000-year substantially complete container either. Now, what sort of modeling have you done for your particular fuel, not a surrogate, I guess, that indicates that indeed it would meet this? Okay, it's more robust, I grant that, but what actual sort of models have you used?

MR. CONNORS: The naval fuel that I'm talking about is different from the Shippingport fuel that Henry Loo analyzed. That's first and foremost. It's a different fuel system.

DR. DI BELLA: Right.

MR. CONNORS: The naval fuel that I'm talking about, we have test results for however long test results are good for. You have to extrapolate them out to lifetimes, but extrapolating those test results would indicate that we have many, many, many years, and I'm talking like a million years, before we would see any significant degradation of the fuel. Now, it has to be extrapolation because clearly we don't have data for real long lifetimes. But extrapolating the materials.

The other thing that Henry Loo knows is that our intent is to pin control rods in our fuel assemblies. To pin control rods so that the control rod becomes an integral part of the fuel assembly. I guess that's all I should say.

DR. DI BELLA: Did your RCRA tests include looking at the fuel rod leach results?

MR. CONNORS: Yes. The corrosion tests and so on include the material that we would expect to use for the control elements that would be put in the fuel modules.

DR. DI BELLA: I was asking about the RCRA tests, the leaching tests that you used to determine whether or not--

MR. CONNORS: I'm not sure about the answer to that question, whether the RCRA tests included the pin control element. I can find out and get back to you, Carl.

DR. DI BELLA: I've heard people say in the Yucca Mountain Project--and I won't identify them--that metallic fuel probably wouldn't be acceptable in a repository. This applies to the Hanford fuel also. And yet you feel quite confident about it, obviously, and I think INEL feels fairly confident about it, too. What is it that you are going on to have this kind of confidence?

MR. CONNORS: I guess the only thing I can refer to on that are the design characteristics that I identified--its battle shock resistance, its high corrosion resistance. It's really that that I'm relating to. I'm not sticking to any particular word like metallic. I'm looking at the overall system that has been designed.

DR. LANGMUIR: I think we're just about on time if we can go on. Thank you, Don.

MR. CONNORS: Okay.

DR. LANGMUIR: Next presentation is by Jim Laidler. His topic is DOE-owned spent nuclear fuel: stabilization technology and development activities.

MR. LAIDLER: Thank you. Good afternoon, I'm Jim Laidler. I'm the director of the Chemical Technology Division at Argonne National Laboratory in Chicago. And this will be a little bit of a change of pace for this afternoon. I'm going to talk about a technology that we're developing for future application, maybe not a long-term but hopefully mid-term, that promises some very significant advantages, and I'd like to explain those to you.

It's a non-aqueous process, and if you're thinking of this in terms of a conventional Purex reprocessing method --and incidentally, this is not reprocessing--this is like night and day from the Purex method. It does not use any aqueous solvents in the process. We actually use an electrorefining technique to separate uranium metal from the fission products and the transuranic elements. The uranium metal goes a separate direction in this process; the fission products and the transuranics show up in the high-level waste forms. And it's applicable to a very broad range of fuel types: metals, oxides, cermets, graphite fuel even, hydride fuels.

And the way that we treat those different fuels is dependent upon the nature of the fuel itself. If it's a metallic fuel, because the feed to the electrorefining process is metallic, then it goes directly to the electrorefiner. If it's an oxide fuel, then we go first through an oxide reduction step, where we reduce the oxide with lithium metal and recover the reduced actinides in metallic form plus the fission products. They go to the electrorefiner then, then we do the separation. If it's a different type fuel, then it would go through some for now unspecified treatment that would produce either an oxide or a metal form which would then go through these other two steps.

The process of separating the actinides and the fission products in the electrorefining step results in the fission products plus the transuranics going with the electrolyte sol in the molten salt electrorefining process to a fission product extraction step where we absorb the fission products and the transuranic elements in a zeolite, and then that becomes our high-level waste form. The process separates the fuel material from the cladding, and we actually use the cladding material itself as the matrix to contain the metallic fission products, and that becomes a second high-level waste process.

The uranium that's the product of the electrorefining step is pure uranium. It's free of fission products--and I mean really free of fission products--and it can go either to interim storage--if it's highly enriched uranium in the spent fuel that we're dealing with, the process then involves an additional step for blending down with depleted uranium to produce a uranium product that's less than 20 percent enriched in the U-235 isotope.

Schematically, the electrorefining process looks like this: We use an electrolyte salt which is a eutectic mixture of lithium and potassium chlorides operated at a temperature of 500 degrees C. We place the spent fuel in a perforated metal basket which we make anodic, and we electrolytically dissolve the fuel material away from the cladding material so that the cladding is left at the bottom of the anode basket together with those fission product elements which will not form stable chlorides. So they stay together with the cladding at the bottom of the basket. The alkaline metal fission products, cesium and strontium and so forth, and the alkaline earths, will stay in the salt as stable chlorides, together with some of the rare earth fission products and the transuranic elements. So we form plutonium chloride, americium chloride, and so forth. And we deposit pure uranium on a steel cathode and recover that uranium by a constant process of scraping the uranium dendrites from the surface of the cathode. Included in the noble metal fission products are the technetium-99. And in addition, we find that the carbon-14 will stay at the bottom of the basket as well.

The overall process is very simple. And this is the entire flow sheet for the electrometallurgical treatment. Depending on the fuel type that we're dealing with, we'll either go through the oxide reduction step or directly into the electrorefiner if it's metallic fuel. The separated uranium is a dendritic deposit which has some electrolyte sol adhering to it. So we send it to a vacuum distillation furnace where we melt the uranium, boil off the electrolyte salt, and cast the uranium into a large ingot which is then placed in interim storage. Now, this can be either recycled or, if it has no value, it can be sent to a low-level waste disposal site.

The salt in the electrorefiner, as you process batch after batch of spent fuel, will increase in concentration of fission products so the decay heat load in the electrorefiner increases to a certain point at which you have to then remove the salt to extract the fission products. And the salt together with the fission products and the transuranic elements are then sent to a series of zeolite columns. We pass the salt through the zeolite columns, again at 500 degrees C. The effluent salt from the zeolite columns is free of fission products and transuranics and can be recycled to the electrorefiner. The first, most heavily loaded zeolite column is extracted once we reach our target loading of fission product elements, sent to a hot pressing operation where we first blend with a glass frit, a borosilicate glass frit, hot press and form a solid monolith of our ceramic waste form. And that becomes our ceramic or mineral waste form. So that's one high-level waste form.

The cladding, together with the anode basket screens and any filters that we use in pumping this salt to the zeolite column then are sent to a melting furnace where we melt under a salt flux. The salt flux removes any residual transuranics that may have been in the cladding holes, and we recycle that salt with the transuranics back to the electrorefiner. This metal waste then becomes our second high-level waste form.

Now, we see a number of incentives for treating of spent fuel. One of the primary ones is because we have a very large number of distinct fuel types, if we had to qualify each one of those types for disposal in a repository, then it would be a fairly expensive proposition. So what we are doing is really homogenizing a whole collection of different fuel types, because the process really doesn't care what the composition of the fuel is, to a single set of common waste forms. Regardless of the fuel that's sent through the process, the waste forms are the same. The only thing that varies is the composition of the metal waste form, and that's dictated by the composition of the cladding material.

Second incentive, of course, is to stabilize the fuel. If we have unstable materials--and we do--in the inventory, then this is a way to get it all into stable waste forms. And incidentally, because we're dealing with a lot of fuel that is highly enriched to alleviate any criticality concerns, you blend down the highly enriched uranium as part of this process, and you separate the uranium out. It doesn't go to the repository.

And then the third incentive is that it does resolve, because it's a non-aqueous system, we don't have a lot of solvent recovery operations and any secondary waste, the volume of high-level waste that comes out of the process is very small.

So we have the three product streams of the electrometallurgical treatment process:

Pure uranium, which we're saying for now can go to interim storage and then the country can decide what to do with that material. If we leave it at 19 percent enriched, then it may have some market value. If it's very low enriched natural uranium or depleted, then it probably has little market value and could be sent to disposal as low-level waste.

The second waste stream is the noble metal fission products, technetium, and the transition metals, plus the cladding material, either zirconium or stainless steel, and that's our metal waste form. The third is the ceramic waste form with the transuranics plus the active metal fission products, cesium and strontium. And those are our two high-level waste forms.

Now, the quantities of waste that we're projecting --and recognize that this is calculated on the basis of mass balance flow sheets and substantiated by laboratory scale experiments. We have not gone to production scale yet. But in the case of oxide fuel treatment, of the per MTHM treated, the uranium product volume, of course, is the same, 50 liters. The ceramic waste form for oxide fuel treatment is about 150 liters per ton. For the metal fuel, it's about 15. The metal waste form is 55 liters in the case of the oxide fuel and 20 liters for the case of metal fuel treatment, and we produce no secondary waste. These are very small waste volumes. It's about 15 to 20 percent of the--well, the packaged waste volume for this process is about 15 to 20 percent of the packaged waste volume of spent fuel if you dispose indirectly.

Now, where do we stand? We've demonstrated the process at what we call engineering scale, about 10 kg per day processing rate, with unirradiated fuel to which we have added non-radioactive fission product elements, the rare earths and the cesium and strontium and so forth. We are now in the process of scaling up the process equipment to demonstrate its performance at higher throughput rates that would be required for application to the treatment of the DOE spent fuel. The electrorefiner being scaled up to a module size of 200 kg per day, and the oxide reduction process to 200 kg per day.

Our waste form production processes are also being demonstrated at reasonably large scale, 20 to 50 percent of what we would see as production scale. And production scale is on the order of a ton per day. Waste form performance testing is in progress, and we've been very gratified with the results with these two waste forms, the ceramic and the metal waste forms. Their performance in terms of leach rate is equal to or better than borosilicate glass standard that's developed by Savannah River. The metal waste form is particularly good. It's about two orders of magnitude better.

In looking at applications of the process, we've tried to put our emphasis on what we see as the major problems in the DOE inventory. The metallic fuels, of course, the N-Reactor fuel, which is severely degrading, the single-pass reactor fuel from the production reactors, the early production reactors, at Hanford, and of course the FERMI-1 fuel that's here, some of that fuel is sodium bonded. Of course our EBR-2 fuel that you've heard about today is also a sodium bonded fuel, and there's about 34 tons of that.

Oxide fuels that will eventually reside in entirety here at the INEL will total something around 300 tons. I'm not sure if that's absolutely precise. But there are more than 50 distinct fuel types. You've heard a number this morning, maybe 90 or 92 different fuel types of the oxides.

Finally, we are also looking at a problem with the molten salt reactor experiment fuels at Oak Ridge National Laboratory. It's a fairly small quantity of material, only about eight cubic meters, 8,000 liters, but it's currently very unstable. They've lost chemistry control on that fuel and uranium hexafluoride is being formed and migrating throughout the facility.

Now, as far as what we're doing where, the development of the process technology is being carried out where I work in Illinois. The process demonstrations are to be done here at the Argonne West facility at the INEL in two major hot cell facilities, a Fuel Conditioning Facility, or FCF, and the HFEF, the Hot Fuel Examination Facility, a major modern hot cell facility.

We are beginning with the treatment of EBR-2 fuel as part of the process of shutting down that reactor, and we will be applying the process initially to the driver fuel. There's about a ton of driver fuel, a little over a ton maybe, and the balance is blankets. This demonstration we feel will be applicable to the FERMI-1 N-Reactor and the single-pass reactor fuels, all of which are metallic.

It's also applicable to any head-end treatments which produce a metallic product. This treatment will be done in the Fuel Conditioning Facility. The operational readiness review has been completed and we're just waiting the approval of the Secretary of Energy to begin hot operations. We have done some operations with depleted uranium to check out the equipment. We expect that approval to begin later this month.

Oxide fuel is important at the INEL because this site will have the major complement of that material in the DOE inventory. Our plan is to install an oxide reduction system in the Hot Fuel Examination Facility at this site in Fiscal 1996. And we'll start initially at a rate of 20 kg per day, and then by 1998 we'll have a capacity of 200 kg per day. And we could use this system for treatment of the TMI-2 core rubble. There's about, I think, 82 tons of that fuel, and so we could at this rate process it in a couple of years.

This is our overall schedule for the development program. The EBR-2 spent fuel and blanket treatment period will extend through about the end of 1998. These are fiscal years. In order to do the treatment of the very large quantity of blanket materials, we have to install a high throughput electrorefiner, the 200 kg per day module, and that equipment will be installed by the end of 1997. We've already finished some cold demonstrations with unirradiated and reactor fuel in Illinois, and we plan to do some experiments with irradiated N-Reactor fuel in our smaller electrorefiner in the Fuel Conditioning Facility at the end of next year and then progress to the treatment at the higher throughput rate at the end of 1997 with N-Reactor hot fuel.

Process development for the single-pass reactor fuel will be completed by 1996. We'll be completing the development of the process for treating the MSRE fuel and flush salts by mid-'97, and we'll be ready to start our TMI-2 irradiated fuel or rubble demonstration experiments at the start of 1997.

And the rest of this is really the waste treatment and waste form production. We really don't have any waste volumes to speak of until we've gone through about two and a half years of treatment of the EBR-2 fuel.

The real advantage of this system is that because it's a batch process, it's scalable to fit specific site requirements. If a throughput requirement is small at a particular site, then we have a small module or a small number of modules. And if it's large, for example in the case of the Hanford N-Reactor fuel, then we'd have say five of the electrorefiner modules rather than one. Equipment is very compact. A five-module electrorefiner takes up about half the space of this open area in the center here of the table. Facility requirements are very small, and the process chemistry is very well controlled and we understand it pretty well.

It has the advantage of being a single process which will treat a very diverse collection of spent fuel types. The equipment commonality and commonality of procedures is a significant advantage. It offers a substantial reduction in the volume of high-level waste, as I mentioned, 15 to 20 percent of the package spent fuel volume. And because this fuel is fairly old, that means you can cram a lot more waste into a given container, repository container, volume. And cost of doing this treatment is very low. This is not just our estimates but estimates that have been done by General Electric Company and by Burns & Roe, and the G.E., Burns & Roe estimate was actually under $200 per kg. Our guess at it is around $350. But that compares, I think, very favorably. If you know what the Purex costs are in Europe and Japan, they're probably ten times that.

So we think we've got a process which has some real potential for application in the future. We're pretty close to being able to demonstrate it on a fairly large scale. Thanks.

DR. LANGMUIR: Thank you, Jim. Questions from the Board? John Cantlon?

DR. CANTLON: Cantlon, Board. Do you have any international collaboration on this process yet?

MR. LAIDLER: We did.

DR. CANTLON: Japanese?

MR. LAIDLER: Yes.

DR. CANTLON: Yeah.

MR. LAIDLER: And that contract was terminated at the request of the Department of Energy.

DR. LANGMUIR: I'm going to show my ignorance--Langmuir, Board--of nuclear chemistry here, but I'll ask a question anyway and you can give a me little tutorial. You're separating uranium from some long-lived actinides or TRU products like neptunium, plutonium, americium, which are among the big concerns late in repository life.

MR. LAIDLER: Right.

DR. LANGMUIR: They're going along with fission products which are hot at the beginning of repository life. You have reduced the volumes, but haven't you created a product which is just as difficult to deal with in terms of repository long-term performance as the spent fuel?

MR. LAIDLER: When we put the fission products and transuranics into the zeolite, it's an ion exchange process, and we're counting on a charge balancing reaction to bind those elements in the structure of the zeolite. It turns out that the--what we call the extraction coefficient or the strength of binding increases with a valence of the material that's being absorbed. So as we put in cesium with a +1 charge, it's less strongly bound than strontium with +2 or the rare earth fission products at +3 and the transuranics at +3. So what we are finding is that when the transuranics go into this zeolite, they stay there. So it's--we expect anyway--to be a very, very stable waste form, and the leach tests that we've done on that material, we just can't get the transuranics or uranium to come out of it.

DR. LANGMUIR: Might they be changing form into oxides in your zeolite? I wonder also about the zeolite being affected by radiolysis. If you've got actinides inside it blasting away at the silicate structure, I wonder how stable that is through time.

MR. LAIDLER: The concern is with not so much the radiolysis. We've done gamma radiation experiments up to about the equivalent of 10,000 years exposure, and we see no degradation of the zeolite structure. But the concern is with the buildup of helium in that system. Now, if you know a little bit about the behavior of ceramic materials, you know that they can tolerate a lot more gas buildup or helium buildup than you can, for example, in a glass. So we're trying now to come up with an accelerated test where we generate a lot of helium in the waste form so that we can look at those kind of long-term effects.

DR. LANGMUIR: One last question related to that. One of the big concerns at Yucca Mountain is that if you get a high thermal loading scenario at the mountain, the natural zeolites will be unstable about 100, 200 degrees or so. Some of them will be at least; they'll alter. I wonder what the temperatures of this might be, this material itself with the actinides in it, the TRU's in it, whether it's going to get hot and whether the zeolite as such is a stable phase.

MR. LAIDLER: We try to limit our centerline temperature of the waste form, the ceramic waste form, to 350 degrees C. And we have done some long-term thermal aging experiments with that material. Now admittedly, again, as Don pointed out, we are not able in a reasonable way to do a simulation of very long-term effects. And so that's a shortcoming in all of our waste qualification efforts, is we really don't know what's going to happen, what the forward reaction rates are going to be, but we're trying to come up with tests that are as severe as possible and yet somewhat representative of the actual conditions in the repository environment.

DR. LANGMUIR: Thank you, Jim.

Any more Board questions? John Cantlon?

DR. CANTLON: Yes, this is Cantlon, Board. I've forgotten the process scale. How does this compare with the Purex process? This is a batch process and you were giving us some numbers. How does that compare, say, with the scale of a typical thing that the French are doing or the Japanese are talking about?

MR. LAIDLER: Well, the French plant and the proposed Japanese plant are 800 tons per year.

DR. CANTLON: Yeah.

MR. LAIDLER: The version of this system that we're proposing be installed, for example, at Hanford is something on the order of 250 tons per year. But recognize that it's a balance. What you're trading off is throughput capacity against cost of the facility.

DR. CANTLON: Sure.

MR. LAIDLER: And if we want to process that material in two years, then you just replicate these modules of the electrorefiner. Right now it takes five modules to do 250 tons a year.

DR. LANGMUIR: Thank you, Jim.

We're right on schedule. I'd like to continue with presentation by David Abbott and Norman Rohrig. The title is "Commercial Spent Fuel Storage Demonstration Activities at INEL."

MR. ABBOTT: Well, as Mr. Langmuir said, I'm Dave Abbott, not Kevin Streeper. Kevin's better looking, but I'm braver. And I'll be talking about some activities we've been doing here at the INEL to demonstrate the performance of commercial spent nuclear fuel and storage conditions.

The work that we've been doing here has been entirely supported by DOE's Office of Civilian Radioactive Waste Management, RW, and there have really been two support organizations involved, us at INEL and then also PNL up at Hanford. PNL does a lot of the technical modeling and test planning and that sort of thing, and then we've been primarily involved in the testing and demonstration activities and the actual operational activities.

All the work that I'll be talking about has been done at Test Area North, which we call TAN, both in the TAN Hot Shop and hot cell and then also on a pad that's located outside the TAN Hot Shop. Between the period 1985 and 1991, we did an elaborate test program where we tested the performance of dry storage casks. We tested both metal and concrete casks. We actually tested four casks, three metal casks and one concrete cask, and in those casks we tested their performance with both intact Westinghouse 15 x 15 PWR assemblies, and then we took some of the assemblies apart and consolidated the fuel rods into canisters so we had two assemblies' worth of rods in one canister. And the canisters had about the same dimensions as the fuel assembly, so we had 2 to 1 consolidation.

Most of that testing work was completed in '91. Since that time, we've been storing the fuel in the casks on a pad out at TAN, and then also been doing some wrap-up maintenance and modifications on the casks getting them into storage configurations. The storage actually occurs out on the pad, and then we also use the TAN Hot Shop to do maintenance work on the casks, and also we have the capability of bringing the casks into the Hot Shop to do any inspections or maintenance work.

Our current inventory, the first cask, the TN-24, is a metal cask, has a capacity to hold 24 PWR assemblies. Right now it has 7 consolidated canisters in it. The second one, the VSC-17, is a concrete cask with a steel liner, and it has the capacity for 17 PWR's and it currently has 17 consolidated canisters. The third cask is another metal cask, the MC-10. It has the capacity for 24 and it has 18 intact 15 x 15 assemblies. And then the last one is a nodular cast iron V-21 cask. It has the capacity for 21 assemblies and it has 21 intact assemblies.

And we are currently doing an enhanced monitoring program on these casks. This work is still funded by RW, and the intent, really, is to demonstrate the performance of the spent fuel under long-term storage conditions. The fuel is all stored in a helium atmosphere and the temperatures are--well, the last time they were measured, the highest temperature was about 340 to 350 C, and there's been some decay since then, so it would be cooler than that, and it varies with ambient conditions, of course.

This is a photograph that was taken some years ago. Not all the casks are in this picture. This is the TN-24. This is the V-21. This is an empty cask that's out there, the REA-2023. This thing here is our transporter. It has the capability to come over and straddle a cask, and then these lifting arms attach the trunnions and then it can lift the cask and then you attach a vehicle to the transport and it will pull it back into the Hot Shop, which is back in here. You'll be seeing this tomorrow, I think.

Description of our monitoring program. As I said, we have an enhanced monitoring program that's being directed by RW, and the purpose is to do a little more inspection than a utility would normally do to try to gain some more information about the long-term performance of the fuel in the casks. Our monitoring program consists of a daily surveillance, quarterly gas sampling, and then if conditions warrant, we have the capability to do fuel inspections.

The daily surveillance is pretty simple, we just go out and walk around the cask, make sure cooling vents are cleared of tumbleweeds and things like that. And then we also have pressure transducers located inside the casks so we have the capability to monitor the internal cask pressure. The casks are maintained at a positive pressure. As I said before, with the helium atmosphere, the pressures are normally about 1.2 to 1.8 atmospheres.

Then we selected two casks, the VSC-17 and the V-21 to do quarterly gas sampling. Those two casks are the ones that are fully loaded, one with intact fuel and the other one with consolidated fuel. We take a sample from the cask of the helium atmosphere, and then it's analyzed by mass spectrometry for these, and I won't read all of them. The ones we're primarily interested in are nitrogen, oxygen and hydrogen, because if we see like nitrogen or oxygen, it would indicate possibly a failed seal or some other problem with the cask. We do a gamma scan to look for krypton-85. Krypton-85 would be indicative of failed cladding on the fuel. And then we also look for carbon-14. The purpose of doing the carbon-14 test is the information that's been requested by the repository. There's the potential, I guess, for carbon-14 to be released from the fuel. It's a volatile material, and if an MPC or something like that were to fail in the repository, then there would be a potential to release carbon-14 and get out through the ground barrier.

And then, as I said, we would do fuel inspections only if we had indication of damaged fuel or some problem with the casks. And so far, our results this year have shown no indications of fuel failures.

Our future plans, at least for the next five to six years, are to continue the monitoring program pretty much the way it's going right now. We plan to reduce the gas sampling period to once per year based on the fact that we haven't found anything very interesting this year. And then we will continue to have the ability to do fuel inspections if the problems occur. We have developed procedures and equipment to do fuel inspections if we need to. We could do a variety of different kinds of inspections. Most likely we would do visual inspections where we'd pull the fuel up out of the cask and look at it through the Hot Shop windows and then also do video inspections. We could also take crud samples, do some scrapings or, if we really had to, we could even take a fuel assembly out of the cask and bring it into the hot cell for more detailed sampling or something like that.

Long-term there's a plan to move all the INEL fuels down to ICPP, and so when we finally get around to doing that with these particular casks and fuels, then we'll have to evaluate the impact on the monitoring program.

DR. LANGMUIR: Question, Dave, are you and Norm both going to talk during this fifteen-minute period that we have schedule?

MR. ABBOTT: Yeah. I have two more lines and I'm done.

DR. LANGMUIR: Okay, you're almost into questions for the overall presentation.

MR. ABBOTT: Okay. Well, I answered all the questions in my presentation.

Then we'd do a final inspection and look at different alternatives for fuel disposition, the most likely being, for this fuel, I think, would be to put it in MPC's and then ship it to the repository.

I'm done.

DR. LANGMUIR: Okay, let's hold questions till the end of both presentations.

Norm, you've got five minutes.

(Pause.)

DR. LANGMUIR: You have four minutes.

MR. ROHRIG: I'm Norman Rohrig, and I'm going to be talking about the non-fuel bearing components from the Dry Rod Consolidation Technology Project. This stuff essentially is what's left over after consolidating for the eight fuel elements, and that was done in 1987. The fuel elements were consolidated. They're now out on the casks on the storage beds which you just heard about, and we're now talking about how to get rid of this stuff in a way so it's not hanging around forever.

There are three reasons to do this: avoid ongoing costs of the pool storage, uncertainty in future storage costs, and the desire to close the pool by approximately the year 2000.

Essentially we've characterized the waste based on radiological analysis done back in 1987. The inconel grid spacers and upper end fitting hold-down springs are DOE Special Case Waste--that's sort of a euphemism for Greater-than-Class C--due to the niobium-94 content from the inconel. The lower end fittings are sort of borderline Special Case Wastes due to nickel-63 in them. And the upper end fittings, guide tubes, and borated aluminum poison rods are low-level wastes. The end fittings are stainless and the guide tubes are zircaloy.

Waste disposition is Special Case Waste will be placed in stainless steel drums and stored in shielded underground concrete vaults at the Radioactive Waste Management Complex. The low-level waste will be placed in carbon steel drums and disposed of in the shielded soil vaults also at RWMC. And all drums are UN/1A2 certified, which means that they're 55-gallon drums except they're taller because that way it reduces the number of trips to the repository.

Waste processing, the upper end fittings are being removed, essentially by drilling the bolts out that hold them down. There is a remote operated shear which has been designed and tested on mockup assemblies, which will be used to cut the grid spacers out of the assemblies. And after they are sheared, you have little pieces of grid spacer tubes which go in one bucket, the grid spacers go in the other bucket along with the lower end fittings go with the grid spacers, etc. Fairly simple.

Waste transportation, it's a standard 55-gallonish-type drum. It's taller, 52 inches. The route includes five miles of public highway, and so an NRC licensed transportation cask will be used.

I'm done.

DR. LANGMUIR: Remarkable. You're on schedule. You guys practiced. We have time for questions for both speakers. Since Norm is up there, any questions for Norm from the Board?

(No response.)

DR. LANGMUIR: They understood everything. Questions for Dave? Carl Di Bella?

DR. DI BELLA: Carl Di Bella. I noticed that your picture of three casks were all vertical casks, and the current conceptualization that OCRWM has for a repository is a robust waste package that would be stored more or less horizontally. And this would put definitely some different kinds of stresses on the fuel rods inside. Do you have any horizontal tests going on or planned?

MR. ABBOTT: We don't have any horizontal tests going on. I think the orientation of this demonstration program was more towards dry storage at reactor facilities and that sort of thing.

DR. DI BELLA: Well, along the same lines there, a major supplier is a horizontal supplier.

MR. ABBOTT: The NUHOMS, yeah.

DR. DI BELLA: I don't know what their names are now, but--

MR. ABBOTT: Yeah, the casks--actually, during the early test program, the casks were tested in both the horizontal and vertical for cask performance, but the storage of the casks was all in vertical orientation.

DR. LANGMUIR: More questions, Board, Board staff?

(No response.)

DR. LANGMUIR: Okay. Well, thank you.

MR. ABBOTT: Thank you.

DR. LANGMUIR: The next presentation will be given by Jeff Snook. The title is "Overview of the INEL High-Level Waste and Contaminated Metal Recycle Programs."

(Pause.)

MR. SNOOK: I'm Jeff Snook. I'm the High-Level Waste Team Leader for the Chem Plant. My boss gave me that title because he thought it sounded better than The Stuff Nobody Else Wants Team Leader. Essentially I own everything at the Chem Plant, or my group does, that does not have the words "spent fuel" in it. I'll be talking to you a little bit about the program, the direction we're taking, the history we've had, and Brent Palmer will be next, talking to you about the technologies that have been derived from our program.

Our mission is easy to state--it's been rather difficult to execute--to treat and dispose of tank farm and calcine wastes. And that target has shifted over the last couple years. We have eleven high-level waste tanks that contain a mixture of sodium bearing waste and high-level waste. We have to be out of the five pillar and panel tanks by March 31st, 2009, and the remaining tanks we have to cease use by June 30th, 2015. Our program also is researching how to treat these wastes for final disposal and get them ready to ship for the final disposal site when it's available. Right now our technologies that we're planning on utilizing when we do treat our wastes is to separate both the sodium bearing high-level waste and calcine into a high- and low-level constituent, so that way we greatly reduce the volume of high-activity waste or high-level waste going to the repository. And we'll dispose of low-level waste that will meet Class A requirements so we can dispose of it in a low-level waste repository.

This is the situation we currently have with our tanks. The only tank we have that currently contains high-level waste is WM-189. The rest are sodium bearing wastes, not technically considered high-level waste, although they are very high-activity wastes and they're essentially treated as high-level waste because of their activity.

We also, throughout the history of the Chem Plant, have solidified our liquid waste into a calcination process. We sent these into the calcine bins for interim storage. We currently have seven calcine bins. The first five are completely full, the sixth we just started filling on our last calcine campaign, and the seventh has completed construction and has not yet been certified but is ready to handle calcine when necessary. We currently have a total volume of about 135,000 cubic feet of calcine and a remaining capacity of over 114,000 cubic feet.

A little bit on the program history. Last time you were here, our plan was to continue calcining, turn our calcine into a glass ceramic, and send that for final disposal. Since then our plans have changed somewhat, because in April 1992 the DOE decided to stop reprocessing spent nuclear fuel. This was a critical decision to our calciner. As you saw, most of our waste is sodium bearing waste. If we process the sodium bearing waste by itself, it has a very low melting point and will agglomerate our calciner bed, essentially mucks it up, mucks up the system. We complexed that with our high-level liquid waste, what came from a result of reprocessing. That prevented it from agglomerating the bed and made the calciner a very efficient operation. Without that high-level liquid waste, we have to add a tremendous amount of inert materials to complex the sodium waste, and you essentially reduce our throughput of the calciner and you're treating stuff as high-level by just adding inert materials. So you're increasing the volume of high-level waste that would go to the repository. So that started our program of High-Level Waste Technology Development to find a more efficient way to treat our wastes at the Chem Plant, because the calciner was no longer an efficient method for us to treat our wastes.

So we started our program called the High-Level Waste Technology Development Program, and two other programs got tacked onto that called the Decontamination and the Radioactive Scrap Metal Program, which I'll be addressing at the end of this. After a couple years, our plan called for constructing and operating what's called a Waste Immobilization Facility, or a WIF. It would treat our high-level liquid waste, our sodium bearing waste and our calcine. The WIF would come on line in time to help us cease use of our liquid waste tanks by 2009 and 2015.

So we got to the point of selecting our technologies that would be used to start to the WIF project, and the Department of Energy realized we didn't have enough money to pay for all the facilities, the treatment facilities, that were required on the INEL and across the DOE complex. And as an example along the same time period this WIF would come on line, the true treatment facility to prepare our waste for WIF and Pit 9 were all coming on at about the same time and we just flat couldn't afford that.

Around the same time, we got the new contractor, LITCO. We'd been doing systems analysis before then and it was a bit of a learning curve. When LITCO came on line, they had a tremendous amount of systems analysis experience, helped direct our systems analysis effort a little more tightly, and they came up with what's called an EM integrated plan, which was to integrate all our INEL facilities to hopefully save ourselves some money. As an example, the TRU treatment facility and the WIF have a lot of the same processes, so if we can use one facility to treat both sets of waste, it would be a tremendous savings. But TRU has to meet the WIPP opening schedule of 1998 and closing at 2018, so their waste was going to be treated before ours, and by finishing off around 2016 or so, you can see that facility would not help us get out of the liquid waste tanks by 2009 and 2015. So again we had to redirect our program somewhat, although we did select the technologies with a Record of Decision this June that would be used to finally treat our wastes and prepare them for final disposal. And those technologies Brent Palmer will delve into in his presentation.

So our program is now looking at more efficient methods of calcination. We have recently decided to start looking at--you may hear the term "sugar calcination" or "high temperature calcination." We currently calcine at 500 degrees C. One of the ideas is if we calcine upwards of 800 degrees C, we can denitrate our waste and have a much more efficient calciner. The final treatment schedule is currently being negotiated with the state via FFCA negotiations, and these will be completed by October 6th, 1995--this year. The sugar denitration we're looking at also, but as you may imagine, putting organics in our system causes some problems, so we have some challenges to overcome looking at these two. But if they work, we plan on installing this after our second calciner campaign, and by more efficiently calcining, it will help us get out of our tanks by 2009 and 2015.

And that was all I had for the High-Level Waste TD Program. Before I go into the scrap metal program, are there any questions?

DR. LANGMUIR: Why don't you go ahead and we'll take all questions together.

MR. SNOOK: Okay. Scrap Metal Program. Any questions? I've got a little bit more, but essentially the Scrap Metal Program is a nonentity anymore at the INEL. The program died at the end of the last fiscal year. We've been trying to resuscitate it. We're still trying, but so far no one else has picked it up. But let me tell you what happened.

The program started in July of 1992 along with the High-Level Waste TD Program as kind of an add-on. Headquarters wanted someone to start a scrap metal program at the INEL. This was a new program that was being started, the High-Level Waste TD Program, so they stuck it on because there was some money. I was called a cash cow for the first two years of this program because this was one of the few programs that was getting additional funding at the time.

The goal of our scrap metal program was to make products from contaminated scrap metal that would see a radioactive use. At the very inception of the program, there were some very limited discussions about free releasing this contaminated metal, but those died in the first ten minutes of our first meeting and just because of the challenges to overcome were just too much. But if we could make products that would see a contaminated use, such as spent fuel canisters, low-level waste contaminated boxes that stay within the DOE system, it was a pretty easy challenge to overcome. And then the goal was to turn this program private so that DOE didn't keep funding it.

EM-30 was the funder, initial funding source, for this program, and they decided to drop the program because there were no legal or regulatory drivers for it. It's not really within EM's charter to run a program like this. There was no reason for EM-30 to fund it. Money was getting very tight, they decided it could be used better elsewhere, and it was very hard to argue that with EM-30 from their point of view.

Prior to the demise of the program in October of last year, we had inventoried the scrap metal at several sites. We had a tremendous amount of interest from private industry, especially those with shut down nuke plants that were trying to figure out what to do with all their scrap metal. Rather than paying somebody to go into a landfill, these guys were willing to disassemble and hand it to us for free, and they were jumping all over this program. Most of the required technologies had been demonstrated, and WINCO at the time, LITCO now, had shown this program to be cost effective. And by that I mean it was cheaper for us to take contaminated metal and turn it into a contaminated product than it was for us to buy the same product with clean virgin steel, which was why we figured it would be a good private enterprise, because somebody could commit money on it and it would still be cheaper for us.

We were to the point where this year we're going to be producing carbon steel boxes for RWMC when the program died. We were going to demonstrate production capacity this year and then end of this year, beginning of next fiscal year try to turn it over to a private enterprise. And that was when EM-30 decided to kill it.

That's all I have.

DR. LANGMUIR: Thank you, Jeff.

Questions from the Board or Board staff?

(No response.)

DR. LANGMUIR: I had one that maybe it's just by way of educating me. Hanford has tanks as well, of course, lots of them. Are your tank wastes very different than theirs? Do they require a different approach?

MR. SNOOK: Yes.
DR. LANGMUIR: They do.
MR. SNOOK: Yes.
DR. LANGMUIR: In a word, yes.
MR. SNOOK: Their waste is--essentially, one of the big changes is their waste is a basic form and ours is highly acidic, and Brent, I'm sure, will get into that, but a lot of people ask, "Why don't you just do what Hanford does?" and the answer is because we just flat can't do it. The wastes are completely different, require different technologies. One example is our low-level waste is very amenable to a grout form. It just does wonderful on grout but doesn't do as well on glass, and with Hanford that's almost flip-flop.
DR. LANGMUIR: John Cantlon?
DR. CANTLON: Yes, as you contemplated privatization of this process, were you visualizing that happening on a DOE facility?
MR. SNOOK: Are you talking for scrap metal?
DR. CANTLON: Yeah.
MR. SNOOK: One possibility was at SMC on Test Area North. They have unique capabilities there. One possibility was to use their facilities. Another was to build a private facility on site or go off site. We were not limiting ourselves, we just wanted to tell people, "We can produce, these are our capabilities, we want a cheap box. Do it."

DR. CANTLON: Thank you.
MR. SNOOK: Thank you.
DR. LANGMUIR: Carl?
DR. DI BELLA: These are two clarifications. Carl Di Bella. On your radioactive scrap metal, the low-level waste that you're talking about that these carbon steel boxes could be used for, I assume this is a DOE low-level waste, or low-level waste in general?
MR. SNOOK: Initially it was going to be an INEL program, so it would be DOE/INEL waste. But we have had the interest of other people, other sites for producing boxes, sending the boxes to them, and then they can do whatever they'd like with them.
DR. DI BELLA: Okay.
MR. SNOOK: But yes, initially it was for DOE use.
DR. DI BELLA: And the other clarification is on your calcination, I guess I was under the misimpression that your calcination removed a substantial fraction of nitrates, and you're saying it doesn't.
MR. SNOOK: Brent?
DR. DI BELLA: Is that correct?
MR. PALMER: It does, but we still remain with five to ten percent nitrates in the calcine, and that's enough to give us the problem he described.
DR. DI BELLA: Okay, thanks.

DR. LANGMUIR: Thank you, Jeff. I guess there are no further questions. I guess we'll proceed.

Next presentation is by Brent Palmer. The title is "High-Level Waste Treatment Technologies."

MR. PALMER: Brent Palmer. I've been associated with most of the activities at the Idaho Chemical Processing Plant and High-Level Waste Treatment Area, so they asked me to give this particular presentation.

The treatment program and particularly the development program that Jeff described has some very specific purposes, and I think they're described here pretty well, is to develop and demonstrate safe, cost effective, and environmentally responsible methods for conditioning, interim storage, qualification, and finally, disposition of the INEL high-level wastes. And the high-level wastes that we're talking about currently include the inventory of calcine in the bins--that's the primary amount of it--the last remaining tank of high-level waste that's in the tank farm, and then probably the biggest challenge of all those is the sodium bearing waste that Jeff described. The sodium bearing waste is produced with our decontamination, decommissioning efforts of some of our solvent clean up and activities like that have occurred in the past that are not directly related to reprocessing but come about as a result of reprocessing activities. And the challenge there comes because of the sodium, as Jeff described, it's difficult to run through our calciner.

Our calciner started its operation in 1963, and it was a very farsighted thing back then by the people that ran the Chemical Processing Plan then, and it's worked very successfully for us for these last 30 years. So as we look for new technologies or ways to treat the waste, we always look at that unit to save our hides again and again. And it's happening again here, and I'll describe a little further here in a moment why that's the case.

As I discuss the Treatment Technologies Development, I'm going to depart here a little bit from the norm. Normally I would launch right into here and how we treat the wastes: we separate them, we dissolve them, you know, we calcine them, whatever it is. But recently I've become a real believer that there's some up front work in most of these areas that is very productive if you do it first, and that is an analysis of the systems, a systems engineering or systems analysis approach.

With most technical problems, there's more than one solution. In fact, a lot of times there's a lot of solutions. None of them are usually the perfect solution. All of them have advantages and disadvantages, and it's very difficult to determine which one is the best or the better of the ones that are available. And so from that standpoint, sometimes instead of just taking the bull by the horns approach and diving into it the way that I personally usually do, you step back and take a careful look and do a careful analysis and a modeling of the situation. Sometimes that pays big dividends. So I want to discuss that with you for just a moment and follow that up then with the actual process development, the technical area.

In a typical systems analysis approach--and we try to be fairly rigorous in our approach to this, and what I'm describing is an effort we've done over the last year and a half. Anyway, in an approach like this, you establish what the problem really is and what the goal of the activity you're pursuing is. Then you determine very carefully the functional requirements for the program and hopefully can quantify those functional requirements. Put some measurable form against them so you can judge how well each alternative measures up against them. You then do something like a VE or a brainstorming approach and you make a real laundry list of the possibilities. What options are available to us, or alternatives and technology, to solve this problem? Then you take each of those alternatives, weigh them against the function requirements, and maybe change them a little bit and then weigh them again and weed out the ones that don't measure up, and do this in a cyclic process till you finally determine that based on the function requirements--"on our waiting, we did teach the function requirements. Here's the best one of all of them." And then recommend and implement whichever one floats to the top.

For our particular case, we had quite a number of functional requirements, and I've just chosen a few here to talk about. We don't have time to go into the whole list, but the ones that almost always are the most important to all of us.

There's safety, of course, and for safety what we required in our evaluation was that industrial safety aspects, radiological safety aspects, environmental safety, they must meet all of the regulations. Now, with most of these alternatives you can build your facility more sturdy or something like that to overcome them. But we did insist that we could identify a way to make the process safe from those standpoints.

With most of the systems in the DOE and even with industry or anywhere, life cycle costs or costs in general become extremely important, probably more than almost any other. We put safety at the top, but when it comes right down to making a decision, once safety is taken care of, the costs nearly always are given a real high weight. But not only life-cycle costs, sometimes near-term costs because of budgeting restraints set in as well.

Regulatory requirements. We insisted that the option either meet all the regulatory requirements or that we had reasonable assurance that we could get a variance from a particular requirement for a specific reason.

Waste volume, we wanted to minimize volumes. This was apart from the life-cycle costs considerations. It's just bad practice to make huge volumes.

Process flexibility. I like the presentation was made, you know, one thing fixes all. That's kind of a nice system if you are smart enough to come up with that. But for us, we don't know for sure what wastes will be made in the future by our D and D efforts, for example, so if there's a choice between two processes and one is more flexible, that one certainly gets higher credit.

For our system we wanted to be very careful, so we came up with a whole list of options. And I won't go through these with you, it's just too boring and too long. But we did go to great lengths to try to identify all the possible options and all of the possible treatment methods that were available to us where the technology was developed at least to the level that we felt it could be completed within just three or four, maybe five years on the outside of additional technology development. Now, you can see here we came up with 27 different options, and then even beyond these options was 3 to 5 more methods of solidifying the waste to make it amenable to final disposition. So many, many options available, just too many to look at and determine which one is best.

So we built a model, a computer model, on this process and embedded all of the schedule and the costs and the technology that we had at our fingertips, and the model it turned out proved to be extremely valuable. It wasn't a huge effort. I think the total effort expended in the model was less than a man year, but it proved to be invaluable and I want to show you some of the results that came about in that model. And actually not necessarily the results per se, but the types of results that it was able to give us.

For example, one thing I mentioned was we had to meet the regulatory drivers. One of the primary ones that Jeff mentioned was we have to cease use of some of our waste tanks by given dates. One thing this model did very nicely, it would take any option or combination of options we chose to try to model and you'd push a button and it would print out a chart something like this and show us, did it indeed meet the regulatory requirements or did it not. You can see the upper line there, and here this one coming down here did not make it, didn't make that particular requirement, whereas our other option here met it rather easily.

These types of charts, doing them by hand would take hours and hours and hours to develop each individual data point as the schedule went on. The model made it very easy. Computers are wonderful, wonderful things.

Another type of thing was with the costs. It's important to minimize the life-cycle costs, and we recognize that importance, but with the near-term budget crunches that always seem to occur, it's almost always equally important to try to minimize the five-year costs, the shorter term costs. So one thing that the model did very nicely is it could print up a graph like this, where we took each of the 27 different options--and these are numbered here to reference back to the other chart--and place them where they stood relative to five-year costs on the vertical axis as opposed to the life-cycle costs on the horizontal axis. You would say, now, for example there's Option 20, for example, pretty low life-cycle costs, so if you only looked at that option, you would say, "Yeah, 20 would fall in there pretty well, but it's got quite high five-year costs." So you could see pretty readily that maybe the options we would want to consider further from the cost basis would be down here in the lower left corner. Again, a very time-consuming thing without a computer, very easily done with it. But a very nice tool that falls out very naturally from a systems analysis standpoint.

Another output that the model made was budget requirements as a function of time. One thing that is very difficult for DOE to handle is big, big spikes. Now, with this particular thing, in some of the options, when we built the plant, we had a huge construction spike. One of the things we were trying to do with the model was show methods, develop methods where we changed various parameters to levelize the funding requirements. This one turned out to be very nice, quite level. In fact, this Option 10 was the one that finally did float to the top. Very level, whereas many of the rest of them had big spikes in one area or the other, very undesirable for trying to budget.

Other things that the model could produce that were useful that I haven't included on the graphs were things like taking each option and sorting them by life-cycle costs or by near-term costs and show us very readily which ones are the minimum cost or the maximum cost.

Lots of other output. However, here's one form here that summarizes the results in a pretty nice way. And you can refer back to this a little later. Again, it's kind of complex, but it does have a lot of nice information here. Here's our total volume of waste currently that we have in the tank farm, and we have two basic choices to make. Do we separate it as Jeff mentioned into high- and low-level fraction or is it better to leave all of the waste, including the fuel cladding and fission products and transuranics, in one form and send it all to the high-level repository? Then, if we do separations, how then do we treat the low-level fraction and the high-level fraction to be most cost effective or most volume effective? And the model produced all of these numbers, the volumes and the dollar amounts associated with each form, and then we can compare them.

And the final decision based on the output of this, and here again, based on volumes and based on costs, are that this Option No. 10, which was to separate the waste into high-level fraction and a low-level fraction followed by converting the low-level waste to a grout form--and this FUETAP stands for Fixed Under Elevated Temperature and Pressure; that improves the density over a conventional grout--followed by vitrifying the high-level waste in a glass form similar to what most of the rest of the complex, actually the world, is doing, is the most desirable form.

And the life-cycle cost for that--and that includes all of the activities that takes the facilities clear out through D and D until they finally are completely no longer of any concern from the safety standpoint--compares $2.3 billion--these costs are all in millions that are on the chart--2.3 billion against 4.3 billion for this option, which was pretty close. Some of the options went up as high as $6 or $7 billion, so you can see the one that we chose was considerably cheaper. When you talk billions, though, everything's relative, you have to take that with a grain of salt. It's a huge amount of money to treat the waste.

But we were very comfortable that when we finished this analysis that given the data we had at the start of this program and embedded it in the model, we then had chosen the right path then to continue our more technical studies. So based on that systems analysis approach, then we began actually looking in more depth with the techniques available to us to actually treat the waste.

Our first cease use date for the tank farm comes in 2009. That does not give us any time or sufficient time to implement a new technology, so in order to meet that particular date, we have to depend on existing technology at the Chem Plant to treat the high-level waste. And of course that's the calciner. The calciner's been functioning--we've had to replace it once with a new one, but the calcination process has existed at the Chem Plant for 30 years and has worked very well. So the basis of this whole process is continued calcination to meet the near-term requirements, regulatory requirements, that we've come to agreement with the state and the EPA.

One thing that's more of an aside than anything real important, we do have to retire all of our liquid tankage that we have now because of RCRA concern and seismic concerns by the year 2015. So we do have to have some surge capacity to continue our operations, so we do have to replace some of that liquid tankage.

And then the second really major point is implementation of new technology to meet the long-term goals. And the decision there, then, based on the systems engineering study, was to separate the waste in the two fractions, the high-activity stream and a low-activity stream. Vitrification of the high-activity stream and grouting of the low-activity stream. And although we feel comfortable with those choices that we've made, there are still some real challenges in the technology and the implementation of the technology.

For the calcination, we've had difficulty calcining the sodium bearing waste all of our time out there. However, we were very successful in blending with our high-level waste. But since April of '92 when reprocessing of spent fuel was curtailed, we very quickly depleted that supply and no longer have it, so we have to go to other options. The option that has been tested and proven and does work reasonably well is substituting non-radioactive aluminum nitrate for the spent fuel materials. And although that works well, and we could use it, it's substituting a non-radioactive species, and quite a bit of it, for a radioactive species that was there before. So it makes extra waste volume we would like to avoid.

So we are attempting some new technology. Jeff mentioned a couple of them, sugar or--and it isn't limited to sugar, there are other things like formaldehyde, formic acid. Those types of chemicals, when blended in with the liquid stream or sprayed separately into the calciner will promote denitration in the hot fluidized bed. And it is the nitrate species that's giving us the problem. The sodium nitrate melts around 350 degrees centigrade and our bed operates at 500 degrees centigrade, so it tends to agglomerate in the bed and in the bin storage. The bin storage is probably the more critical of the two, and we want to maintain our bin storage in the retrievable form, so we have to very carefully then control that sodium content. So any denitration chemicals would aid us in that.

The last thing we've come up with now that does look attractive is the higher temperature. The higher temperatures very rapidly promote denitration. At 500 degrees centigrade, though, we just have not been able to get rid of all the nitrates. At 7, 800, based on the limited tests we've done, we're confident we can eliminate enough nitrate that it is no longer an issue.

Separation technologies. This also was a challenge. We looked at a number of things. I've listed the main ones here. Freeze crystallization, sodium extraction, both of those actually try to separate the sodium from the rest of the waste so we could more easily treat the remaining waste. The sodium separations method relied then on the sodium being separated efficiently enough from the fission products it would become low-level waste and could be disposed of in that fashion. Precipitation is similar to what the other sites are doing when they neutralize their waste and drop the bulk of the fission products our and separate that from the remaining solution. Pyrochemical elevate the temperature of the calcine. For example, aluminum or zirconium at least hopefully would be volatilized and most of the fission products would remain. Although the concept looked pretty good, it's been more of a challenge than we could handle. It didn't get the separations we would hope for.

So when all was said and done, radionuclide partitioning--and I'll describe the details of that in just a moment--was selected as the separation technology of choice, and specifically we would--of course our fission products of biggest interest are strontium and cesium--separate the strontium using an extraction process. And the chemical that we found that worked best with our waste and with this specific chemical, strontium, was a crown ether, and we found it to work very well. We've tested it in the laboratory on a cold scale and we've tested it with tracers and with a limited amount of actual waste and it's performed very well.

Separation of cesium, this one is a bit more of a challenge. We're not anywhere near done with the testing here. Since our cesium separation has been done very successfully at the other sites--as Jeff mentioned, other waste is quite different from ours. It's in the basic form and ours is in the acid, and the acid presents a whole new challenge with separation of cesium and there's very limited ways of doing that and we're still struggling with that a little bit. The ammonium-molybdophosphate that I've mentioned here is a good ion exchange agent, but we've yet to figure out just how to implement it on the engineering fashion into the process. That's probably surmountable, we've still got some work to do there.

Separation, then, of the transuranics using a process called TRUEX, Transuranic Extraction. This process was actually developed at Argonne East and functions very well for us with our waste. We've demonstrated this again in the lab with tracers and with actual waste, so it works very well. We have few reservations about that. Since it's an extraction process at the Chem Plant and throughout the complex, we feel pretty comfortable with extraction technology based on the old Purex type work we're all familiar with.

High-Activity Waste Vitrification, as you heard when you were here three years ago and as Jeff mentioned, glass ceramic over the years has been the choice that we were going to go towards, and that was based on vitrifying the entire calcine volume. And that process worked very well with that. It makes a very durable form, very nice form, very dense. We got waste loadings that were really impressive. However, once we did the systems analysis, it very clearly showed us that the cheaper way to go was glass. It's not a technical decision, it's a cost decision, because glass makes a--the ceramic is a very durable form and the glass is a very durable form. So based on the economics, we did select the glass, and the glass is very much like what is used throughout the complex, in fact throughout the world. There's very similar, slight differences in the frit makeup and the additives just to better fit our material, but leach tests and everything on it work very well. We don't have too many worries there.

Low-Activity Waste Immobilization, here again we looked at three ideas, glass, glass ceramic and then grout. And we could immobilize our low-level waste in any of these three. They did make durable forms. Here again, the grout made just as durable a form as the other as long as we made it carefully, did our recipes carefully. However, it's much easier to implement, it doesn't have the high temperatures, high pressures involved like the other processes, so it's relatively easy to use, very inexpensive relative to the others. It doesn't have the corrosion problems that we might have with the other ones.

One difference in our waste that I don't think has been mentioned is our waste has a lot of fluoride in it, and once you get to elevated temperatures, the fluoride becomes a real corrosion concern.

The grout here would be a little different than has been implemented at other sites. We would not make it into a large monolith, it would be in a transportable form, a barrel-type arrangement, so that it could be transported to wherever the site needed to be to handle it. We didn't have any plans of making it non-moveable.

And using these technologies, here's the overall plan. Our liquid waste then would be evaporated when appropriate, but ultimately solidified using our calciner. Calcine would then go to bin storage for an interim period. And that interim period can be up to 500 years, at least based on our tests, and I have to say the same thing that all others before me have, that sometimes on these longer term studies it's a little difficult to extrapolate. But based on our tests, 500-year lifetime is within the realm of possibility for these bins. So our time is fairly flexible there.

This calcine then at some later date would be retrieved, sent to a dissolver, so it's produced into a liquid form. And we've demonstrated that that indeed can be done, both the retrieval and the dissolution. Any future wastes that are produced, liquid wastes, could also be combined then into the same step.

Go to the separations facility, separate into low- and high-activity fractions. Low-activity waste would be grouted, stored in an interim basis, if necessary, and then sent to the final disposal location as a low-level waste. And our low-level--all of our work indicates this would be a Class A waste according to the NRC standard, so a very nice--if you've got to have a radioactive waste, a Class A waste is a very nice one to deal with. High-activity waste would be accumulated in the tanks that I've mentioned for vitrification at a later date. When that came on line, then, the canisters--and here again, we're still flexible; since we haven't built the facility, we can make the canisters to whatever a repository called for--and then finally to the repository.

Questions?

DR. LANGMUIR: Thank you. I've got one for you to start. My experience with grout, if it's what I'm thinking it is, is it not a concrete type grout?

MR. PALMER: That's correct. Ours we actually found that the Portland cement type worked well for us.

DR. LANGMUIR: Well, that's a very high pH grout, and you're concerned about extracting cesium and strontium from an acid waste. It would seem to me that starting out with a little bit of grout addition you'd have an alkali waste and you'd be into somewhat easier separations. You're going to add it anyway. Can't you add a small amount of an alkali material like carbonate, raise the pH, and get your cesium and strontium out more readily and then continue to add the alkali and the grout mix when you're done? I mean, it's tough, as you say, to get these elements out of an acid system. You're going to go alkaline anyway in the grout process.

MR. PALMER: That's correct.

DR. LANGMUIR: Is there some way to wed these together in a manner that allows you more ready extraction? I mean, cesium goes beautifully on some micas, illite micas, a very cheap way to go with it.

MR. PALMER: Um-hum. We just didn't want to deal at all with going basic in the precipitation. Right now our wastes are totally clear, very easy to handle, very easy to retrieve, and we felt that operations we employed would be more simple with a straight, nice liquid rather than trying to--you know, what you say is true and it would happen, and we looked at that as--if you look at that fault tree, we had precipitation in there with that and we tried to look at all those options. We just didn't want to get into the dealing with the solids in the radioactive environment. It looked like if we can solve the one problem with the cesium, it was an easier way out for us. So that was a judgement on our part at this time, and hopefully it was a good one.

DR. LANGMUIR: And your costs are not exceptional here? With this method, the costs aren't that different?

MR. PALMER: No, no, the costs were--in fact, as I said, this option was quite a bit lower in cost overall than the other options, including, you know, the precipitation type options.

DR. LANGMUIR: John Cantlon?

DR. CANTLON: Cantlon, Board. In one of your options you were talking about use of sugar. Was this a low-level waste or one of the high-level?

MR. PALMER: This is for calcination of the sodium bearing waste.

DR. CANTLON: Right.

MR. PALMER: And here again, it's not high-level by definition, it's about an order of magnitude lower in activity than our high-level waste but still very radioactive--

DR. CANTLON: Repository bound.

MR. PALMER: --greater than Class C type. Excuse me?

DR. CANTLON: Repository bound.

MR. PALMER: The high-level fraction after we did the separations would be repository bound, yes.

DR. CANTLON: And you have that problem of putting sugar in there, microbial problems that you have in the repository if you've got sugar in--

MR. PALMER: Well, the sugar totally volatilizes during the 500-degree step. We don't--

DR. CANTLON: Oh, I see.

MR. PALMER: There wouldn't be any carbonaceous material remaining from that step in the final product.

DR. CANTLON: Got you.

DR. LANGMUIR: More questions? Carl Di Bella?

DR. DI BELLA: Carl Di Bella. When you showed the comparison of Option 10 and Option 27, the reduction in volume of high-level waste going to a repository was dramatic. I think it was a factor of 20.

MR. PALMER: Yes.

DR. DI BELLA: Something like that. And the cost, I think, followed that. I noticed the cost for the no treatment option was on the order of $10 billion, and the other one was substantially less. My question is, of that $10 billion cost, how much of that is incurred here in moving and packaging and how much of it is the transportation and whatever the repository folks charge you? Do you remember the rough--

MR. PALMER: We were assuming--yeah, I think I can give you a seat of the pants number, actually. Don't have the tip of my tongue, but we were assuming in this particular model, I think, about 300,000 per canister, and we get just a little less than a cubic meter per canister. So if you've got your calculator there handy, you can use that.

(Pause.)

MR. PALMER: The comparison between those two numbers was what you were referring to?

DR. DI BELLA: Actually, when I said 10 billion, I was adding up the 6.46 billion and the 4.3 billion and rounding it.

MR. PALMER: Oh. These are two separate cases.

DR. DI BELLA: Okay.

MR. PALMER: This is if you went to a glass ceramic and this is if you chose a glass as the final form.

DR. DI BELLA: Well, then the factors are--they're still roughly a factor of 20 comparing the two cases.

MR. PALMER: Between this case and this case.

DR. DI BELLA: Yeah, I guess 27A versus 10A or 27B versus 10B.

MR. PALMER: For the high-level fraction, that's correct.

DR. DI BELLA: Right. Okay, so you're using 300,000 per canister, but my question is, is that the RW part of the cost? I'm asking just what the EM part of the cost is and what the relationship is between the two.

MR. PALMER: Well, it depends on how they work, how this fee going to the repository is worked. But the fee to the repository is--let's say we went with this form right here, which is the one we chose. WE've got 1,000 cubic meters.

DR. DI BELLA: Right.

MR. PALMER: So 1,500 canisters at 300,000 per canister, that would be the repository cost, and that's how much of this total cost would be the repository part, related directly to the fee going to the repository.

DR. DI BELLA: I see. Okay. So I can take--

MR. PALMER: All the other costs would be incurred here.

DR. DI BELLA: 300,000 per cubic meter is--

MR. PALMER: 300,000 per canister.

DR. DI BELLA: Which is--

MR. PALMER: A canister holds about 5/8 of a cubic meter.

DR. DI BELLA: Okay, thanks.

MR. PALMER: And all the rest of the costs that are there in that 2.3 billion would be EM costs here on site.

DR. DI BELLA: Okay.

DR. LANGMUIR: Other questions?

(No response.)

DR. LANGMUIR: We're ahead of schedule here, but we've sort of decided to stay that way and let everybody get home early today. Why don't we take our fifteen-minute break. My watch, we may not agree with anyone else's, say 2:35, so by my watch, in fifteen minutes we'll reconvene and continue.

(Whereupon a break was taken.)

DR. LANGMUIR: Our next presentation is by Ken Henry. His topic is Greater-than-Class C Waste Management Program.

MR. HENRY: As indicated, my name is Ken Henry. I work for Lockheed Martin Idaho Technologies here at the Idaho National Engineering Laboratory. My topic this afternoon is Greater-than-Class C radioactive waste management.

I think it's important to start out by changing our perspective somewhat. First of all, Greater-than-Class C radioactive waste is low-level waste as opposed to spent fuel or high-level waste. Secondly, Greater-than-Class C waste is not generated by the Department of Energy, it's commercially generated low-level waste. And lastly, there currently is no Greater-than-Class C low-level waste at the Idaho National Engineering Laboratory, or at any other DOE site, for that matter. Later on in this presentation you will see the acronym GTCC used extensively, and that stands for Greater-than-Class C radioactive waste.

Let me start out by addressing the statutory requirements for Greater-than-Class C low-level waste disposal. They're contained in the Low-Level Radioactive Waste Policy Amendments Act of 1985, which is Public Law 99-240. The two major requirements identified here are that, first of all, the federal government, that is the Department of Energy, shall be responsible for disposal of Greater-than-Class C waste, and also that Greater-than-Class C low-level waste shall be disposed of in a facility licensed by the Nuclear Regulatory Commission. There is another requirement that we might talk more about later, and that is that the Department of Energy shall also identify options for recovering the costs of disposal from the waste generators.

The question might come up why is someone from the Idaho National Engineering Laboratory talking about commercially generated low-level waste? Going back in history a few years, an earlier version of the Low-Level Waste Policy Act gave DOE responsibility for assisting states in compact regions in managing and disposing of their low-level waste having lower activity than Greater-than-Class C waste. The states in compacts have that responsibility. The Department of Energy selected the Idaho National Engineering Laboratory as the support field office to perform that function. Then when the Amendments Act in 1985 came into being, it established DOE responsibility for Greater-than-Class C low-level waste disposal, and for consistency we put that program in the same place.

So here at the INEL we have what we call the National Low-Level Waste Management Program that primarily provides assistance to states and compacts in managing low-level waste. And as a subset of that program, the Greater-than-Class C Low-Level Waste Program assists the Department of Energy in technical and programmatic studies related to and leading to the eventual disposal of Greater-than-Class C waste. Over the last several years, the Greater-than-Class C Waste Management Program has developed a considerable amount of technical information and we've evaluated programmatic options that are pertinent to developing and implementing a strategy for this particular waste type. First of all, we have expended considerable effort in characterizing and projecting the future quantities and characteristics of Greater-than-Class C waste, and later in this presentation I'll be discussing that in considerably more detail.

We have also evaluated the technical feasibility and the economic impacts of alternative disposal options. These disposal options ranged from shallow land burial to intermediate depth disposal all the way up to deep geologic disposal. We have studied methods of waste treatment prior to disposal and the suitability of existing facilities to perform that treatment. We've also looked at the probable waste packaging and transportation methods to the disposal site, and we've also considered pre-disposal storage methods and facilities for conducting that storage.

Now, I might mention that first of all, in the Amendments Act, the Department of Energy was made responsible only for disposal. Storage was not mentioned. And in fact with regard to disposal, there was no prescribed disposal method or schedule. However, since the eventual disposal may take a long time frame to establish, the DOE has felt that they had at least implicit authorization to conduct a limited amount of storage of Greater-than-Class C low-level waste, particularly in circumstances where there may be a potential threat to public health and safety by leaving the material in the private sector.

Now, to go back and fine-tune a little more the definition of Greater-than-Class C Low-Level Waste that I started out with, first of all, it's a waste that is generated by licensees of the Nuclear Regulatory Commission or Agreement States. Thus, it's commercially generated as opposed to DOE generated. Secondly, it has concentrations of long-lived and/or short-lived radionuclides that exceed the limits for Class C waste presented in 10 CFR 61.

For those of you that may not be familiar with 10 CFR 61, that's entitled "Licensing Requirements for Land Disposal of Radioactive Waste," and it's roughly the low-level waste equivalent of 10 CFR 60 for high-level waste. In 10 CFR 61, there are three classes of low-level waste that are defined quantitatively in terms of their radionuclide content. It defines Classes A, B and C, and those three classes are all disposed of in commercial disposal facilities such as the one located at Barnwell or at Hanford.

Greater-than-Class C low-level waste, of course, exceeds the upper limits for Class C waste and 10 CFR 61 identifies that material as being generally not suitable for shallow land burial. There are no upper concentration limits for Greater-than-Class C low-level waste except that by definition it's neither spent fuel nor high-level waste.

I mentioned that the NRC has declared it's generally not suitable for shallow land burial. In a 1989 revision of 10 CFR 61, they went a little bit further and they stated that Greater-than-Class C low-level waste must be disposed of in a geologic repository under Part 60 unless other disposal options are proposed and approved by the NRC under Part 61 licensing. So basically they've expressed at least the acceptability of disposing of Greater-than-Class C waste in a repository, but they have left options open for DOE to choose some other method if they wish.

This slide gives a few examples of what's included in the Greater-than-Class C low-level waste category. And, by the way, our waste characterization and projections data is organized consistent with this slide in that we've categorized the material into Nuclear Utility Generated, Sealed Sources, and Other Generators.

The Nuclear Utility Generated material largely consists of activated metals such as the wastes from dismantling core shrouds and upper and lower core support plates at the time of decommissioning. It also includes operations-related wastes such as filters and exchange media, what have you.

The Sealed Sources category, underneath the heading here are indicated some of the normal uses of sealed sources. They're used for irradiation, numerous instrumentation applications, and for oil well logging. For those of you that may not be familiar with the sealed sources, they're typically quite small, perhaps about the size of the end of your finger. The radioactive source is encapsulated within either a single or a double layer of stainless steel and the sources capsule is contained within whatever device is appropriate for its intended application.

The Other Generators category, what's listed here is some of the potential generators: users of carbon-14, research labs that use irradiation, and manufacturers of sealed sources. And this Other Generator category is really a catch-all for everything that isn't generated by nuclear utilities and isn't a sealed source.

The projections data that I'll be presenting to you in a moment here is based on extensive study over the last several years. Our initial report on this subject was published in August of 1991, and end of Fiscal 1994, in September, we issued a thorough update and revision of that report. The report number is indicated. If anyone feels they'd like a copy of that report, please feel free to contact me and we will mail one to you. Both reports have been based on extensive analytical and survey data. We've tried to review all of the potential generators of Greater-than-Class C low-level waste. We've utilized input from expert consultants in the field, and the results of the data were independently peer reviewed prior to publication.

This gets into the numbers. What I'm showing here are base-case projections through year 2035, so we're covering a little over a 40-year time span. The data are organized here in terms of the nuclear utility waste, the sealed sources, and the other generator wastes, the same categories I talked about earlier, and totals are shown. In the three columns we show first unpackaged volume in cubic meters, packaged volume in cubic meters, and radionuclide activity in millions of curies.

One of the things I want to mention is, first of all, if anyone is having trouble with cubic meters to cubic foot conversions, there's roughly 35 cubic feet in a cubic meter.

The two columns on packaged versus unpackaged volumes, those numbers were obtained by first looking at the unpackaged volume of the waste as generated, trying to estimate for each waste type what type of dilution may occur as it's being packaged for disposal and then coming up with a packaged volume.

Now, the number I'd most like you to remember from this is this total packaged volume right here of roughly 2,000 cubic meters. And the point of wanting you to remember that number is that we view that as being quite a low number in terms relative to other waste categories. For example, for Classes A, B and C low-level waste, there are about 40,000 cubic meters per year disposed of in commercial disposal sites in this country as opposed to 2,000 cubic meters of Greater-than-Class C low-level waste over a 40-year time span.

Another way to get that 2,000 cubic meters in perspective is I always like to evaluate meeting rooms by their capability to hold Greater-than-Class C low-level waste. My rough estimates of this meeting room indicate that it won't quite hold 2,000 cubic meters, but certainly with another room this size it would fit quite comfortably. We have no proposals yet from the Shilo Inn to do that.

You'll note also from the numbers that most of the packaged volume, that 1,350 cubic meters, comes from nuclear utilities, and of that amount, most of it is activated metals that will become GTCC waste at the time of decommissioning. And in the column on radionuclide activity you will note also that nearly all of the activity also comes from the nuclear utilities.

Last but not least, I wanted to say that all of the Greater-than-Class C waste that's currently in the inventory, which isn't very much, is being stored at the site of generation.

In about the 1993 time frame, we were taking a look at the overall progress of our technical and economic evaluations and the program strategy and we felt a need to reassess the program strategy because we were looking at some options that could include either new facilities or perhaps extensively modified facilities for either storage or disposal or both. Those options could become expensive, and our waste characterization and projections data were showing that really the quantities of Greater-than-Class C low-level waste were going to be quite low. In fact, much lower than was initially envisioned at the time the Low-Level Radioactive Waste Amendments Act was passed. And also our technical and economic evaluations of disposal concepts showed that for a low-volume waste the unit costs of disposal would be quite high. And also, the storage by the Department of Energy to the extent that it was provided would also be quite expensive for low volumes of material.

So we conducted a formal program reassessment. We actually conducted two program reassessments. One was done by the staff here at the INEL that was involved with the program. A second reassessment study was done by a subcontractor that was working independently but concurrently and under slightly different ground rules. The two studies were allowed to proceed along parallel paths, and then at their conclusion we found that the major conclusions and recommendations from the reassessments were somewhat different but surprisingly similar, and this slide shows kind of a merging of what those recommendations were.

First of all, it was recommended that at least the utility generated Greater-than-Class C low-level waste should be co-disposed in a geologic repository. Our mind-set at the time was the same repository intended for spent fuel and high-level waste. Secondly, primarily for non-utility generated Greater-than-Class C, if it's for some reason not accepted into the repository, it could be co-disposed with DOE Special Case Waste, and I think you have heard that term before. I will be discussing Special Case Waste at the end of this presentation because I was specifically asked to.

It was also recommended that a separate program be initiated for the Department of Energy's responses to potential public health and safety problems, most of which would be related to sealed sources. The Nuclear Regulatory Commission has identified that among the holders of sealed sources there are some potential problems in that many of the current owners are fairly small companies. They're encountering some tough economic times. There's an NRC concern that proper management of those sources may not be carried out, and so they have asked the Department of Energy to respond in a few instances, and we view that as being done under a program that will become separated from the Greater-than-Class C Low-Level Waste Program for a couple of reasons. One is that we don't really view those sealed sources as being a waste material. They retain their functionality. They could be recycled and reused somewhere in the future. And secondly, not all of the sealed sources that may become a public health and safety threat would properly be classified as Greater-than-Class C wastes.

Lastly, the reassessments recommended that the Department of Energy provide pre-disposal storage of Greater-than-Class C low-level waste, only for waste from non-utility sources. It was felt that the utilities were generally capable of storing their own low quantities of their own GTCC wastes and that the limited acceptance for storage would be primarily that it was dictated by public health and safety concerns.

Following the two program reassessments, we then decided to go out and get some further input from potential stakeholders of the program and any members of the interested public. We've held two of these workshops, one in the East, one in the West. Both of those were held earlier this winter, one in Washington, D.C., on April 11th, and the second one in Portland on April 13th.

Numerous organizations were represented. In addition to the Department of Energy, we had NRC people, EPA people, quite a few nuclear utility representatives, consultants, state people, general public, and last but not least we had Nuclear Waste Technical Review Board representation. Carl Di Bella was there.

This slide summarizes some of the major stakeholder input that we received. First of all, most of this input came from nuclear utilities. In fact, the other generator categories and the sealed source users were not really represented in the workshops. But there were quite a few nuclear utility personnel there who did have input, and one of their primary recommendations was that we manage Greater-than-Class C waste with spent nuclear fuel not only for disposal in the repository but also for pre-disposal storage. What they were recognizing was that there was a potential for some legislation that may provide some near-term storage capability, and what they really want to do is they want to be able to get rid of their Greater-than-Class C low-level waste at the same time they get rid of their spent fuel. If they get rid of the spent fuel, they don't want to keep a facility open just to store a small quantity of GTCC material.

Along that same vein, they recommended that as soon as possible we should develop waste acceptance criteria to assist the generators in their planning. The point there is that in the case of utilities that are in a decommissioning process they need to know up front what kind of waste form is acceptable, what type of packaging is acceptable, because after a certain point they may lose their capability to do repackaging even if it were deemed necessary.

They encouraged that we develop a waste disposal fee early to aid them in their cost estimating for their decommissioning planning. And they went on to suggest that that decommissioning fee should be less than that of spent nuclear fuel on a volume basis. And in fact they felt that if we pursue co-disposal in the repository that perhaps that fee could be included within the 1 mil per kilowatt hour that they now pay.

So as a result of the program reassessments and the input we received from the stakeholder workshops, our current draft Program strategy for managing Greater-than-Class C low-level waste consists of five major elements.

The first, as already indicated, is to pursue co-disposal in a geologic repository, and our preference is a spent fuel and high-level waste repository. One reason for that is that the utilities are already obligated to send their spent fuel and perhaps some non-fuel bearing components to the repository and it would be convenient for them to deal with just one DOE agency. Another advantage of this option is that as you recall earlier, there's a legislative requirement that Greater-than-Class C be disposed of in an NRC licensed facility, which the repository will be.

Secondly, we still have a plan to provide limited DOE storage capability for Greater-than-Class C waste, and as I indicated, that would be primarily for material that poses a potential public health and safety threat.

We will be developing waste acceptance criteria that's compatible with the repository's packaging and waste form requirements based on the assumption that we will succeed in implementing that co-disposal option.

We'll be developing fee determination and collection methods that will cover not only the Greater-than-Class C disposal operations but also storage if it is provided.

And lastly, if there's a need identified, we would further pursue the co-disposal of Greater-than-Class C waste with DOE Special Case Waste, which I will talk about more in a minute.

DR. LANGMUIR: Could you speed up just a little bit, Ken, we're almost out of your time period here.

MR. HENRY: All right. I just have four slides left. They're related to Special Case Waste. As I mentioned earlier, I was asked to address Special Case Waste since it is identified as one of our co-disposal options.

Special Case Waste, many people think of it as kind of a nebulous waste category. In many cases it's not well understood, even within the DOE system. This slide lists some of its attributes. It's material that's owned or generated by DOE. It may have originally come from--some of it may have originally come from the private sector, but it didn't become waste until DOE was done using it for its own purposes.

There's a real characterization problem with the Special Case Waste category because a lot of it is not well categorized. In fact, if it were better categorized, it may not be viewed as Special Case Waste. Instead it may satisfy the requirements for some of the other waste categories. But in lieu of that characterization data, it's generally material that doesn't seem to fit the current disposal plans for either shallow land burial as low-level waste, shipment to the future Waste Isolation Pilot Plant as transuranic waste, or shipment to a repository as high-level waste.

And Special Case Waste can include a wide variety of waste forms, some of which might be similar to commercially generated Greater-than-Class C waste.

Now, I've identified just a couple of examples of Special Case Waste subcategories. I've picked those that are most likely to be similar to Greater-than-Class C waste.

This first one is a subcategory called Special Performance Assessment Required. It's SPAR waste. It exceeds the NRC's limits for Class C low-level waste, so if it were commercially generated, it would be Greater-than-Class C. It's viewed as not being generally acceptable for shallow land burial. Here at the INEL we have our latest estimate is about 87 cubic meters of it, and it consists largely of test reactor hardware and skeletons from fuel assembly consolidation experiments.

Another example of another subcategory of Special Case Waste is the Non-Defense Transuranic Waste. It exceeds 100 nanocuries per gram of transuranics. It does not satisfy the current acceptance criteria for the Waste Isolation Pilot Plant because they currently accept only defense waste. The current INEL inventory of this material is about 30 cubic meters, and quite a bit of that has been received in past years from the private sector for R and D purposes or for public health and safety reasons.

Now, I want to mention that here at the INEL at least we have recently finished an integrated planning task for all environmental management activities. In fact, that's the subject of the next presentation. And everything I'm talking about here as Special Case Waste is included in that plan and a disposal plan is provided.

So this is my last slide. The options for future treatment and disposal of Special Case Waste are, first of all, after the material is better characterized and treatment plans have been developed, it's quite likely that some or perhaps a large part of it may become suitable for near-surface disposal. Special Case Waste that's highly activated or contains long-lived nuclides may be viewed as being suitable for repository disposal. Here you can view that word "repository" in a generic sense. It could be either the WIPP facility or a Yucca Mountain type of repository. The last option is in the future the Department of Energy may choose to establish some type of intermediate depth disposal capability for Special Case Waste, and those plans have not yet been finalized.

That concludes my presentation. Are there any questions?

DR. LANGMUIR: We have time for one perhaps. Bill Barnard?

DR. BARNARD: Bill Barnard, Board staff. Ken, what's the total volume of Special Case Waste that DOE now has?

MR. HENRY: You can find varying numbers. I might mention--and I think I mentioned at our public workshops--that we had conducted a study here about five years ago that included not only the INEL but other DOE sites as well. We came up with a nationwide total of somewhere around a million cubic meters. I personally believe that number was biased high. I think if we were to repeat that study we'd probably come up with lower numbers even today now that we've had five years of additional characterization data and disposal planning.

I might say that of that million cubic meters, roughly 80 percent of that was attributed to Hanford. And I think most of that came from underground storage tank materials that did not satisfy the high-level waste definition and also some planned decommissioning wastes from obsolete production reactors. Our last estimate of the Special Case Waste inventory here at the INEL was about 38,000 cubic meters. And here again, the major problem is characterization.

DR. BARNARD: What's the current estimate of the number of sealed sources that we use here in the United States?

MR. HENRY: I'd hate to even guess. There are a lot of sealed sources, thousands and thousands. There are a lot of sealed source licensees, probably in the high hundreds. I'm glad you asked that, because it does allow me to make a point I meant to mention earlier, and that is that of the sealed sources that are out there, only a small fraction of these would become classified as Greater-than-Class C at the time they become waste. Most of those would fall below Class C limits and be eligible for commercial disposal.

DR. LANGMUIR: Thank you. I think we need to move on.

The last formal presentation of the day before our public questions and comments opportunity is presented by Clark Williams, and the topic is integration of environmental management activities at INEL.

MR. WILLIAMS: Afternoon, ladies and gentlemen. I'm going to brief you on some very recent activities at the INEL, which stems largely from the fact that at the INEL we've got 405,000 cubic meters of waste total, about 700 cubic meters of spent nuclear fuel, plus a whole host of other materials that in a time of declining budgets and increasing regulatory requirements are putting in jeopardy our ability to be able to achieve final disposition of those waste forms and materials in a time frame that's acceptable to the stakeholders.

Along about--in recognition of that problem--March the 1st, the president of Lockheed Martin, Mr. John Denson, pulled together a team of about 65 technical and program experts and charged them with finding a solution to that problem, and in short doing nothing less than integrating the efforts of five previous contractors prior to the time that the activities were consolidated here under a single contractor last October.

Using a conventional systems engineering approach, the team achieved an integrated solution for INEL EM activities and build that around a strategy of fully treating all of our waste forms in order to make them most acceptable to disposition at national repositories and other disposal sites. The solution also was one that focused on minimizing the total waste volume that was shipped to those repositories. The team developed an analytical tool that will live on that has the capability to evaluate the different alternatives that were considered by the team, with the final result that quite literally an integrated solution does more and ends up costing considerably less, as we shall see in a few minutes.

The governing criteria as put forth by our president and affirmed by the manager of the laboratory, Mr. John Wilcynski, was to address the budget realities while meeting the environmental regulatory regulations; to achieve real, measurable results in the sense that waste would be made road ready, ready for disposal; that we integrate ES&H risk into the evaluation of the alternatives; and that stakeholder concerns be addressed, particularly those with respect to the State of Idaho, that we expeditiously clean up the site and that we get waste ready to move out of the state of Idaho to its ultimate place of disposal.

This figure illustrates the approach that we took. Again, by using simple fundamental systems engineering principles, we were able to take what had previously been addressed in what we call stove pipes of both funding and contracting space, where the rule was normally to take an inventory, to apply a technology to it, sometimes very innovatively, to select a facility to deal with that waste inventory and ultimately to move it at disposal. But with very little cross-talk across programs. That's where stove pipe comes from. So we took a basic systems engineering approach that looked at combining waste inventories, using common technologies in shared facilities, and ultimately sending waste that had been treated, fully treated, to its ultimate disposal site.

We started by considering four basic alternatives. The first we called Baseline, and that's familiar to most of the members of the Panel, I suspect, in the basic elements that were provided as the input for the Baseline Environmental Management Report, fondly known as the BEMR. We used that as the baseline for measuring the effectiveness of the other alternatives that the team conceived and analyzed.

The second alternative we called Full Treatment. The theme was maximizing volume reduction and stabilizing all forms of waste, with the idea that it would require minimum characterization and repackaging prior to shipment to its ultimate site for disposal. The bet here was that the cost of full treatment would be less than the cost of the transportation and the characterization that would be required of a non fully treated waste form prior to or involved in shipping it to its ultimate disposal site.

The third alternative was dubbed Minimal Treatment. That allowed somewhat less treatment as an alternative feature and somewhat more repackaging of existing wastes prior to shipment. It of course ends up relying a little bit more on exemptions. For example, the no-migration determination that WIPP might be required to accept TRU waste that was not fully treated.

The final alternative was to place waste in compliance storage and defer treatment and disposal into the future. That's simply begging the problem in the near term and putting off until later what ultimately we must come to grips with anyway.

This looks like a busy slide, but there's a little bit of insight here, so I'll spend a couple of minutes talking about it. The four alternatives that I just described are listed down the left-hand side. Across the top are nine different scenarios which the team decided were essential that the alternatives be evaluated against. Those scenarios, those nine scenarios, came about because there were four crucial state variables that the team determined could cause major swings in the outcome of the evaluation of any one of these alternatives. They were whether or not the repository at WIPP was available and whether or not it opened with a no-migration determination in place. The team also considered that the availability of Yucca Mountain and whether or not it accepted highly enriched uranium as a disposal form at Yucca Mountain, the third and the fourth of the crucial state variables.

The possible combinations of these four state variables generate nine different scenarios, and those nine scenarios are listed across the top of the matrix, as I said a moment ago. For example, you could make the assumption that WIPP opens with a no-migration determination and that Yucca Mountain opens and allows HEU into the repository, and that defines Scenario No. 1.

The numbers in the matrix are nothing more than the accounting of the four alternatives and the nine possible combinations, 36 different cases that we felt warranted attention. The first four that we analyzed are circled. S1, WIPP opening with a no-migration determination and Yucca opening and permitting HEU into the national repository, were selected because that is consistent with current DOE policy.

Final alternative, that of storage, is essentially the same as saying, "There is no repository available at WIPP and there is no Yucca Mountain available or other national repository, and therefore you are stuck with putting it in storage here and leaving it at the INEL."

I might note, too, that the Full Treatment

Alternative, if you fully treat all your waste, makes equivalent Cases No. 2 and 14, because under that fourth scenario, if you treat fully waste, TRU waste is no longer susceptible to the outcome of the no-migration determination.

A rather simple but rather robust computer model was developed by the team. It was capable of exercising the quantitative inputs and providing as outputs waste inventory as a function of time, risk and cost as a function of time for each one of the alternatives that was considered.

I'm going to take just a minute to talk a little bit about what the Full Treatment Alternative was because it emerged in the final analysis as the preferred alternative. Full treatment to the INEL means that spent nuclear fuel, rather than being placed into dry storage as was previously the plan, is placed directly into MPC's until such time as the national repository--and we call it Yucca Mountain; it may be somewhere else--is available to receive that waste form.

High-level waste, in both its calcine and its liquid form, would be separated into its high-activity fractions and low-activity fractions, with the high-activity fraction being vitrified in a very small vitrification facility to produce what we believe will be a glass bead form ultimately, and used to fill the void fraction in the MPC's in order to drive down the costs of disposal of that waste form.

In 1995 dollars, that's a potential $700 million swing in cost savings. Now, that's not to say that there are not some technical issues that have to be addressed. But in the time frame between now and roughly 2005, when we think that that first waste form will be ready to go to the national repository, we don't think that those technical issues are insurmountable.

Mixed low-level waste, we have a very, very small inventory of NaK, a matter of a few barrels. I'm not going to talk about that, that will be treated locally and disposed of as low-level waste. But all the rest of our mixed low-level waste forms will be treated at what we call WERF. That's our local incinerator at the INEL. The WERF facility will be used to incinerate that mixed low-level waste inventory and operate it for three years, until such time as the backlog is retired. Because WERF is so expensive to operate and because there are other more economically feasible alternatives over, after that three-year campaign, we've hypothesized that the remaining mixed low-level waste stream would be fed to a thermal destruction and stabilization facility, which is represented by this dotted line.

We have at the INEl now the Pit 9 Project, which is a thermal destruction and stabilization unit that is being built as a pilot to treat the waste at the RWMC, which we call Pit 9 Waste. We used that facility for sizing purposes and made the assumption that the technology will prove itself out in order to combine these waste streams and treat them under this type of a regimen. It is the intent of DOE to privatize this activity, and in fact, on the basis of the latest internal review board results, DOE/ID is moving ahead very aggressively to privatize the activities within this box. Pit 9 is a candidate. Other technologies, other companies, will also have the opportunity to put forth their plans in order to drive the costs of that treatment strategy down to the lowest possible.

Low-level waste, quite frankly, is treated at this particular time much more inexpensively in a commercial treatment facility. We are currently using the SEG facility at Oak Ridge, and would anticipate that we would continue to do so, with some of that waste being used during the three-year campaign of the WERF facility as filler for those times when the facility is not being optimized by the treatment of mixed low-level waste.

This is a histogram of the costs associated with the Full Treatment Alternative and the other three alternatives that we took a look at. By integrating waste streams and using common facilities and multi-purpose facilities and a privatization strategy, the Full Treatment

Alternative comes out far ahead of either of the two other alternatives which were--three alternatives which were considered.

I might point out that by the year 2030 we are essentially done at the INEL with fully treating our waste streams and fully dispositioning those waste streams to their ultimate disposition site. There is some remaining infrastructure and D & D and transition and some minor treatment that remains after the year 2030, but within 35 years that portion of the INEL's mission is done. We can go on and do other things.

Minimal treatment, storage, and baseline all have significant legacy costs, and notice that this is in millions. That's a $40 billion top out for the baseline, and that's a lot of money. The strategy of get it done and get it done now, at least in 1995 constant dollars, makes a lot of sense.

What happens if you do a present value calculation on the outcomes? Full Treatment still wins, but if you use the assumptions and the OMB guidance circular that was in place at the beginning of the year when we did the analysis, which if I remember correctly was based on a 3-percent escalation and a 2.8-percent real growth in the economy above that, so you discount it 5 percent, and Full Treatment still ends up being the winner.

DR. LANGMUIR: Clark, if you'd try and wrap up in a couple of minutes.

(Pause.)

MR. WILLIAMS: I'm going to jump ahead a couple of slides. This is the actual cost profile of the Baseline Environmental Report against the full Treatment Alternative and against the current EM projected funding capabilities. Over the next 35 years, integration gets you a $7 billion savings over what was originally hypothesized in a non-integrated solution.

This is our favorite chart of all. We call this our Idaho chart. This shows the disposition of waste leaving the State of Idaho over the next 35 years. The area in the light purple is essentially the environmental restoration wastes that we have here at the INEL. The darker purpose is all of the other waste streams and the spent nuclear fuel. You can see that we're essentially done by the year 2020. There are still some spent fuel tailings and some ledge storage and some other miscellaneous items which take you out through the year 2050.

I'm not going to talk about this because I'm out of time, except to say that we did a rather innovative thing in risk space. Rather than following the conventional, tradition, absolute risk calculation regimen, which was quite simply impossible, for the 132 waste streams and the several thousand transitioned and waste states that we considered during the analysis, our risk experts came up with a rather innovative, relative risk, which we used to gauge the outcomes of the different alternatives that we analyzed. The insight primarily to be gained is that each one of these breaks in the curves represents reduction in risk, either as a direct result of treatment or as a direct result of getting waste to its ultimate repository.

In summary, we're pretty excited about what we've been able to do in a very short period of time. Full Treatment eliminates the funding peaks. It levelizes spending. It saves $7 billion over 35 years, compared to the Baseline Environmental Report, and it achieves additional--has the potential to achieve additional cost savings if regional or complex wide streams are integrated as well. If you consider that what we did at the INEL is a suboptimization, think what you can do if you do it on a complex wide basis.

We demonstrated measurable results. We got waste ready to leave the State of Idaho, satisfying both the WIPP and the Yucca Mountain windows. Extends repository operating life through volume reduction. WIPP is very sorely pressed towards the end of its life, and the question of whether or not a second WIPP like repository will be required is problematic, but it's an issue that will have to be addressed. If you fully treat the waste, you duck that problem, that issue, altogether. And a Full Treatment Alternative results in the best waste form for storage, irrespective of the outcome at a repository national level.

My final slide is risk reduction as achieved by treatment, and it's achieved by disposal to deep geologic repositories and of concern to us locally. Our stakeholders have the benefit of having the waste moved out of Idaho and having achieved measurable results.

Any questions, Mr. Chairman?

DR. LANGMUIR: Thank you, Larry. I realize that you had a lot to cover, but I wondered--I didn't really understand fully, because we didn't have time, I'm sure, to get into what Full Treatment was comprised of. And you had an overhead on it, a very detailed overhead, which could probably take an hour to explain.

MR. WILLIAMS: That's right.

DR. LANGMUIR: Which is in the middle of the--could you go into some of the--give us a Reader's Digest version of what Full Treatment is in your view?

MR. WILLIAMS: The slide that I put up earlier is a synopsis of Full Treatment, and it's the slide in your book which precedes the detailed foldout. The reason I put the detailed foldout was just to let you know that there's a great level of detail in flow chart space below that which you see on the overhead projection. And we'd be pleased to spend any additional time that you or the other members of the Board or any other members of the stakeholder community would like to spend in going through that.

DR. LANGMUIR: I guess what I was asking for was a very brief synopsis of what's in it.

MR. WILLIAMS: It's the expanded version of what you see here on the board. We considered 132 waste streams. We've got one, two, three, four, five, six, seven, eight as a summary level representative of the major waste streams on this board. What's in the more detailed foldout that you have is the detailed disposition flow chart for each of the 132 major waste streams, through the facilities which will accomplish treatment, storage, and ultimately disposal. The items in blue are all of those facilities which would be required as facilities beyond which we currently have envisioned or are on the drawing books at the INEL at this time. It served as the basis for the state diagram as the inputs to the model for the analysis of the alternatives that were done.

DR. LANGMUIR: Thank you. Time for one more question, I think, from the Board or Board staff. Leon Reiter?

DR. REITER: Leon Reiter, staff. Just a clarification. In your scenarios, do you assume a probability for various things happening?

MR. WILLIAMS: We did not. This was a deterministic model. Bear in mind we did this fundamental analysis in a little over three weeks.

DR. REITER: Okay. How did you then assign weight? Just equal weight in calculating the costs for all the possibilities?

MR. WILLIAMS: We did not. The four fundamental alternatives that we assumed were evaluated against the four circled scenarios. The next step in the analysis will be as we further refine the analysis to incorporate a probabilistic capability to be able to work a scenario on line to answer the "what if" questions.

DR. REITER: See, that's the real issue, then, because supposing Yucca Mountain doesn't open. In storage, did you assume that there would be a final disposal?

MR. WILLIAMS: Ultimately you've got to come to grips with it, and weight--

DR. REITER: Is that part of your cost?

MR. WILLIAMS: It is.

DR. REITER: What part of the cost is it?

MR. WILLIAMS: It is. Let me recover that slide and I'll show you.

(Pause.)

MR. WILLIAMS: Storage out through the year 2030 costs this much. The simplification that we made in the model was that ultimately full treatment would be required. It was also the most conservative to make in cost space in terms of minimizing long-run costs, so with very, very little exception, we literally lifted full treatment and put it into this red area that says, "Ultimately I have to treat waste in order to ultimately disposition those waste streams."

DR. REITER: Present day dollars, then, becomes much less.

MR. WILLIAMS: That's correct, that's correct. But that was incorporated into the present value calculation that we did, and that's why you see the curves come reasonably close. You don't meet any of the stakeholder concerns, you don't do anything, you continue to put present day dollars into keeping things in the ground and surveiling and maintaining without doing very much, but the present value ends up coming very close.

DR. LANGMUIR: John Cantlon?

DR. CANTLON: Cantlon, Board. The stakeholder community you're talking about must be the Idaho stakeholder community. It surely can't include the Nevada or the New Mexico stakeholder community.

MR. WILLIAMS: It includes--it is Idaho.

DR. LANGMUIR: Garry Brewer?

DR. BREWER: This is Brewer, the Board. The assumptions you make in the net present value calculations are extremely critical and they were very conservative, and the picture that you get given the assumptions that you've got could change radically with very reasonable assumptions about the discount rates. That's something that I think you should keep in mind, because the cost argument that you conclude with is very, very soft.

MR. WILLIAMS: The next generation of the model and the analysis will include those considerations as well. And our ability to be able to capture those more accurately than we did on the first pass through.

DR. BREWER: That's the most important assumption that you make in the whole analysis of the discount rates that you apply in the MPV.

DR. LANGMUIR: Further questions from the Board or Board staff?

(No response.)

DR. LANGMUIR: Thank you very much, Clark.

MR. WILLIAMS: You're welcome.

DR. LANGMUIR: The program is showing at this time an opportunity for people in the audience to ask questions or make comments. I would ask that you come up to microphones to do so, identify yourselves for the record. Do we have any takers?

UNIDENTIFIED SPEAKER: Or givers.

DR. LANGMUIR: Or givers.

MR. MALONE: My name is Charlie Malone, and I'm with the Nevada Nuclear Waste Project Office. I have a question to ask Mr. Henry about the Greater-than-Class C low-level radioactive waste disposal strategy. Now, I think that when you presented your presentation you showed that there had been two meetings, scoping meetings, I gather, and that a strategy was going on. And what I'm holding here is the Notice of Inquiry that was issued on March the 13th of '95 about that strategy and inviting people to comment on it. And I wonder if you could tell us where that is and what the schedule is for coming to final grips with the strategy.

MR. HENRY: Yes, based on our programmatic reassessments of the program strategy plus the inputs received during the public workshops that were held subsequent to the March 13th notice that you mentioned, we are in the process of finalizing our draft program strategy. Our intent is, following full DOE concurrence, our intent is to prepare that in the form of a report to Congress which updates them on what the latest program strategy is. And since it's been quite some time since the disposal requirement for Greater-than-Class C low-level waste was laid upon DOE, and we feel that we owe Congress an explanation of where we stand and what our plans are.

DR. LANGMUIR: Further comments or questions from the audience?

(No response.)

DR. LANGMUIR: If not, we need to take a ten-minute break and then reassemble for the round table discussion. Please make sure all speakers of the day are present to sit at the table. It's currently--on my watch at least--4:01, so let's reassemble about 4:10.

(Whereupon, a break was taken.)

DR. LANGMUIR: Okay, we'll start the round table discussion. This is going to be fairly freewheeling in the sense that there will be opportunity, first of all, from those of us at the table to interact, but I'm going to encourage people in the audience to do so as well as we proceed if they have questions relevant to the issues at the table here, or new issues, and we'll suggest when that's appropriate, too. But I'm going to let Carl Di Bella start us off.

DR. DI BELLA: Okay, this is Carl Di Bella, and this will be sort of, I hope, an open-ended toss-up kind of question. I notice a number of speakers, including our last one, Clark, are very concerned about the amount of volume that is taken up in a repository, and Clark went as far as suggesting that maybe in the void space in the spent fuel they could put in glass beads with high-level waste. And actually that may have a very good synergistic effect for, say, criticality. But in the final analysis, you're disposing of the same radioactivity of waste in the repository. I also notice several other speakers are very concerned about this volume of waste. Brent was in his analysis, too. And so I'd like to ask how much have you looked at how important volume really is as opposed to radioactivity or tons of fissile material or what have you? Or do you just take that as a given from RW, so to speak, and maybe isn't that a form of stove piping in itself?

Maybe, Steve, let me see if I can get you to start out on that. Is volume the right thing to be looking at?

DR. LANGMUIR: Excuse me, before--let me interrupt for a second. I forgot to mention that everybody needs to identify themselves for the record as we proceed around the table here. Go ahead, Steve.

MR. GOMBERG: Okay. Steve Gomberg reluctantly answering this question. When we develop the requirements, we look at two specific factors. We tend to talk generally about metric tons heavy metal. I guess to me that's an accounting measure. It allows us to compare against a 70,000 metric ton trigger, it allows us as a basis for establishing fees and whatnot. But I think the real issue for us is a volume equivalent, and that you can equate to a number of canisters, number of MPC's, if you will, of waste that we would have to handle in the repository.

So I think for us that volume, the number of canisters is one of the ultimate design considerations, and then the characteristics of each canister, which would allow us to determine spacing pitch between the packages, consistency with the overall emplacement of other waste within the repository. And those are all the kinds of information that we will be pursuing over the next several years to ultimately integrate the acceptable DOE spent fuel waste forms into the program.

DR. DI BELLA: Do you really have a shortage of volume in the repository, particularly for wastes that don't generate very much heat?

MR. GOMBERG: Certainly for wastes that don't generate much heat there. The other consideration I would assume would be criticality concerns as far as the spacing between canisters. Other than those two, I don't know of other significant drivers that would limit us too much, but I think those things, you know, we're in the advanced conceptual design stage right now. We're very early. We don't have a repository layout per se, we don't know how much repository block will be licensable, and so a lot of these questions still need to be addressed before they can be, you know, formally finally answered.

DR. DI BELLA: Anyone else want to tackle this?

MR. LAIDLER: Laidler, Argonne. I think that volume is really just one part of the total jigsaw puzzle. But if you consider that we're striving towards some kind of standardization of a repository container and the MPC is one of the leading candidates right now, that has a certain volume capacity to it. And if each one of those--I heard a number this morning that was a little mind-boggling, $3.5 million per copy. And if you try to project that to just the total number of metric tons that we have to dispose of, we're talking about $35, $40 billion just in container costs alone. If you can reduce the volume that has to go in the containers, you're saving money. So that's one part of the picture.

MR. ABBOTT: Dave Abbott. Another consideration from the INEL standpoint is if we're going to put our spent fuel in MPC's or by other dry storage capacity, the cost is pretty proportional to the volume, because the amount of fuel you can put in an MPC is pretty much limited by volume. So it saves us a lot of money if we can get better or more volumetric efficiency out of it. And it also reduces the number of shipments that would be required for us to ship from here to an MRS or a repository.

MR. EDGERTON: Brian Edgerton with DOE-Idaho. Just to amplify on the last two statements, as part of our Record of Decision, we did look at some life cycle summary type cost analyses for spent nuclear fuel management for DOE spent fuel, and the per unit cost on MPC's was growing substantially. You're looking at $3 to $3 1/2 million per unit MPC, and that was certainly looking at some of the numbers that you're talking about there, Jim Laidler, very, very substantial potential cost for disposition of this material in the repository as envisioned.

I think there's also some concerns about what the forthcoming National Academy of Sciences report may say about thermal loading and what the implications may be for volume or space or whatever you want to call it available in the first repository. No one knows what that may be at this point, but there's some real serious implications in that area also that could have impact on the amount of material that could be disposed in this first repository.

Steve, you want to address that?

MR. GOMBERG: No, not really. No, I think those are all very good points, and we do--obviously we are balancing a lot of considerations to get to a final answer. And I think all these things are going to be addressed through the NEPA process, raised through licensing and other considerations at the point that we get there, and they're all very valid considerations. There's a broad range of factors that will come into play.

DR. LANGMUIR: I'm not sure who this question is for--Langmuir, Board--but we heard from Jim Laidler about this technology idea of dissolution stabilization and so on, separating the waste into a long-lived mix with the cesium, strontium sort of materials, and then the uranium coming off in a separate stream. The impression I got was that was a hot product, unlike what we've been viewing as a fairly cool glass product from the defense side of the ledger, and that's going to presume we change the thermal loading issues at the repository. Maybe not a lot, but, Steve, how are these things being addressed by the DOE? Are they being considered in their impact on thermal loading?

MR. GOMBERG: Well, right now there's several different forms that would come out. One would be the uranium metal, there'd be various different high-level waste forms, potentially zeolitic waste form that we don't really have a lot of information on. To my knowledge right now, there has not been a final recommendation made, and therefore not a serious consideration within our program to look at heat implications or suitability of these waste forms for disposal. We're waiting for a National Academy of Sciences report to come out making recommendations on electrometallurgical processing.

We basically start, though, by addressing the requirements on the waste form on the overall repository system that need to be met. We have not done that, to my knowledge, for the electrochemical processes. We have a lot of information on borosilicate glass right now. And you're right, that does not appear to be a major heat driver within the repository compared to spent fuel. I don't know if in the long term the wastes that come out of the electrometallurgical would be a major heat driver, either, once again compared to spent fuel.

DR. LANGMUIR: One thing that's occurred to me as we've listened today, those of us involved in the commercial side of it, the Board is by and large looking at that. We're sensitive to the fact that the DOE is a bit behind in a number of aspects, particularly related to source term definition when you're looking even at the source term issue. And we come here today and find that there's lots of potential options to putting different kinds of materials together, creating different kinds of wastes from the defense side, and then going to repository with them. And the sense I certainly have, and I think maybe others have, that you've got a way to go with evaluating the consequences of disposing that kind of waste in a repository and understanding what it's going to do in terms of releases or might, predicting it, doing experimental work, the modeling work that would give you some handle on the consequences of using that kind of waste in a repository. And it strikes me that those uncertainties are really going to be tough when you're looking at deadlines coming back up as fast as you are in terms of licensing and potential disposal.

Steve, any thoughts on that one? Or anyone else at the table?

MR. LOO: Henry Loo. I would like to make comment about the thermal loading as Dr. Di Bella's indicated about the repository that we have looked at for the '94 PA about the container corroding away fairly quickly. And one of the reasons is the fact that with the DOE spent fuel and the high-level waste that we have looked at in this 12 metric ton hypothetical repository is fairly low as far as thermal loading is concerned comparative to--you know, comparing to the commercial spent fuel. And that's one of the reasons, too, that is giving, I think, the higher corrosion rate. You know, making the conservative assumption that you're going to be running a colder repository. And, you know, you're talking about only reaching a maximum temperature of 90 degrees centigrade and not over, you know, like what the commercial folks for the RW type of thermal loading. And I think by doing some other consolidation or concentrating the high-level waste and putting it into a glass form or putting the glass into the spent fuel should help us to bring it up to closer to the commercial spent fuel. I think that might in some respect would help the problem that we're seeing in the FY-94 PA results. Just, you know, kind of comment.

DR. LANGMUIR: I think Dennis Price had a question relating to criticality.

DR. PRICE: Yeah. Dennis Price. You indicated, Mr. Loo, that you could not readily ignore the criticality possibility, and you indicated also that the consequences were small, relatively small you felt, but you could not ignore the criticality possibility. And then you indicated that the probability of that, at least as far as you had gone with the fault tree at this time, was 10^{-7}. And I was wondering what members of the panel might feel about what is a probability of occurrence and consequences of that occurrence such that that probability would not allow you to readily ignore the criticality possibility. That's a double negative, but I'm trying to use your phraseology in it. What probability is acceptable with respect to criticality and given the consequences?

MR. LOO: Are you asking me?

DR. PRICE: I'm asking everybody.

MR. LOO: Okay. I guess that's one of the questions that we've been--we lacked an answer to ourselves, because in the process of performing the evaluation, you don't have a measure to compare with and say, "Yeah, I have achieved what the requirement calls for." If you look at 10 CFR 60, it's double contingency, you know, .95, all the good words there, and they don't say, "Well, if you look at within 10,000 years, if your probability is below this," -7, -8, whatever that number per year, it would be acceptable. And I don't think NRC had specifically addressed an acceptable probability level, and you know, I guess I don't know. Anybody else have any thought on what would be an acceptable one? Now, I heard some numbers brought up before was 10^{-9} per year. Is that low enough? I don't know.

DR. PRICE: You're talking about what is reasonably acceptable, and 10^{-7} is a pretty small number. And what would a prudent, reasonable person find acceptable? I was listening to some of the lawyers talk about DNA the other night with 1 in 20 billion, and they were arguing that there was a reasonable doubt. And when you think about out of 20 billion people finding one and then putting that one person on the scene there, you know, it gets kind of very, very small. And we're related somehow here. You actually came to a conclusion about that. That 10^{-7} wasn't quite small enough, and I'm just wondering how people feel about the whole issue.

MR. TAYLOR: This is Larry Taylor with LITCO. That was an issue that we raised over two years ago in some of our initial studies, and it may not be a situation of whether or if it is acceptable from a technical standpoint, but politically whether you could ever justify it to the stakeholders. And particularly when you recognize that most of the probability risk assessment work that's gone on in support of reactor systems is usually for a common cause or multiple component failure, but only over a 40-year lifetime. So if you take the 10^{-7}, multiply it times 6 or 7,000 canisters, and then again times 10,000 years, it becomes a palpable number. And so indeed 10^{-7} might not be an adequate number. Do we shoot for 10^{-11}, 10^{-14}? Nobody knows right now. And nobody can offer any definitions, either, on what an acceptable limit is.

MR. CONNORS: This is Don Connors from Bettis. There are a couple of pieces of guidance we might use. DOE has turned out in their environmental guidance, "Here's how you should write Environmental Impact Statements," some guidance saying that accidents with a lower probability than 10^{-7} generally need not to be considered unless they lead to very large consequences. And I believe, although I can't quote it, I remember an NRC NUREG regulation that basically said the same thing, 10^{-7} you should not--you need not consider the consequences of the accident.

DR. PRICE: And in this case, the consequences you assessed, could you describe what you really think? I think small consequences, would that be a word you'd use?

MR. LOO: Well, I think the basis when we made that statement is that 40 CFR 191 right now states that if any process or event has less than 10^{-4} probability of occurring within the 10,000-year period could be eliminated from the discussion here. And in doing the criticality evaluation, like Larry was saying, if you take a look at the probability is 10^{-7} per year, and you look at over a 10,000-year period, that brings it down to within the range that we need to look at. So that's the reason why we have included that moderated criticality as one event that we need to consider in the complex PA, and we need to consider it and evaluate further.

But one of the things that I really want to emphasize and I indicated on my slide is that when we get the evaluation, there's a lot of uncertainty, you know, involved that we have pretty much consistently tried to be as conservative as we can when we're doing the evaluation and make sure that we're not--we can stand up and defend the numbers. And I think the reason is based on the 40 CFR guidance and what we have evaluated, and that's why I say that we can't ignore it.

DR. PRICE: But are you indicating--and maybe you were indicated that the 10^{-7} is actually a larger number?

MR. LOO: Well, I think we're saying the same thing, the 10^{-7} per year, but if you look at the 10 over the 10,000-year time frame, then it's no longer a really small number. That's what Larry was trying to--

DR. REITER: And that's on a per canister basis, too.

UNIDENTIFIED SPEAKER: Is that per canister?

MR. LOO: No, no. This 10^{-7} is for all the high-enriched canisters that are in the repository.

DR. REITER: In the repository.

MR. LOO: Right.

DR. REITER: But it's on a per year basis, so how does that number enlarge over a long period of time? Because who cares about on a per year. You really care over the total period of concern.

MR. LOO: That's correct. That's why I'm saying, if you multiply 10^{-7} over the 10,000-year period, now you're bringing that number down closer to what needs to be evaluated for 40 CFR 191 guidance.

DR. LANGMUIR: I had a related question on criticality.

UNIDENTIFIED SPEAKER: There's someone behind you.

DR. LANGMUIR: Sorry, excuse me.

MR. WILSON: James Wilson from LITCO. I'm the fault tree analyst that helped with this program. I think it's important to be very clear on differentiating your numbers. As the discussion went here, was it per year or per year per canister, things like that. And also differentiating probability and risk--or consequence, I should say. The reason that consequence was deemed acceptable was because it was based on a relative value, relative to the amount of radioactivity in the repository due to the burnup that was present. The additional radioactivity added by the criticality, if all the casks experienced a slow-cooker type of criticality would be less than one percent of that, which was resultant from all the burnup that had happened in the repository. So there were some bases that are not printed anywhere, but we just kind of created the concept of relative risk, relative to the risk that you are currently accepting in the repository. How much do you add to that by the criticality occurring?

DR. DI BELLA: Carl Di Bella again. Just to take this one step further on the consequence side of the risk equation, in order to get the slow-cooker kind of phenomena, you have to have a wet repository, which in itself implies something about thermal loading. Now, can you see that being eventually a recommendation for low thermal loading from a criticality point of view?

MR. LOO: You mean purposely?

DR. DI BELLA: Yes.

MR. LOO: Well, eventually, depending on your period of interest, your spent fuel is going to cool and your waste--you know, in this case it's spent fuel is going to cool down enough that you're going to have the same problem no matter if you do it earlier or later. Just a matter of you've got a set of requirements that you need to meet, this 300-year containment requirement from 300-year to 1,000-year. You've got the release requirements. So it's a possibility to recommend that "Go ahead and load it. We're low and we'll go ahead and make--but if there's any water infiltrating into the repository, get down there as soon as you could." But I don't see any gain by doing that, because eventually you're going to see that problem over a longer period of time. I guess that's my personal perspective.

DR. LANGMUIR: A more general question related to the criticality issue and thermal loading. We've been listening from the sidelines. The Board is really not that involved in criticality. We're very interested in it and concerned about it, but we've heard a number of discussions from different groups within DOE as to their conclusions regarding the possibility of criticality. I got the sense from looking at some of your overheads, Henry, that you had geochemists, hydrologists--my favorite group of people, of course--along with physicists and chemists and a whole host of people of different disciplines looking at your assessing the risks from your standpoint at INEL. That seems to be--and I laud you for that--that's the way I think it should be done.

There have been other groups within the DOE program who have not has as broad a group of individuals within their analysis of criticality who've spoken up about the risks of it, Bowman and Venneri obviously the key ones, and others as well who've supported them elsewhere within the program. One gets a sense that there's a cacophony going on here of conclusions regarding it. Some well-qualified groups have suggested that it's not an issue at all. You seem to be saying that it could be an issue. That was the impression I got from the end of your discussion. Where's it all going? When is this going to come together in some sort of a coherent consensus, or will there ever be one?

At least from the majority of DOE folks, Steve, are they--what's the status of this?

MR. GOMBERG: Certainly within our own program we've been looking at criticality. Certainly we're looking at LEU fuels and MPC's and coming up with different strategies to meet the NRC regulations. Criticality is one of the issues that we've been trying to address as a Steering Group and trying to integrate the necessary expertise and calculations that we need to do to make some formal, hopefully presentable, conclusions on the impacts of the various HEU fuels. Certainly the waste form itself is something that we need to consider also, how degraded is the waste form, how degraded will it be over the time frame of interest, what are the thermal strategies, what are the other pathways to get water in there. And certainly it is no easy single way to calculate--no one expert can sit down and calculate the equation.

And like I said, we've been focused on LEU primarily within our program and we're trying with working with EM to get the expertise to get the analyses together to see if it really is a problem or not. I think there are different opinions as to whether it is or not. And hopefully in a very short time frame we will be able to at least develop a path forward or recommended strategy, look at other options, or if there are engineering considerations that we can use to help ensure that we keep a criticality from happening, then that's the way we would prefer to go.

DR. LANGMUIR: Dennis Price?

DR. PRICE: Mr. Steve, if that number were to drop down to 10^{-4} or 10^{-3} as the best guess conservative guess, how would DOE feel about that number as being acceptable?

MR. GOMBERG: Meaning that any set of scenarios is considered a likely scenario and therefore--

DR. PRICE: No, I think the way, for example, we started with 10^{-7}--

MR. GOMBERG: Right.

DR. PRICE: --was through summation of cut sets out of the fault tree, and if the fault tree is really thorough, it would cover all the possibilities of occurrence and assign to each cut set, that is combination of events, a probability to that. And then the overall probability of all possible ways in which that could happen becomes the probability of that top event occurring. And I think that's where the 10^{-7} came from, if I understood what was going on there correctly.

And if that number were to drop, as it sounds like it could very well be, first of all, there were some conservative assumptions given in there, and then secondly, on a per year basis over a long period of time, that number may very well drop. Let's say there's some validity to that number and it actually ends up dropping down to the 10^{-3}. You really have to wrestle with when is it too low--too large a number?

MR. GOMBERG: I guess--I really don't do much of the criticality calculations and really have a good feel for the specifics as far as when it becomes too low or too high. Maybe I could ask for someone in the audience who has a better feeling to maybe express an opinion.

MR. CONNORS: This is Connors from Bettis again. The probability of a criticality in a water pool, on surface, is generally considered to be between 10^{-3} to 10^{-5}. So, you know, you're down in a realm of the probabilities you're just discussing. I think there's more than just the probability. You also have to have the consequence, and risk is the product of the probability times the consequence. Dr. Loo has indicated that the consequence of the criticality in the repository sounds like it's very small. My perception would be that even if the probability is as large as 10^{-4}, if the consequence is small, then the overall risk is going to turn out to be acceptable.

DR. PRICE: Are you suggesting then that there isn't really a larger probability number, that since the consequence is small that we could tolerate and find acceptable criticality?

MR. CONNORS: I think you could.

DR. LANGMUIR: Leon Reiter had a question.

DR. REITER: Leon Reiter, staff. I wanted to rephrase a question that Dr. Langmuir asked that I think maybe got lost a little bit, and that was to Dr. Loo.

MR. LOO: Well, let me correct you. You know, I'm not a doctor.

DR. REITER: Okay. In your evaluation of performance assessment and looking at criticality, have you evaluated the Bowman and Venneri hypothesis and the likelihood of it being correct?

MR. LOO: No. That's one of the things that I--this is Henry Loo--that's why I was going to interject here that when we started this evaluation last year as part of the performance assessment, we realized that, you know, something has to be done. I mean, you know, we need to look at criticality. We talked about it in FY-93, we took the conservative approach by limiting the amount of mass in each one of the containers. When we were starting the '94 PA analysis, we said, "Okay, let's sit down and look at what other possible scenarios could lead to a criticality when we put this material in the ground." And it was really just a first attempt, and at the time we felt that considering the repository condition, how much water is available, how could water get into the repository, and how the container could corrode and any kind of neutron absorber that is in the container could get leached out or vice versa, the uranium could get leached out and possibly move away from the canister.

So please understand that this is just a first attempt that we have tried to put our arm around this problem, and we have not looked at what Drs. Bowman and Venneri can suggest about the far-field criticality. The reason at the time when we evaluated this problem, our feeling is that with the DOE spent fuel, there probably is a higher probability of a near-field criticality as compared to a far-field criticality because of the fact that in order to have a far-field criticality, you've got to actually just dissolve the uranium. The uranium's got to get into the water and move away from the canister, and then the criticality. And then there's some assembled in a large enough mass quantity to have a criticality. So, you know, we didn't think that as far as to a criticality would be a lot more credible in near-field. So we have not looked at what Drs. Bowman and Venneri have suggested.

DR. REITER: Excuse me for interrupting. So you will be looking at it in '95, or--

MR. LOO: Well, we--go ahead, finish your question.

DR. REITER: I'm not quite sure what the conclusion was because stating that we didn't think it was very likely the effort we're concentrating on the near-field is a conclusion in itself. I'm not quite sure--are you going to be looking at Bowman and Venneri in far-field events?

MR. LOO: We will be working with the RW folks to try to see how to evaluate that situation right now. We are working with the RW folks right now.

MR. GOMBERG: Steve Gomberg. We've just begun our own internal evaluations of the Bowman papers, and certainly from that standpoint when you can have far-field criticality it becomes an issue for any type of fissile material bearing, whether it's low enriched or high enriched, and I don't know what we're going to find out. We've been very meticulously going through all the assumptions and everything. I think as Henry says, though, for near-field within a can, within a package, has been the prevailing assumptions as far as a criticality event occurring.

MR. CONNORS: Connors from Bettis again. I just saw a paper, I think it was dated May 5th, by Konynenberg and a group of people who basically took apart the Bowman-Venneri postulations.

DR. PRICE: But isn't the most important issue here that the risk is so low because the consequences are small, that we should not--or should we?--spend a lot of money on the issue of criticality?

MR. WILSON: Bowman's paper--Jim Wilson again from LITGO--Bowman's paper presented some pretty hairy consequences. He was postulating--I don't remember the exact number--but 10 kg's of plutonium thrown up into the atmosphere, something like that, and part of the problem has been that Bowman has presented a moving target. Each time his paper has been counted, he's issued a new paper that frankly has been stronger, at least in my opinion, and he has taken care of some of his weaknesses in his earlier papers in his later issues. But again, Bowman's privilege has been the ability to construct the scenario the way he wants to do it. He ends up with an end result and says, "If I have this end result, I'll have this thing happen." And indeed there may be some truth to that.

I think the weakness in Bowman's paper is how do you get there from here. And I think that's--in my opinion, I think we can construct a strong argument for saying that's a low probability that you'll get to that event.

DR. LANGMUIR: Langmuir. Does he still envision a silica sphere in the repository fourteen feet in diameter with plutonium uniformly distributed in it? A little hard for a hydrologist-geochemist to envision. Is that still assumed?

MR. WILSON: His initial--for those of you that aren't too familiar with it, I'll try to summarize the initial paper. The initial paper envisioned a concentration of plutonium that due to some dynamics spread out quickly to approach an autocatalytic situation. I think that became too hard for him to support, and he left that. And he postulated kind of a scenario where you gradually build up in a large sphere a concentration of uranium over a transport of the uranium to that--or plutonium to that position and gradually build it up. The problem there is he sacrificed the large, explosive quantity. In other words, I don't know if I can get you to visualize this, but there's a hump. He's trying to go over the hump and come backwards. And it's just as hard to describe if you don't have the criticality background.

It turns out the only way for him to get into that situation is to get an environment where you don't get a large explosive quantity. In other words, he can create that kind of environment where you're overmoderated, you dry out, you approach an autocatalytic criticality, but you don't have--you can't get enough material there to make it impressive. In order to get impressive, you have to get incredible. And so I think those are the weaknesses there, and I think we can handle these kind of things and indicate that they are a low probability event, and low consequence.

I would like to return to a point that was made earlier about the 10^{-3}, 10^{-4}. Again, you have to be careful the units that you're assigning to it. When we look at the regulations and it says that if you have less than 10^{-4} of having a criticality in 10,000 years, you can neglect the issue. In other words, that's the level of negligibility. That's not the level of acceptability, that's the level of negligibility. So there has been no acceptability level set, but a negligibility level has been given us. And you made the point that we feel we are quite conservative that turns out to be and you move up to the range of 10^{-3}, 10^{-4}. We feel that we're not going to do that because we are conservative. We feel we have topped out or maxed out the probability and said that we will not approach 10^{-3}, 10^{-4} per year because of our conservatism. I think there might have been a misunderstanding there of what we meant by conservative.

DR. PRICE: Dennis Price. I do think that terminology is very important, and specifically in the area of negligibility being closely related in its word structure to negligent. And you know, I think we have to watch our terminology.

DR. LANGMUIR: John Cantlon?

DR. CANTLON: I'd like to move to a little bit less esoteric dimension of this and to ask the question of you engineers that have been looking at this. Particularly in the rather attractive idea of mixing the waste glass with the spent fuel, what's the engineering challenge of bringing that about in terms of getting glass frit, moving it from the sources where it comes from? What's the relative volume of the glass frit you're going to have--or not frit but the glass waste? What's the volume that you have to dispose of in the system? How much of it is INEL responsible for? Do you have to import it or do you have enough on site to handle all of your spent fuel? I'm trying to visualize that process, that challenge.

MR. PALMER: We haven't looked across the whole complex, but for us here, by consequence, not by design, our projected volume available in the MPC is almost exactly equal to the high-level waste if we used the separations high-level, low-level scenario that I described, it matches up very nicely. So if you'd just look at that one chart I gave you, there was about 1,000 cubic meters of high-level waste, something like that. That very closely coincides with what we would have available, so it makes it very attractive. Of course the driver is the $700 million savings that results from the volume decrease. And what it amounts to is we then dispose of our high-level waste fraction with no additional transportation or volume impacts to the repository. It's a freebie.

DR. LANGMUIR: Maybe you could suggest to DOE that just 10 million of that 700 million could be used to do research on the consequences of mixing it.

MR. PALMER: And that's the question, do we want to spent the money up front to determine the consequences? And there are some concerns about mixing glass with the fuel in terms of the silica, the frit that we have in there, and the preferential dissolution of the Boron away from the frit materials. And, you know, it goes back to this bomb in the repository business. So there are some concerns and we would have to spend some money up front to quell those concerns and say, "Yes, it's okay to mix glass with the fuel." Personally, I think the real issue are things like heat loading and structural integrity. You know the more engineering related things rather than the postulated accidents. I think that's where the big challenges are.

As far as getting the frit and the material in it, the challenge there is relatively achievable. We can do that in the design of the facility fairly nicely.

DR. CANTLON: But again, pursuing this, looking at it system wide now, you're I presume planning to bring all of DOE's spent nuclear fuel here, is that correct?

MR. PALMER: No. Just a fraction of it. As they described earlier, we can go back to what Gary and Al and Brian described, but--

DR. CANTLON: The Hanford is going to stay at Hanford and not worry about it.

MR. PALMER: Aluminum goes to Savannah River, we get the zirconium and the cats and the dogs.

DR. LANGMUIR: Carl Di Bella.

DR. DI BELLA: Carl Di Bella. Earlier I suggested that perhaps there were a few people that were skeptical about metallic fuels' acceptability in the repository, and it's clear there are a few people here in the room that feel that some metallic fuels anyway are acceptable. I'm wondering, Steve, or anyone else in the OCRWM Program that might be here, what are you telling them, or what is your Steering Committee saying about the acceptability of metal fuels in the repository? Metallic fuels, excuse me.

MR. GOMBERG: Certainly if you look at the regulation on its own face, the considerations as far as waste form criteria go is, does it create a problem from the standpoint that it would affect the overall ability of the repository to perform its waste isolation function? Is it combustible, pyrophoric? Those sorts of considerations we need to analyze. Certainly the integrity of the cladding, the integrity of the waste form and the data that we have on that will help us to evaluate that.

I don't think that I know or can answer right now whether from a licensing perspective going to the NRC with certain information that we can or cannot say right now that metallic uranium fuels are suitable for disposal and that it's something that I think we need some additional analysis on before we can say for sure. Certainly it doesn't necessarily exclude it completely from the repository, but there are a series of repository based calculations looking at the performance of the fuel over the long term, how it degrades, how the oxygen gets to the waste, and various other things that we just, I don't think, have done in a detailed fashion right now. So I think that's one of the key issues that we need to strive for, and certainly it's one of the number one issues that the Steering Group is trying to address.

DR. DI BELLA: Carl Di Bella again. Any feeling for the timing when you might have an answer on an individual kind of fuel or maybe a generic answer to this question?

MR. GOMBERG: We've been trying to focus on N-Reactor fuel as far as the Repository Task Team activities. One of the things that we were trying to do in order to lay out our work is to try to identify those FY-96 activities, the kind of things that we need to do very near term either to determine suitability of a waste form or provide guidance back to EM on potential treatment options, because they may not be acceptable. So I think one of the things we're trying to do is assess the data that's out there, get together the teams that can do the analyses, and hopefully in the FY-96 time frame get that work done and be in a position to make recommendations on the fuel.

MR. LOO: This is Henry Loo. I might interject something here. In the '94 PA, we looked at oxidizing all the N-Reactor fuel. But not knowing how much oxygen will be available, because the assumption in the PA was oxygen will be always there. But in the '95 PA for the high-level waste, we probably would have a better model. We have included an oxygen transport model in there so it will give us a better feeling on how much oxygen is available down there in the repository. But when we make the assumption that the uranium will be converted into oxide form, but we don't know at what rate. So we took a look at the range of reaction rate. We're talking about somewhere maybe between .1 of a year to 10 years. If the rate is such that we're talking about a 10-year type time frame for all the fuel to be reacted, the amount of heat generated is fairly negligible compared to what you already have due to the thermal decay of spent fuel.

Now, if it's ending up that it's a lot faster, a real fast reaction, within that .1 year time frame, then we're talking about maybe we need to look at it might not be acceptable. That's what we kind of noticed, you know, in our '94 PA evaluation.

DR. LANGMUIR: More questions or discussion? Anybody in the audience like to participate again?

(Pause.)

MR. MALONE: Hi, I'm Charlie Malone with the Nevada Nuclear Waste Office. Now I'd like to ask Mr. Connors if he could comment for a few moments on the status of the agreements between Idaho and the Navy as far as the receipt of more spent fuel.

MR. CONNORS: I guess the only thing I can say is that I know that the Navy, the Department of Energy and the Department of Justice are working on this from the legal standpoint, and I don't think I should comment any further than that.

DR. LANGMUIR: I think it's time perhaps to close the panel, but please sit, if you would, stay where you are. This is the opportunity for a briefing on tomorrow's tour by Harlin Summers, if he will come forward.

MR. SUMMERS: Yes, good afternoon. We do have some recommendations for those of you going on tour with us tomorrow. First of all, we'd like to encourage you to wear casual clothing, and hopefully something in maybe a jean-type, something that would be made out of cotton rather than some wools, some nylons and some polyesters cause some false readings off our instrumentation going in and out of our areas. Also, please, you may want to wear a jacket in our spring weather here--excuse me, summer weather, I forgot where we were.

Also would like to recommend good sturdy walking shoes. We'll be doing quite a bit of walking, quite a bit of standing looking at hardware, etc. And for--well, I guess anybody, not just ladies, but no high heels, please. High heels and even moderately high heels with small surface areas do cause some problems again in some of our instrumentation that you may have to walk over.

Any of you have security passes from your work areas, you may bring those, those that have visible pictures on them. For those of you who do not have security passes, we have visitor passes that you'll wear tomorrow, so we can take care of it either way.

Tomorrow we'll be eating at a cafeteria, and you will need to buy your own lunch. Therefore, bring money for that. Otherwise, the bus ride, etc., are free.

We do have a rather energetic schedule. To do so, we're trying to leave at 7:30. And our bus location here at the Shilo is just outside this door and over to the right. Getting buses in and around parking lots can be rather interesting for drivers, so we've kind of chosen a spot right out here just to the right of this front door. You won't be able to miss it, it's a fairly large yellow bus.

Other than that, we just invite you to come, and we'll see you in the morning.

DR. LANGMUIR: Thank you. Let me close the meeting. First of all, thank the speakers for a superb day, very informative day. A lot's happened since our last meeting in '92. My sense is that there's much more coordination than there was between the different parts of the DOE program here, and I'm optimistic we're getting somewhere. It's a major effort ahead of you clearly. Maybe if there's another visit we'll see even more progress, Republicans and other people willing. So thank you, and we stand adjourned.

(Whereupon, the meeting was adjourned.)