NUCLEAR WASTE TECHNICAL REVIEW BOARD

The Panel on the Engineered Barrier System

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ELLIS D. VERINK: Good morning. I am Ellis Verink, a member of the U.S. Nuclear Waste Technical Review Board, and Chairman of the Board's Panel on the Engineered Barrier System.

On behalf of my colleagues on the panel and myself, I would like to welcome you to this meeting and thank you for taking your time to attend. I also would like specifically to thank Phil LaMont, DOE Richland Field Office, for making arrangements for our meeting here in Richland.

The Board was created in 1987 by an Act of Congress. The Board consists of 11 scientists and engineers nominated by the National Academy of Sciences and appointed by the President.

The Board's function is to evaluate the technical and scientific validity of the U.S. Department of Energy's activities under the Nuclear Waste Policy Act of 1982 as amended, and to advise Congress and the Secretary of Energy of our findings and recommendations.

In simplest terms, we are an independent peer review body. We are required to report to Congress and the Secretary of Energy at least twice each year. Four such reports have been delivered and we've just completed work on the

fifth one. It says here we have just completed work on a fifth. I'm not sure if that has another connotation.

JACK PARRY: That was after the report.

ELLIS D. VERINK: That was after the report, yes.

It should be printed and delivered by the end of this month. Several members of the Board and the Board's staff are present here this morning, and let me introduce them briefly.

The Board members include Dr. Clarence Allen, professor emeritus at California Institute of Technology, who chairs the Board's panel on structural geology and geoengineering. And Dr. Dennis Price is a professor at Virginia Polytechnic Institute and State University and is chair of the Board's panel on transportation systems. I am a professor at the University of Florida. Senior professional staff present include Dr. Bill Barnard, who is our Executive Director, Dr. Carl Di Bella, who serves the Board's panel on the engineered barrier system, Dr. Bob Luce, who serves the Board's panel on hydrology and geochemistry, and Dr. Jack Parry, who serves the Board's panel on

environment and public health.

Also attending for the Board are two members of our support staff, Ms. Linda Hiatt and Ms. Karen Severson.

You can recognize all of us by our blue name tags. If you are unfamiliar with the Board, please feel free to button hole anyone with a blue tag during the breaks or afterwards and we'll be glad to discuss the Board's history, mission, activities and so on.

The Nuclear Waste Policy Act of 1982 assigned to the DOE the mission of developing permanent geological repositories for the disposal of high-level nuclear waste and spent nuclear fuel. Accordingly, much of DOE's activities in the mid '80s were aimed at identifying and characterizing potential repository sites throughout the U.S.

In 1987 Congress amended the Act to limit the DOE characterization only to the Yucca Mountain site, a candidate site located in Nevada roughly a hundred miles northwest of Las Vegas. If the Yucca Mountain site is found suitable and if a repository is built there, then most of the waste disposed of there will consist of containers of

spent fuel from the nation's commercial nuclear power plants. However, containers of high-level waste from defense repocessing activities at Hanford, Savannah River or INEL may be commingled with the containers of spent fuel. And defense high-level waste is the reason for holding our meeting here today.

We are interested in how much there is of high-level waste at Hanford, its range of compositions, what is being planned to get it ready for repository disposal. Our ultimate concern, of course, is how the waste may affect repository design and performance.

With one exception, today's very full agenda deals exclusively with Hanford plans and activities for preparing its high-level waste for repository disposal.

As I mentioned a moment ago, most of the waste slated for the repository is not defense high-level waste, but rather is spent nuclear fuel from commercial power generators. The spent fuel will be disposed of in containers that hold many individual fuel rods or several intact fuel assemblies. Just how large these containers will be, how thick will their walls be, what they'll be

made out of, how many rods or assemblies they will hold, have not been decided. Part of the process the DOE will use to make these decisions is to develop a set of conceptual container designs for subsequent evaluation, refinement and eventually selection.

In today's last presentation, a member of the DOE's management and operating contractor team for the repository will discuss recent progress on the development of a set of conceptual container designs.

We are very pleased that meetings of the Board and its panels are open to the public. This not only provides a valuable mechanism for the Board to receive public input to help the Board carry out its own function, but it gives the public a view of the Board's activities.

You will note that the meeting is being recorded. Meeting transcripts will be available on a library loan basis from our Arlington, Virginia, office a few weeks after the meeting.

This is the first formal Board activity

at or near the Hanford location. We are aware that the Hanford facility is a huge one, and there are probably many activities unrelated or only distantly related to high-level waste disposal and are therefore outside of our meeting purview.

I will solicit your participation periodically during the meeting, and if you have a question or comment, I ask that you use the microphone, there is one right here, as you can see, and identify yourself for the record.

If you picked up an agenda before the meeting, you can see that we have a very full schedule and therefore I would like to request that any remarks or questions be kept as short as possible and be confined to today's subject matter.

It's time now to move on to the meeting. Once again, welcome, and thanks to all of you for making -- for joining us today.

Our first speaker is Ms. Linda Desell, who is with the DOE's Office of Civilian Radioactive Waste Management in Washington.

Linda, please.

LINDA J. DESELL: Good morning. Is this working properly? Can you hear me in the back?

UNIDENTIFIED SPEAKER: No.

LINDA J. DESELL: How about that? How about if I talk loud? Okay. Okay.

Thank you, Dr. Verink, for inviting us here today, and what I would like to do is give a very short introductory set of remarks before I introduce Jeff Allison, who will be standing in for Ken Chacey.

The Office of Civilian Radioactive Waste Management implements the Nuclear Waste Policy Act, as Amended, and it requires the placement of defense wastes in a commercial repository unless the President found a reason for a defense-only repository. And some years ago President Reagan made the determination that defense wastes would be commingled with the commercial wastes in the first repository.

OCRWM manages the development of; a geologic repository, a monitored retrievable storage facility, and a transportation infrastructure necessary to support the waste acceptance and disposal.

We develop the requirements for waste acceptance from defense production facilities and we will provide transportation and disposal of high-level waste from the defense facilities, including Savannah River; Hanford, Washington, here; and Idaho National Engineering Laboratory,

where this Board will go in a couple days.

Current plans include disposal of approximately 7,000 metric tons uranium equivalent of high-level waste in the first repository. This is approximately 10 percent of repository volume, and this is slated to begin in the year 2010. And here we have an estimate of the number of canisters that might be needed for the different facilities.

The Office of Environmental Restoration and Waste Management, which we effectually call EM, is responsible for the environment remediation and restoration of DOE facilities and manages the waste vitrification activities at Savannah River, Hanford and Idaho Falls.

And they will be doing most of the talking here, trying to inform you all of their activities in this regard.

They are also responsible for producing a canistered high-level waste form for disposal by OCRWM. And we will then accept delivery of that and dispose of it in the first repository.

The interfaces that OCRWM uses to do its job with EM are that we accept their quality assurance program for waste form production facilities and then we also review certain selected technical documents to assure a consistent waste form will be delivered to OCRWM for disposal.

As a result, I would like to introduce the gentleman who is going to kick off most of your technical information today, Jeffrey M. Allison, seated here, graduated from Prinston University in June, 1983 with a Bachelor of Science in chemical engineering, went on to work for Hanford operations here for Rockwell and Westinghouse and then joined the Department of Energy a few years ago, and since becoming a DOE employee, it's been my pleasure to work with him on a consistent basis in the waste acceptance and waste form area.

Thank you, Doctor.

JEFFERY M. ALLISON: Thank you, Linda. I would like to welcome the Board to Richland. It's a pleasure to be able to interface with you on some of our Hanford activities at such an early stage in the program here.

As Linda mentioned, this has been one

of a series of meetings. The first meeting and interaction we had with the Board was February 10th and 11th down at the Savannah River Site at our defense waste processing facility. The defense waste processing facility is the first in our

series of vitrification facilities. After that we will be constructing and operating the West Valley demonstration project up in Buffalo, New York, or near Buffalo.

The Hanford site here is scheduled to start operation December, 1999. In fact, we just underwent a big milestone late last month where we initiated site preparation and ground breaking. So if we go out on some kind of a future tour or something like that, you will see you will have an opportunity to see that facility being constructed.

As Linda mentioned also, this is a series of meetings, and our next interaction will be later this week at the Idaho facility where they're doing some early development activities for their high-level waste vitrification program, so as you will see from Savannah River to Hanford to Idaho, we're in various stages of managing these types of solidification facilities.

As we did at the Savannah River

orientation visit, if you do have any questions, please work with Linda and myself to try to get those addressed. We really would like to work with RW and through RW with the Board to addressing any concerns that you have on our program so we can

make sure that your issues are identified as early as possible within our preparation program.

As you mentioned earlier, Dr. Verink, Phil LaMont has been very instrumental in getting these meetings pulled together and kicking them off, and I would like to introduce Phil and have him make any kind of introductory remarks or anything he might want to say about logistics or anything.

PHILLIP E. LaMONT: Thanks, Jeff. Is this on?

JEFFERY M. ALLISON: It should be.

PHILLIP E. LaMONT: I just want to welcome the Board and staff and Headquarters personnel and members of the public to Richland for what I think will be a very informative and interesting series of presentations about our defense high-level waste and plans for the future.

I just also want to take a minute to

acknowledge some assistance that I had from Jim Greer of PNL who is sitting over here in helping me pull this together, Dave Nyman, who is not in the room at the present time, from Westinghouse Hanford, who was very instrumental in helping me pull this together, and Mary Goldie from the

Department of Energy, Richland Field Office, Office of Public Affairs. Thank you.

JEFFERY M. ALLISON: Thanks, Phil. Our first speaker will be Jon Peschong from DOE Richland. Jon is in the organization for tank waste disposal, will be giving an introductory presentation on an overview of the Tank Waste Remediation System at the Hanford site.

JON C. PESCHONG: Thank you. I'm Jon Peschong. I'm with the Richland Field Office, and I'm here today to talk about the Tank Waste Remediation System here that we have developed at Hanford. It's been in evolution for, depending on how far you want to go back, for probably 15 years, and we'll go through some of that chronology and we'll bring you up to date on where we are right now.

In order to best attack the topic, I would like to divide it up into two major areas.

First, I would like to talk about the actual waste we're going to talk about today. There are many kinds of wastes at Hanford. We're only going to talk about a segment of that kind of waste. So I will briefly go through that. And then the second portion of the presentation will be

the system itself that we have developed to handle the waste, and it will be broken up into an overview of the system, the evolution through history, and finally where we are today, the recommended program.

If you take a look at all of the Hanford site waste and group it, it can be grouped in this manner. And as you can see, it is grouped into volume and radioactivity.

Let's talk about volume first. There is about five -- four or five different kinds of waste, single-shell tank waste, double-shell tank waste, there is this mixed group of waste and then finally solid low-level waste.

The type of waste that the Tank Waste Remediation System is designed to remediate includes the single-shell tank waste, the double-shell tank waste and then the cesium and strontium capsules, so you can see in terms of volume, it's about 26 percent of the volume at the Hanford site.

If you switch modes of thinking and go over to radioactivity, we're dealing with approximately 99 percent of the radioactivity at the Hanford site. Once again, single-shell tank

waste, double-shell tank waste and cesium and strontium capsules. So about 26 percent of the volume, 99 percent of the radioactivity we'll talk about today.

Much of the waste that we are going to talk about today is in single-shell tanks. This is a brief slide on the tanks themselves. The key points to remember is they are single-shelled. There is no secondary liner in these tanks. They were constructed in the 1943 to 1964 time frame. There is 149 of them. They had varying capacities, 55,000 to a million gallons.

An important point, as you'll see as it comes down to the last bullet, they are all at least 150 feet above groundwater, and that's important because 66 are assumed to have leaked a total of one million gallons. Because of their nature, Hanford quit adding wastes to the tanks as of 1980, and currently the tanks contain approximately 37 million gallons of saltcake, sludge and liquid. What we mean by saltcake, sludge and liquid, is saltcake is essentially a solid of varying hardness, it varies from all the way from loose packed kind of salt crystals to very hard concrete sort of material. Sludge, the thing

to envision when we talk about sludge is peanut butter is a good surrogate for sludge. And then of course a supernate liquid, and they contain all three.

Hanford had embarked on a program to stabilize and isolate the tanks, and essentially what that meant was to physically disconnect the single-shell tanks from service and pump out interstitial liquid so that the liquid could not leak to the ground.

In terms of curies, there is approximately 155 million curies tied up in these saltcakes, sludge and liquid.

A term you will hear today and probably tomorrow is a term called a tank farm, and essentially what that is is a collection of tanks. There are 12 single-shell tank farms, six in the

200 East Area and six in the 200 West Area. This is, the reason for this is buried in history. It's duplication, back in the Manhattan Project era. And the rest of it is duplicative information.

The second kind of tank that we have here in the Hanford site that the Tank Waste Remediation System involved itself with double-shelled tanks. These are newer tanks and

there is a key design difference, in that these have a primary and secondary containment area in them. None have leaked. They are all approximately a million gallon capacity. And they have 24 million gallons of mostly liquids, also sludges and salts.

Although this is not the hard concrete material that I mentioned before. It is mainly more mobile material, approximately 110 million curies of double-shell tanks.

DENNIS PRICE: Excuse me. Is there a space between the shells?

JON C. PESCHONG: Yes. It is on the order, I believe it is on the order of a foot or a foot and a half.

DENNIS PRICE: Is that space monitored?

JON C. PESCHONG: Yes. There is leak detection in the second layer and there is monitoring on the ventilation. In the case that there was a leak, you would monitor for radioactivity, we could sense an increase in radioactivity.

DENNIS PRICE: So the inner shell has never leaked.

JON C. PESCHONG: That's correct. There are six double-shell tank farms, most of them, five are in the 200 East Area. That is relevant, because that is where the vitrification plant is going to be built. One is in the 200 West Area.

That concludes what I planned on saying about the tanks and the wastes themselves. If there are no questions, let's move on to the system that we have established to deal with these wastes.

For the next part of the presentation, where I am going to head on this is, we'll briefly talk about what has to happen to the tank waste and then we will go through history on where we started out on this thing, why it changed and where we are now. So right now I am talking about, is basically what has to happen.

We're talking about tank wastes here, the liquids, the saltcake and the sludges. We are not talking about the tanks themselves. That will be handled by environmental restoration people.

The facets in the system we plan on addressing is tank safety. That deals with the in-tank safety problems, characterization, chemical characterization of the waste itself, retrieval of

the waste, and pretreatment, in order to provide a feed to the Hanford waste vitrification plant and the gravel facility.

Pictorially, it looks something like this, with your initial waste forms on the left side and the final waste forms on the right side. Again, three major kinds of wastes. The single-shell tank, the double-shell tank and the cesium and strontium capsules.

Let's briefly go through each one and the plans for each one. The cesium and strontium capsules are wastes from single and double-shell tanks that have been processed to remove the cesium and strontium. They are put into capsules that are approximately 20 inches by three inches, 20 inches long by three inches in diameter, approximately

1900 capsules. They were leased to commercial irradiators in 1988, I believe it was, or 1989. One has leaked and the DOE is recovering them all from commercial irradiators from their long-term storage here at Hanford. In the 1988 EIS it stated that we would over-pack these and then send them to a repository in the form as is. However, with the leak, that is in question, and there is the possibility that we will pretreat them

and blend them in with HWVP feed, but that has yet to be determined.

In terms of double-shell tank wastes, the EIS stated that we would pretreat it in what was formally -- what was B Plant, and then the pretreated feed would go to HWVP in grout with final deposit to the near surface vaults here at Hanford.

For single-shell tanks the EIS did not make a decision. It meant we needed more information, and means, the question marks. We do not know if they will be in-place disposal, or if it will go through the same route as double-shell tank wastes, that being treatment with glass and grout.

Stepping back in time, we go to 1988 and the HDW EIS, it defined the basic program. It defined pretreatment. Double-shell tank waste at B Plant, terminal waste forms of grout and glass, with double-shell slurry and double-shell slurry feed were available for grout feed without pretreatment, and, again, additional study before dealing with single-shell tank wastes.

At the time that the ROD was prepared, it was felt that B Plant could comply with all of

the Washington Administrative Codes and the other national standards so that it could be operated to pretreat. There was some doubt on this, so a study was performed in 1989, and it reconfirmed the earlier decision to use B Plant as the pretreatment facility.

But that didn't set well. It was a bit of controversy. And we kept studying it.

Basically, what happened is our increased exposure to regulations here at Hanford led us to an increased awareness of how tough it would be to make B Plant comply with the current regulations. And we performed a Risk Assessment in 1991.

The goal of the Risk Assessment was to

find out things that would prevent HWVP from making good glass. And the number one risk that this study concluded was B Plant could not pretreat, could not meet the regulations to pretreat the waste.

Technically, it could deliver the waste, but it couldn't do it in compliance with the laws and regulations.

There was also significant concern with the lack of continuity of HWVP feed, and that was

that we could probably start the plant up in 1999, but we couldn't keep a continuous feed stream to it so it would have to be shut down for approximately three to four years in the 2001 to 2002 time frame. These are two major problems with the system as it existed.

So what the Department of Energy decided to do was to, as a follow-on to the Risk Assessment, we performed the Redefinition Study, and what that was, that was a Redefinition Study on the pretreatment scheme, primarily. We added single-shell tank waste to this Redefinition Study. We thought that was a major flaw in the EIS, in that it didn't consider both double-shell and single-shell tank waste.

In order to perform these Redefinition Studies, we solicited the comments of outside agencies. Involved was Westinghouse and PNL, DOE, the Richland Headquarters -- Wait. I've got the wrong slide here.

We also had the Yakima Indian Nation, Washington Department of Ecology and the State of Oregon comment on the decision study.

This led to a statement by the Secretary of Energy on December 20th, 1991, to

redefine the program. We are going to take approximately through August of 1993 to redefine the program.

We are issuing a Decision Plan, which the crux of that is to lay out the decisions that need to be mailed to recover from loss of B Plant and to ensure continuous feed to HWVP. That Decision Plan is updated every three weeks and we solicited outside comments on that. The Program Plan is set for issuance in 1992, September. And finally, it will all wrap up in March, 1993.

So in conclusion, this is the recommended program. Tank safety is the first consideration. In order to meet the objectives of continuous feed and pretreatment outside of B Plant, will develop a new tank farm in 1996. We will have the grout campaigns. The initial pretreatment module will replace B Plant for certain capacities. And we will plan to maintain HWVP start-up in 1999.

Are there any comments?

CLARENCE ALLEN: When you say tank safety is the first consideration, there are two tanks in particular that are of major concern?

I don't know --

JON C. PESCHONG: Well, no.

JEFFERY M. ALLISON: Could you give a little overview of the tank safety?

JON C. PESCHONG: I can address that.

In the past, the program has had just two entities: The operations of the tanks and the remediation of the tank waste. And these were at Hanford sometimes competing for resources. And this was being back in the 1988 to 1991 time frame.

The tank safety issues I am talking about are generation of hydrogen gas, possibly explosive, organics and ferrocyanides.

Because the tank remediation sites were competing for resources with tank safety, that was not a good situation. We have combined the two to say that the top priority is tank safety. In other words, this pretreatment facility that will come on line in 1997, its main goal is to pretreat the waste for the purpose of tank safety. In other words, get rid of the hydrogen generators, get rid of the ferrocyanides, get rid of the organics. Rather than prepare the waste, primarily for glass and grout. So if we cannot do both, we will do tank safety first.

Did that answer your question?

CLARENCE ALLEN: Yes.

JON C. PESCHONG: Okay.

ROBERT LUCE: I was a little curious about the restarting --

ELLIS D. VERINK: I will ask the speakers to please identify themselves.

ROBERT LUCE: I was a little curious about restarting the evaporator. Could you describe something about that, what's involved, the magnitude of its capacity.

JON C. PESCHONG: Right. Let's see. Let's go back to this slide. The evaporators are important because it's not on line now, but if it is on line, it essentially can take double-shell tank supernatant and evaporate it off and decrease its volume.

And that's important because we have tank volume problems here at Hanford. There's double-shell tanks, and depending on how fast you can get waste out of the double-shell tanks into grout and how fast you can evaporate it, we have varying degrees of problems with tank space.

The evaporator schedule, it was originally slated to start in the fall of this

year, and I believe it's slipping to the winter of this year.

The big picture is that it's an important component in alleviating tank space shortages.

Did I answer what your question was?

ROBERT LUCE: In part. I was just curious, you know, what its rate of evaporation is, just curious.

JON C. PESCHONG: I don't know that. Is there anybody here that knows its capacity?

DENNIS J. NEWLAND: I'm Dennis Newland. I just happen to know that we plan to go through about eight million gallons in a little over a year time period.

CLARENCE ALLEN: One question here, Clarence Allen.

One of the alternatives for the single-shell tank problem is in-place disposal. Of course, it's now in-place, but it's not working very well.

How does this in-place disposal differ from what we now have?

JON C. PESCHONG: Well, that decision hasn't been made yet. But schemes that are envisioned is the main reason that the waste is migrating because of gradient established by water going down into the soil. So possibly if you capped the single shelled tanks with a water impermeable barrier, the ability of that waste to migrate would be severely decreased.

One of the drivers for that option is that it is currently thought that there may be extreme exposure risks incurred with the retrieval of that waste. And given two options, it may be less risky to leave it in place than it is to try to retrieve it and expose all of that to the atmosphere and the environment, more than it is now.

But, again, you know, that requires an EIS to make that decision, and that EIS is getting initiated right now.

JEFFERY M. ALLISON: Thanks, Jon. Our next speaker will be Bob Long of the Hanford Waste Vitrification Program. He is with DOE-RL. He will be giving an overview of the HWVP.

BOB LONG: As Jeff said, I'm Bob Long with the Department of Energy. I am the branch chief of the Engineering Branch on the HWVP,

and I am just going to give you an overview with where we are with respect to the project. The gentleman's name you see here is my boss, Bob Brown, who is the Treatment Projects Division Director.

What you see here is an artist's rendition of the HWVP, or the Hanford Waste Vitrification Project as we refer to it, which will be located at 200 East Area.

The main building here which is the Vit. building, or vitrification building, where our main process goes on. Right here is the canister storage building. Our filtration building is right here. And this is our OCRB, which is our main office building.

The mission of the HWVP is to incorporate pretreated high-level and transuranic wastes into a borosilicate glass contained in sealed canisters for disposal in a geologic repository.

I won't to spend a lot of time on this slide because I think Jon pretty much walked you through it, same concepts.

This is just a summary level project schedule of activities on the HWVP Project and

where we are now. The next slide will go into more detail of the status, exactly where we are.

We've completed preliminary design. Fluor Daniel in Irvine, California, is preparing that. The detail design is approximately 37% complete.

We receive interim status expansion from Washington State DOE.

The site preparation for construction started just this last week. And the construction company who's performing the construction is United

Engineers Catalytic.

The packages that we've awarded in the last couple of weeks is the, as we refer to it, Package 110, which is your clearing and grubbing and grading, Package 130, which is the roads and site prep. I don't know if these particular packages have been awarded within the last couple of days, but they will be within the next few days or so, Package 150, which is the area security lighting, and 160, site mechanical utilities. The safety evaluation report has been issued.

The next few slides you are going to see coming up is what we refer to as our TPA milestones. And the milestone number starts with

the alphabet and it goes 03, 07, etc., 01.

The first one is initiate the installation of the Vit. building, electrical and instrumentation, which we scheduled to do in November of '94. 01 is to submit the HWVP RCRA Part 2 permit application to Ecology and EPA in 6/98.

Milestone 02 is complete the HWVP construction in 6/98.

03 is Vit. building and HWVP detailed

design in June of '94, is when we plan to finish all of the design.

ELLIS D. VERINK: We have different charts.

BOB LONG: Are your charts mixed up in your book?

DENNIS PRICE: There are some differences.

BOB LONG: What happened, is the handouts that you have, I changed late Friday afternoon because they were missing some of the milestones. So if you will bear with me, I can get you copies of the ones I have here, because I had like five or six major milestones and I don't think they are in your presentation.

04 is initiate the construction of the CSB, or multi-purpose storage complex in February of '93.

Initiate construction on the Vit. building foundation in March of '93.

Initiate the installation of Vit. building mechanical building and piping, 8/94.

ELLIS D. VERINK: Who the who are the three parties to this three-party agreement?

BOB LONG: DOE, State of Washington

and, who is, Jon --

JEFFERY M. ALLISON: EPA.

BOB LONG: EPA.

ELLIS D. VERINK: Thank you.

BOB LONG: Now I'm going to talk in summary level on the process requirements of the HWVP.

We will: receive pretreated high-level and transuranic waste slurries; incorporate radioactive waste components into a vitrified borosilicate glass, eventually putting them into canisters; seal vitrified waste in canisters for shipment to repository; provide storage for filled canisters until shipment. Capacity is for 100 Kg per hour glass production.

ROBERT LUCE: Is that continuous production?

BOB LONG: Yes. Correct, Dennis?

DENNIS J. NEWLAND: Yes.

ROBERT LUCE: 24 hours a day?

DENNIS J. NEWLAND: Yes.

BOB LONG: This is a simplified process flow diagram. Basically, what happens is our pretreated feed comes in, we chemically mix it, add frit, f-r-i-t, it goes to what we call a melter feed tank where we do our waste form qualification test, it goes to the melter. After it's processed there, basically ends up in the canisters.

Because of the evaporation process, some of the condensate goes back through the process and to determine if it is high-level or low-level. If it's considered low-level, it goes to our grout program; high-level, we reprocess and send it back through again.

This is a slide that basically shows the same process, except when it goes through the SRAT, the SME and then the melter, eventually into the canister.

This is an artist's rendition of the melter turntable.

ELLIS D. VERINK: Can you tell us a little bit about that.

BOB LONG: Excuse me?

ELLIS D. VERINK: Can you tell us a little about that?

BOB LONG: Denny, can you help me out on the melter?

DENNIS J. NEWLAND: Well, yeah. The melter is in the upper right there. It's basically a batch process. And we have kind of a turntable of the canisters on it, it's a vacuum transfer from the melter to the canister. We use several mechanisms for ensuring that we don't overfill, etc., like weight in the canister, etc.

ELLIS D. VERINK: Is there some online system for composition control of the glass or the waste or anything like that?

DENNIS J. NEWLAND: Tom, perhaps -- there is Tom Weber.

ELLIS D. VERINK: Use the microphone, please.

Perhaps that's going to be presented later.

DENNIS J. NEWLAND: It is. It is part of this afternoon's agenda.

ELLIS D. VERINK: Okay. You can proceed.

BOB LONG: Basically, our canister storage building will be able to store some 2,000 canisters. We will be producing something like 370 canisters per year, an average of one every a day.

This is the canister itself. It's approximately 10 feet in height by two foot in width.

In summary, the HWVP is proceeding on baseline for hot start-up in 1999. Major plant systems and features incorporate DWPF lessons learned. Test programs support design and process vitrification. Processing implications of TWR expanded waste tank feed sources will be assessed.

Do you have any questions?

ELLIS D. VERINK: The DWPF waste at Savannah River, they seemed to have some containers that didn't meet the mark so far as composition, that they had a little difficulty with.

Do you have this sort of a problem to deal with, and if so, how do you plan to hit it?

BOB LONG: Denny?

DENNIS J. NEWLAND: Tom, are you going to --

The question is, how do we plan to assure that the quality of the glass is --

E. TOM WEBER: I'm Tom Weber, Manager of the HWVP technology function. I'll be speaking to you this afternoon, first thing after lunch, on the HWVP Waste Form Qualification Program, and will address a number of your questions on how we intend to control the glass and what we will be producing.

With respect to your remark on the container issue at Savannah River, I believe that there were some canisters that were produced, these are the steel containers that were produced by a vendor for which there were some quality tracability issues and some materials tracability issues.

My understanding is that those canisters are being considered for use in their testing program but I don't know that a decision has been made as to whether they will be used in the testing program. I understand that those issues are being addressed with respect to the canisters that DWPF will procure for actual use in their radioactive glass production.

ELLIS D. VERINK: The impression I

got was that part of that was tied in with control of the composition of the glass, and that once the canisters were there and filled, that they didn't really have any mechanism for incorporating them. I'm wondering if there's any back-up to avoid that sort of a problem here.

E. TOM WEBER: The approach that we

are taking to processing the glass is directly analogous and based on the Savannah River process. It is a characteristic of this process that once the glass has been poured -- or once in fact the batch is released to the melter and the glass then is processed through the melter and poured in the canister, there is not an identified recycling capability to address deviations of the glass at that point from what was intended. The strategy for control is based on never releasing a feed batch to the melter that would not produce an acceptable glass.

ELLIS D. VERINK: That is certainly ideal. I would be interested in hearing how you are doing that.

DENNIS PRICE: Mr. Long, Dennis Price from the Board. On the canister characteristics slide that you gave, I take it that

there is a long history to that canister.

How did you inherit the canister design? Where did it come from? And how did OCRWM interact in accepting that design as part of their system. Do you have any information you can give me on that?

BOB LONG: I'm going to need some

help from Bill Miller. I think Bill was on it. But I believe this is the same design that was used at DWPF, and there was a lot of history.

WILLIAM C. MILLER: Well, I could give a little bit of it. The canister design is based upon the same design from Savannah River. In fact, we are using the exact same melter design, the same basic canister closing design.

But the canister configuration and size is basically the same as that that was developed, or is being used, planned to be used for West Valley waste.

ELLIS D. VERINK: Could you be a little closer to the microphone?

WILLIAM C. MILLER: Sure. The specifications for the canister waste were developed for the Savannah River waste, and at this point our approach has been to use those same basic

specifications in the development of our systems to handle the waste.

As I understand it, there is a more general specification now being put together to cover all of the DOE waste sites, maybe it already has been completed, and of course the intent is that we will meet those specifications.

But so far most of our work is being geared up on meeting specifications that were established for the Savannah River waste.

DENNIS PRICE: To what extent, if you know, perhaps you don't know, was the design of the canister optimized to fit into the OCRWM system? What system considerations were given to the design, the dimensions, the type of canister and so forth to fit into the system, the transportation system, the handling system and so forth?

WILLIAM C. MILLER: I think I might want to call on Tom Weber again. Tom is really our resident expert in this area.

E. TOM WEBER: We have several people here in the audience that have been associated with the process of waste form specifications that are now a product of the Office

of Civilian Radioactivity Waste Management in the present structure of the institutional interfaces. Those specifications were developed during the mid '80s by committees that I think some other people could speak to in more detail.

But the canister was defined as a

product compatible with production of glass in the vitrification facilities. That was incorporated by the committees that were developing the specifications which included the representatives from the repository organizations. And that resolved in the definition of a canister of this configuration as part of the waste acceptance preliminary specifications that were issued by OCRWM for the Savannah River plant and are currently in a process of being updated within the OCRWM organization in conjunction with the DOE Waste Management organization.

DENNIS PRICE: Can you tell me anything about the cask for transportation that the canister is to be carried in and how is it designed to interface with that cask?

E. TOM WEBER: I can't speak to the details of the transportation system. Perhaps someone else can.

It's my understanding that the transportation capability, the cask capability to transport canisters from the vitrification plant sites such as Savannah River, Hanford or West Valley, would be -- is a programmatic function of the Office of Civilian Radioactive Waste Management. Perhaps someone else can speak to the features of the cask transportation program.

LINDA J. DESELL: Dr. Price, this is Linda Desell. I don't believe we have any of our transportation people here who could answer your question at this time, but we can certainly get the information back to you.

There is one other thing, the gentlemen that was talking, mentioned the waste acceptance preliminary specifications of WAPS. The WAPS, such as they presently exist, are being used by EM, but will be changed somewhat in the future in that not so much of the specifications or technical qualifications will be changed, but they were originally issued as a document that had both EM and RW specifications in them. They will not be issued again, or issued in final form.

The new systematic approach that Dr. Barlett brought with him when he came to the Office

of Radioactive Waste Management has resulted in the development of a different type of document which, from a systems approach, we have an acceptable waste document.

ELLIS D. VERINK: Could I

interrupt. We understand that we're not standing close enough to the microphones and they are having difficulty picking up what's being said. So if you can just pull the microphones over next to you.

Sorry to interrupt.

LINDA J. DESELL: That's all right. Is that a little better?

ELLIS D. VERINK: Okay.

LINDA J. DESELL: The documentation that will include the RW specifications concerning acceptance of waste are presently into our Change Control Board and are being reviewed in final form. The portions of the specifications that were EM specific will be included, as I understand it, in a separate EM documentation to be issued sometime in the future.

DENNIS PRICE: Let me ask another kind of follow-on question.

To what extent was the canister design considered as a part of the waste package for

emplacement, the design characteristics of the canister as they would become part of waste emplacement, and what was the philosophy behind waste emplacement that interacts with the canister design?

LINDA J. DESELL: To be honest, Dr. Price, I was not involved in that, and unfortunately, the person that could have answered your question was not able to come today. And I will try and get the answer for you.

DENNIS PRICE: Thank you.

CLARENCE ALLEN: A more general question here.

Let's assume that tomorrow Yucca Mountain is found to be unsuitable for further development as a repository, which is certainly possible.

Is this program dependent upon that, or would you go ahead and develop there, even if you didn't have any potential off-site place to move this stuff to?

JEFFERY M. ALLISON: Could you repeat that?

CLARENCE ALLEN: Let's assume tomorrow Yucca Mountain was assumed to be

unsuitable as further development as repositories, which is certainly a possibility.

Would this program we are speaking of here move ahead anyway, or is it totally linked to that?

LINDA J. DESELL: First of all, if Yucca Mountain is found to be unsuitable, we would have to report back to Congress, and I believe you know the requirements of law beyond that. With respect to EM's program, I believe Jeff would have to answer that.

JEFFERY M. ALLISON: I don't see any reason why we wouldn't continue with the program. The program of solidification and stabilization of waste is being done not just -- it's obviously being done for disposal sampling, we are with RW to meet those goals, but it is also being done with the problems of leaking underground storage tanks, their short-lifetime, and so we are looking to move from an interim waste management standpoint to putting the waste into a more stable form.

And so I would think, just my opinion now, that we would continue with the program, because our assumption would be that RW would

develop another repository that would eventually be acceptable for our waste form, so we would continue with that and work with them closely to identify any changes that we would have to make.

But our assumption, my assumption is that we would continue with that.

ELLIS D. VERINK: While we are interrupted for a moment, we are a little ahead of schedule. If there are any particular questions from the audience, we might entertain one or two.

ROBERT COOK: Robert Cook of the Yakima Nation.

Some of these questions that you had asked I was involved with. I was the NRC representative in the early '80s through '88, actually; three years on the waste package waste form development, '80 to '83.

As I remember, the glass canister design, this is in response to your question, the glass canister design kind of evolved of its own with the centerline temperature being the limiting parameter for diameter of the glass.

And also there was an effort to make these things shipable by truck, which limited the size of the canister to which you see now.

So it's kind of a centerline temperature issue, given a maximum estimate of the sesium and the strontium content, and the shipping limitations.

Regarding the question of flexibility, we raised that same issue that has been raised here, is that if the repository is not compatible and for some reason you need a good waste form capability over the long run, we're concerned that the glass in fact will not serve that purpose.

We've proposed that a more -- a different waste form, like calcine, be established here on an interim basis, which allows you to improve that waste form in the long run if you need to. In fact, instead of diluting the wastes, you concentrate them and go to a more flexible type of waste form for the future, whatever that repository may be, if the design requirements change on the waste form, to make it better than glass.

JACK PARRY: I can confirm Bob's understanding about the development of the canisters. I was involved with it also. And, generally speaking, that's the way it developed.

JEFFERY M. ALLISON: Thanks, Bob.

Our next speaker will be Denny Newland. Denny is with Westinghouse Hanford, and he'll be talking about activities associated with waste characterization, retrieval, grout and pretreatment at Hanford.

DENNIS J. NEWLAND: First of all, let me introduce myself a little further, give you a little idea of my background so you can tell where my expertise is and is not.

I've got a Bachelor's Degree in physics and a Master's Degree in nuclear engineering, and I spent really the first 19 years of my career here at Hanford on the FFTF.

I have really only been involved in this program for a year now, and I'm the manager of Tank Waste Disposal. That's a group of activities dealing with taking the waste out of the tanks, pretreating them and then putting them in their final form.

So I have responsibility for retrieval, pretreatment, the grout program and actually operations of the vitrification plant, not the construction of the plant on the project as it is currently structured.

By way of looking at your agenda, I can

see that we've kind of built it from a generalist point of view and getting into progressively more detail as the day goes on. So perhaps some of us up here early are not the technical experts, but I think as the day goes on, you'll have a chance to interact with the technical experts.

So if I can't answer a question, I'll confess to that, and if someone in the audience can, great. If not, we'll get you the answer.

This is a slightly more complex diagram, but you have seen it essentially in the top level diagrams that the previous two speakers used. It's intended to display certain things.

First of all, we've got a series of double-shell tanks and single-shell tanks, each of which has some safety issues associated with them.

We have a need for characterization of the materials in those tanks for not only retrieval and pretreatment, but for safety issue resolution. And I'll talk a little bit more about that.

We have a need in this program for technology development. We talked a little bit about the retrieve versus leave decision, and, again, that decision will be revisited in a Supplemental Environmental Impact Statement, and we

hope to publish a Notice of Intent for that this summer.

The previous decision had a couple of fundamental decisions, one that we are probably going to revisit in the supplemental, and that is that the cesium and strontium capsules would simply be over-packed and sent to the repository. It's not clear that that would be technically acceptable. And so we plan to revisit that decision.

Another one, though, that was made that still is in the reference plan here at Hanford, and that is that we will pretreat the waste, divide it into a high-level fraction and a low-level fraction. And we're doing that primarily for cost considerations. The high-level fraction, of course, is intended to eventually wind up in the repository. The low-level fraction, which is the majority of the waste by volume, currently is planned to be disposed of in near surface vaults in grout waste form.

We will talk a little bit about characterization first. As you might expect, characterization is to provide chemical and physical and radiological information on the waste.

And I mentioned earlier support safety issue resolution, retrieval pretreatment, grout, glass, some information needed for RCRA permitting, etc.

ELLIS D. VERINK: Could I interrupt you. The word grout, perhaps you better define it the way it is used here.

DENNIS J. NEWLAND: That's actually kind of become part of the vernacular here. It's a cementitious waste form that's been used as a low-level waste form throughout the country before.

JACK PARRY: Is that similar to the salt stone?

DENNIS J. NEWLAND: Similar. There might be a slightly different formulation, and we tailor the formulation to the specific waste that will be tied up in the grout.

Evaporator operations also require characterization type of information, and as well as waste transfer.

We use bottle-on-a-string sampling techniques for the liquid, with a supernatant within the tanks. We also have a core sampling technique for sampling sludge and saltcakes.

To date we only have the push-mode

sampling capability. We are developing the rotary mode core sampling capability. But that's probably a year away from being deployable.

The push-mode, of course, can be used for soft sludges. The rotary mode would need to be used for the harder waste forms like the saltcakes, etc.

We're also upgrading our laboratory analysis capability for the various chemical, physical and radionuclide methods. There is some work going for in-situ characterization, things like some radionuclide analysis in-situ, we have some infrared scanning equipment that we have just tested to look at temperatures, etc., on the surface of the tanks.

Artist's conception of the core sampling approach. We have a core sampling truck. It has essentially a drill rig associated with it and it can operate in either a push or a pull mode.

This represents the tank down here. The samples are brought up in 19 inch segments, eventually deposited in one of these casks. And we have been successful in getting push-mode samples with this approach, and we're expanding also our capability with respect to adding trucks and adding different sampling methods, like the rotary mode method.

Here's a picture of the truck. This was essentially equipment designed specifically for the Hanford problem, designed here at Hanford.

The focus of the characterization program has been on tank safety issue resolution. Although we haven't exclusively taken samples for that, we have been able to get samples for other purposes, but predominantly right now we're in such a need for information to resolve the tank safety issues, that that has the highest priority.

This is just a picture of some of the sludge in one of our tanks. This pipe I believe is an air lance. It's not the sample bit.

CLARENCE ALLEN: What's the scale here, approximately?

DENNIS J. NEWLAND: This is the wall of the tank you see here. This starts the sludge. Tanks are up to 75 feet in diameter. I would expect this is maybe five to ten feet.

WILLIAM C. MILLER: Denny, I think that pipe is probably a two inch pipe.

DENNIS J. NEWLAND: Okay. Here's a picture of a different waste type, some of the saltcakes. You can see a pool of liquid here, but over here you can see some of the crystalized saltcake type of material. And that's the kind of material that would require the rotary mode sampling capability.

The status of the program. We routinely take liquid samples, bottle-on-a-string sample. All of the saltcake and sludge samples to date have been done usually by the push method. 15 double-shelled tanks sampled. 27 single-shelled tanks. We hope to get 10 samples in '92. And once -- again, we're looking to double our sampling capability, both in the field and in the laboratory.

The typical range of measurements that you would expect in the laboratory, cations, anions, organics, radionuclides, corrosivity, etc.

Some methods still need to be developed for the types of wastes that we have, ferrocyanide speciation, for example, organic complexants, noble metals, some technologies have to be developed in order for us to get the information that we need.

And I mentioned some of the in-situ measurement capability that we're trying to develop, as well.

Here is a core sample. You can see that this one actually gets pushed out of this tube onto this tray, and you can see this particular sample was rather solid. It should be approximately a 19 inch segment there. So that's the type of the material we get.

Some samples, the material comes out and just kind of settles because it's more of -- more towards a liquid than these. And, again, the sample can kind of change over time if it's just kind of a soft sludge, etc., presents some interesting challenges to deal with in the laboratory.

I would say the key issues with respect to the characterization program, the magnitude of the data needs, we need this data for almost everything we're planning to do in the future. Laboratory capacity will have to be upgraded, and we have plans to do and are working towards that.

Hard saltcake sampling, we're about a year away from having that capability. The tank safety issues really dominate in terms of needs, and so they dictate what samples we take on what schedule.

That then leaves the retrieval, etc.,

programs, the second priority. And we have some particular regulatory requirements for single-shell tank waste sampling, RCRA protocols, etc., that are currently imposed upon us, that may not need to be imposed on us if we, through this supplemental EIS process, if we elect to retrieve all of these tanks, then it doesn't -- we clearly don't need that level of information. The information is driven by if we desire to leave the tank there, then we need to know what we're leaving.

So there may be some relief by just choosing a different path with respect to single-shell tank data needs.

I'll move to retrieval. Obviously, its purpose is to remove the wastes from the single and double-shell tanks. We may have to treat the wastes upon immediate removal in order to transport it through pipelines. Add water, for example. The retrieval program may need -- may -- our retrieval may be the technique chosen to mitigate safety issues. For example, our highest priority, safety issue tank, 101-SY, perhaps an interim mitigation step would be to dilute the material, which would mean retrieving it, putting it in multiple tanks, and thus reducing the problem. We haven't chosen that yet, but that could be a driver for retrieval program development.

And, obviously, our current thinking, anyway, is that we will have to retrieve a great deal of these wastes and provide it for pretreatment and vitrification and grout.

We tend to, based upon some prior decisions with respect to EIS, we tend to have our programs divided into double and single-shell tanks, and they do represent a different category, a problem, if you will, the double-shell tanks are by and large newer, obviously double-shelled, so they are a little more robust to things like leaks, etc. But in truth, we are evolving to consider them just tanks, we have got different problems with different tanks and we have to treat the problems in both.

CLARENCE ALLEN: A question. Basically, though, the materials in the two tanks are not radically different?

DENNIS J. NEWLAND: I guess we probably only find the saltcakes really in the single-shell tanks.

WILLIAM C. MILLER: Well, in fact, there is quite a difference.

The single-shell tanks are primarily sludges and saltcakes. Most of the water has been removed from them.

The double-shell tank wastes tend to be sludges and liquids. We have not evaporated those down nearly as much as we have, because of the potential for leakage in single-shell tanks. So the methods for retrieval of the wastes probably will be substantially different between the single-shell tanks and the double-shell tanks. Similarly, because of the chemical compositions of the wastes and so on, they may very well have to be treated somewhat differently. And in the next talk, when I talk about pretreatment, I'll discuss that a little bit more.

DENNIS J. NEWLAND: Just magnitude-wise, 28 one million gallon tanks, double-shell tanks. Single-shell tanks, there's 149 of them, and they range in volume from 55,000 gallons to one million gallons.

Double-shell tanks currently hold 24 million gallons. The single-shell tanks, 37 million gallons. So 61 million gallons of waste, that in order -- we may have to add water, we will have to add water at least, as our thinking is today, in order to remove some of these wastes. So the volume of the wastes will vary, depending on the retrieval and pretreatment techniques or approaches chosen.

Continuing with the scope of the retrieval program, we have to develop in-tank mobilization hardware. I mentioned we may have to treat it for transport, add water or some other technique. We may have to modify the tanks in order to be able to do this. We're looking at confinement barriers that might be useful during the retrieval, for example, some of the single-shell tanks that are known leakers that may be advisable to put a confinement barrier under them prior to retrieval. And the retrieval program also deals with its own safety and environmental permitting and analysis.

Status of the retrieval program. For the double-shell tanks, we have really, primarily, tried to adapt the Savannah River mixer pump technology to our situation. We are looking at slurry properties, mixing capabilities, erosion of the water jets on the tank structures, monitoring during this activity. We have a 12th scale mockup facility in our building, a quarter scale mockup

facility, and, again, retrieval program, the priorities for it are dictated from other needs within the TWRS program, primarily the safety program needs.

Although some of the characteristics of our wastes are different than Savannah River, we expect to be able to make those mixer pumps work. The initial feed for HWVP we're confident, we have done enough work on that particular waste to be confident that it will work to get the waste out of the tanks for HWVP.

We do have some other higher sheer strength wastes in the double-shell tank system, and we have more development work to do to make sure the slurry -- or the mixing pumps will work.

We have a process test currently planned at calendar year '96 to install one of these mixer pumps and go through a testing program.

This is kind of a schematic of what we would do. We will probably have to install two, perhaps four mixer pumps in each tank. The mixer pumps essentially eject two jets of water and then the head oscillates, such that the thing will cover a 360 degree arc. 300 horsepower motors on the mixer pumps. And these water jets are expected to

stir up the sludges and essentially mobilize the sludges, and then in that mobilized state, we would transfer the mixture out of the tank with a retrievable pump.

The single-shell waste tank retrieval with most of the liquids already removed presents a different problem. We're currently more in the technology survey mode, trying to identify the technologies that may be useful in tackling that particular problem. We use waste simulants, etc., for our development work. Look at --

We have needs for mapping the tanks. We may have to modify tanks in order to accept the retrieval equipment. Problems in sludge and saltcake dislodging. Maneuvering inside the tank. Surveillance during the retrieval operation. Transport of the wastes. All problems that have to be dealt with over the next few years.

And, again, on the single-shell tank, tanks, the safety issues dominate in terms of dictating our priorities.

Now, we have done some engineering studies, and at this point it looks to us like some long-reach robotic systems with multiple end defectors are prime candidates for adapting the

technology to reach in this environment.

In the past we've used high water volume sluicing, and that may be acceptable, too, provided we can assure ourselves that for the leaking single-shell tanks, that either we will not leak a significant amount or we can put an acceptable barrier under the tank to minimize any further environmental damage during that operation.

We do have some technology development programs underway, targeted to do their initial demonstration during '94. We have -- we are targeting to complete, actually retrieve the first single-shell tank in 1999.

This is a concept that we think has promise. Again, it has the robotic system in the tank, maneuvering an end effector which will essentially go throughout the tank and mine the material. This material head as envisioned is what we call a confined sluicing approach. It has -- it's kind of a hemispherical head. It has some high pressure water jets that would be used to dislodge the material and then a vacuum air conveyance system that would remove the material as it is dislodged and bring it to the surface for further treatment prior to transportation.

This confined sluicing technique has been used in industry and to a large extent our problem in the single-shell tanks will be in engineering today's technology. Robots exist, confined sluicing techniques exist, but getting them to exist and work in our particular application will be the biggest challenge.

Key issues on retrieval. We have several waste types, and so we can't use the same approach on everything. So that will dictate development of multiple approaches. Tank safety issues will continue to drive our priorities. The waste characterization, especially the physical properties, we have limited data, so we will have to structure our program to get the right data first.

We've got some leaking, or suspected leaking single-shell tanks. The transfer systems that exist today, many of them will have to be replaced, because they are quite old, and in fact would not meet modern standards. And we do have a limited amount of double-shell tank storage.

Obviously, the first stop for these single-shell tank wastes will be in a double-shell tank prior to going to the vitrification -- the

pretreatment or the vitrification plans.

So tank space operational logistics, etc., will ultimately limit our options.

Let me move on to pretreatment. Its purpose and objective, resolve tank safety issues, and I guess the primary tank safety issues at this aspect of our program will be targeted on destroying organics and ferrocyanides.

CLARENCE ALLEN: This is Clarence Allen once again.

When you repeatedly say tank safety, is this primarily an explosion problem?

DENNIS J. NEWLAND: Well, there are four categories. One, there is hydrogen generating tanks. There is tanks with ferrocyanides in them. There are tanks that had a high decay heat. Let's see. I've forgotten the fourth.

WILLIAM C. MILLER: Organic.

DENNIS J. NEWLAND: Oh. Just tanks with a high-level of organics in them.

And of those, those categories of tanks, there are multiple tanks within each category. So a large number of our tanks have been designated safety watch list tanks that we need to he -- that we have been refocusing our entire

approach here at Hanford on resolving these safety issues first. And that need then, as I have been saying, dictates the retrieval program, pretreatment program, the subsequent disposal of these wastes.

The organics are a particular problem in that upon irradiation, they release hydrogen. Organics, of course, are a problem for our low-level waste disposal technique, the cementitious form, cement doesn't like organic materials, so we have to destroy those organics before putting those types of wastes to the low-level disposal.

JACK PARRY: Jack Parry of the staff.

DENNIS J. NEWLAND: Yes, sir.

JACK PARRY: Do you also have a problem that was mentioned at Savannah River on mercury content?

DENNIS J. NEWLAND: Not so much. Can anyone help with that?

WILLIAM C. MILLER: No. The mercury content of our waste is much, much lower than that at Savannah River, and investigation we have looked at so far, we don't appear to have any

kind of a problem in terms of accumulation of mercury.

DENNIS J. NEWLAND: Again, a major purpose of the pretreatment system is to minimize the glass volume, and thereby minimizing the cost of disposal of this material. The glass being the targeted waste form for the high-level fraction.

We think the largest fraction, 90 percent, could be disposed of by the low-level waste form. Just leaving the 10 percent that requires deep geologic repository. And that is our reference approach. That is the approach identified in the '87 or '88 Environmental Impact Statement. And still today that's our reference approach, driven by the cost of disposal of the high-level material.

Another purpose of the pretreatment is to provide the feed to the vitrification plant and the grout within the specifications for those two plants.

We'll use the pretreatment facilities

to separate radionuclides from all the high-level waste tanks. The scope of the program includes development, demonstration and construction of those facilities and processes.

It includes things like dissolving soluble salts, we will wind up removing cesium and strontium from the waste, transuranics, we will wind up removing, organic and ferrocyanide destruction, as I mentioned before, and also all of the administrative and permit aspects of those activities are a part of the pretreatment program.

We have been looking, we here at Hanford, as well as across the DV complex, have been looking at disposal alternatives since the 1970s. Here again, repeating that at Hanford in recent years the priority has been given to resolution of safety issues, and so that has kind of altered our approach.

We've really only begun to look at processes and technologies for destroying ferrocyanides and organics. And when I say only begun, we need plant scale processes, not laboratory scale processes. There are laboratory scale processes that can do those jobs, but the challenge of scaling them up to a plant is formidable.

Ion exchange, we have done that here at Hanford. Dissolution of soluble salts, we have done that here at Hanford. So we don't really

anticipate major problems doing that. In fact, we have done those things on a plant scale here at Hanford.

But just those approaches is not enough. We will wind up with perhaps an unacceptably large amount of high-level waste to be disposed of in the repository without some more advanced processes. For example, to remove the transuranic fraction. And we have some work going on in developing a process to do just that job, the transuranic extraction.

Other processes are under investigation. Splitting by salt crystallization, solid sorbants, nitrate destruction, may be a desirable aspect of the pretreatment program. Selectively leaching. Calcination and leaching. The selective leaching might allow us, for example, to do minimal pretreatment prior to disposing of as low-level waste or as glass.

Key issues in the pretreatment area was

mentioned earlier, that the previous facility thought to be capable of doing that has been determined not to be capable. That leaves us with a hole in our program, and thus our ability to provide continuing feed to vitrification and grout.

We're actually within the TWRS program today, we're three or four months into what we had considered to be a 15 month program baselining effort.

So in March of '93 we hope to have considered all the possible changes to our program, dictated by things that have happened to us since the '87 EIS, and have a new reference program plan.

High disposal costs for glass are likely to be with us, even in the new program plan. And so that will probably continue to drive us for advanced separation processes and the facilities to do those. These processes are complex, and, again, I mentioned the scale-up problems being formidable. There may be a desire to remove cesium from some of the initial grout feeds. If we choose to do that, then that will put additional pressure on the pretreatment approach.

Talk about the grout disposal program. This is our low-level waste disposal program. Its objective is safe disposal of low-level waste. And in doing so, it provides tank space, one of the few approaches or the few techniques that we have for providing needed tank space. We can either build new tanks, get the evaporator on line, or grout some of the existing waste that has been designated

as low-level waste. And so it's one of the purposes of the grout program.

The scope of that program. Development of grout formulations needed. Dry material and mixing facilities. The underground storage vaults. And, again, its safety and environmental analyses.

This is a picture of our dry materials facility. We have poured an initial grout vault, did that in 1989, I believe. That grout vault, though, was composed of wastes that were only slightly radioactive and non-hazardous. The needs for the future will have a higher level of radioactivity and as well as a hazardous material disposal.

This is the grout treatment facility itself. The dry materials are trucked over, air conveyance to some bins at the top, and then there is a mixer module where the wastes from the storage tanks are mixed with the dry materials and any necessary added water, and then they are pumped to an underground vault which looks like this, really quite a structure.

Each vault is capable of essentially disposing of one of the one million gallon tanks, results in 1.4 million gallons of volume by the

time we're finished. But this vault has RCRA liner, has several design features to enhance its performance as a low-level waste system.

And we are probably a year away from qualifying this system to be usable as the low-level waste form.

We're doing a performance assessment, and that's probably the longest lead item. We had done some initial work to show what this system is capable of doing in terms of preventing exposure to the public through the groundwater bath. That initial work was subjected to a peer review panel and we got comments to do a lot more work, and so we are doing a lot more work. And as I said, we are probably a year away from having a qualified system --

ELLIS D. VERINK: This would be below ground or above ground?

DENNIS J. NEWLAND: Yes. It's below ground. In fact, over this there is a RCRA cover and then over a set of four vaults there's another cover called a Hanford barrier. Both of those covers are designed to prevent water infiltration as well as intruder intrusion.

This is approximately a year old.

These vaults are finished today, essentially. The backfill is over them. They have been hydrotested. So we're nearing completion, I guess. We probably have another six months worth of activity. But we're nearing completion of the first four of these vaults.

DENNIS PRICE: What's the life of a vault?

DENNIS J. NEWLAND: About -- Let's see. I think it's like a hundred feet by 50 feet by 34 feet tall.

DENNIS PRICE: The life, l-i-f-e.

DENNIS J. NEWLAND: Part?

DENNIS PRICE: The life, l-i-f-e, how long is a vault good for in time?

DENNIS J. NEWLAND: Oh. Well, we're examining these vaults for, our initial approach was to examine them for 10,000 years. And we did that analysis, and that was what was in our first performance assessment.

It turns out the peak release from the vaults, it has not yet reached its peak in terms of release rate at 10,000 years. And so the peer review panel wanted us to go and study them for even longer periods.

And so we're extrapolating these calculations out much, much longer times, and of course, you know, the arrow bands get wider the farther out in time you go.

So that interaction with our peer review panel will be interesting over the next year. But we're showing by our calculations at least preliminarily that we don't hit peak release until, you know, in the 70 to 100,000 year range.

JACK PARRY: You mentioned a peer review panel. Could you describe who they are and what their function is?

DENNIS J. NEWLAND: Well, it's a DOE internal review panel, and they were set up just to do this type of activity, to review performance assessments.

And in fact the Hanford grout

performance assessment is the first performance assessment through this process. They are a group of technical experts within the DOE system. Of course, none of them -- no one on the panel is from Hanford. But there would be a Hanford representative on a panel, for example, to look at the Savannah River performance assessment. There must be 20 such people on the panel. But basically

people experienced in problemistic assessment, performance assessments, etc.

DENNIS PRICE: As I understand your answer, no one from outside DOE is on the panel?

DENNIS J. NEWLAND: I don't believe so. I believe this is just, at their stage, it is an internal DOE peer review panel.

Now, whether the performance assessment must be subjected to some sort of an outside look or DOE simply selects to subject it to an outside examination has yet to be determined.

This disposal system, of course, will not be licensed by the NRC, as the repository is. I'm sure you're aware of that.

MR. BARNARD: Do you need a RCRA permit, put it on an NRC license?

DENNIS J. NEWLAND: Right.

The status of the grout disposal program. Major facilities constructed, as you can see. We did do an initial fill in 1989. The four vaults that I mentioned are about complete. We're probably three or four months from submitting the final safety analysis report. Operating procedures, facilities being completed. Performance assessment being augmented. And the

operational readiness review is being kicked off.

Key issues, I would say, on the grout disposal program. The amount of radionuclides in the waste planned for grout disposal. Although, we have gotten an opinion from the NRC that what is being planned can be considered incidental waste, that opinion is being challenged in the form of petitions before the NRC. So those kinds of questions have yet to work themselves out.

This is the petition I mentioned.

The grout waste form and the barrier performance and degradation over much longer periods of time than we had anticipated, much greater than 10,000 years, are being examined.

There may be some LDR materials in future wastes for the first three campaigns. We know there are not, because we have done the sampling for those. But we could run into that in the future. We do have a sampling program that would prevent us from doing that inadvertently.

If the grout program is delayed substantially, that will impact the tank space situation here at Hanford, either cause us to build more tanks -- well, ultimately that will have to be the answer. If we have no low-level waste outlet,

if you will, from the TWRS system, all we can do is build more tanks.

We are kicking off activities to look at other low-level waste forms, but those are really embryonic at this point, and probably could not bring an alternate waste form on line in less than a decade, I would judge.

ELLIS D. VERINK: I have seen somewhere some reference to in-situ vitrification. Does that have any implications here at all?

DENNIS J. NEWLAND: In-situ vitrification is something that has been studied here at Hanford, and could potentially be an alternate approach to low-level waste disposal.

ELLIS D. VERINK: Is that still

being tested?

DENNIS J. NEWLAND: Yes, it is. Within the DOE system, I know they plan to actually have a demonstration run over in Idaho next year. Of course, we're following that.

JACK PARRY: But you're not planning in-situ vitrification within the tanks?

DENNIS J. NEWLAND: No. The technology to assure that you could just in-situ vitrify the tank just isn't there. That's probably a long development, to do that.

ROBERT LUCE: I want to go back to your characterization of the sludge in the tanks. This is just a small part of this whole system. Because I assume the composition of the sludge is important in how you are going to treat them.

While I'm familiar with some of the RCRA methods for sampling, I guess I didn't understand some of the terminology here. You actually take cores in all of these situations, and sometimes you push them and sometimes you pull them, and then this rotary would be actually cutting your way through more --

DENNIS J. NEWLAND: It would be like drilling through the harder saltcakes, etc.

ROBERT LUCE: And I guess the second part of this question is regarding, I guess, is this what you call waste mapping, where you can take samples at different depths and different places throughout this, or is it sludge fairly uniform?

DENNIS J. NEWLAND: We have no assurance, if you will, that it is uniform. In fact, in some of the tanks we know it is not. There are saltcake regions as well as liquid regions.

ROBERT LUCE: Well, within the sludge itself, how do you characterize it by just saying -- well, how many samples to you take? Do you take them over a number of places and a number of depths?

DENNIS J. NEWLAND: That's basically the approach, we take a number of samples the full range of depths, and whether we take, how statistically accurate we need to be will depend on the intended use.

For example, I would think we wouldn't need to be too statistically accurate for the retrieval. Once retrieved, then we have the waste in a mobilized form, in another tank where we could do further analyses, if you will, for future processing.

ROBERT LUCE: I was just curious. How do you shield the drillers while you're doing this drilling?

DENNIS J. NEWLAND: I don't know. We have done this a number of times, and I'm sure the exposure to the workers is within guidelines. But I don't know the types of exposures that we're getting for each sample that we take. I guess I

just don't have that information.

Techniques for shielding are, you know, the same techniques used everywhere, time, distance, you know, and material between you and the source.

DENNIS PRICE: Do I understand correctly that when you take your waste in total, 90 percent of it, after your separation, is low-level, and 10 percent of it is high-level?

DENNIS J. NEWLAND: Yes. Roughly.

DENNIS PRICE: Yeah. What is the capacity of the canister storage building?

DENNIS J. NEWLAND: Each canister storage building module has the capacity for roughly five years worth of vitrification plant output.

DENNIS PRICE: Five years output. How many canisters are capable of being stored?

DENNIS J. NEWLAND: 2,000.

DENNIS PRICE: 2,000 here?

DENNIS J. NEWLAND: Yes.

DENNIS PRICE: So you are producing -- When you start, you're going to be producing 370 a year, so you've got under, what, about six years that you could be running and stay running until your capacity is reached?

WILLIAM C. MILLER: Well, until you build the new storage facility.

Again, the design of the canister storage facility is 2,000 canisters per building, if you will. And the intent is that we will build additional storage buildings as necessary to be able to maintain adequate storage on-site.

If the repository is available, obviously we will not have to build those future facilities. If the repository is not available, then we will build those facilities to be able to provide safe storage of the canisters.

ELLIS D. VERINK: Any other

questions from the Board?

I think there would be time for a question or two from the audience, if there are any. Be sure to identify yourself, please.

MS. GAYLYN SPRIGGS: I am Gaylyn Spriggs from Neveda.

I am wondering if you have come up with a new definition of low-level waste or if you are talking about the same thing that we have in open trenches and that kind of thing from around the country, and if it is the same waste, why are we talking about underground vaults and the need to

talk about them for a hundred thousand years?

DENNIS J. NEWLAND: The waste, I may with using the term low-level waste inappropriately. It's part of the common vernacular here at Hanford.

But I believe the technical term is it is considered incidental waste. We're needing these types of disposal systems for two reasons. One, the radioactivity is fairly high. Much higher than you would find, for example, in the commercial low-level waste repository, or at least we're trying to qualify our system to handle higher levels of radioactivity than an NRC licensed low-level facility would handle. And, two, there is the hazardous waste disposal aspect of it. Ours is intended to dispose of the mixed waste.

JACK PARRY: The waste, then, is not contact handleable?

DENNIS J. NEWLAND: No. We hope to qualify our system to handle levels of radioactivity that would be above contact handling.

JACK PARRY: Then it is actually mixed wastes?

DENNIS J. NEWLAND: Yes, it is.

ROBERT COOK: Robert Cook with the

Yakima Nation again.

The issue of the organics and the nitrates in the grout, you mentioned you are taking out the organics.

Nitrates are just as big a hazard. Grout really isn't depended upon from a RCRA standpoint.

Why aren't you planning on taking out the nitrates as well as the organics since they pose a RCRA hazard to the groundwater? And relative to the lifetime, it's my understanding from a RCRA standpoint, the lifetime of the facility is 300 years, in the context the monitoring perpetually for 300 years, and then nothing beyond that for RCRA standpoint.

That's a rub. I mean, it contrasts with the NRC requirement and the nuclear requirement for long-term integrity for high-level waste repository. Why isn't the design of the grout facility from a RCRA standpoint, considering long-term lifetime, 10,000 years or something, comparable that you have got for the nuclear wastes?

DENNIS J. NEWLAND: Well, let me try to take your questions, and if I leave out one,

please repeat it.

Why aren't we removing the nitrates, I think, was the first question. The answer is that we think we can show this disposal system is acceptable for disposing of nitrates from a RCRA stand point.

ROBERT COOK: Long-term?

DENNIS J. NEWLAND: Long-term, or at least as required by the RCRA laws.

ROBERT COOK: 300 years, though. I'm saying -- the issue is the long-term integrity of the facility with respect to the nitrates. I mean, you can talk about the organics, you've got the containment of the organics, yet you're taking them out. I mean, it doesn't make any sense to take the organics out and not take the nitrates out, because you're not depending on the grout to any extent for containment in any case, you have the barrier around the outside.

So the question is, long-term integrity beyond 300 years for nitrates.

DENNIS J. NEWLAND: The reason for taking the organics out is a technical one. The grout waste form would not set up to a solid mass if we had too high of level of organics.

Now, that's not the case with the nitrates. And we do measure as a part of our performance assessment, we do assess the potential leakage of nitrates from that system, as well. So we have that information. We do intend to do that.

As far as going beyond what is required by the RCRA law, just because, perhaps to be analogous to what we're doing at the repository, we are doing a performance assessment, which involves studying a number of cases and the sensitivity, doing significant sensitivity analyses to those cases, such that we can assess our system and have, you know, a range of expected performance from that.

And so we intend to look at that. And we fully expect that we will be able to meet the laws plus understand what our system will do in the long-term.

Keep in mind here, what we're trying to do, if you will, is to qualify the envelope of the grout system, how much radioactivity or hazardous material could be put into the system.

In other words, I would like to qualify the envelope. The choice as to whether we put materials in there up to that maximum or not is

really separate. And that could be a choice made by the policy makers and with input from stakeholders, etc.

So we're trying to understand the technical performance of our system, and that's really the work that's going on today, the choices of how much we challenge that envelope is a separate choice.

Again, there's lots of opinions on that, and I know the DOE intends to request input from stakeholders on that. But at Hanford, we absolutely need a low-level waste disposal capability, or we will be in trouble.

TAE M. AHN: What precipitated the hydrolyesis process? What is the reason you developed the process used by your project?

DENNIS J. NEWLAND: Why did we develop, or adopt the waste --

TAE M. AHN: Ion exchange process instead of precipitate hydrolysis project.

DENNIS J. NEWLAND: Well, I don't believe we're going to be exactly the same as either West Valley or Savannah River from that aspect.

Our current thinking is we would do ion

exchange in a facility not in-tank, although we are looking at some in-tank options, like West Valley. The precipitate hydrolysis approach at Savannah River is because of their benzene problem. We are looking at other approaches that would avoid that problem.

WILLIAM C. MILLER: And in fact Savannah River, of course, is well aware of the problems that they are having with the benzene and also some issues on organic carry-over into their vitrification plant.

They are actively pursuing ion exchanges as a potential future pretreatment method for their wastes, and we are working closely with them.

So there are a number of issues. We do have, of course, a number of safety issues associated with our tank wastes, and we really don't want to introduce a new safety issue at this point.

PHILLIP E. LaMONT: I was down to Savannah River a few weeks ago, and learned one thing that I didn't realize before that kind of addresses the question of the process versus ion exchange here at Hanford.

Of the quantities of supernate to be treated at Savannah River are up in the many tens of millions of gallons of waste, and we at Hanford do not have anywhere near that quantity of supernate that would be treated.

And in order to come up with a practical approach and treat those large volumes of wastes, they were treated at the facility with sodium tetraphenylborate, as opposed to ion exchange.

CARL JOHNSON: Carl Johnson with the state of Nevada.

In reference to your remarks on the retrievability option you're considering in the supplemental EIS, is there an underlying or guiding assumption within your review of that option that a Yucca Mountain repository will be available?

PHILLIP E. LaMONT: That a repository will be available has been a part of the reference approach here at Hanford, and I would expect that that will be, and, again, it's just my speculation, I would expect that that will be the position adopted for this supplemental EIS, as well.

ELLIS D. VERINK: I think his

question asked whether or not specifically you are treating Yucca Mountain as being the place. You know --

PHILLIP E. LaMONT: Oh. Well, whether it's Yucca Mountain or some other repository, I guess it's not important to this program at Hanford.

ELLIS D. VERINK: Well, I think maybe we're a few minutes ahead of time. Let's take our break now, and be back here at, say, 10:20. Would that be all right?

(Morning recess).

ELLIS D. VERINK: Let's reconvene, then, please.

WILLIAM C. MILLER: My name is Bill Miller. I am work for Westinghouse Hanford Company. I have the responsibility for the development of the processes and facilities to do the retrieval of the tank waste as well as the pretreatment.

What I'm going to do now is to take and build upon the presentation that Denny Newland just went through to talk about, in a little more detail, some of the work that we are doing in the work of pretreatment.

Now, there's a lot of information in this presentation. Some of it gets a little bit technical, and I tend to somewhat jump over some of that.

Please feel free at any time, though, to stop and ask questions if you want to hear more about one of the topics or you don't understand what I'm talking about.

From an overview perspective,

pretreatment is probably one of the greatest technical challenges in the cleanup of the Hanford tank waste, a great number of the types of wastes we deal with, very large quantities of wastes to deal with.

Furthermore, because of the considerations in terms of what it is going to cost to dispose of the high-level waste and also because of the amount of materials that would be going to the low-level waste form, there's probably the greatest potential in the entire program to reduce the costs of the waste disposal program in the pretreatment arena.

Now, as Denny indicated, we're going through a rebaselining of the Tank Waste Remediation System at this point. There have been

a number of decisions that have been made such as the decision to not use the B Plant as the pretreatment facility.

So in the area of pretreatment, we really are in a state now of rebuilding the program to redefine the processes of the facilities that would be used to be able to separate the high-level radioactive waste from the remainder of the waste.

Jon Peschong showed this figure to you before, and, again, I would just like to reiterate the magnitude of the situation that we have to deal with in terms of pretreatment, the substantial volume of waste to be treated. We're talking about in the neighborhood of about 250,000 cubic meters of waste between the single-shell tanks and the double-shell tanks.

Similarly, though very small volume, the cesium and strontium capsules, if the decision is made to dismantle those capsules and dispose of them, that would probably go through a pretreatment process to be able to do that. And what that does, of course, is it encompasses indeed most of the radionuclides that we are talking about, several hundred million curies of radionuclides that have to be separated for disposal as a high-level waste.

In many respects, the wastes here at Hanford are similar to those that are at Savannah River, as well as West Valley, but in many respects they are different.

One of the things that we have done in many cases, at least in the double-shell tank wastes, is we have tended to segregate the wastes. Also because of limitations in tank space, past practices have led us to do a lot of concentration and removal of waters from the single-shell tank wastes.

And here you see kind of a very brief summary of the various kinds of wastes we're dealing with and the volumes.

Again, the single-shell tanks, primarily we're dealing with saltcakes and sludges. 37 million gallons from a number of different fuel reprocessing processes that have been used over the years here at Hanford. Substantial amounts of sodium nitrate in the single-shell tank waste as well as nitrites and phosphates and so on. This is in the saltcake now.

The sludges tend to be metal oxides and hydroxides as they neutralize the wastes. The wastes at Hanford are stored in the basic state,

basically because of the materials of construction used for the tanks, and so there is a lot of sodium that is added to the wastes.

There is probably in the neighborhood of more than 50 percent of the waste in the single-shell tanks, saltcake, probably 35 percent, somewhere in that range of sludges. Now, over the years there are a number of different types of waste, single-shell tanks, over the years, in terms of the processes to minimize tank space requirements.

Again, they have been mixed. So you have kind of a mixed bag of wastes in the single-shell tanks.

Generally, in a double-shell tanks, though, we have segregated the types of wastes.

There are four basic wastes that we currently classify as high-level wastes. Neutralized current acid wastes is basically the first cycle, extracting out of the PUREX process, a little over a million gallons of that waste. This is probably the highest heat waste that we have on the Hanford site. Substantial amount of cesium 137 and strontium 90 in that waste. A lot of iron hydroxides in that particular waste.

Second, double-shell tanks that we have, cladding and removal waste, this is the waste when we dissolve the fuel in the PUREX process that takes the zirconium cladding from the fuel, there is about a million gallons of that. Because it is basically the cladding, there is not a great deal of radionuclides in it. However, there is enough

TRU contamination that we do have to handle that as a TRU waste.

Plutonium finishing plant is one of the processes used to finish, or was used to finish the plutonium product from the plant. Relatively small volume of waste from that particular plant, about a hundred thousand gallons. Not much in the way of heat, but a substantial amount of TRU was involved in this particular waste.

Complexant concentrate, this is the waste that probably you have heard something about, the tank 101-SY, our burping tank, that tank is a complexant concentrate waste. Substantial amount of, this material, about 4.3 million gallons.

In the past, to reduce the heat load in the single-shell tanks, we went through a process of removing the cesium and strontium, which resulted in the capsules, the cesium and strontium

capsules we will talk about. And this is basically the waste that resulted from those processes.

And it's a real mixed bag of complexants, TRU, there's quite a bit of cesium 137 in this particular waste.

ROBERT LUCE: Excuse me. What's a

complexant?

WILLIAM C. MILLER: Complexant is an organic compound used basically to hold some of the transuranics in solution. Am I right, Langdon? Langdon Holton is our resident expert from PNL.

Can you explain that, Langdon?

LANGDON HOLTON: Yes. The complexants in the CC waste are EDTA, EEDA and decomposition products, and as Bill indicated, within the CC waste, they do retain in soluable form transuranium, primarily americium, and also neptunium.

WILLIAM C. MILLER: All of our technology development is done basically by PNL, so they are really our resident experts. I have asked Langdon to be here to answer the difficult questions.

I have presented the data on a little

different format for the double-shell tank waste here, and then I will talk about single-shell tank waste.

Talking about some of the key chemical components in the waste. And you can see by the various double-shell tank wastes, generally the kinds of compositions that we have.

I don't want to go through this table because there's a lot of information here. But an area that I am sure you are interested in is in terms of ultimately the high-level waste form, which is the glass. And some of these constituents do have an impact on the viability of the glass waste form.

Particularly chrome, phosphates and zirconium. As you can see in the various waste types, the PFP sludges as well as the CC supernates, have a fairly high-level of chrome and one that we definitely are going to have to do some separations or it will limit the amount of waste loading we can get in the glass for those particular waste types.

Phosphates, the CC wastes, there's a fairly high phosphate level, and we also know that even though on average, -- well, we don't show it

here, on the single-shell tank waste, there is a substantial amount of phosphates also we have to deal with.

As I mentioned, the neutralized cladding removal waste is essentially the dissolution of the zirconium, and therefore of course it has very high zirconium levels that we have to deal with.

One of the processes in pretreatment, then, is to remove these particular materials and separate them so they can go to the low-level waste form. Another possibility is of course to do some blending of these wastes so that a particular bad actor might be diluted by another waste form so that it would be acceptable for the combined waste.

In terms of the radionuclides --

ELLIS D. VERINK: Pardon me for just a second.

WILLIAM C. MILLER: Sure.

ELLIS D. VERINK: Taking chromium as an example, does the units of chromium in the sludge, for example, as .4, is that equivalent to .012 in the NCAW slurry and the 001 to 15 in the sludge?

WILLIAM C. MILLER: Yes. These are

Molar concentrations.

ELLIS D. VERINK: But if you have it .4 somewhere in the sludge, that means you have .001 to something or other in CC sludge, is that right? Or are those limits at various points?

WILLIAM C. MILLER: These are concentrations based upon some of the core samples that have been taken --

ELLIS D. VERINK: Are those acceptable concentrations?

WILLIAM C. MILLER: No. These are what's actually there.

ELLIS D. VERINK: These are the limits?

WILLIAM C. MILLER: No. These are measurements of what the wastes actually consist of.

ELLIS D. VERINK: Would you try to dilute those or is that something that you would accept?

WILLIAM C. MILLER: Well, at this point these particular ones would exceed the acceptable limits for --

ELLIS D. VERINK: You don't show what the acceptable limit is.

WILLIAM C. MILLER: No, I don't. I didn't choose to get into that at this point. But from a pretreatment perspective, what we've got to do is to tackle those particular elements in those waste forms to reduce it such that it can make an acceptable waste form.

ELLIS D. VERINK: We would need to know what that acceptable limit is in order to decide what to do, wouldn't you?

WILLIAM C. MILLER: Oh, absolutely, and we do know that. I just didn't happen to show it on this particular table.

One of the speakers this afternoon, Tom Weber, are you going to talk at all about glass composition?

E. TOM WEBER: Yes. We'll discuss the example compositions.

WILLIAM C. MILLER: And you will get into some of the limits we have, like zirconium?

E. TOM WEBER: Not specifically in what was prepared, but we can speak to that with the PNL people, between myself and PNL people, we could speak to that.

WILLIAM C. MILLER: Okay.

ELLIS D. VERINK: Okay.

WILLIAM C. MILLER: Unfortunately, I have another chart that shows the limits on the left-hand side, but I didn't bring that particular one.

And, again, the point I'm trying to make here is that we are -- there are a number of constituents we have to deal with on a pretreatment perspective to be able to make an acceptable glass, as well as of course minimizing the total volume of high-level waste.

In terms of radionuclides, in general, from an overall quantity, the vast majority of the radionuclides tend to be cesium 137 and strontium 190.

Now, in terms of single-shell tank waste, first in terms of talking of chemical compounds, the majority of the single-shell tank waste is sodium nitrate. Certainly, well over half of the total weight of the materials in the tanks. Again, phosphates, nitrites, hydroxides, aluminates, substantial amount is the sodium nitrate.

And as was discussed earlier, that is an area that obviously, if we can find a way to

reduce the amount of nitrates from a low-level waste form, it certainly can reduce the environmental -- potential environmental complications of that, as well as reduce the volume of low-level waste.

ELLIS D. VERINK: Pardon me. You mentioned a little earlier that you were adjusting, I presume, pH or something or other, with sodium. In what form do you do that?

WILLIAM C. MILLER: Sodium hydroxide is the primary one.

ELLIS D. VERINK: Okay.

ROBERT LUCE: Pardon me.

ELLIS D. VERINK: There is still free sodium hydroxide, in addition, then, is that right?

WILLIAM C. MILLER: Right.

ROBERT LUCE: What are the units of total weight? I don't recognize that Mg.

ELLIS D. VERINK: Milligrams.

UNIDENTIFIED SPEAKER: I think it is megagrams.

ROBERT LUCE: A little difference.

WILLIAM C. MILLER: I stole this out of another presentation, and I chose not to

change it. But it's in millions of grams.

From the standpoint of radionuclides, the predominant radionuclides in the single-shell tanks tend to be uranium, zirconium 93, technetium, which tends to be a concern from a low-level waste form because of its long half-life, and it tends to at least in some of the processes, it would tend to go the low-level waste form, so that is one of the particular interest to us that we want to try to remove in pretreatment. And, again, strontium 90 and the cesiums. And this tends to be where most of the radiation load is associated with the low-level waste.

We've been looking at pretreatment technologies for several years now. Pretreatment in and of itself is not an end. It is only intended to provide a product to be used for our low-level waste form as well as for our high-level waste form.

However, what we found is that as we looked at variations in pretreatment processing, and assuming that, as is the current reference, glass is our high-level waste form, we find that with no separations at all of the waste form, we will produce somewhere greater than 200,000

canisters of glass.

If we remove only the soluble salts,

that is soluble in water, we can reduce that by about a factor of five, to 40,000. Still, a quite large number of canisters, however.

If, however, we go to selective radionuclide removal, solvent extraction or some other processes, we're able now to get this down to a number which you are probably more used to seeing, somewhere in the neighborhood of 10 to 15,000 canisters of glass.

Now, as Denny Newland mentioned earlier, there is a high cost associated with the disposal of glass canisters. At current the best estimate is somewhere in the neighborhood of $350,000 per canister for the disposal cost.

Second of all, the cost to generate that glass, the current best estimate based upon the annual operating costs of the vitrification plant, is in the neighborhood of $250,000 per canister.

So you can see that the investment in each canister of high-level waste is in the neighborhood of around $600,000 per canister.

So that really is the incentive for a

pretreatment process, is to reduce the amount of high-level waste, drive the inert materials to a low-level waste form, so that we can bring this number back down to some number, something like this.

ELLIS D. VERINK: What was the other? 250,000?

WILLIAM C. MILLER: If you take the operating costs of the vitrification plant, determine what is the actual cost to produce a canister of glass, in other words, 370 canisters in glass, roughly over a year at about a hundred million dollars a year operating costs.

DENNIS PRICE: Okay. If you do your separation, how long at 370 canisters a year before you have completed your waste processing?

WILLIAM C. MILLER: Okay. If you get the number of canisters down to this range, the total time to process the waste is around 40 years through the vitrification plant. And that is the design life of the vitrification plant.

So, again, this number of canisters tends to be consistent with the overall systems approach we have taken, that is, the vitrification plant, there should only been one built here and

it should be size adequate to handle all of the waste.

Now, if indeed the decision is made to not use these more aggressive separation processes, then we would have to go back and look at the sizing and/or the number of vitrification facilities to be able to process the high-level waste.

Just to summarize, again, what the purpose then of pretreatment is, that is, as we have mentioned earlier, there have been a number of safety issues identified with the wastes that are currently stored in the tanks at Hanford.

The current focus of essentially the entire Hanford site in terms of tank waste is to resolve those tank safety issues. And specifically from a pretreatment perspective, the resolution of those tank safety issues can be performed by destroying the organics and the ferrocyanides.

We have to do sufficient separation of the radionuclides from the inert material. And of course the vitrification plant and the grout plants have to be operated within certain defined limits for the compositions of the materials being fed through them, and it is the job of

pretreatment to assure that the wastes that come out of the separations are within those separation limits.

Some of the process functions, then, that we are looking at to do these separations.

First is removal of the soluble salts, basically just by water dissolution process. Removal of soluble fission products. Then becoming now, getting more aggressive, removing some of the insoluble fission products, and there are a number of ways that that is possible to do that.

Separate the actinides, destroy the organics and the ferrocyanides, and one that we are looking at, have not made a firm decision on yet, is the destruction of the nitrates and the nitrites. Again, that's one that we believe has a substantial potential payback.

Some of the process options that we are looking at for soluble salt removal. Just basically, if you will, separating the liquids and the solids first. Obviously, most of the soluble materials are going to come with the liquids. And then by doing what we call in-tank sludge washing, you can remove the rest of the soluble material from the sludges themselves, for soluble fission products, ion exchange processes, solvent extraction processes, and also potentially some precipitation processes.

For insoluble fission products, precipitation is another alternative here, is where we also get into strontium extraction from the solids. Number of potential processes for actinide separations, the process that we have probably done the most work on here at Hanford is called the TRUEX process. This is a specific solvent extraction process developed at Argonne that appears to have some promise. But then there are also other solvent extraction processes that have been used throughout the year in the fuel reprocessing arena.

Alternatives to solvent extraction include selective leaching, the process where we can go in and specifically take out discrete elements from the waste; ion exchange, solvent extraction, and precipitation.

Basically, oxidation is the method to destroy organics and ferrocyanides, as well as nitrates and nitrites. Organic/ferrocyanides, you could use either the thermal or the chemical oxidation. The nitrates is normally only considering thermal.

Now, because of the fact that we do not have a facility to perform our pretreatment operations, because of the fact that we have ruled out B Plant as our separation facility, and also because of the fact that we recognize that some of these more advanced separation techniques are going to take a substantial amount of development, we have proposed a three-phase approach for pretreatment, that basically begins with the use of mature technologies and evolves to the more aggressive approaches that still tend to be somewhat developmental.

The first phase, then, we call near term processes. These would generally be proven technologies that could be implemented mostly within the tanks, though as we look at some of the processes to do organic and ferrocyanide destruction, it may involve the use of what we might call module. And a module might be a device that we stick down inside of a tank, much as like West Valley does for ion exchange, it may be a device that we bring in remotely and park on top of the tank or near a tank. Or it may actually involve a small facility where we contain some processing equipment.

Again, the kinds of processes we are looking at here, organic ferrocyanide destruction, doing the sludge washing, which again we would do primarily in-tank, and then ion exchange, which is primarily directed towards removal of the cesium.

Now, this is intended to provide us with the initial separations capability, and, again, it's basically equivalent to the soluble salt removal only, which again would take us down, if you will, from 200,000 canisters to about 40,000 canisters.

So obviously this gives us the basic capabilities to treat all of the Hanford wastes, if we chose to stop there. But, again, there are economic reasons to go beyond.

The second phase, then, of our pretreatment processes that we have proposed is what we call intermediate term processes. These now tend to be somewhat more developmental, and they are really evolving processes, but generally intended to be performed in within the tanks themselves, or, again, within these modules that could be closely coupled with the tanks.

Here what we're looking for are removal of specific species of materials that tend to drive us to larger quantities of glass, such as chrome, aluminum and also taking some of the transuranics out. So, again, tend to be looking primarily at leaching processes.

Also a key element of these intermediate processes would probably be some form of blending, where again we can reduce the concentration of a bad actor, if you will, by blending it with another waste that has relatively low levels of that particular material.

The third phase are the long-term processes, and these are the more aggressive processes, things like the TRU, a process I mentioned where we now take and dissolve the sludges in an acid, and then using some form of transuranic extraction, such as solvent extraction, to separate out the TRU waste from the remainder of the inerts. Also to go after strontium, technetium as we talked about earlier, and then ultimately to minimize the amount of organics in the low-level waste organic destruction.

These are long-term wastes, probably are talking implementation 15 to 20 years from now. The other wastes would be expected to be available -- other processes available in time for the start of the HWVP, which is now December of 1999.

However, we recognize that there are other processes out there. And we do not intend to close our eyes to other evolving processes, processes that can be developed. So we intend to maintain an active program, looking at alternative processes that can be implemented because they have either a significant performance or cost incentive associated with them.

Salt crystallization is one possibility to provide that capability. Solid sorbants. Again, nitrate destruction, both from a performance standpoint, low-level waste form as well as the reduction in the quantity of low-level waste. Leaching and dissolution, calcination which tends to be a possibility for a lot of reasons, it can destroy the organics, it can destroy the nitrates as well as the ferrocyanides.

A number of different processes we are talking about for pretreatment, and I don't intend to try to go through a description of all of those, but just to kind of give you a feel for how some of these processes tie together. Here you see a typical possibility or a menu, if you will, of processes that may be available. Wastes are stored in the tanks. They are retrieved from the storage tanks through the use of the retrieval system. And first, most likely, would go through a liquids and solids separation. The liquids then are supernate, then would go through organic destruction as well as cesium removal.

Out of that then comes what we call our low-level waste form, or low-level waste. It goes into holding tanks until that can be made into the cementitious grout form.

The cesium is removed, would then go into our high-level storage tanks, as well as, any coming down out of the solids, the solids would then be dissolved, those that are undissolved go to high-level waste, filtration, the filtrates go through high-level waste, and then through the extraction of the strontium as well as the TRU.

And, of course, if we get into things like technetium removal, that would tend to be done down in this phase. Nitrate destruction, if it's implemented, would be performed over in this phase. But, again, ultimately, pretreatment, then, separates it into a low-level volume of material which we envision will encompass at least 90 percent of the volume, and a high-level waste form which reduces down to about 10 percent of the volume.

One of the challenges we have, of course, in the pretreatment processing is that as we go through these processes, we tend to add a lot of material, hazardous chemicals as well as just volume to the waste to be disposed of.

And so that is certainly one of the system trade-offs that we have, is the more aggressive sometimes we get with these processes, we tend to increase the amount of waste that will be disposed of, particularly in terms of the low-level waste forms.

So that is a trade-off that we have to look at in terms of our system engineering evaluation of all of these various processes.

Let me talk now in a little more detail in terms of what we are doing in each one of these areas for pretreatment. First let me talk about some of the tank safety issues. Most of the tank safety -- or the tanks that we identify, what we call our watch list, which are the tanks which have

known safety issues, tend to be on that watch list because they have both a fuel as well as an oxidizer. The fuels tend to be hydrogen, ferro-cyanides and organics. The oxidizers is nitrates. So within the tanks we have both elements of potential combustion.

Now, there is an active program currently working to what we call mitigate the tank safety issues. The mitigation would generally be a process done within the tank where you can reduce the potential of the hazard, etc., through analysis, to show that the hazard is really not severe, or in the case of the burping tank, the 101-SY tank, where we tend to get a build-up of hydrogen of instantaneous release, mitigation in that case would possibly be a process of going in and mixing the waste so that you do not get the build-up of hydrogen so you do not get this instantaneous release but that it evolves on a routine basis.

Now, if those are not successful in totally resolving the safety issue, then the next means then to resolve that issue is then now to go in and destroy some of those bad actors. And basically, again, what we want to do is take this

oxidizing potential here and control it to dispose of those materials.

So the processes that we're looking at to potentially destroy the organics and ferrocyanides, ozonization, that's one that appears to be a reasonable candidate, high temperature or high pressure wet oxidation, this is a process like steam reforming or super critical water. There are some potentials there. Electrochemical oxidation. Calcination is a good candidate. And then there are others that we are looking at.

So this is an area that we fairly recently got into from a pretreatment perspective and one that we're giving more and more attention to at this point.

Okay. In sludge washing, which would be another one of the early processes that we would implement, this now is to, if you will, dissolve the soluble salts out of the sludges that are contained within the waste. Basically, involves settling by gravity of the solids and then just using water to wash the soluble salts out of the waste. This is a process that has been used in the past, certainly not new. It's similar to those processes that have been used at Savannah

River, West Valley and also at Hanford in the past.

We have developed fairly complete plans for doing in-tank washing of the neutralized -- or current acid waste.

But there are a number of other candidates. It's our expectation that based upon the wastes that we have currently characterized, there are at least eight years of material that we can process, providing feed to the vitrification plant that will not require a substantial amount of separations to provide a reasonable feed to the vitrification plant through sludge washing.

As I mentioned, this is not a new process. There has been a lot of development work done. Pilot testing with synthetic wastes, actual lab tests with some of the wastes, and also some process testing done within the old B Plant back when it was being planned as the pretreatment facility.

Fairly simple process, as I mentioned. Here you can see a simple schematic. You start out with a tank that generally consists of liquids with settled sludges at the bottom. We add some flocculenting agents basically to try to drive any

suspended solids down to the sludges. And then using a pump to be able to extract the liquids off of the surface.

So we then draw down the liquids out of the tank. And then that material goes off to another storage tank. It has the majority of the cesium 137 in the waste, and that then would go through a cesium ion exchange or whatever process we would use to separate the cesium.

We then fill the tank back up with buffered water to protect the tank from corrosion.

If you remember, Denny Newland talked about the mixer pumps, the Savannah River mixer pumps for retrieval. The intention is we would also use those mixing pumps to do that, to be able to dissolve any of the soluble salts. Once again, we would then settle that material, draw it off, and go through the process another time.

So by the time we complete, then, we basically have the sludges which are mostly removed of the salts, and that is what is needed to be to the glass plant. The liquids, after going through a cesium ion exchange, would be available to go to the grout plant.

Okay. To dispose, then, of these

liquids, it is necessary to go through an ion exchange or some form of cesium --

DENNIS PRICE: Excuse me. Could I just interrupt for a second. How clean is clean on this? How do you determine that you have done the job?

WILLIAM C. MILLER: In terms of the --

DENNIS PRICE: This sludge washing.

WILLIAM C. MILLER: The sludge washing?

DENNIS PRICE: Yes.

WILLIAM C. MILLER: Basically, our goal of course is to get to the point where we have removed enough of the sodium salts that it does not add to the volume of the glass.

I do not have the current specifications. I can get that data for you. But basically the goal is to reduce the volume of waste going to the glass plant. So it's really a matter of economics of how much of the sodium do we remove and whether or not the remaining sodium will interfere with the glass itself.

The sodium, again, does affect the

quality of the glass, and therefore it could affect the waste loading. But radionuclides are intended of course to stay with the sludges, except for the cesium, which goes through the ion exchange process before it goes to the grout process.

Did I answer your question?

DENNIS PRICE: Yes.

WILLIAM C. MILLER: It's really driven more by economics. The number of times you wash the material, the more number of times you wash it, the more water you've had to add and now you have to clean up that water. And so it gets to the balance point of have we removed it enough that we don't affect the glass without having creating another half million gallons of liquids that will have to be evaporated and go through ion exchange.

Ion exchange, then, is the process that we would propose to use to separate out those soluble radionuclides from the supernate that is drawn off the tank initially as well as that that comes out from the sludge washing process.

And this again is a process that is fairly well developed. It was used for a number of

years at Hanford. If you remember, we talked about the cesium and strontium capsules. The cesium was removed from the single-shell tank waste through an ion exchange process. However, the processes have continued to evolve and we are continuing to look for better methods for acquiring ion exchange. One of the ion exchange resins that looks very promising is a resorcinol based resin that was developed at Savannah River.

Again, Savannah River has also a very active program looking at ion exchange. And that one does appear to have a substantial high capacity for cesium removal.

Another one that we are testing that looks quite good is a Duolite CS-100. So we have been through a number of tests characterizing some of the more recent available ion exchange media.

These two tend to be the ones that appear to be the most promising. We have looked at radiation effects, and of course when we get different labs working on the same problem, we tend to get differences of opinion. The Hanford data seems to suggest that the Duolite CS-100 resists radiation better. However, Savannah River data

suggests that the resorcinol based resin is better from a radiation resistant standpoint.

So we are working with the Savannah River folks to try to resolve this, and we are trying to come up with the best possible material, and in fact Savannah River is in the process of putting together a test program to test ion exchange. They have set up a fairly large test facility. We intend to hopefully work with them to be able to do some tests with that same facility and make sure that we have a consistent set of data that we are all working with.

Ion exchange is basically not unlike the water softener that you may have in your home. Basically, a bed filled full of resins. The liquid waste is run through that after it goes through a filtering step, run through the packed bed. Out comes the relatively low-level supernate, which then is sent off to the low-level waste form.

There are a number of options then as

to what to do with the resin. One of the options is to, basically, once you have reached the point of saturation in the bed, you remove the bed and dispose of that potentially as high-level waste, and that could be potentially packaged and sent to

the repository if it would meet the repository requirements. Or go through some other form of processing.

An on-line processing that has been tested is to actually dilute with an acid solution through the column, remove the cesium 137 so it can be sent off to the glass plant. That's kind of been our preference in the past because of the volume of ion exchange resin that might be required to be disposed of.

But there are a number of options. And those two are the ones that we are primarily looking at in terms of how to dispose of the cesium 137.

We have been looking at column loading and the ability to dilute the cesium 137. And we have found that column loading with the CS-100 is relatively high. In fact, I think there's some more recent data that suggests that the resorcinol based is substantially higher than this.

So we have some good candidates from the standpoint of being able to remove the cesium. Also from a single column we find that we can remove at least 95 percent of the cesium, and it was our intent to actually stage these to have

multiple columns in series so our removal will be substantially better than 95 percent.

We've looked at aging of the resins, and for example, the CS-100, we have found that after 55 dilution regenerations, there is still fairly good performance of the CS-100, so we are seeing some reduction in the material itself. There are ongoing tests with ion exchange.

Again, this is a process that we feel relatively comfortable with. It's really a matter now of engineering the best possible system, based upon, again, the impacts of the overall waste in terms of solid waste from the resins as well as the performance of the materials.

So we do have column loading experiments in process. We are looking at various alternatives. And we have completed a study looking at various alternatives, including re-evaluating some of the in-tank processes like the tetraphenylborate process used at Savannah River, a number of engineering studies are underway. We are in the process now of trying to come up with the best design to reach an overall system objective for tank waste disposal at Hanford.

ELLIS D. VERINK: Presumably, spent or used ion exchange would just go into the waste, is that right?

WILLIAM C. MILLER: Well, it depends upon the resin. Some of the organic resins, of which these two I was talking, or both organic resins --

ELLIS D. VERINK: You will burn them?

WILLIAM C. MILLER: They can be burned, but generally the melter is not necessarily the best waste place to do that. The concentrations of the organics can be potentially not acceptable.

So if we go with an organic resin, some other means of disposal may very well be appropriate. That's one reason why we are seriously looking at the possibility of diluting the cesium off of the columns, rather than just filling them once and then disposing of the resins. Ultimately you will have to dispose of the material. The question is how much radionuclides do you have to separate from that material, once you have decided to dispose of it.

ELLIS D. VERINK: Uh-huh.

WILLIAM C. MILLER: Okay. We are talking about so far basically those near term processes, organic destruction, sludge washing, that will take care of the first several years of feed to the glass plant, but we recognize that, again, without doing some more selective separations, that we will end up with a large number of glass canisters produced.

So this intermediate phase is really intended to be a means to go in and take out selective elements from the waste, such as chromium, such that we can extend the time that we have to develop these more developmental advanced type of separations processes.

Again, the goal here is to reduce the canister production relative to that that would be produced only by sludge washing. And furthermore, to assure that we do not have to build large facilities to implement this. That is, to look for processes that can generally be implemented within a tank or within a relatively small facility close coupled to the tanks.

Again, the idea here is to have something that fills that window, if you will, between the sludge washing where we have

potentially only a limited number of wastes that can be effectively processed in this way, to the time that we have these more advanced separation processes. And, again, the goal here is to minimize the cost of the program.

Any waste to be made in the glass is just a matter of how much waste to put in versus the amount of glass formers you put in.

We're in the process of trying to evaluate what characterization data we have, and of course it's in various states of development of that data. But trying to characterize the tank wastes that are out there that may be suitable for intermediate processing.

So we tend to look for tanks that have high fission products, or high amounts of TRU, that if you could remove those components, such as chrome, you could reduce the volume of the wastes substantially that would have to be made into glass.

Similarly, we are also looking for wastes that maybe have low fission products but high amounts of TRU, again, where possibly here you could leach out the TRU from the waste. There are lab tests that are going on with one of the

double-shell tank wastes now looking at chrome removal. Also we are going to be starting some additional lab tests to look at some other possibilities.

Again, without mentioning it here, looking at part of this is looking at ways to blend these wastes so that again we can take a waste that has a high-level of a particular constituent and basically reduce its relative concentration by mixing it with something that has a very low-level of that particular constituent.

Now, again, jumping to those long-term processes, those processes that are going to produce a significant reduction in the number of glass canisters by going through some form of more advanced separations. To date most of the work that's been done here at Hanford, and I have tried to identify these separation processes, have been focussed on the solvent extraction process I mentioned earlier, one we call TRUEX.

And there has been a fairly large amount of analytical work and laboratory work, trying to develop the TRUEX process for the double-shell tank wastes.

There was also a systems engineering

study done for the disposal of the single-shell tank wastes. That draft report was issued last fall. And in there it identifies again solvent extraction as one of the primary candidates for being able to separate the radionuclides from the single-shell tank wastes.

But over the last year there have been a number of technical reviews as well as other reviews, looked at the program, and these reviewers as well as ourselves have come to the conclusion that there may be some technical problems associated with the TRUEX process, certainly technical issues that have to be resolved. Also the fact that so far the program, because of a lot of reasons, really only focused on the TRUEX process. There is no fallback to that particular process as defined in the program a year ago.

So we really recognize that there are some issues that need to be resolved in that program. Certainly to look at some alternatives to TRUEX. And certainly to try to have at least one or more fallbacks to the TRUEX process.

Because of those issues, then, we have now revised the program to investigate other

alternative processes, and I'll talk some more about those in a little bit, but our goal, of course, here is to dispose of the tank wastes, and so at that point is when we lay out the three phase process, which then would allow us to get on with the disposal of the tank waste in the near term using processes that are mature, gives us time to investigate these alternate processes and to verify, either confirm the performance of TRUEX, that it meets our needs, or show that it does not and come up with a suitable alternative.

In this, the tank waste remediation system, we are really doing two activities to evaluate these alternatives and to gain more national consensus on the processes that we are using, not just an area of pretreatment, but in really all of the various elements of the program.

First we are establishing a series of technology working groups, we are calling them, one for each area of the program.

For example, there is one in retrieval, one for pretreatment, one for glass vitrification, so on. And this consists of people, both that are here on-site, involved in the development of those processes, as well as off-site technical experts

from other DOE sites and so on, who are involved in the development of similar or other processes.

And the intent is basically to use these working groups as a vehicle by which to assure that we have identified the right needs of the program, as well as to assure ourselves that we have identified the right alternatives to evaluate.

The intention, then, is to go through a series of meetings with these working groups, to come up, if you will, with a short list of candidate technologies to be developed, particularly in the area of retrieval and pretreatment, are probably the areas that are most developmental, and then to document those in technology plans, again, one for each area of the program, which will lay out the entire development program for the technology needs of pretreatment, retrieval and so on.

So we're really working to gain a national consensus in terms of the processes that we choose to implement and the manner in which we go about implementing those.

I will give you a little bit of background on where we stand in terms of

developing solvent extraction processes. There has been a lot of lab work done both by PNL here as well as Argonne National Labs, on a small scale, if you will, looking at Hanford wastes.

So they have looked at a number of the double-shell tank wastes, working with synthetic wastes. Argonne has also done some continuous tests using synthetic wastes of one of the Hanford waste types, as well as they have also done some work on studying the radiation stability of the solvent itself, CMPO, and again found no radiation effects.

So there has been quite a bit of work done on the solvent extraction process. But, again, it's only been done basically at the lab scale. And that certainly is an area where we need to get more experiences in terms of doing continuous tests with the material, both on a bench scale and potentially also at a pilot scale.

Issues that we have to still resolve in terms of solvent extraction. Again, we used some fairly aggressive acids in this, so we concern ourselves with material destruction, and there is a corrosion program ongoing, looking at that.

Again, we do have a wide variety of feed materials that are materials in our tanks, the compositions are quite different. We have got to assure ourselves that the processes that we have developed can handle that wide variety of materials. And, of course, there are test programs underway or a plan that will provide some of the answers to those questions.

The key issue, again, in pretreatment, is that in the process of separating these wastes, we create some additional volume of waste. And so obviously one of our goals is to minimize the waste, in terms of the amount of material that we add, as well as being able to potentially reduce the nitrate levels in the waste.

So there are processes specifically associated with the solvent extraction process to remove the nitrogen, and, again, as I also mentioned, there are also separate activities, looking at the destruction of nitrates.

Again, our goal here is to ultimately, if this process continues to look valuable, is to do some continuous testing with actual wastes, both lab scale and potentially at a pilot scale.

But solvent extraction is not the only

process available to us. For the long term, there are a number of alternatives. I have mentioned some of those earlier. Leaching processes, for example, dissolution, some ways to remove aluminum, carbonates, can remove some TRU. Various processes such as salt splitting to separate the high-level waste from low-level waste. Solid sorbants, to separate some of the actinides.

Here you see some activities, I don't really care to go through all of them, but so far in the tank waste program there has been an ongoing activity under the Office of Technology Development, under EM 50, to look at alternative processes. And for the last few years they have actually had ongoing programs, looking at various methods for being able to treat the high-level waste.

We're in the process now of integrating with those activities and to assure that the activities that they are looking at are consistent with the needs of our program, and also to assure that we have no duplication of effort. I mentioned earlier that we will be developing these technology plans, for example, for treatment, we will have an overall integrated program of ODT and the tank

waste remediation system.

Here you see some other processes that are being considered, some laboratory work is going on in these as well as analysis. No need really to go through those at this point.

Again, some other processes. We are in the process of developing an exchange agreement with the French as well as the Japanese on solvent extraction, and in fact we are in the process of obtaining some of the French solvent to do some testing to see how it compares with the CMPO solvent that we use.

Again, really trying to bring in both the national as well as the international knowledge that's out there in terms of separation technologies to be able to assure that we come up with the most viable processes we can, the most cost effective processes, also.

Down the line, we do have a number of mature technologies that we can handle the waste to provide suitable materials to the glass plant as well as the vitrification plant, and that could provide a number of years of feed to that plant, but that in itself is not going to be a cost-effective solution. There is a substantial amount

of development to develop these more aggressive processes to reduce the total cost, and again, we believe it is a three-phase approach that we have proposed, helps provide that kind of a transition to assure that we have the time to develop these long-term processes, yet have a viable program to dispose of the tank wastes.

Questions?

ELLIS D. VERINK: The next speaker is going to need a change in slide projecters. While that's going on, we might entertain questions for Bill.

WILLIAM D. BARNARD: Bill, you mentioned

that some of these tanks are on a safety watch list. How many are there that are on this list?

WILLIAM C. MILLER: I believe the number is 55.

Can anybody correct me on that? I believe the number is 55.

WILLIAM D. BARNARD: Thanks.

ROBERT LUCE: Luce, staff. Could you elaborate a little bit more on the problems with the TRUEX process?

WILLIAM C. MILLER: Basically, one of the problems that has been identified is the

formation of crud, if you will, that collects in the extraction chambers and that crud tends to plug up the material.

And so what we have to do is have a process that basically prevents the formation of that crud.

Also there are some corrosion concerns. The corrosion program that we are proceeding on seems to be coming up with some solutions of materials and process changes that will solve those concerns. I think those are the key issues. The other concern, of course, is that we have to deal with, is that because you are, in many of these aggressive processes, you are using an acid dissolution. You have to use acids to dissolve the wastes, before you can put that waste back in the tank, you have to neutralize it again. Again, you are adding to the volume of the waste. And that's a trade-off that you've got to look at, is are those trade-offs worth the increase in waste that's created by that process.

ELLIS D. VERINK: Anyone in the audience want to ask a question?

CARL JOHNSON: Carl Johnson, state of Nevada.

Maybe you could clear up a little confusion. You talked extensively about your three phased approach to pretreatment.

Were the costs involved in that three phased pretreatment considered in the 250 K per canister cost of vitrification?

WILLIAM C. MILLER: No.

CARL JOHNSON: Do you have a number of what the three phased pretreatment would cost on a canister basis?

WILLIAM C. MILLER: No. And in fact that's an activity that we're still in the process of trying to develop.

We've made some earlier estimates, and of course to implement some of these more aggressive pretreatment processes, like solvent extraction, it's going to require some fairly large facilities, or a large facility here at Hanford. And that could cost at least as much as the vitrification plant itself.

We have made estimates of what that facility might cost, what the operations of that facility might cost, and still, based upon -- and I don't have the dollar per canister cost, but the projection still suggests that building the

pretreatment facility, going through the separations, is still substantially less expensive than producing 200,000 canisters of glass, or even the 40,000 canisters of glass.

So we've done some systems studies, we've looked at the cost. I can't tell you what the cost per canister is. But I can tell you in terms of life cycle cost, the overall cost of the program, so far what we have looked at, it indicates that it is less expensive to build the facilities and do the separations than just generate all the glass.

ELLIS D. VERINK: Dr. Price has a question here.

DENNIS PRICE: I think I need to be straightened out. Obviously I am missing something somewhere, because Linda Desell said, I thought she made a presentation of 1200 canisters at Hanford, and I'm hearing 10,000 to 200,000 canisters. So obviously I have -- I am missing something here. Because I think --

JEFFERY M. ALLISON: I will answer that. The 1200 canisters is what has currently been committed to by DOE from a NEPA standpoint. That were the number of canisters

that were contained in the Environmental Impact Statement. The Supplemental EIS, that is, done at Hanford will address the other canisters.

I think the numbers that Bill had are more planning bases than anything else. They are firmly committed to -- in other words, supported by a NEPA decision.

DENNIS PRICE: Okay. But it would seem to me that it's almost misleading for a slide to come up saying 1200. I'm trying to be kind here. But saying 1200 canisters from Hanford, it makes the Hanford waste thing look pretty simple.

But to say we've got to plan on anywhere from 10,000 to 200,000 canisters, there's a big different between 1200 and 10,000 to 200,000. So the numbers are getting used kind of loosely here.

Phil?

PHILLIP E. LaMONT: This is Phil LaMont.

The 1200 canisters is an approximate number that represents processing of the double-shell tank waste in accordance with the Environmental Impact Statement Record of Decision. It also assumes TRUEX pretreatment for the CCPFP

and NCRCW type waste and the sludge washing.

In fact I saw Linda's slide and I went and reverified those projections, and the latest number from Westinghouse is unofficial, but it's 1287. So it seems to be pretty consistent. The larger numbers of canisters that Bill showed assumed both single and double-shell tank processing, or a variety of pretreatment options.

And the fact that there has not been a NEPA decision on the disposition of the single-shell tank waste, so for that reason that is why they have not shown in that database.

But for the purposes of doing our system evaluation for disposal, we are looking at the potential for disposal of all of the tank waste, and when you look at all of the single-shell tank waste, you begin to get numbers in the neighborhood of 10,000 to 15,000.

DENNIS PRICE: From a repository standpoint, I don't think they care whether it comes from a single-shell tank or a double-shell tank. The numbers are at issue. And to say 1287 is the number for the repository, maybe that's true, but to turn around and say, no, it's 10 to 15,000, that's a different picture. So I guess I'm

still not clear.

WILLIAM C. MILLER: Again, the number that was generated previously was based upon a NEPA decision that was made for the double-shell tank waste, which included disposal to the repository.

In the 1987 EIS, Hanford defense waste EIS, no decision was made on the single-shell tank waste. And at that time in-place disposal options for single-shell tank wastes were still being considered and have not been ruled out yet by any NEPA decision.

So because of that I believe the official record for the database does not yet include those canisters, because there has not been a decision. But certainly if you assume that those wastes are going to be disposed of, the numbers I presented are the numbers that the repository can be expected to see.

DENNIS PRICE: Thank you.

ELLIS D. VERINK: This gentlemen has been waiting here.

ROBERT COOK: Robert Cook of the Yakima Nation again.

The requirement for the chromium and

the sodium in the glass, there is an idea that that is necessary to have a low leachability for the glass. And there's a requirement that NRC has on low leachability for glass. There's no requirement on the waste form that NRC has. It's on the engineered barrier for the long-term release rate for the whole system. Okay?

So trade-offs in this whole system evaluation ought to look at other barriers besides the glass and having to make TRUEX and do all of this.

It may be a lot cheaper to put a nice thick canister outside that thing and forget about what the glass looks like, put a little more chromium in it, or put a little more sodium in it, and be done with it.

ELLIS D. VERINK: Thank you very much.

We should start with the next presenter.

CHRIS CHAPMAN: Good morning. My name is Chris Chapman. I am with Pacific Northwest Laboratories. My area of interest and experience is in the vitrification system.

This morning I'd like to provide a

summary description of the high-level waste smelter technology pioneered and developed here at Hanford and now being used throughout the world.

The content of my presentation is centered here at the vitrification plant, the real digester in the middle, the liquid fed ceramic melter.

The objective of my presentation is to review some history, to give a context to where we are today, and to give you, at the end, my speculation of where we'll be tomorrow, so to speak.

This is a periodic table which shows some of the major constituents in high-level waste. The point of this, the message of this, is that it contains many of the elements in the periodic table, and the glass and the process equipment must be able to accommodate these large number of constituents and do it correctly. Particularly here at Hanford, from tank to tank, as has been indicated, there can be quite a bit of variation, so it must account for that.

Now, what I want to do now is to go back quite a bit in history, nearly 23 years, to start where high-level waste vitrification started

and progress to date by technology.

This is a picture in the 300 Area, 324 Building, which you will be touring tomorrow, showing the, at that time, in the late 1960s, the calciner and the metallic melter, which was part of the waste solidification engineering prototypes. This tested four different processes in the late 1960s, processed 44 million curies of material, and settled on at that time these two pieces of equipment.

The metallic melter, although it was selected, had four major limitations.

First, its longevity was limited to about 2,000 hours, or three months, which was undesirable due to the frequent change out.

Second, the capacity was quite limited. For example, something of this nature, if it was to be applied to the current HWVP flow sheet, would require six, four to six lines of these, that is, replicas.

Third, it was relatively low temperature.

And fourth, the resonance time in the glass melter was relatively short, four to six hours, and at times the discharge glass could have

raw calcine being discharged from. From a quality point of view, that was not deemed to be very desirable.

About this same time the French, they used a different calciner, proceeded and put into operation this sort of system.

Due to the lack of available competitive technologies, also the British Nuclear

Fuels System -- or Fuels Limited Company in England have adopted this.

But for the reasons, the limitations we found for the metallic melter, we addressed, went to the next approach, which addressed two of the concerns.

First, the changeout of the canister. This being the in-can melter, each time this was filled, it was essentially replacing the melter, but then the package could go to the repository. So that was addressed, one of the four concerns.

The second being that of capacity, the high surface area where there could transfer energy in. This would eliminate it from the current HWVP process to about two lines of this nature.

With these limitations, in the early

'70s it was recognized that we still would like to address some of the major concerns of the metallic or in-can melter. And return to the glass industry. This will essentially be the -- is the outline of my talk, looking at historically how the evolution and selection of the technology has come to be, as well as the basis for each evolutionary step through particular pictures.

So initially we in the United States looked at molybdenum electrodes inside a ceramic lining, very similar to the conventional commercial glass industry. This was our first rather modest approach with molybdenum electrodes inside a refractory container. It provided all of the facets that we desired, higher temperature, higher capacity, long life, but with the electrodes molybdenum are volatile to oxidation and somewhat require some feeding in for renewal, this complication stunted its being pursued further, and as opposed to an oxidation vulnerable material, we changed to large nickel chromium plates found at the end wall of the cavity.

This is a schematic of the early engineering scale device that frankly proved that this technology could be implemented in a full and

remote facility, although it doesn't look like it from this sketch. Large massive plates that are oxidation resistent at either end of the cavity. This shows, this is a picture of that melter. Here we're looking at the plate electrodes with the molten glass contained inside.

This device, even though rather simple,

provided many of the capabilities we wanted. We could get about 150 degrees centigrade higher operating temperature, long-term resonance time, excellent mixing for discharge.

It was, relatively speaking, a compact unit. And from its general capacity capability, that is, dissipating energy within the bulk glass, there was no real limitation to its capacity. We tried some liquid feeding of this device in the early stages, and that looked promising. But the real first application of it was discovered in putting it in as a feed from the calcine. This generalized process at that time was Defense Waste Processing Facilities, it was like in early 1980, late 1979, this was the reference designed for DWPF.

Where the calcine would drop here and glass additives or glass formers added here, or

frit, so-called frit, deposited here, as shown in this photograph. Here is the powder coming in.

Now, as with the metallic melter that had frit feeding two dry solid streams coming together, mixing of those streams was very poor. Although this technology could address what was better than the metallic melter with the defense high-level wastes that have high iron and other transition metals, one could have in the waste rich phase the formation of crystals, in this case spinel, that would grow and then precipitate to the floor. So this was sort of a disincentive.

This is a section view of the bottom of the melter, with about six inches of sludge composed of spinel, which one could extrapolate, that that wasn't going to be very desirable for a long-term operation.

So we come upon the idea, let's do as the glass industry axiom says, well mixed is half melted. Place the glass formers in with the feed, and then feed it to the melter directly.

This started becoming more popular in the early, oh, about the mid '70s. Here I'm showing you the mixture of waste and glass formers, are fed on top of the molten surface. This is a

picture during operation. This is the slurry coming in and this is the so-called cold cap, which is a dried out material as it's heated from the molten glass below.

So we have some material here that's nearly completely dry, some slurry concentrate, and these are vent holes looking right down into the molten glass. This proved to be very advantageous for reliable operation, production of a consistent uniform product, and we eliminated the complicated calciner for the Defense Waste Processing Facility, the cell, or canyon height was reduced by about 30 feet, which has substantial capital cost advantages.

This is an outside view of the so-called pilot scale ceramic melter. It was started up in 1978. And on your tour tomorrow you will see this, some 14 years afterwards. There have been two rebuilds for technical reasons to look at different developmental issues, such as plenum heating and the like. This has been essentially the work horse in support of the nation's vitrification projects. First, for Savannah River in the late '70s and early '80s, and then West Valley Demonstration Project, and

recently here in direct support of the Hanford Waste Vitrification Plant.

Along the technology road that I speak of with the large plate electrodes, this adaptation of the technology was used in the 300 Area North demonstrating fully remote high radioactive vitrification.

This is a section view of the radioactive liquid fed ceramic melter, showing the massive plates, and this foot that we'll see a little bit later, why that's there, is the melting cavity, it's discharged over into this zone.

Here now we're looking at the inside cavity. This is that electrode that you saw in the previous slide and the foot that directs more power near the floor. This system was constructed in 1984, installed and started up radioactively.

Let me go to this slide. This is the assembled system out at ex-cell. It was fully remotely installed and started up and processed from 1984 to 1987, 22 million curies of cesium and strontium from the 200 Areas. This was -- the project was very technically and operationally challenging but was completed quite safely and quite successfully.

The specific activity of this material is and was very high with, say, canister surfaces that had radiation of up to about 350,000 rem per hour. Those were produced for repository -- for the benefit of Germany's repository testing, providing high heat and radiation sources for them.

Now I'm coming to why the foot and why we jumped away from large massive plates, and this is a temperature profile. It distorts the actual reality. But the concern is down in this zone here where the temperatures could be a bit too cool. The foot was inserted on these to kick this out. But the preferred approach was to go to multi-zone arrangements that we could direct energy near the floor while processing most of the energy and sustain high temperatures here.

This has been deployed most generically for the technology in operating plants. We will look at each one of those in turn. Here the early versions, the later versions at Savannah River and DWPF and the successful PAMELA operation.

This gives you a pictoral view of what I'm talking about, separate zones, heating near the floor, and then the power electrodes for melting

here. This is of course empty. But the molten glass, when it was full, was about two inches above the top cavity.

This is the unit in operation. It was started up in 1977 and has on and off operated since then. It operated for three years, at that time, up until 1980, that had been the longest operating unit of its kind. It turns out this is a seven-tenths scale in plan view of the DWPF configuration, so it was directly helpful to that activity.

You will see this also on your tour, even though it's also had two modifications, relines and reconfiguration of the refactory.

In the next year this unit is planned to be used for two 30 day continuous runs at separate times in support of the Hanford Waste Vitrification Project.

This is an overall view of it in the late '70s. The environment -- or some of the systems have been changed. But I think you will be able to recognize this device on your tour.

Chronologically, for their configuration, dual zone devices, the next system is that at PAMELA. Once the Germans saw the

technology in the engineering scale, they rushed home and began an intense development of their own. This was realized in their PAMELA facility at Mol, Belgium.

This was during construction. This is a picture of a picture. It's not an artist's redition. That's why it's grainy. But of the completed facility. At the old European reprocessing plant. This is a schematic of the melter. This had four zones. There was actually four sets of electrodes so that not only could they have vertical temperature control but also lateral, which they felt desirable.

A flat bottom device with a bottom drain and the conventional underflow discharge outflow system.

Here's a picture looking through the shield window of the top of the melter under completely remote operation.

The next slide is an under view showing the two discharge points, the bottom drain and the overflow.

The unit started up in 1985, in October of 1985, and was the first production plant of its kind. It completed its mission in August of 1991, processing all of the high-level waste at the Euro-chemic site. During this period they produced 2700 canisters, processed about 500 tons of glass, and were very successful in their operation.

The first melter operated 2.8 years, encountered some problems with noble metal precipitation, and shortout, and I'll speak to where they are currently in their melter design later.

But the two units that were used spanned the two -- the entire period achieving operational effeciencies that were excellent, and I think it attests both to the German proficiency of the operation as well as the ruggedness of the technology.

Here at home, this is a picture of the Defense Waste Processing Facility that includes this type of multi zone adaptation.

Here is a section view of the melter and the relevant turn tables.

This picture is more colorful and shows the two sets on the same wall but in reality they are diametrically opposed for sustaining operation. Again, two zones. This is the largest

to date device that is planned to be used internationally.

Just taking a picture, if you haven't toured it, this is the device, it's rather --

that's the reason for the schematics, because you can't really see much. But it is installed in the DWPF.

Now, when West Valley came to being a demonstration project from the Congressional mandate, we looked at what are the concerns relative to the state-of-the-art design at that time, in the early '80s. The concern about non-conductive sludge accumulations. The one that was most startling to me was an experiment in which the organics were excessively high for a Savannah River flow sheet that was tested out here in the PSCM that you will see tomorrow, and it caused a reduction of nickel amd hafnium, sulfides to come to the floor, and from a melter technologist, looking at the relatively short path that could occur, it didn't take a big leap of faith to see that there could be a dead short and this would be a dead melter.

So we came upon the concept that is the slope bottom, bottom electrode, for the West Valley Demonstration Project, to address this concern.

This is a plan and section view of the

West Valley demonstration melter, showing the sloped floor, and actually it is greater than this angle, but it gives the idea. The idea was to correct these molten materials that were conductive near the bottom so that they could be addressed through remote operations, if need be, and at a minimum, allow one extended operation before running into electrical shorts which can be the undoing or the are Achilles' heel of this type of technology.

In case you're not familiar, the West Valley Demonstration Project is in western New York, 35 miles south of Buffalo.

This will give you a little view of the site. This is somewhat dated. This is the old site of the Nuclear Fuels Services Company. The reprocessing plant. I lived there for five years, and I know it's not that green all the time. It turns to a pale white most of the time. And that's when we had to do construction, when there was two foot of snow.

The association of the vitrification

plant to the old facility, we will look at that in greater detail. I don't know if you can see it, but these are the location of AD-1 and 2, neutralized high-level waste, and then the AD-3 and 4 TRUEX tanks are located here.

So now we are schematically zoomed in and focused on the vitrification plant. It is intended that when the canisters are produced, they are taken in to what used to be the dissolution cell for reprocessing and stored on an interim basis, and when the repository opens, it will be brought out the other way.

Now, further looking into the vitrification cell, we see the location of some of the tanks, the remote crane here.

This is the melter. During installation in 1984, we went from concept to this, essentially a twinkle in our eye in late 1982 to realizing the melter's operation in 1984. I think it was a very progressive and aggressive program.

Here is the melter and these folks are bringing in the turntable, which is off to the side.

Looking into the melting cavity as it really is, this glass contact material here as the slope towards the bottom electrode with the two side electrodes and the bottom electrode, which I have mentioned. There are two discharge ports here and here. This white material is up in the plenum area where the slurry -- well, below the slurry, but in sort of the gas space.

Hanford had a great deal to do with this project. All of the equipment in the cell was designed by folks from Hanford. We also supplied these prototypic devices, the melter and the turntable to the project.

This shows essentially the completed equipment. It was operated, here is a concentrater, feed tank, the melter and turntable, as well as the scrubber, which is an HPWF operation.

This system was operated for four and a half years in an effort to validate the process design as well as qualify the process to produce the intended product for ultimate disposal.

After four and a half years, the melter has been destructively examined, which during that operation, I might add, it represented, they processed 35 percent of the tonnage that they anticipate. So it was quite representative of the overall approach. And with this, there was essentially no life threatening elements discovered, only a little of spalling here and there, which might be -- will be expected. So that this device shows that it can have an operating life well in excess of two years, maybe five to seven years.

Now, following this technology of slope bottom, bottom electrode, the Japanese jumped on board in the mid to late '80s. Here is a picture of the Tokai location, and here is the site of the construction for the Tokai vitrification facility.

This is an artist's rendition of the facility, which is, it is my understanding, they are currently in cold checkout phase operation.

Here is a schematic of the melter. They are not as large as we contemplate here for the United States, but has many of the same elements.

They have a strong preference for bottom drains, and that's the purpose for this slide. They are trying to discharge glass only through the bottom.

Meanwhile, back in Germany, they are

concerned with noble metals shorting out, has led them to dramatically increase their slope. This is an earlier version. I don't have a slide of the latter version. But this is going to 45 to 60 degrees. So as to discharge noble metals. This is a concern in burning fuel with high concentrations of noble metals.

So in the way of summary, the current state of art that I see for the technology is that for the newer plants, the sloped bottom, bottom electrodes are part of the design. For the Japanese and German preferences, a bottom drain is preferred, while the U.S. prefers the discharge system shown here.

In my opinion, the evolution will continue for this technology, so that more of its capabilities can be more fully utilized, and that is going to higher temperature operations.

For Hanford, with the large quantity of waste, a high temperature melter can double the waste processing rate by increasing the waste loading substantially. Say, up to 58 percent.

Some of the issues about the chromium, this is another dimension, with the current temperatures we are limited to about a half weight

percent. At 1550 we can get two weight percent chromium, it doesn't sound like much, but it is a factor of four. As well as when we increase the waste loading, we can achieve substantial repository savings.

In the minimum case, if there is 10 to 15,000 canisters, we might in the long haul be able to have that, and achieve a billion dollars savings, potential, for reducing the number of canisters shipped to the repositories.

So for these important reasons, they are important to me, I believe the technology will continue to evolve as the Department's and world's technology preference for vitrification of high-level waste. That's it.

ELLIS D. VERINK: Are there questions from the Board?

WILLIAM D. BARNARD: Bill Barnard, Board staff. How much waste is the West Valley? How much high-level waste will ultimately go into the repository?

CHRIS CHAPMAN: It is currently projected to be a nominal number of 300 canisters, but depending on how much -- there's a number other details that might kick that up a hundred or so. And whether Phase II, the cleanup of the facility which has quite a bit of TRU wastes, if it doesn't go to WIPP, it may go there. But specifically high-level waste, 250 to 350 should capture it.

ELLIS D. VERINK: Any other questions from the Board?

We have time for one or two questions from the audience, if there are any.

LINDA J. DESELL: This morning Dr. Price asked a question, and I did try and call on break to get the answer for that.

I believe you asked how did these specifications concerning the canisters interact with the requirements on the transportation cask designs.

Is that a fair statement?

At the moment, the design of the transportation casks for the vitrified high-level waste has just been transferred from EM to RW, and due to the schedule for the development of that cask, we can -- the impacts the specifications at the moment, or the specifications are not having tremendous impact on the design of that for the moment, because we're still, the schedule for this is a little bit off in the future, and we have time to get more information from Hanford, Savannah River and other places, to input into that design.

DENNIS PRICE: I would like to kind of ask a somewhat general question on an impression I have gotten from this morning.

I have gained the impression that a number of things have happened, maybe including unanticipated things that you are now dealing with because they were not anticipated at sometime by maybe another generation of people involved or whatever.

A couple times this morning questions about continuous flow causing like Plant B to be no longer viable, through-put questions. Now you've got fuels and oxidizers in the same tanks and you've got questions about stratification and a number of things.

And I guess the impression I've gotten is a lot of things have happened here that were not anticipated, and that this causes the activities pretty much which you are coping with, which you have inherited.

Is there something that we ought to learn from that, those of us who are professors in colleges of science and colleges of engineering, is there something that we're not getting across to prevent, or at least minimize the potential, or is there a general view in a laboratory environment that you plunge in and you work the problems out and that's what's happening, you've plunged in and now you're working the problems out?

Can anyone help my thought processes on this a little bit?

WILLIAM C. MILLER: Let me at least address part of that. Obviously, in the past here at Hanford the number one goal of the site was production. And to maintain that production capacity, decisions were made in terms of what to do with the waste that certainly were addressed toward minimizing the impacts on production.

And so we have taken steps, for example, with the single-shell tank wastes, that have done things to consolidate that material and mix it, so we have a number of different materials now and we don't have a good characterization on because we have not kept good track of what went where.

So we're now, if you will, faced with the situation of having to find out in detail what's in those tanks and how to deal with them.

DENNIS PRICE: But even the leaking tanks, part of that was unanticipated. You didn't expect to run into leaks.

WILLIAM C. MILLER: Certainly we didn't plan on tanks leaking, that's for sure. And certainly I don't think that the people who built and planned to put those tanks in-place and use the waste probably intended that they would be there in-service as long as they have been.

So, again, I think, partly what you see is a result of the priorities of the site. I think also just the fact that, you know, again, waste, treatment of the waste was of a secondary nature for the Hanford site.

Certainly in retrospect, I think we certainly could have done better in terms of being able to plan for what to do with the waste. In fact there were plans that were developed and for various reasons those were not always implemented, partly because the technology was not fully understood, and we had not made a decision in terms of what to do with those wastes. And as a result we do have a monumental problem in front of us in terms of being able to handle the tank waste area.

DENNIS PRICE: And some of the people involved presumably among the cream of the crop of our graduates who did not embrace in their views some of the problems which you're facing, and maybe there's something in the university procedure that produces these graduates that, you know, if you've got thoughts that we ought to be attentive to.

Is there something wrong with the way we teach our engineers and scientists that could be corrected, should be corrected, or is it just something --

WILLIAM C. MILLER: Well, I think certainly some of that has indeed happened. 50, 30, 40 years ago concern for the environment was certainly not as strong as it is today. I don't think we fully understood the implications of what we were doing. Or at least the importance that was given to the activities production and so on was so overriding that other activities were secondary.

But I think the concern for the environment now has really changed that a lot. And I do believe that certainly people now who make decisions here at Hanford, again, we take a systems approach. For example, pretreatment. The goal is to reduce the number of canisters.

But if in the process we increase the total amount of waste here at Hanford, then that may not be the best solution.

So we are really taking a much broader perspective, and I think we have, as a society, become much more familiar with the consequences of these -- the long-term consequences of these decisions and we are trying to evaluate that now in terms of our processes to clean up the Hanford site.

So I think really, if there had been a problem in the educational system, it has been corrected, and I am not sure it was an education problem anyway; I think it was more of a society thing.

ELLIS D. VERINK: I think we should call a halt for a moment to the morning session. We will reconvene at 1:15. Thank you.

(Noon recess).

(Afternoon session).

ELLIS D. VERINK: Well, let's get underway. Tom Weber is going to be our next speaker.

E. TOM WEBER: My name is Tom Weber. I am with Westinghouse Hanford Company. I am in a position of managing the technology function for the Hanford Waste Vitrification Project. We perform the technology function for the HWVP with Westinghouse, providing the project basis and integration and requirements, and with Pacific Northwest Laboratory performing the majority of the technology activities that we need for the HWVP Project.

So we will be referring in many cases to the developmental basis for HWVP to work that's being performed by Pacific Northwest Laboratory.

In the topic of waste form qualification, I'll be reviewing with you in summary form this afternoon the basis for the waste form qualification process derived from the Department of Energy's waste acceptance process. This will be a review I think for most of you. But we will status the HWVP in that process at this time.

I will give you an overview a little bit of a repeat of some things this morning, perhaps with a little bit different cast in relation to the basis to pursue compliance with the waste acceptance process and our approach for HWVP. And some of the technology activities and schedules that we have in the current project in order to complete the basis for waste acceptance compliance.

I think most of you are probably familiar with the waste acceptance process that has been established by the Department of Energy in the interface between the Office of Civilian Radioactive Waste Management and the Defense Waste Management Organization, currently the EM organization.

The specifications that have been developed in that context consist of the generic specifications which are available for reference, are in draft form.

The waste acceptance preliminary specifications, which were prepared for the Savannah River DWPF project and issued as OGRB-8.

There is also a waste acceptance

preliminary specification that was formally issued

for the West Valley project. As was mentioned this morning, for the Hanford Project, we have been using the Savannah River specifications as a surrogate, up to the 1990 time frame, and moving into -- up to 1991, when the specifications were updated, a draft was submitted for review in the interface between RW and EM, and we have been utilizing those draft waste acceptance preliminary specifications as the basis for our strategy, our planning and for the preparation of our compliance documentation.

With respect to the HWVP, at the present time we have prepared a waste form description document which has been issued. That document addressed the double-shell waste types that were described this morning by Bill Miller.

That has put us in a position to prepare a waste compliance plan which we have now completed in draft form at a point where we are working the waste compliance plan documentation within the project.

Our schedule for issuing that document for review outside the project is in the fiscal year '93 time frame at the present project schedule. But we are at the stage of actively

preparing a waste compliance plan.

This plan, of course, identifies how we would intend to meet and comply with the waste acceptance specifications as defined in this particular document. That would be followed by the preparation of a waste qualification report which would provide evidence and documentation of our ability to meet the specifications consistent with our approach as defined in the waste compliance plan.

I think the Board is aware that the DWPF project at Savannah River at the present time is preparing the waste qualification report packages and submitting them to the review process that has been established within the DOE organization, combining the DOE EM and RW participation for formal review of that documentation.

After satisfactory acceptance of the waste qualification report, would lead to the production of radioactive glass. And during that production phase the production records, in combination with the waste qualification report data, would be the basis for product acceptance by the repository.

Again, a summary overview, just to

establish a context for our discussion of approach. This is a summary of the major elements of the waste acceptance preliminary specification, the 1991 draft that we are currently using.

You're aware that there is a Section 1, which deals with the waste form itself and which contains the specification elements dealing with the glass, the borosilicate glass product.

The chemical composition, the radionuclide inventory specifications require the producer to report to the repository the compositions as required by those two specifications. It does not impose limits, but provides a requirement for reporting that information within certain limits and with specified -- with uncertainty specified by the producer.

The product consistency element is the specification which provides for testing of the waste form and demonstrating that has durability that is better than a reference glass which has been defined as the environmental assessment glass that is part of the Savannah River NEPA compliance documentation.

Phase stability applies to specifying the crystalline characteristics of any such phases

in the glasses, and also provides for a temperature control limitation with respect to the glass transition temperature.

The canister specifications relate to the material of construction for the steel can which will contain the glass, and identify requirements for fabrication and closure and identification of the canister.

The specifications in Section 3 of the WAPS identify characteristics of the canister waste form, relate to the exclusion of the sterile, consistent with 10 CFR 60 requirements. They provide for efficiency of canister fill in relation to the repository, space ultilization, it provides for handling characteristics and maximum radionuclide-based characteristics. They involve dimensional features and other handling and integrity features associated with handling the canister in the facilities that would receive and implement final disposal.

Now, with that summary review of the nature of the specifications that we are working to, I would like to drop over into the process features of HWVP and highlight the aspects of our process features which we see being related to

compliance with the waste acceptance specifications.

This overview reflects the requirements for the HWVP process that were identified this morning, to get the waste into the plant, make the glass and get it into the canister, put the canister into storage until such time as it can be shipped to off-site to a repository, and with a capacity of 100 kilograms of glass per hour, nominal production capability for the melter system.

This is another way of viewing the process flow through the feed preparation and canister fill stages of the vitrification process. This is similar to slides that you have seen this morning.

The waste, when it comes into the plant, comes into the initial stage of concentration capability. The waste is heated to boiling, formic acid is added in order to establish a redox state and start reducing some of the nitrates and carbonates and some of the other components in the waste.

After concentration, through the first stage to roughly a hundred to 120 grams of waste

oxide per liter of slurry, the slurry is transferred to the slurry mix evaporator stage. That's the stage where the frit is added and the chemical adjustments are performed.

The critical control region for glass composition is represented by this dashed line, the box that surrounds the slurry mix evaporator, the melter feed tank and the melter, are the focus for the process control.

The release of a batch from the SME to the melter feed tank does not occur until the batch has been analyzed and found to meet all criteria for producing an acceptable glass. When those criteria are satisfied in the process control, the batch is transferred to the melter feed tank where it is maintained in a homogeneous condition for feeding to the melter so that the melter then is fed continuously and glass is poured continuously into the canister.

The process incorporates a recycle stream which represents a component of the melter feed stream in addition to the waste slurry and the frit.

Yes, Doctor?

ELLIS D. VERINK: I've heard

reference to taking of a grab sample from that. Where would the grab sample be?

E. TOM WEBER: The reference to a grab sample refers to the pour stream exiting the melter and pouring into the canister. In the connection that is made between the melter and the canister, there is a throat protector and a bellows connection which provides sufficient seal to maintain the canister at a negative pressure relative to the melter plenum. And it is that negative pressure which forces the glass from the glass pool, over the overflow to drain into the melter.

That device, that bellows device, comes in two versions. One is strictly a bellows that is a simple closure. The second design is a bellows which contains, built into it, a sampling device which allows one to insert a crucible, or a small cup, into the glass pour stream and then withdraw it from the pour stream, collecting a glass sample which then cools and can be retrieved, once the bellows is disconnected from the canister.

The canister is rotated away to make room for the next one.

ELLIS D. VERINK: That would be

done, what, once during each melt?

E. TOM WEBER: The sampling of the glass stream in the process control scheme that we're planning to use for HWVP is similar to the purpose of the sampling of the glass stream that Savannah River has defined in their process control stream, and that is as a basis for verification. The use of that grab sample varies, depending upon the degree to which verification is felt to be needed.

For example, in the initial stages of process verification in cold testing at Savannah River, they will take a grab sample for virtually every canister. This is during the cold testing of the facility. Savannah River has indicated that they will take a number of grab samples when they start up the facility in their initial phases of hot operation.

However, when they get to equilibrium production in the facility, they have identified an intent to do a minimum of one grab sample per thousand -- or per macro batch, which they define as a one million gallon tank of waste prepared as feed to the vitrification plant.

ELLIS D. VERINK: That would be

taken before they would make any pour, or would that be midway in the pour, or when would it be?

E. TOM WEBER: Well, that's strictly at the discretion of the operator. It's a manual -- It's what would pass for a manual operation in a completely remote situation. In other words, the operation of this grab sampler system is based upon the use of a master slave manipulator to insert and remove the cup.

ELLIS D. VERINK: But the control is going to be on what's in the SME --

E. TOM WEBER: It is in the feed batch, in the feed batch.

ELLIS D. VERINK: That's where the frit has first been added to the waste, is that right?

E. TOM WEBER: Every component that will be fed to the melter has been added at this tank, the slurry mix evaporator, when the batch is ready to be sampled to determine its adequacy within the process control system. So it has everything that's intended at that point.

ELLIS D. VERINK: The difference in composition between that and MFT, then, is what?

E. TOM WEBER: None. It's strictly a transfer from this tank to the melter feed tank.

ELLIS D. VERINK: Why do you need the melter feed tank?

E. TOM WEBER: The melter feed tank provides a means of staging feed in a consistent and dedicated manner to the melter. In other words, there's no batching, there's no adjustment operations. There's nothing that is done to the batch in this tank, except maintain it in a homogeneous condition and feed it to the melter.

By doing that, one has the opportunity to batch to specification in the SME tank, and even to make adjustments if they are necessary in the chemical composition to bring the batch in to the control point, while maintaining a continuous flow of feed to the melter from this tank.

ELLIS D. VERINK: Now, you say it's

a continuous flow to the melter?

E. TOM WEBER: Right.

ELLIS D. VERINK: It doesn't go in batch by batch?

E. TOM WEBER: Well, batches are established in the SME. Then they are staged to

the melter feed tank. Then they are fed continuously from the melter feed tank.

ELLIS D. VERINK: I see. And is it the grab sample that gets tested in the corrosion test, so-called?

E. TOM WEBER: Well, yes. The grab sample provides a basis to do compositional analysis and also to do the product consistency test, the durability test, of the actual waste.

However, the plant and the process control system are intended to be fully qualified, such that one will have sufficient qualification of the relationships between composition as defined at this point and the properties of the glass, and with the use of appropriate models containing the property composition correlations, one can adequately define the composition of the glass in the canister, based on the information obtained at this point (indicating).

ELLIS D. VERINK: Rumor has it that sometimes the glass, after it's cast, is not considered suitable. It must be based on the corrosion test.

Can you conceive of how that would happen?

E. TOM WEBER: Well, I think it would be interesting if we could establish the basis for the rumor.

ELLIS D. VERINK: Yeah. I think so, too.

E. TOM WEBER: Because the purpose of the program that the Savannah River people are running in their integrated DWPF Miller system, their pilot scale test system, they are producing glass on a regular basis, running a scaled process system.

And they are demonstrating routinely that they have control by sampling at this point of the composition of the glass that they are producing, and they are doing sampling and characterization of the glass in relation to the characterization performed at this point.

Based on your earlier reference to that

rumor, I did at noon hour call John Plodnick at Savannah River, and I asked if there was experience that they had published or reported of producing a glass that was not acceptable under conditions where their sampling had indicated that it should be. And he indicated that they had not experienced that condition and that none of their data that

they would regard as applicable to qualification of the process had ever indicated that kind of problem.

They have reported a case in work that they have done in the hot cells where they were batching with actual radioactive waste to produce a glass, and under the circumstances they were working with in their developmental laboratory hot cells, their analysis showed that the batch that they had made up would not produce an acceptable glass.

They went in and added chemical adjustments, utilizing their process control model system to tell what they needed to do, and they compensated, established an acceptable glass -- or an acceptable batch, and then produced an acceptable glass.

ELLIS D. VERINK: I'm glad to hear that. But the word we got was that there were a number of canisters that were set aside as not being -- they were in never, never land, they couldn't be put in their storage area or anything else, because they didn't know what to do with them.

E. TOM WEBER: I think that is a point that we should follow up specifically with Savannah River. My understanding is that they have metallic canisters that were procured from the vendor --

ELLIS D. VERINK: Maybe that is what it was. --

E. TOM WEBER: -- that they do not have a full quality assurance certification, that would meet their criteria for using them in the actual production process.

ELLIS D. VERINK: Uh-huh. I think it would be important to get that straightened out.

E. TOM WEBER: I think perhaps we need to work that in the interface with the DOE and the EM people to make sure that the Board has the correct information on that.

JEFFERY M. ALLISON: Dr. Verink, I think where we are getting a little bit confused, that what you're talking about is the empty canisters that Savannah River went out and purchased, about 120 of these empty stainless steel canisters, and we went back and looked at them and found out that they did not meet the draft waste acceptance specifications for certain constituents

in the stainless steel.

And so they have set those canisters aside. They are looking at using them in their test facility. But they will not, since they do not meet the WAPS, use them in the full scale DWPF system when they go radioactive.

And we are working with them right now, as well as the RW folks from a Q.A. standpoint to make sure that we don't have that problem again.

But, as far as Tom mentioned, as far as the glass, we don't have any indications that there are glass being poured that will not meet the specifications without some adjustments. I think Tom is consistent with that.

ELLIS D. VERINK: As long as you can get that straightened out.

JEFFERY M. ALLISON: Yes. I think that misunderstanding was the canisters and whether that has to do with the actual glass. But there is an issue with the canisters at Savannah River, but not the glass, as far as we are aware of.

ELLIS D. VERINK: I will be glad to have you get that straightened out.

JEFFERY M. ALLISON: I will try to, yes.

DENNIS PRICE: As I recall, that trip we made, the statement was that if you pour the wrong, an unacceptable glass into the canister, you've got that canister on-site because you can't do anything else with it. And so my impression was the glass was in the canister.

ELLIS D. VERINK: That was the impression I had.

E. TOM WEBER: Well, the DWPF facility has not operated --

ELLIS D. VERINK: This could have been from the pilot plant, because they are still building the big one, I guess.

E. TOM WEBER: That's right. That's right.

ELLIS D. VERINK: Presumably that is what it is from.

E. TOM WEBER: The discussion concerned the necessity to exercise complete control at the point of releasing this batching to the melter because once that batch has been released to the melter and the glass is poured in the canister, then you have that glass for whatever property and composition you have indeed produced.

And if there is an issue with respect to certifying that glass with respect to, and it would be primarily the property requirement associated with the specification for durability, then one has to deal with that on a non-conforming case basis, and I think one would have to evaluate that glass and its characteristics to determine whether those deviations would in fact be acceptable or not acceptable for placement in the repository.

ELLIS D. VERINK: It puzzles me a little bit why the composition for final certification isn't taken from the melter, the last point before casting, rather than at an upstream point.

E. TOM WEBER: I think that is a feature of engineering a high capacity, relatively high capacity facility, which is necessary to deal with the volumes of wastes that the defense, the DOE defense program has accumulated, in the context of a totally remote operation. And sampling of the melter system, of the glass as a routine basis, would be a very challenging situation for a high capacity production activity.

The capability exists to sample, as we

have discussed, the intent of the programs, is to demonstrate that that sampling is incidental and provides verification, but the control can be maintained by controlling what is fed to the melter and only feeding those compositions that will make an acceptable glass.

The other point that I wanted to bring forward with this slide is that we do have the melter offgas stream, the steam and volatile components which come off the melter are carried into a recycle stream that involves ion exchange and filtration to capture -- ion exchange for cesium and strontium and filtration to capture transuranics, which are then brought back into a recycle waste collection system, and after concentration, are fed back into the batch.

So that we have a three component glass batching situation. Savannah River also works with a three component glass batching situation.

In our case, the fresh frit is the same component that Savannah River is using and the fresh frit is added at the same point in the same way of the process.

The HWVP pretreated feed is our waste sludge.

The third component is a recycle stream which is based upon that internal process. Recycle system contains primarily oxides that are part of the glass formulation, and it represents nominally three and a half percent of the total feed, but it can range between 0 and 7 percent.

This would be analogous with the third component, which is the pH screen at the DWPF.

JACK PARRY: Mr. Weber, Jack Perry of the staff.

Could you tell me approximately the weight percent fission products and actinides?

E. TOM WEBER: The weight percent?

JACK PARRY: Yeah. You've given us

percentages of frit and feed.

E. TOM WEBER: The fission products and actinides will vary depending upon the particular waste stream that we will be processing.

Typically, the fission products and actinides will be in the 10 percent or less range for the glass components. They represent minor components for the glass formulation and with respect to effect on the glass properties.

In the final stage of the waste form production, this just represents the handling of

the canister once it has been filled with glass. There is an inner seal which is added after the glass has been poured.

This process is essentially an equivalent in terms of the flow sheet and the process systems to that which is currently being implemented in the DWPF plant. We are using the same designs for the canister, for the canister inner seal, for the preliminary and the final canister decontamination, decontamination uses a frit slurry which is prepared under pressure onto the canister surface in an abrasive cleaning operation.

After cleaning, the canister is smeared

to determine that it is acceptable to move on through the process, meets the surface contamination criteria.

It then goes to the welder system. The welder is the resistance upset, weld system that is being used in the DWPF facility, and from there the transport after inspect to storage is in a similar transport to that being used at Savannah River.

We've been talking in commentary about the features of the approach to compliance that we

will use with HWVP, and I think there has been sufficient reference in the discussion that everyone here is aware that we are making major use of the DWPF process system features, and also of the approaches for process control that DWPF is applying in their facility.

The general principles are that we will control the glass properties by controlling the glass composition. We do depart from the DWPF approach to the basis to develop and define our glass formulations.

We are working with a compositional variability study to establish property composition correlations, and that's the subject of the next talk this afternoon so that you will be seeing quite a bit of detail about that compositional variability study.

That is the basis on which we will define a qualified composition region, and we will select glass compositions within that qualified region. We will match glass compositions to waste compositions through a process that we refer to as feed processibility assessment.

And we will then use product control models which will give us a basis for relating

compositions during the process to the acceptable composition envelope in our target compositions.

To establish compliance, we will be using a series of developmental testing activities and scaled testing, ranging through small scale, pilot scale, then into the HWVP full plant testing. We will have the benefit of the DWPF experience in starting up their systems and qualifying their systems during cold operation and also in hot production experience, as that type of information is expected to be available to us as we put together our compliance basis information.

And then at the point of hot production

data which would verify the capability of our systems would be reported.

There are various areas where we are depending directly on the qualification established by Savannah River. Particularly in the area of the canister, since we are using an identical canister design and equivalent specifications. And equivalent systems for canister handling.

We intend to utilize the data generated by the DWPF project and submitted in their waste qualification report as applicable to the HWVP qualification requirements for those

systems.

We then make adaptations of a number of features of the compliance approach by DWPF especially and also West Valley with respect to the chemical base, the radionuclide base, the exclusion of undesirable materials.

What we will do is take the model that the other projects are using and the general features of their strategy and we will adapt it to our waste and our situation and we will produce that data which would be sufficient to demonstrate the ability to comply for our particular waste compositions and characteristics, so that that will apply then to these other specifications.

We have already discussed composition considerations and the fact that the product composition control is a significant feature.

The product composition control is relevant to compliance to this group of specifications which have various requirements to report information having to do with composition radionuclide content or where there are specific limits to be observed. And utilizing the composition variability study within this process control context, we are establishing with it

correlations of properties and composition, and specific examples of the status of those correlations will be provided in the next presentation.

But in general, the features are that we have identified 10 major components, and are in the process of demonstrating that those 10 major components are a sufficient basis to define control for the glass properties.

There are multi-component constraints which are incorporated in these criteria. The property correlations are based on three properties which relate to the ability to produce the glass. The liquid dust, the viscosity and the electrical conductivity, and the one property that is specified in the waste acceptance specification is that of the product consistency specification, based on the PCT durability test.

What we obtain with the CVS is an envelope within which we can select acceptable glass compositions, and in accepting glass compositions we, by having the waste composition as a given, would utilize the CVS as the primary means of identifying the frit compositions that we would add to formulate our production glasses.

Schematically, I think this is a diagram which is familiar to many of you. It represents the consideration of those property relationships that constrain the processing capability for producing the glass and that would provide an envelope of compositions within which the properties would be acceptable to meet the production basis.

And let me comment here, that a number of the constraints that Bill Miller mentioned in the pretreatment presentation with respect to those components that were being looked at as limiting the waste loading, are in many cases related to the ability to produce the glass. They are constraints with respect to being able to process the glass through the melter, and implement a continuous processing for the glass. They're not necessarily related to the acceptability of the glass, as it relates to the repository specifications, or the waste acceptance specifications.

The envelope related to the waste acceptance specification is established by the specification 1.3 on consistency, product consistency. That envelope, when overlaying with the processable envelope, provides the property

region that we refer to as a qualified region.

All compositions that would fall within this region should be producable and should be acceptable.

When we have a specific waste to produce glass with, we would use that waste composition as a given, utilize the composition variability study to define a target composition, and then we would recognize that there are plant operating limits that would be established for acceptability and that there would be some variability expected. But in all cases, that variability and those limits would fall within the range of acceptable properties.

I referred to a feed processibility assessment, which is the process that we have established programmatically to systematically assess the current feed characteristics and the kinds of glasses that we could produce from the characteristics of the waste that exist in the tanks.

We combine with the CVS the waste information to determine what kind of glass we could produce. We also assess implications of waste components to the operating basis for the

plant, things like potential for corrosion of plant systems or other features which aren't related to acceptability of the waste product are assessed as part of this process, and we end up with a basis to provide feedback on constraints to pretreatment that would derive from our ability to make an acceptable glass from the material that's fed -- available as fed to the vitrification plant.

This schematic depicts that process,

starting with the characterization of the waste that would be based on the core samples that were described to you this morning for which the characteristics of waste in the tanks would be obtained.

That characterization gives us a best estimate for the tank waste compositions. Then those tank waste compositions would be fed into the pretreatment flow sheets. The pretreatment flow sheets would be defined through the development process that Bill Miller described to you.

Once those flow sheets and the waste compositions are brought together, we then obtain a best estimate of the pretreated feed composition

for any given waste tank after it's been processed and prepared as feed to HWVP. We take that information and do a glass formulation assessment, and we also assess the implications of that need for all aspects of the plant operation, and we conclude with an HWVP processing capability for that particular waste feed.

That conclusion could in fact say that there needs to be some constrain fed back to pretreatment. At least they need to be informed of a constraint wherein if we are limited by some component that this pretreatment flow sheet would give us in the feed, we may be looking at a need to reduce the waste loading in order to accommodate it.

By observing this feedback, there is a basis for doing economic optimization, between whether it is better to pretreat at a preliminary level and accept more glass canisters, or whether the economics would drive you to a more sophisticated and presumably more costly pretreatment in order to make fewer glass canisters.

So this is the process that we invoke within our program to establish the basis to process.

We have done this assessment, our initial assessment of this kind has been performed for the four double-shell tank waste types that were identified this morning which had been the basis for the HWVP program and plant design up to this point. We are at a point of initiating the work on the initial single-shell tanks that would be fed to HWVP.

In order to give you something concrete

to see in the way of the kinds of results that derive from this feed processibility assessment, these are the 10 components that the CVS incorporates. These are the four waste types, double-shell tank waste types that were described this morning.

This represents the composition of this major component in the glass that exists in the pretreated waste, based on our best estimate after reviewing the pretreatment flow sheets.

By taking this information and utilizing the composition variability study correlations that Don Larson will describe to you in just a few minutes, a frit composition was derived that's represented here.

When that frit composition and the

waste composition are combined, we obtain a set of representative glass compositions that are shown for each of the waste types, and utilizing the composition property correlations that are available to us at this time, we can define the property values that we would expect for these processing properties and for the PCT, and also we can indicate a waste loading.

Now, one point that I would like to

have you appreciate is that our nominal waste loading target for the glasses in HWVP is 25 percent waste loading.

You can see that based on exercising this formulational approach, we have some variations in the waste loading that we had actually obtained.

The NCAW, which is our initial waste type and has been our reference basis for a lot of the development, we're showing a 26 percent waste loading.

For the NCRW and the PFP, we're showing a 22 percent waste loading. And that's a limitation that results primarily from zirconium alumina with respect to accommodation for processability.

And then you can see that the CC waste composition that was analyzed gave a very high waste loading, because that particular waste was very high in silicon. So it was not necessary to add as much of the glass formers, in the form of a frit, and therefore we get a very much higher number.

So the point is, we will be

essentially defining a formulation for each of our waste types and we will be working to optimize that waste formulation within the various constraints.

ELLIS D. VERINK: How big a batch would you be dealing with? That's a batch by batch thing?

E. TOM WEBER: Well, actually, there are two tanks of NCAW waste, there are five tanks of CC waste, there is one tank of PFP waste and there is two tanks of NCRW waste. So these wastes would be pretreated and we would expect that we would be dealing with some combination of blending for the waste within -- from different tanks within each waste type.

ELLIS D. VERINK: Uh-huh.

E. TOM WEBER: That would depend

on the details of the staging through pretreatment.

In order to carry forward, the basis to project our glass compositions and exercise control and processing will be using modeling. We will be using models which will be derived based on the CVS work. They will provide us with a capability for projecting glass composition, based on the process stream samples and mass balance model that would reflect the tank measurements in the process, and they would incorporate features which would rationalize the analytical errors and the analytical uncertainties associated with the glass analyses and the feed analyses.

Now, there's a number of points at which data in a number of key data components that would be utilized in this modeling, starting with the preparation of the waste in the early stages, what comes in to the plant, the recycle stream, the frit compositions.

These compositions fed into a projection of what one would expect at the batching point in the SME, and then utilizing the actual sample analyses from the SME, the tank level, relating all that data to the target

composition that's been established from the CVS within the envelope, and then feeding onto the melter feed tank, which is sampled. It is sampled primarily as a basis to obtain additional verification in the production records. And then the parameters for the melter that would be incorporated in these process control modeling capabilities.

I think you've been exposed to the process control, composition control system models that the DWPF is using. PNL will be developing it themself similar to~the PCCS for the HWVP that recognizes the specific features of our approach which I have just described to you.

We will be doing confirmation testing. We will be doing testing based on scaled, developmental system with non-radioactive simulants, including one-fiftieth scale, one-tenth scale and roughly half scale demonstration level. There will be full scale data obtained from a full-scale feed processing tank system which can be used for testing, and you will see that tomorrow on your tour of the PNL facilities.

The HWVP will be run in a qualification mode with simulant feed and the DWPF

experience with simulants will provide a further data set for our use with radioactive feed.

We will be performing scaled system testing started with the laboratory crucible melting of materials from core samples from the actual waste made into glasses, and you will hear about our initial radioactive glass production this afternoon in the presentation by Gene Morrey.

We are projecting in our program a bench scale, an integrated capability of feed preparation and melter at one-fiftieth scale which would go in a hot cell and which would be used to demonstrate our ability to produce acceptable glass with actual pretreated prepared radioactive feed.

And then DWPF's experience in producing glass in their hot cell systems, as well, would be then combined with the full scale production capability that would be evaluated when HWVP goes into production and with the DWPF experience for the radioactive glass production.

The timelines for these activities are shown here. I am not going to spend a lot of time. But we are just showing that we are doing scale

testing.

The LFCM slurry integrated test is a slightly less than half scale testing capability that we're currently in a position to utilize for processing tests.

We are currently doing radioactive

glass testing in the laboratory. We are currently doing model development. We are currently doing glass composition envelope development.

You can see that these activities stage into a basis to feed data to our waste form qualification report, our waste compliance plan which defines our compliance approach, would be expected to be in review process starting in the '92 or '93 time frame. I am sorry. Review starting in the '93 time frame, and then putting us in a position to complete the waste qualification report and to incorporate the actual HWVP, pre-operational testing in a manner that's directly analogous to Savannah River's plan for incorporating their waste -- or completing their waste qualification report sections.

So in summary, we do gain considerable technical basis from the other vitrification projects, and thus see a considerable saving with respect to the full range of things that we might have to do, did we not have the experience and the lead to follow from these other projects.

However, we do have unique characteristics to our wastes, so we will have unique features in our processing. We will be following a means of obtaining glass property control that uses our unique correlation approach and establishes a basis to define compositions that we can certify as acceptable, and we will be using the scaled testing sequence and the testing in the plant facility itself to provide the data to verify that ability to control our process.

Are there questions?

ELLIS D. VERINK: Maybe one or two.

DENNIS PRICE: Do you have the advantage of a failure modes effects analysis on this process? Have you performed a failure modes effects?

E. TOM WEBER: There has been a failure modes effects process, or analysis performed on the plant systems as part of the design process. There are various features of that that would be relatable to the process control

features for our glass process control. That failure modes effects analysis that addresses specifically the glass process control has not been performed.

DENNIS PRICE: With what

information you have about failure modes or perhaps even what intuition you have, what is the worst case failure mode, in your opinion?

E. TOM WEBER: Probably -- I guess I would say that the worst case failure mode might be derived from loss of homogeneity of the feed, such that in relation to having established a composition that you know is acceptable, that at the point that it would be ready to be fed to the melter, you would end up with insufficient agitation to assure that it was homogeneous, when fed to the melter.

So that would be, you know, a very -- the basis to monitor and assure that agitation is fully effective, would be a very critical element of process control in the plant.

DENNIS PRICE: Is there a mode in which the melter, and I have forgotten the terminology, where you mix, would both be at capacity, at full, so that your alternatives for

correcting a failure in the mix are pretty well taken away from you? Do you understand what I am asking?

E. TOM WEBER: Yes. And I think that would have to occur in terms of having a SME batch which was a full batch, which you could not correct through simple chemical addition.

And I think in that case the plant would be in an upset mode. That batch would have to be transferred to a separate hold tank, to a spare tank, and then there would have to be remedial action with respect to reworking that batch to bring it back into an acceptable configuration for the target composition.

DENNIS PRICE: Have those back-out design features been --

E. TOM WEBER: There is spare tankage, yes.

DENNIS PRICE: How about failure of the melter and how about overfill, spills, overflow spills, things like that?

E. TOM WEBER: Well, certainly the control of canister fill is a critical feature of the melter pour systems.

The approach that is being taken will

incorporate redundancies. The canister fill level system that HWVP is designing is a gamma source system which will provide a sensor array that where the gamma tenuation from the glass as it fills the canister will indicate the level in the sensor array.

There is also a weighing system, a canister weight system, and there is also the thermal characteristics. When the glass goes into the canister, it turns red very rapidly at the level that the glass is being -- at the level that the glass is entering the canister, where you have it in contact with the walls, it's getting red very rapidly.

DENNIS PRICE: And in your pouring process you have a containment for the amount that should go into the canister and then that's isolated from the rest of the melted --

E. TOM WEBER: Since the pouring process is driven by pressure differential, the control of the pouring process is through this differential pressure, the vacuum that is maintained on the canister.

So, you know, that control is kind of an instantaneous thing. If you relieve the

pressure differential, you stop pouring.

DENNIS PRICE: So you don't have a physical containment of the amount that should go into the container before you start the pour?

E. TOM WEBER: No. No.

DENNIS PRICE: Wouldn't that be a good idea?

E. TOM WEBER: Well, --

DENNIS PRICE: So that all you could possibly get out of it is the amount that is to go into the container.

E. TOM WEBER: That would significantly constrain your production capacity.

DENNIS PRICE: I don't see why. It just has to do with the pour itself.

E. TOM WEBER: The configuration, Chris Chapman showed you this morning the configuration of the liquid fed ceramic melt.

The system is designed to provide for pour control, either through a bottom drain by an on/off of the bottom drain, or through the overflow by the pressure differential, and the application or removal of that pressure differential. It's expected to be a sufficiently reliable control that one can control the level of glass that would be

poured into the canister.

DENNIS PRICE: Well, it's just -- that may be true with the redundancies you are talking about, if you start looking at the reliability numbers. I just don't know.

But it would appear to me, a real simple thing, from the melter, there is a release into a containment cavity of some kind that is the amount that just goes into the canister. And then when you start the vacuum process, you simply can only draw that amount and nothing more. And it's a physical thing.

E. TOM WEBER: Well, I don't think anyone would argue that one could design a chamber with, you know, the attendant complexity and space and other features that it would require.

DENNIS PRICE: You see, I just did it in my head, because I misread your drawing that I saw up there a while ago. I thought that was in the design, so I looked at it incorrectly.

E. TOM WEBER: The glass pour is directly from the pour, either through a tube representing the overflow configuration or through an orifice representing the bottom drain.

ELLIS D. VERINK: Well, thank you

very much. I guess we are a minute or two behind. Don Larson is next. Thank you very much.

DONALD E. LARSON: I'm Don Larson,

Senior Technical Advisor to the PNL HWVP Technology Development Program.

I will be describing the Glass Envelope Definition Program which Tom was referring to, and which also has been referred to as the composition variability studies. The chief architects of the studies and principal investigators are here, Dr. Bill Hrma, our principal glass scientist, and also Greg Piepel, who is the principal mathematician on the project.

The objective of the study is to provide validated and verified models that will describe glass properties as a function of composition so that a high quality consistent product could be produced that is compatible with processing in the plant.

The properties that we are interested in are properties that have to do with waste processing and also acceptance at the repository.

One of the principle properties is the melt viscosity which affects the glass transport, and we will be measuring and modeling this

property.

Also we have the melt electrical

conductivity, which has to do with the joule heating in the melter itself, which we will also be measuring and modeling.

The liquidus temperature is the maximum temperature at which the melt could be at equilibrium with solids, and we will also be measuring and modeling the liquidus temperature. And the reason that that is important, if you have a lot of solids in the melter, they could settle out and affect the melter operation.

Phase separation, we will be monitoring that during studies. And what that is is we do not want any molten soft phases separating out, such as phosphates or sulphates or molybdates which could affect the melter operation. We will not be modeling that. We will be monitorin it. It's not felt, deemed necessary to model that particular property.

The processing characteristics. We have a companion testing program with melters that we are looking at the processing rate and processability within the plant of the glass to assure that we can achieve appropriate production

rate and that the glass will not foam. The test facilities for doing that work you'll see in your tour tomorrow.

We are also interested in the properties that have to do with waste acceptance. The composition is being handled in another part of the program, but it will draw heavily from the composition variability study that I am describing here.

The durability of the glass will also be measured and modeled. We are looking at two different durabilities. One is the product consistency test that Tom referred to, and that is part of our plant product quality control program.

And also enables us to compare our product quality with a large database that is currently being generated. We are also measuring the glass durability using the MCC-1 test. And the reason that we are using that particular test is because there is a broad database for glass durability using that test so we can compare our product with that database.

We are also measuring and modeling the glass transition temperature. The glass transition temperature is basically the softening

point of the glass. And if you allow the glass temperature to rise above the softening point, there is the potential that the glass devitrification could accelerate.

We will also be doing time/temperature transition studies to look at the glass crystalline characteristics as a function of time and temperature and also properties of the glass that are affected by crystalline formation.

The devitrification I have already addressed.

The idea behind this effort is to provide the capability that we can formulate an acceptable glass from a wide variety of waste composition. The waste that we are centering the studies around are primarily double-shelled tank wastes but with modification to the approach that we're taking, not even modification, expansion to the approach that we are taking, with different elements, it is also applicable to the single-shell tank waste.

Currently we have 10 different elements that we are looking at. These are indicated here. They represent the principle constituents that are in the double-shell tank

waste. We do have one component which we call "others," and this has the minor constituents in the waste that constitute a small weight fraction. But it gets those in this study.

The approach that we're taking to the study is outlined here. And what we have done is with waste characterization information, limited pretreatment information and a series of scoping studies that we have done, we've statistically designed an approach for testing to enable us to do the modeling of the properties as a function of composition.

The additional elements of the approach I'll be dealing with as I go through the presentation sequentially.

The models or equations that we are fitting include Fulcher's equation and what we're doing there is determining the melt viscosity as a function of temperature and composition.

So we do have temperature effects in that particular property. We are also fitting the Arrhenius equation, which gives us the melt electrical conductivity as a function of, again, composition and temperature.

For the balance of the properties,

we're using empirical equations, both first order equations and the second order equations.

The first order equations basically requires less information and it gives us a heads up on how the study is going.

The second order equations require more data, but if you have the data, it generally gives you a better fit and it will give you an indication of how the different components interact with each other.

To date we have looked at compositions that are within the acceptable region, outside of the acceptable region and around where we perceive the boundaries of the acceptable region is going to be. And as a consequence of this, we've had acceptable properties and non-acceptable properties that we have measured.

To date we have tested 81 glasses. We also have another 40 glasses that are being tested. Several of the glasses that we have tested are specialty glasses to give us a little better, more accurate representation of the particular types of glasses that we may encounter from different wastes.

I will start getting to the bottom

line as best we know it at this point in time and touch on some of the results to date. What we have here is to give you a feel of how good our models are fitting the information that we are getting.

What we have down here is the predicted properties of the glass, and then along the vertical axis. Along the horizontal axis, we have the measured properties of the glass, or a pseudo measured property. Now, when I say pseudo measured property, what that is, for the electrical conductivity of the melt and the melt viscosity, for each glass that we tested, we determined the viscosity and electrical conductivity as a function of temperature.

Now, that temperature, or we may not have had 1150, exactly that temperature that we tested at, but we had it close, and then we fitted a line to the viscosity and electrical conductivity information, and then off of that fit we took the value of electrical conductivity, or viscosity at 1150, and that is our pseudo data for that glass.

As the R square statistic here, is a measure of how well the fit accounts for the variability in the data.

Now, Greg won't completely agree with this, but -- well, it's not totally accurate, but I kind of look at it, is how good is your fit, and 1.0 is an excellent fit, and as it goes down, the fit is not as good.

As you can see, the predicted information -- the predicted melt viscosity agrees with the pseudo measured melt viscosity very well.

DENNIS PRICE: Is that R square to Pearson product moment?

DONALD E. LARSON: I don't know. Is that a Pearson product moment?

DENNIS PRICE: You identified the other two.

HUGH BENTON: I'm sorry. I didn't hear the question.

DENNIS PRICE: Is the top R square to Pearson product model?

HUGH BENTON: An expansion thereof, yes.

DONALD E. LARSON: What we have here is what we call an effects plot, and in the effects plot we have the predicted property along the vertical axis. And along the horizontal axis we have the percent weight change of a particular component from a base case composition.

And as you can see from the melt viscosity, the melt viscosity decreases significantly as the alkali metal content increases, and it also increases significantly as the silica.

Next we have the electrical conductivity at 1150 degrees C. And, again, with all the data plotted here, we get a very good agreement between the predicted values and the pseudo measured values.

On the effects plot, the melt electrical conductivity increases significantly as the alkali metal concentration increases.

The next property that we have is the transition temperature. And, again, we get relatively good agreement between the predicted properties and the measured values.

On the effects plot, the transition temperature decreases significantly as the alkali metal content decreases.

DENNIS PRICE: Could I ask another question about the linear fit that you are showing. That is how you derived a linear fit, so it is really not a line of fit but it is a descriptive straight line?

DONALD E. LARSON: It is an empirical fit.

DENNIS PRICE: It is an empirical fit of the data, which means it is not -- it's descriptive of the data?

DONALD E. LARSON: We're probably talking semantics, but, yes. Okay.

DENNIS PRICE: I think it's a difference between reliability and validity. If you validate your straight line, you have the straight line from a separate set of data. Do you understand?

DONALD E. LARSON: Well, my understanding of validation is if you can -- which I will get into a little bit, and then if you had some questions we can get into it more, but validation in my eyes is what we will do is get an independent set of data that was not generated in this program --

DENNIS PRICE: Yes.

DONALD E. LARSON: -- and then we will compare our models to that data.

DENNIS PRICE: I agree. I agree.

Yes.

DONALD E. LARSON: The next fit that I have here is a first order model fit for Boron release from an MCC-1 test. And as you can see in this fit, there is a significant increase in scatter, and then we do have a number of data points here that are out doing their own thing.

Those data points that do not fit well at all, we have taken a look at those particular glasses and it appears in a number of those glasses there has been a liquid liquid separation, which has caused a discontinuity in the property.

Now, that data is still valuable in defining where the acceptable region is, but in terms of modeling the property within the acceptable region, it don't do us much good.

Also the increase in scatter that we see, we strongly believe that the scatter to some extent is being caused by second phase properties, such as crystalline material being there that may affect the durability or some liquid liquid separation.

And we are taking a look at the glass properties and how it affects the durability so that we can perhaps by using several different equations improve the fit or determine what areas a certain fit will work in and what it won't work in to better --

DENNIS PRICE: Just by inspection of that data, it would appear that if you had a non-linear fit, you would account for a lot more variability.

DONALD E. LARSON: That's true. However, the more things you want to account for and go non-linear requires a tremendous increase in the amount of data that we get.

And one thing we're doing now, we do have to look at, we are working on now, is how good a fit is good enough, and when can you stop? We have not fully defined this.

And let me give you a for instance. We can do a statistical test and somebody says, I have a significant lack of fit because I can only predict it within plus or minus 1, as an example. Well, if all I have got to hit is between 2 and 10, I don't care. You know, I can hit my barn.

And these are some of the things we're considering, and we haven't defined yet how good a fit is good enough and how much scatter can we take. If what we're trying to hit, a target this

big on the side of a barn and all we have to do is hit the side of the barn, I can take a bunch of scatter. But this is still being considered.

DENNIS PRICE: Uh-huh. But all these that you are showing us are statistically significant R square values?

DONALD E. LARSON: Most of them do have some significant lack of fit, at a 90 percent confidence level, and I have to be the first to admit I'm not -- I can repeat the words to you but I'm not fully sure of what I'm saying.

However, in looking at the fits that we've got for the electrical conductivity, the viscosity, the transition temperature, looking at the fits and what I know I have to hit, by going back and looking at what the acceptable limits are, I'm fully confident I can hit within the acceptable limits, even though with the statistical interpretation, there may be some lack of fit. I feel comfortable with it from an engineering standpoint.

DENNIS PRICE: Did you have a decision to level out the level .05 being good enough or .20, something like that?

DONALD E. LARSON: I can't address

that. If we've got questions along those lines, I personally am not that familiar with it, but we could have our statistician who did all of the work address these, when we're done with the formal presentation, if you would like to pursue it.

JACK PARRY: One question. Parry on the staff.

Doesn't the data perhaps suggest there might be some question about the reproducibility of the MCC-1 test?

DONALD E. LARSON: We have run duplicates, and of the number of duplicates that we have ran, we got a reasonably good agreement between samples.

JACK PARRY: What was that?

DONALD E. LARSON: I don't recall off the top of my head.

TAE M. AHN: Excuse me. Can I answer?

DONALD E. LARSON: Yes.

TAE M. AHN: We have only two or three predictive occasions in MCC-1 testings.

Those occasions are still not very reliable, depending on parameters you use, you can generate

all sorts of curves. I don't think that fitting is unusual at all, if you practice those, using the existing models.

DONALD E. LARSON: Let me go on just a little here and you will get a little more warm fuzzies, because it gets better from here.

For that particular information, we did a second order fit, and also removed those second seven points, and the fit did improve, but there is still room for improvement and we're looking at the information and what's involved, and we do need to do further work on that to better improve our fits.

On the effects plot, leachability of Boron increases significantly with the alkali metal content and also the boron content, and the leachability decreases significantly with the aluminum content, the silicon content and the zirc content.

Now, we have also modeled the PCT data. This is a second order model. The PCT data for Boron release looks a whole bunch better. For some reason we didn't see those seven fliers sitting out in the dingle berries someplace. Why? We're not sure. But that fit looks pretty good.

Again, we're looking at both fits, and

we're working on improving them. But, again, I think what a lot of this is going to come to is how good of a durability number do you need?

For the PCT, is very similar to the MCC-1. The leachability of the Boron goes up significantly with the alkali metal and the Boron and it increases significantly with the aluminum, zirc and silicon.

Now, one thing we have done is did some looking at the effects of temperature history, in particular, canister cooling, on the glass properties. In particular, the PCT, Boron release, as compared to quench samples, which most of our durability information is obtained in quench samples. You can see here for a lot of the values, there is no impact of temperature on durability.

And this is what we would expect, if there is no phase separation.

If there is some phase separation, such as crystalline D, we compared our information with a lot of other information, and in a lot of cases, in a lot of areas, there is no impact or no significant impact on durability. Obviously in a couple of other cases we have here, there is a

significant impact of temperature history on durability, and we do plan to pursue this further when we do the time, temperature transition studies.

We will be looking at the effects of temperature on crystallinity and also the durability to try to define better to the areas where you do have a phase separation effects that could affect that particular property.

We have also developed a visualization tool, the tertiary waste envelope assessment tool, more originally called TWEAT by its developer, Dr. Burtis.

What we do is we input the glass composition components, which also input the property constraints, and the tool will show you the acceptable composition envelope, specific glass properties, and also display the constraints.

Let me show you a summary of a TWEAT run. And in the TWEAT run we input the waste composition, the tool is currently being modified so that it will go ahead and calculate the recycle composition, we input the frit composition. And then you can do parametric studies with that.

In the future what we plan to do is to incorporate an optimization routine into the tool such that we can give the tool an initial starting point for the frit and then it can optimize on a property. Such that perhaps the way it will work is we will come up with a glass composition that has a maximum durability.

We also input into the tool the limits of the properties that we want to input. What it does is gives you an acceptable waste composition range, and these colored areas here are basically unacceptable composition ranges due to one type of a limit or another which is colored.

We do also have a mouse that you can click at a particular composition, and for that click it will give you the waste composition and also print out all the properties of that composition.

It will also indicate to you for the composition that you've clicked, do you have test data within that composition region or not.

The last major area that we have in the program is model validation. The validation program that we have is currently just being started, and what we are doing is generating

independent data, and we are also collecting independent data that we can compare our models to.

For the laboratories, glasses that have been generated in the laboratory, the radioactive glasses, Eugene Morrey, who will address this next, will talk about our experience with validating so far with radioactive glasses.

We are also accumulating a substantial database, using non-radioactive laboratory glasses. We are getting information from Savannah River, West Valley, our own MCC-1, the work that they've done here.

On bench scale, the plans are, is to build a bench scale melter which will -- we will run non-radioactive glass through the melter, get the properties of that. We will also run active radioactive glass through it with waste that has been pretreated. And measure those properties that we could check our models against.

And then on the pilot scale we have

generated and will be generating a significant database that again we can compare our models to.

So we're going to make damn sure that things work. And with the validation, we believe

this will give us a very powerful tool for plant process control and also waste form acceptance.

In summary, the current results indicate that the empirical modeling, based on experimental -- statistical experimental testing, appears to adequately predict glass properties.

I've showed you results on the electrical conductivity, the viscosity, glass transition temperature, the durability can use some improvement and we're working on that.

The other property that we're also modeling but we do not have any results yet, we're still generating the data, we will be doing some empirical modeling, the University of Montreal will be doing some modeling that will be based on thermal dynamics and also data to get the liquidus temperatures, and we do not have results of that yet.

We also feel that investigation of glass temperature history effects on some properties such as durability is planned. The approach that we are using here we feel appears to be viable to define a glass envelope for HWVP operators when supplemented with melter testing and also redox modeling.

Now, the redox modeling, what that is is a model, again, based on test work to assure that we don't have a foaming situation in the melter which slows down the melter operation.

ELLIS D. VERINK: I see we're just a few minutes over. Let's reserve questions and go on to the next paper, if we could.

DONALD E. LARSON: Okay. Thank you. This is Morrey.

EUGENE V. MORREY: My name is Eugene Morrey, and as Don mentioned, I'll be talking about the laboratory scale radioactive testing that we have been doing and have got started. Additional contributors on this work include Mike Elliott and Dr. Joe Tingey.

To give you an outline of where I am going in this presentation, I'll start with the primary objectives of my work and show how we fit into the broad approach of simulant and model validation; give you some details on the work that we have done and plan to continue in the radioactive area; give you a look at some of the data that we have received and the comparisons with the simulant, data that we have, both in waste and in glass; talk a minute about future plans; and

then draw some conclusions.

The primary objective of the radioactive laboratory scale testing work is to confirm that waste simulants accurately represent the HWVP glass and the process stream properties, the actual radioactive waste. Additionally, the data is going to be used in model validation and showing product quality.

I will put up a slide that you have just recently seen. As Don mentioned, this is where we fit in, and we are doing radioactive testing with actual core samples from double-shell tanks. A small amount of simulant testing. But there's additional simulant testing done elsewhere. And we provide data, produce data that will contribute to each of those need areas.

I would like to give a broad view of what happens in the testing of the core samples that are taken from the tanks. Part of the work, the characterization work is actually done by the double-shell tank characterization program, 4-SWVP. It is funded by that program but actually the basic same personnel will do that, the characterization work as well as the process testing.

I'd hoped for two view projecters, because I have photographs that go along with this. I'll have to go through this and then show the photographs.

But the core samples are brought into the hot cells in the 325 Building and extruded on an extruder. They are then characterized separately as segments, stratification samples are taken and analyzed chemically and radiochemically, and the physical properties are also measured of the different segments. The segments are combined and then full characterization is performed on the combined sample. That includes physical, rheological, chemical and radiochemical characterization. A sample is then set aside for future testing.

This is a photograph from inside the hot cell showing the extruder. The sample is laid out on this extrusion tray as the extruder is drawn back. And it's designed to preserve stratification, as I mentioned.

This is -- It's a little difficult to see, but a lot of things are in the hot cell. This is a photograph of a segment of NCAW waste taken from tank 102-AZ. As you can see, it's

mostly solids which retain their form in this segment and a small amount of supinate and softer slurry.

This is the viscometer that we use to perform the rheological measurements. It's a Hawk viscometer and has capability for temperature control of the sample.

Once the core samples have been characterized, they are then processed through a pretreatment process and then through a process that duplicates the HWVP process on a laboratory scale.

At the time these core samples were processed, the baseline was the B Plant pretreatment, and so that was the pretreatment that was followed here. Ferric nitrite was added as a flocculent, and to facilitate settling, and the supernate, if any, that was available, was decanted.

Then we go through two water washes, three to one volume water washes and the supernates are decanted after settling. Each of those decants are analyzed to determine what components came off in the supernate. Sodium hydroxide and sodium nitrate additions were made to simulate what would

happen in the tank farms following pretreatment.

Characterization was then completed on what we would call the wash solids or the feed to HWVP.

At this point the HWVP takes over the funding of the work. We concentrate the wash solids to 120 grams of total oxide per liter and we act it with formic acid at 95 degrees C. The aforemade slurry is then characterized, everything except for chemical analysis. Frit is added, and characterization is then performed on what we call the melter feed. Even though in this scale we use a crucible. And finally we dry the sample and send it over to 324 Building for vitrification.

This shows the apparatus that went into the hot cell for the formic acid addition. It includes temperature control of the reaction vessel at 95 degrees C, a controlled addition rate of formic acid using a peristalic pump and then condensing of the consensible gases during the formic acid addition.

This is the apparatus that is used for melting and pouring the bar mold. It was -- We don't like to complicate the process while we're using hot stuff, so we have a photograph here of

just frit being poured in the laboratory. The glass is melted in a crucible and then poured into a premelted bar mold for quenching.

As it is given a minute or two to cool, the bar mold is broken away and the glass is put into a furnace for kneeling.

This is a photograph of actual radioactive waste generated in core sample number 2 of tank 101-AZ, which is the NCAW core sample.

Yes. This is the total amount of glass that we were able to produce out of the core sample after all of the characterization was done and so forth, was I think about 60 grams, which so far has been the most that we have yielded from a core sample.

Once the glass has been produced, it then goes through some product testing and analysis. We do the MCC-1 28 day leach test on the radioactive glass, which is a monolithic leach test. We do the product consistency test on the crushed glass, seven day leach test. Both are performed statically in DI water at 90 degrees C. Glass density is measured. We measure the radiochemical composition of the glass, in addition to the crystallinity and the redox potential.

This is a quick photograph to show the samples that are prepared for the MCC-1 tests in the hot cell.

I would like to touch on a little bit of the comparisons that we have made to date and some of the results.

So far we have data from two NCAW core samples, a simulant which we call simulant number 3 which we ran through the exact same procedures on the same scale as our core samples, and an independent simulant database that was built up of historical data that's been generated on the project. This is an abbreviated list of some of the properties that we have compared. And just a general statement based on preliminary results from the core samples and preliminary comparisons, the behavior of the simulated waste appears to be consistent with that of the radioactive waste.

This will show a couple examples of the data. This chart is -- shows specific gravity of formated NCAW waste. The correlation here was developed from simulant waste and shows specific gravity as a function of weight percent solids. The radioactive data is overlaid on top of this correlation, the other data, and is shown with the

circle data points there and fits very nicely with the correlations that were developed with the simulants.

Similarly, these are data points, DB simulant meaning database simulants, showing rheological data for formated slurries. Apparent viscosity versus shear rate. One would expect for a given shear rate the apparent viscosity would increase as your weight percent solids increase. And we see that the radioactive data fit that trend with the database simulants.

As you increase with weight percent solids, so does the apparent viscosity.

Simulant number 3 showed a little inconsistency which was also inconsistent with the radioactive samples, and there were a number of possible reasons for that, including degree of settling in the viscometer prior to measurement.

Glass property measurements to date include the two radioactive core samples, the simulant number 3 and model predictions. Glass properties include the durability testing that I talked about, density, crystallinity and redox state.

To give you an idea of how well we're

able to measure the composition of the glass and how well we'll be able to predict it, I put together data showing the actual measured composition of one of the core samples versus the calculated composition, which is based on the known frit composition, the waste loading and the measured wash solids composition. And as we can see, the data, or the composition matches up well. There is three components there that are highlighted, and that's because we used alternative preparation techniques and analyses to get some of the components to a more accurate degree. Just using an ICP with the two fusion dissolution techniques that we used left us a little bit short of reaching a hundred percent on our oxides, so we did some additional work with standards and other techniques.

This shows the results of the MCC-1 testing. Here we have the Boron release rate for different samples that were tested for the 28 day test. Simulant number 3, ATM-10, and then the two radioactive glasses.

As we can see, for the ones that we were able to test out of the hot cell, the results compared very well with the model predictions.

It's also evident that we experienced a consistent bias in the hot cell testing, which we have since then investigated and made corrections for. However, based on comparing the simulant results to the core samples and their respective predicted values, the data appears to match up well with what's predicted and simulant data.

This is selected radionuclide releases that we are also measuring for the leach test. One would expect that if a radionuclide does not precipitate out in certain forms, that it would be near the Boron normalized release rate in the leach rate, and we have found that several of these radionuclides in fact show up either equal to or less than the Boron release rate.

Redox potential was measured in the radioactive glass in the simulant and compared to our acceptable range. All the glasses were found to be within the acceptable range. Based on the accuracy, or the inaccuracy of this particular analytical technique, the results of the simulant and the radioactive glasses was considered to be relatively well, for as well as we can measure that at this point.

Just a brief slide on future work. As future core samples become available, we will take pretreated samples, different waste types and vitrify and test them. In a meeting, or sitting down with the model developer and the statistician and myself awhile back, we guesstimated that perhaps 12 to 15 samples would be needed for model validation.

That of course is dependent upon how the results come out along the way, and so that could increase, depending on the variability of the results.

We are currently testing the third NCAW core sample, and we have included the capability this time to measure offgas during the formating reaction. We're looking at hydrogen and actually ammonia for safety reasons, some of the other gases, to understand some of the mechanisms, such as the N2O, the CO2, and then some total releases to start supporting permitting assumptions, such as release of carbon 14, iodine 129 and the volatile organics.

Future testing on the core samples may include offgas measurements during calcining and vitrification and also additional latch properties, viscosity and electrical conductivity, which we at this point don't have the capability to do that in the hot cell.

In summary, we were able to take radioactive -- actual radioactive waste through the HWVP process and produce a glass with predictable properties, in respect to chemical composition, durability, crystallinity and redox state.

Comparisons to preliminary radioactive data indicate that the simulants and the models are representative of the actual radioactive slurries and glass.

And finally, additional testing and

model development are needed to improve model validation.

ELLIS D. VERINK: Any quick questions on anybody's mind? Yes.

ROBERT LUCE: I am Luce, Board staff.

How about the long-term predictability of these properties? Are you aware of any research concerning the rate of vitrification or change in soluability properties caused by radioactivity, your intended composition over time spans of the

order of thousands of years? I am just curious about that.

EUGENE V. MORREY: I am not personally aware of that, or I don't know -- that's --

DONALD E. LARSON: The answer is no. At this point in time our program is oriented more towards process control, and we are not looking at the repository, long-term repository aspects of the glass.

Now, there has been some work done on that, way back when, with the commercial type of waste glass back in the late '70s by John Mendal.

ROBERT LUCE: Including

radioactivity elements?

DONALD E. LARSON: Yes. He doped it with actinides and he also doped it with gamma emitters, and looked -- I know he looked at the effects on crystallinity and I would have to check to see if he looked at durability. But there has been some work done on that. What has been done off-site I'm not sure.

ELLIS D. VERINK: I see that we are a few minutes over. Let's take our break now and reconvene at 3:40.

DONALD E. LARSON: One thing on crystallinity that is noted, Gene was saying they looked at the crystallinity, and in the radioactive glasses, we predicted there would be no crystallinity, and lo and behold, there wasn't.

(Short recess).

BRUCE NICOLL: I am Bruce Nicoll, and I am with the Richland Field Office, and I have been responsible for the quality assurance program for the HWVP for the last several years.

And this afternoon you have heard a good deal about the technical program for HWVP and now we are going to switch gears a little bit and talk about quality assurance. And I know that this problem has been -- the presentation you have been all been waiting for all day just with bated breath, so we'll get on with it.

The quality assurance program at Hanford has been around for quite some time. We've been doing things under a quality assurance program since the days of the Atomic Energy Commission, and we have moved on to the ERDA and then later to the DOE requirements. And our contractors at DOE have been working under these programs for several years, so this is not something that is new to us.

One thing we have found out over the years is that quality assurance activities are ever changing. We have a number of requirements that have evolved since we have started HWVP, and we will talk a little bit about how those a affected us.

Earlier Tom Weber talked about the waste acceptance process, and so I won't go through this again. But the reason that I am showing you these documents is because the acceptance specification up here is where the requirements for Q.A. come from. And that document indicates that in addition to the technical specifications that have to be met, we also have to have a quality assurance program under which the data is developed. And we will talk about that a little bit.

Those requirements come to us from the repositories program in the form of RW-0214, and we are currently in Revision 4 of that document. And the requirements in RW-0214 are based on the NQA-1 quality assurance program, which is with its 18 criteria.

In addition to that, there are some features that are added to it. Probably the most

important feature is the software qualification program. And we also pick up a management assessment of the quality program. And then we see that throughout the quality assurance area, that the 214 adds emphasis and specific interpretation to 214 -- or I mean NQA-1.

In addition to the requirements that come out of RW, we are also subject to the DOE orders. And DOE Order 5700.6C is applicable to DOE activities.

This compliance document came to us late last year, and it changed the way that DOE looks at the quality assurance activity. It's going more toward a total quality management kind of an approach, and it is structured differently than the NQA-1 program was structured.

On HWVP, there may be a provision within 6C for an exclusion from the requirements of 6C in that it says that it applies to everything that DOE does, with a few exceptions, one of them being licensed facilities. And how this activity applies to the licensing process is something that has not totally been agreed upon within the department.

So what we've done here at HWCP is just

adopt it. And any additional requirements that come out of C6, we've incorporated them into our program. So no matter which way it goes, we have it covered.

Within DOE the responsibility for quality assurance resides with the line organization. And therefore the Treatment Projects Division here that has HWVP within that is responsible for the quality program, and that is the area that I have been working in. To have our independent overview, the Office of Compliance up here, assists us with audits and surveillances.

This overhead provides an indication of the functions that are performed by the various project participants, with RL up here with the project management responsibility with, once again, the Office of Compliance off here to the side. Then Westinghouse provides an integrating function, and then we have Fluor, PNL, UCAT and Westinghouse operations going on here.

In the case of the compliance office, they have the auditing responsibility that comes down through all of these organizations, and at any time can look at them. In addition, we look to Westinghouse to overview all of the other

activities. And of course each and every one of them are responsible for overviewing their own activities.

This matrix provides you the current status of our Quality Assurance Program descriptions and plans. If you look at the dates issued there, these are the most recent issuances of these documents. To give you a feel for how long we've been working at this on HWVP, the first DOE QAPD was approved in February of '89. The same information for Westinghouse is 11/85. Fluor

Daniel was May in '86. UCAT, shortly after they came on Board produced their first Q.A. plan and it was approved in July of 1990. And Battelle, it was February of '87.

And so what you see here is an evolution as we have gone from OGRB-14 into the RW-0214 requirements, as those come down to us, we revise and revise, incorporate those new requirements and put those into the procedures, and so you see the latest date here of the program.

In using these documents, we have a tiered down approach, where you start out with the top box up here being Headquarters with their Quality Assurance Program, description, they levy

their requirements, on to RL, and then we go down to Westinghouse, and in turn down to these other contractors.

And that's the way that we follow our quality documents down on the program, which differs slightly from the way the things are organized.

And the reason we're doing this is so that we can take advantage of integrating activities here of Westinghouse to pull this whole thing together. Each one of these organizations have implementing procedures.

In addition to that, because all of these parts working on HWVP have to work together, there are certain activities that we feel have to be done in common if we're going to have any semblance of order on the project. So we have produced project procedures which integrate certain functions such as non-conformances and surveillances when we're doing them in common and that sort of thing.

The waste form producer organizations, whether they be Savannah or West Valley or HWVP, are required by Headquarters to qualify their Quality Assurance Program. And what we mean by

qualify is that each participant is required to prepare both their Quality Assurance Program description, their implementing procedures, then they have to get it approved by the next higher organization, they implement it and then there's an audit that comes in and takes a look to see if they are carrying things out in accordance with the program that was previously approved.

As I said, for several years we have been working with our Quality Assurance Program, and we're in the process of implementing that program. Everybody has an approved program. There are variations among the participants on how long they have been working at the implementation. And we're refining it and getting it improved.

When we start looking at the overall qualification on where we are, our lower tier contractors, we're talking PNL, UCAT, Fluor Daniel, having through the process of having their Quality Assurance Program and their implementing procedures approved by the next higher organization. Once they have that done, we are scheduling early in next fiscal year audits of their programs to assure that they are meeting their written program.

Westinghouse and HWVP, we are at the

stage where we have received preliminary approval of our Quality Assurance Program descriptions from DOE Headquarters. We are about ready to send our procedures in for them to be reviewed and accepted by Headquarters. And we expect the whole process of review and acceptance and auditing to be completed by about this time next year.

As I pointed out, RW-214 brings in to play a different feature that requires the management team to come in and do a self-assessment of the quality program and determine how well it is coming about and where things are in need of fixing. Westinghouse and DOE this year completed their first management assessments and we have gotten feedback there, and we're in the process of correcting our program to meet those needs.

All of the program participants have a program where they are training their people to the quality requirements, also to minimum requirements that are required for their particular activities on the project.

In conclusion, the HWVP program is working to the requirements of DOE Order 5700.6C, and we are fully implementing DOE RW-214. And we expect to have our quality programs qualified

within the year.

ELLIS D. VERINK: Any questions?

Thank you very much. And now for our anchor person, Dr. Dave Stahl.

DAVID STAHL: Good afternoon. It's a pleasure to give the Board an update on waste package and EBS designs. The outline has basically been identified here in this package.

I'll talk very briefly about the

engineered systems, goals and strategy and the overview of the reference of basically SCP design. Give a little refresher on thermal considerations. And then go into a lot more detail in design approach and the performance assessment implications.

I will start off with the engineered systems goal and strategy. Basically, it hasn't changed. We want to achieve a conservative design that's licensable and meets the regulatory requirements. I want to use the engineered, or engineering systems approach. We will go into that in more detail later. We were going to look at the multi-barrier approach. We will take advantage of the unsaturated nature of the Yucca Mountain site. We go into consideration of technical alternatives.

And lastly, we want to resolve technical and regulatory uncertainties.

This next chart was shown by Dr. Bartlett in respect to the entire program, but we feel it also pertains here in Waste Packages of EBS development. We again have information here from site characterization and from our testing program.

We're going to move along to achieve a

design. We're going to resolve the issues and we're going to evaluate performance, using performance assessment proposes.

I should point out here, these are some of the applicable regulations. I think most of you are aware of all of those.

Now for a quick overview of the reference design. You've seen this schematic representation before, and just a cross-section of potential repository at Yucca Mountain, pointing out the natural and engineered barriers.

Here are the unsaturated rock units and the saturated rock units which are part of the natural barriers, and here is the potential repository and engineered barrier system.

This is an artist's rendition of the

surface facility and a little cutout here of the subsurface facility. Material will be coming in to the surface facility via either truck or rail. We have in this concept two waste buildings, and that has not been defined, but at least in the SCP design they had two buildings. There's a performance confirmation building here which will serve to monitor the testing of materials in the repository.

Also you have seen this before. This is the underground facility layout. It shows a cross-section here for spent fuel and for defense high-level waste in a vertical emplacement bore hole concept. And there are several different considerations here. One is the bore hole spacing and the other is the drift spacing. And that defines the local and area power density of the system. In other words, how much heat are the packages putting out per unit area, like an acre of the repository.

One concept, they could be 15 feet apart, and here you have a commingling of spent fuel and high-level waste glass containers.

Here are some examples of Yucca Mountain waste package designs. On your right

here we have waste glass containers. We anticipate about 14,000 of these. Most of them are from Savannah, or will be from Savannah River Laboratory. As you have heard, about 1300 from the WVDP. And about 300 canisters from West Valley.

Over here on the left we have spent fuel containers. And in the SCP design, anywhere from 25 to 35,000 of these, depending upon the configuration. In this particular design, which we call the hybrid design, we have both PWR, that's large nine by nine cross-section, nine inch by nine inch, and DWR, which are roughly six by six inch cross-section. There are other designs which have either all PWR or all BWR assemblies. And you can see, it's roughly the same design envelope. 76 centimeters, or about two feet in diameter, and you can see about 10 feet in the case of the glass and about 15 feet in the case of the spent fuel containers. Again, from the SCP.

Just a word about materials selection. As you know, we have studied six candidate alloys extensively, three austenitic alloys, two stainless steel and one high nickel alloy, three copper alloys, high-purity copper, copper-nickel, and 90

percent aluminum bronze.

This work was done by Lawrence Livermore Laboratory. More recently they have looked at other nickel-based alloys. They have done a lot of studies with alloy C4. They have also studied titanium alloys, grade 12 and 4. Grade 12 was extensively evaluated.

Materials from the early studies where they had something like 30 some odd materials were re-examined and other suggested materials were evaluated but less rigorously.

They exercised the criteria that was developed by Lawrence Livermore National Laboratory. Here is a reference to the report that defined those criteria. And basically the titanium grade 12, alloy C4, and that's a typo there, that should be alloy 825. Amasing how many times you look at these things and don't find them. Those are the three alloys were the highest ranked, the copper-based alloys were in their evaluation very poorly ranked because of the problem with both oxidation and radiolithic effects.

Now I would like to go on and talk about thermal considerations. This is material again from the SCP. I won't go into it in any great detail. This defines some of the performance measures for some of the components, and over here are the temperature goals.

What I did want to point out here, with regard to the canister environment, what we had suggested in the SCP was we wanted to maximize the time spent above the boiling point in the bore hole environment. And the reason of course is to limit the corrosiveness of the container.

Again by way of refresher, I have shown this many times, this is a particular analysis for spent fuel, 57 kilowatt per acre. This is the hybrid design with consolidated fuel, as it turns out, with an output of about 3.3 kilowatt, and you can see the temperature distribution here is a function of time.

In the case of the container surface, we peak here at about 245 degrees centigrade, something like 30 years after placement, and then you have a gradual decay. In this evaluation, you can see that the surface of the container is still above the boiling point after a thousand years.

Now, Tom Buscheck and Eric Ryder have done some other thermal analyses -- well, let me talk first about Tom Buscheck's work on the

hydro-thermal umbrella. This work came, I should say the conclusions came about as a result of the G tunnel testing. And what you're looking at is a cross-section of the drift. Here is one drift, here is another drift. This is a vertically in-place spent fuel container, and you can see that there is a dryout zone and then condensation zone as the water can then condense and drain off to the cooler areas.

So this creates this hydrothermal umbrella outside. Outside of this umbrella we have damp conditions. Of course, out here, this is the unperturbed area. And on to the next drift you have an identical situation.

Now, as you can see in the next chart, these zones will begin to merge with time. This distance represents half the distance between those sets of drifts that we saw in the previous chart. Here is a profile at 30 years. This is the boiling front. Here is the same situation, 60 years. And at 100 years. And as the heading indicates, at about 80 years after emplacement, is when we do have a merger of those boiling fronts.

Okay. Now we get to some of the calculations of Ryder and Buscheck. They were

looking at the impact of aging of the fuel, and the areal power density. And what is shown here is for ten-year old fuel and for 57 kilowatt per acre, this is the reference case, that is one.

If we go to cooler fuel -- excuse me, less highly loaded fuel, you will need more repository area, obviously, and if we go to a higher loading, then you will need less repository area. And as you go down the chart, as we age the fuel, you can see in all cases we need less repository area. If you could age the waste for 100 years, for example, you would only need one-quarter of the area at 57 kilowatt per acre.

The problem is, of course, that it's not easy to get fuel at this kind of age. It's not very effective as far as holding the fuel in a surface facility for that length of time.

But realize, of course, that the age of the current fuel, or at least by the time the repository opens, will be well in the area of 30 year old, so it will probably be in the range of 30 to 50 year old fuel anyway, and with a higher kilowatt per acre, you can see here that we won't need as much area for the repository as we had originally estimated.

In previous presentations to the Board, many of my colleagues on the project have talked about the geomechanical, geochemical and hydrological impacts on the EBS environments, so I won't go into them. I will be talking briefly on the impact of the thermal effects on EBS components, particularly the containers. You also heard from others on the waste form. I won't deal with that today.

So this chart talks about the container degradation, and as far as the thermal loading, I should say. And you can see the first one has to do with general corrosion of containers, if indeed the environment is hot and dry, then general corrosion will be driving and we will have to define the temperature and exposure time under those conditions. Also if we're going to have some moisture or water contact the containers, then we need to define the exposure time for the onset of localized corrosion, and of course be able to model that.

And if we do have those kinds of exposures that do lead to failures, then we do have to model gaseous and aqueous release of radionuclides. And of course thermal loading can

impact the mechanical properties of the rock, and we need to look at that to see its impact on the loads that might be attributed to the container.

And lastly, we feel it is not -- that is, thermal effects, are not strongly coupled to the heat output or the size of an individual waste package. What we're looking at of course is the totality of the waste package, that does have an effect. But an individual waste package we believe does not have a strong impact.

Okay. Now I'm going to move into the design area and tell you about our current design approach. Now, I said earlier we're going to use a classic systems engineering approach. We have defined some waste package design requirements, and we're going to be refining those and producing a waste package refinement document. We're going to develop out design.

This is October of '92. We're going to evaluate those options and by the start of advance conceptual design in June of 1996, we will select some preferred designed. We're going to develop and engineer these designs and eventually verify the design requirements are satisfied before license application.

The program itself is closely coupled between the design activities, performance assessment and testing and modeling. And we show that here in this inter-active loop.

As I showed on the engineering systems approach, you have a design and you need to evaluate that design, and we're evaluating it with materials and test support and performance assessment. And we also have interfaces between, that you can see here, repository and site, and certainly in the case of design, the MRS and transportation system, as well. And of course in performance assessment, regulatory requirements and interpretation are very important.

DENNIS PRICE: Excuse me. There's no indication of any kind of interface with the utility up there with respect to waste package. Do you have any comment on that?

DAVID STAHL: Yes. Of course, we will have an interface there, but that really comes in through the transportation people. OCRWM transportation sector is responsible for picking up the waste at the utility and either transferring it to the MRS or to the repository directly. So, yes, there is an inferred interface there.

DENNIS PRICE: By that answer, it indicates that as you see the interface, it doesn't have anything to do with the operations of the utility, then, itself. It's just simply a pickup at the utility?

DAVID STAHL: Well, there's more to it than that, and in the next slide I'll answer that. Perhaps that is the direction your question is leading. If not, please ask it again.

These are some of the design options that we are considering. Various barrier types. We'll talk a little bit about those.

Material options, we'll discuss those briefly, as well.

Canisterization. This is an issue which does have the utility interface. It has to do with what kind of internal package or canister the utility might seem appropriate for them to load their spent fuel into. If, for example, they have a concrete modular cask storage design, they will use a internal canister. That canister, if it can be transported, could be part of a disposal container. So you do have that interface, and certainly we like to know what the geometry and capabilities of that canister might be. The same

situation applies to the MRS, if canisterization is done there.

I'm going to talk a little bit about

emplacement modes. As I mentioned, the SCP design focused on vertical bore hole placement, but there was some discussion in the SCP about horizontal placement and more recently the M & O has been looking at drift emplacement.

And lastly on this list, waste package capacity. As noted in the SCP designs, we have seven fuel assemblies there. There was something like about two metric tons in the non- consolidated case and four metric tons in the consolidated case. In new designs we are considering, we are talking about perhaps 10 metric tons or more for drift and emplacement designs.

This is a summary of our design approach. As I mentioned, we start with a range of concepts. This doesn't reflect them all, but just to give you an overview. We have the small thin walled bore hole emplaced. That's basically an SCP design.

One variation would be to take that same container and overpack it with another container material to make it more robust, and

I'll talk about this in a little bit more detail in the next few slides. Basically, the same geometry.

The next option, we could look at higher capacity drift emplaced packages, that could be partially shielded or totally shielded.

We're going to be looking at corrosion resistant and corrosion allowance materials, and we'll be also looking at ceramic materials, would fall into this general category.

As I mentioned, we will be able to accommodate a range of burnup and fuel age. One of the design approaches, as I mentioned, is to be able to retrieve a single waste package from any particular location in the repository. Either to move it to another place or to examine it.

We do have variable thermal loading capability. We'd like to be able to adjust the waste package locations prior to backfill to optimize thermal loading.

And as I mentioned on the previous, one of the previous charts, we want to reduce those concepts during ACD and LAD, that's advanced conceptual design and licensed application design to one reference, and perhaps alternative designing

for detailed evaluation.

CARL Di BELLA: Dave, the way I read

that slide, your concepts that you're working with right now are going to include the final concept, you're not providing a mechanism for some new concept to come in after ACD starts.

Is that correct? Or is there going to be a mechanism for that?

DAVID STAHL: I would say that we're not limited to the present concepts. If a new design comes forward in the process, we will certainly would be open to that. I mean, there's new technology being developed all the time. But certainly we'll start it with an envelope of certain designs and focus them down to a one or two preferred designs.

Talk about what a robust waste package is very briefly. From a regulatory perspective, we feel it increases the certainty of meeting the containment requirements. Also we feel it's tolerant to a wide range of repository conditions. In other words, we feel they can take hot, humid air, for example, and cooler humid air, and perhaps at some time, periodic, flooding episodes might occur on the repository. The design must be

tolerant of that, as well.

We want to have a multibarrier waste

package and EBS concept. And we want to use a defense-in-depth approach. That being that each barrier of the many that we use, even of itself, could meet the containment requirements. So each of these then would be redundant.

As I mentioned in a previous slide, it could be partly or fully self-shielded, in the robust case. And because it's larger, it does lend itself to drift emplacements.

One of the things I should mention is that this option of the drift emplacement has been opened up by the fact that we're considering a ramp design into the repository, rather than a shaft as far as moving the spent fuel down into the emplacement position. That enables you to go to heavier packages in the 50 ton or so range, which we couldn't consider before.

Now, from a performance perspective, if this is just schematic, if we have a breach distribution here for I call a non-robust case, we would have a short, or small spread of failure rate and a peak, here with a robust waste package where we have a combination of failure rates which would

then be combined, you have certainly delayed start of failure, a smaller peak and a failure rate spread out over time.

This is very important from a performance assessment, determining the release of radionuclides meeting 10 CFR 60.113.

This is a little better drawing of a cross-section that I showed before. Just to refresh you, this is the three PWR assemblies and the four BWR assemblies, perhaps in one of those six candidate materials.

One of the options that we're considering is this SCP hybrid design with another barrier. Here we show it with an inconel liner, which is this inner unit. Basically, the same as the design you saw in the previous curve, or previous chart. And then we have a secondary container, in this case, it's a three inch thick steel case. And you can see, this is 36,000 pounds.

Here's another option. It shows 21 PWR assemblies, roughly 10 metric tons of fuel. This is the basket, put into the same inconel liner, same three inch thick steel case, and now we have about 45 tons total weight.

This is just a schematic of how we

might emplace containers in the drift, put them on some kind of structural support, the spacing between the containers would be variable, depending on the areal power density that we would like to achieve.

Now I've alluded to some of these, but this chart kind of lists the advantages of the drift emplacement alternative.

One of the things it does do is improves heat dissipation from the package, because now we have a much larger area of rock into which we are dissipating heat.

It does permit the management of thermal loading, increases the time the waste packages will remain dry. It permits relocation of the packages and certainly considers robust waste packages, including the corrosion allowance or corrosion resistant materials. It accommodates larger packages, as I mentioned. We feel it permits easier retrieval. And we also believe it would reduce the potential for damage due to seismic events.

Of course, it is a bigger piece of equipment and one would have to be able to emplace it in the drift. This is just a schematic of a transporter which would run on some crawlers on some compacted material, it is concrete or other material. This is the waste package in the emplaced position and this is the waste package in the transport position. This would allow the crawler to move over emplace positions and fill in gaps, for example, that you may have left between widely spaced containers.

Another option is side load emplacement. A little different design of the crawler. This is a lower profile. And you can see in this case we've got them side by side. It means you do not have to go over the waste package in order to emplace another package or to fill in between packages.

This shows some of the invert material, in this case it's rock and welded -- non-welded tuff.

One of the things that has been suggested is you might reduce the head room here, and that is certainly possible.

A short summary of the near term container materials effort. If we do consider corrosion allowance materials, we need to learn a little bit more about them, and we have begun to do that at Lawrence Livermore Lab, performing a degradation mode survey on the iron-based corrosion allowance materials.

We will be looking at some other corrosion allowance materials, and I'll mention that a little bit later. Chief objective is to identify the gaps in the information base and perform some prototypic scoping tests to fill those gaps as we identify them.

Also at the same time we need to restart the degradation model development work that was ongoing previously at Lawrence Livermore.

As far as supporting that model development, we need to do parametric testing and plan and initiate that testing hopefully in the near term.

And lastly, we need to develop long-term materials tests, test matrix and plan and initiate testing. We hope to do this within the next fiscal year or so.

These are some of the activities we plan to do in the waste package EBS design effort. We need to evaluate and select those materials.

This is the list of some of the

analyses that we will be performing in the near term. These first few are 10 CFR Part 60 driven, including retrievability, some of these others are more in the handling area. And as I mentioned previously, we need to initiate detailed evaluation as part of the advanced conceptual design effort.

Okay. The last section of my talk deals with performance assessment implications, and there is probably a little bit more detail in here than you may want to hear, but I'll go through it quickly.

I mentioned that we need to define the degradation modes for the corrosion allowance materials. We need to perform materials testing and evaluate materials interactions.

And then we need to develop predictive models for the behavior.

We have models -- Excuse me. We have initiated model development for the inner containment barrier breach, but we have not done much in regard to the outer containment barrier breach. And certainly when these barriers breach, we do need to protect radionuclide release.

As I mentioned, the inner materials will be one of the alloys that we have selected. I have got the right spelling here for Alloy 825. The outer containment can be either corrosion allowance or corrosion resistant materials. I personally prefer the corrosion allowance materials, because of the dominant degradation mode is general corrosion, both atmospheric and aqueous. And the beauty of that from a performance perspective is that we can predict the performance. The rates are usually parabolic, if we do have a protective film. If it's not protective, then the rates would be linear. But, again, fairly well known.

As far as the corrosion resistant materials, the dominant corrosion mode is usually a localized corrosion. It is usually excellent as far as general aqueous corrosion. For example, 825 is susceptible to pitting and stress corrosion cracking. And the initiation of those events is usually a random process. So it's more difficult to predict the performance of a corrosion resistant material.

And as I indicate here, the rates are usually rapid once the process has been initiated. And we do have degradation modes for those six candidate materials plus the titanium alloys.

A little bit about the iron-based materials. These are just several classes of materials that indicate here, low carbon structural steels. These have been evaluated previously by other programs, BWIP and Basalt have looked at low carbon structural steels. A new class of weathering steels, low copper steels, they've been around for 20 years or so. They seem to be a candidate. Low alloy steels, cast irons and coated steels are, again, other classes of materials that we will be evaluating.

There are some natural analogues as far as steels that do exist that can support model validation. But as I mentioned, we do need to have degradation mode surveys for confirmation of these.

There is a lot of atmospheric testing that has been done with testing, structural steels. Rates are usually dependent upon humidity and the amount of pollutants. Of course, they are also temperature dependent.

The rates are generally above 20 microns per year. Rates for weathering steels are much lower. As I mentioned, data is now available for about 18 years. They are less than three microns per year. But the key is development of proper surface film, or patina. If that is correctly established, then these materials may perform very well.

Of course, what's missing is data at elevated temperatures and we don't know enough in regard to wet-dry cycling of this material in atmospheric corrosion.

And lastly we need to determine the effects of microbial action.

As far as aqueous performance, similar kinds of things. Here, though, of course, we have pH, Eh and flow rate as the principal dependent parameters.

Neutral to mildly alkaline conditions are preferred for iron-based materials. And the rates are usually above 50 microns per year. Weathering and low alloy steels are somewhat better. There is also some possibility of the pitting corrosion of these steels, but there is usually a low aspect ratio. That means the ratio of the depth to the width of the pit is small, usually in the range every one to two.

And, again, we need to know the effects of cycling and microbial action.

Now, in addition to the iron-based materials for corrosion allowance materials, you could also use copper base.

I won't go through this. This is the degradation mode survey work that was done by Lawrence Livermore National Laboratory, studying atmospheric and aqueous corrosion. Also we note here, pitting corrosion is not likely but can occur under some conditions.

And as you know, stress corrosion cracking can occur for copper alloys. We do have natural analogues existing. Copper is known to be immune to some microbes but not all microbes. There have been some microbial reactions, as well, with copper and copper-based alloys.

This shows waste package breach model hierarchy, it comes basically out of the SCP for the hierarchy of degradation. We certainly have the breach of the outer containment barrier first for our multi-barrier design.

If it's a corrosion allowance material, then uniform oxidation and corrosion would be important.

If it's corrosion resistant material,

then localized attack or stress corrosion cracking

would be the more predominant mode.

And as I mentioned, pitting attack is the dominant mode. Of course, once the outer containment is breached, then the inner containment would be exposed, and that could breach, as I mentioned, if we used one of the corrosion resistant materials that has been under study at Lawrence Livermore. And if the barrier is breached, then we can begin to release the radionuclides, either carbon 14, C02 in gaseous phase, and if moisture comes in, the aqueous radionuclides could be released.

ELLIS D. VERINK: Dave, some of the materials that you talked about as a potential outer barrier would serve in ways, as providing an environment for inner container. Where would you put that in this particular --

DAVID STAHL: Yes. We certainly do need to determine the interactions. I had mentioned that on one of the earlier slides, introduced the subject. I will try to find it. Whenever we have coupling of materials, we do need to evaluate those interactions.

One of the things I failed to mention,

and you reminded me of it, is the fact that in the

case of glass canisters, there is some data that indicates that iron-based materials might be detrimental in the sense that it might promote the formation of iron silicates and dry glass solubility.

Again, that needs to be confirmed. That's one of the reasons we're considering copper, corrosion allowance materials for glass containers, principally.

Did that answer your question?

ELLIS D. VERINK: Yes.

DAVID STAHL: I mentioned earlier this is a coupled program, and if you can see that very well, on the left hand mode we have the model development line of activities, and in the middle column here we have the materials testing activities. And these would be going on in parallel.

We must identify those modes, which we basically have in the degradation mode surveys, and as I said, we need to do that for the corrosion allowance materials, we need to develop conceptual models of, of course, develop the test plan, conduct tests, evaluate the models, modify the models, do confirmation testing, long-term

testing so that we can finalize that model. Again, compare these results to perhaps any analogue data so that we can get some validation of the model that would be used for total system performance assessment.

There are a lot more loops here for performance assessment that are not shown, but certainly at each stage here where we do have a model, we will be using that model to evaluate the performance of the system.

So by way of conclusion, I just want to note that I have talked briefly about the engineered system goals and strategy, given you a brief overview of the reference design, talked about the thermal considerations in regard to the SCP and the new design concepts, I talked about our design approach, and lastly covered the performance assessment implications of those design concepts.

ELLIS D. VERINK: By implication, the idea of a multi-purpose cask seems to fit pretty closely into what you're talking about.

Do you have any words about that general subject?

DAVID STAHL: Well, as I mentioned, there's a little distinction between a

multi-purpose cask and multi-purpose canister. Multi-purpose canister is one, as I mentioned earlier, that could either be loaded at the utility or at the MRS. And then that nugget or kernel, whatever you call it, could be moved to the next stage, in the case of the multi-purpose cask, it would mean that whole unit would have to move from stage to stage and be emplaced in the repository. That seems to be a little overkill, in my opinion. You want to design I think the cask for each element of the system, be it storage, transportation or disposal.

CARL Di BELLA: Dave, you're saying you are ruling out the pre-LAD studies, the universal cask studies?

DAVID STAHL: No. There are other people within the M & O that are looking at the multi-purpose cask and multi-element containers, and that certainly will feed into the concepts that we are developing here.

I was just giving you my opinion in response to Dr. Verink's question.

ELLIS D. VERINK: Yes. Over here.

DAVID STAHL: I am sorry. Did I answer your question?

CARL Di BELLA: You surprised me. Who were the other people? I thought B & W were responsible.

DAVID STAHL: There are different elements of the M & O that are looking at systems studies, because we do have the impact of the container, the canister on these other elements as I mentioned, the transportation and storage.

CARL Di BELLA: Let me pursue this just a little bit longer.

DAVID STAHL: Sure.

CARL Di BELLA: Your ACD is supposed to start in October. By then you are supposed to have developed a number of concepts that you're going to weed out as the process goes.

DAVID STAHL: Uh-huh.

CARL Di BELLA: And are you saying other people besides you are also developing these concepts?

DAVID STAHL: Not developing concepts. They are looking at existing concepts to see how they impact on the total system.

CARL Di BELLA: How is that process all going to come together?

DAVID STAHL: Well, we're working

with them in the development of that system study.

Does anyone want to make any other comment on that?

DIANE HARRISON-GIESLER: Diane Harrison-Geisler, Department of Energy.

What Dave is referring to is the M & O is doing a system study on universal casks, and it is a study to look at the implications of a universal cask throughout the system, that is, transportation, the effects on storage and on disposal. And if as a result of that systems study it shows that the universal cask would have maybe more benefit than detriment, then we would most certainly consider a universal cask in our list of concepts.

Now, the concepts that Dave has been referring to are just of the ones that we are looking at at this time. These are not the only concepts, and come October, '92, hopefully we'll have a little more money, we'll be able to expand the concepts if there are others that are worthwhile, programs the universal cask.

And then during ACD we will narrow down that, from that selection of concepts, down to one or two, and that's during, within the ACD

phase.

CARL Di BELLA: When is the M & O supposed to have this system study sufficiently completed that you can decide whether to admit the results of their study --

DAVID STAHL: Well, there are several phases. The first phase is supposed to be complete by June and then, was it by the end of this calendar year, the second phase?

DIANE HARRISON-GIESLER: I'm not certain, but I think by the end of this fiscal year, by October, they should have some results.

CLARENCE ALLEN: According to your schedule here, you see, October of '92 you expect to develop design options. And then in '96 you select preferred designs, in plural, and then sometime in the years after that, up to 01, you're finalizing the design.

DAVID STAHL: The design, yes.

CLARENCE ALLEN: Of course, as long as we have different designs, it may imply a totally different layout of the repository.

Can we be accepting utterly different designs for the layout clear up until 01?

DAVID STAHL: No. By that time we

will have completed the repository and other designs, so we have a compatible system.

I would hope that the configuration of any alternative design would fit into the current design of the other systems. It would have to.

DENNIS PRICE: But, for example, you have a 1998 date of acceptance, which is affecting the cask design part of things.

DAVID STAHL: Uh-huh.

DENNIS PRICE: Which certainly would compromise the integrity of the view of the universal cask, if you're doing a system study of the universal cask.

DAVID STAHL: Sure. But that would only have a minor impact on the total inventory of spent fuel that is out there.

DENNIS PRICE: But it might have a considerable impact on the operations and the existence of equipment and facilities at the repository and at the MRS.

DAVID STAHL: Well, the repository is not going to be available before the year 2010 or thereabouts, or, at the earliest. So the MRS, if it does begin to

DENNIS PRICE: Yes. But if you've

got the casks incorporated into the functions, very deeply imbedded into the functions of the system, that's going to determine what goes on at the repository and the MRS.

DAVID STAHL: Sure.

DENNIS PRICE: So it compromises, because of their 1998 date, it compromises a pure look, anyway, at something like the universal cask, does it not?

DAVID STAHL: Yes. It will certainly not be introduced into the system in 1998. This will be much later on. So we would have the most flexibility, hopefully, in the system, until the time we start to receive waste at the repository.

ROBERT LUCE: I'm alarmed to hear that apparently only the high power density at the potential repository is being considered. While it may be considered or somewhat accepted at Lawrence Livermore National

Laboratory, I just came back last week from a two day conference in Las Vegas on performance assessment in hydrogeology, and that was not the case there, that there was universal acceptance of this --

DAVID STAHL: I was at that meeting. I am not sure what results you are referring to.

ROBERT LUCE: Well, there wasn't a vote. But there were questions about that power loading. It wasn't as if it was the only one. I would like to know, how was it accepted as sort of the dominant or only --

DAVID STAHL: Well, we have made no decision. As I mentioned, there is a decoupling between a particular design of the waste package and the areal power density. If you have a highly loaded package and you decide that you want to load areal power density, then you spread the packages out.

So if that is what you want to decide, for hydrology or other reasons, you have to option.

ROBERT LUCE: It doesn't follow

through a lot of the rest of your talk. But I would like to take a little exception to what you were saying about, let's see, what was it, the individual waste packages don't have an effect.

It's my recollection at that meeting that it hadn't been -- only two waste packages were

considered as a system for the thermal effects. And otherwise, it was just assumed that you would have a uniform heat distribution.

DAVID STAHL: Most of the things that were talked about at that conference dealt with the reference design, which was 57 kilowatt per acre. That, as we understand it, is a hot repository, and that is much of the repository will be above the boiling point.

Now, if you want to look at some of the data that Tom Buscheck showed at that meeting, you would have done something like 25 to 30 kilowatt per acre, such that you have the rock below boiling at all times. A much cooler repository than the current referenced design.

ROBERT LUCE: Well, all right.

DIANE HARRISON-GIESLER: Excuse me. Diane Harrison-Giesler, DOE. I guess I would like to emphasize -- reiterate, we presented at the

February meeting and at the October meeting and also I thought came across here, is we are not leaning towards a hot repository.

We are still evaluating a range of temperatures and thermal loads in our design for the waste package. It's not geared towards just

the hot end. We are looking at a range.

DAVID STAHL: Yes. One of the things that the drift emplacement gives you, if you are willing to space the packages out, you don't have the impact on the near field rock that you would have in a bore hole emplacement.

ROBERT LUCE: Good.

ELLIS D. VERINK: Other questions?

ROBERT COOK: Just a couple questions. What is the limiting aspect of the high temperature repository? Is it the groundwater travel time or rock integrity, or what's the limit on the 57, or the upper end?

DAVID STAHL: Well, we are looking at a series of temperature limits that I showed earlier, drift access temperature, surface temperature, rock transportation temperature --

ROBERT COOK: So it is operational

time limits?

DAVID STAHL: For the most part.

ROBERT COOK: No long term performance?

DAVID STAHL: There could be some performance interaction.

ROBERT COOK: What about vapor

transport? You know, you've got a travel time or an ice-ability aspect for the geology. It sounds like you've kissed that off, practically. You know, you don't see that in any of the designs that you have talked about.

DAVID STAHL: There would be trade-off, in the sense that you have greater containment, but you do have the ability of more rapid gaseous pathways.

ROBERT COOK: So that is a drawback to that high temperature design?

DAVID STAHL: It could be. But you don't know exactly what the performance is in the condensate zone, for example. That would have to be evaluated.

ROBERT COOK: One other question. You talk about this integrated thing. It seems like there would be a desire to have a designer that would be responsible for the whole system analysis, including the defense waste.

I mean, you haven't talked about incorporating what we heard about this morning into this whole design concept, which is a very, very costly and big aspect at least just here at Hanford.

So how does that get integrated? Where is your interface and how do you get integrated with the defense waste?

DAVID STAHL: Well, there are several options that we have been looking at for the defense and the West Valley waste. As I indicated in one of the previous charts, you could have commingled wastes, and that is, you have a package of spent fuel and a package of cooler high-level waste glass. Another alternative is to have separate drifts for the spent fuel and high-level waste glass.

ROBERT COOK: But the little glass packages are what I am talking about. You are talking about bigger packages, and there is huge costs associated with the numbers of glass packages that you have.

So if you try to do a systems analysis, it may be that you will want to go to a bigger defense waste package, too, or bigger glass package or whatever it turns out to be.

DAVID STAHL: Yes. We have looked at that, Bob, and one option would be to put four glass canisters into one larger container, which you then over-pack, and it fits very nicely into

about a five or six foot diameter package.

ROBERT COOK: Does that reduce the $350,000 cost per package to --

DAVID STAHL: It does have an impact, it does reduce the cost, because you will have fewer containers that you have to seal -- load, seal, inspect and emplace, so there are some savings.

But we haven't spent a lot of time looking at the high-level waste site. We have been concentrating on spent fuel.

CHUCK WILSON: Chuck Wilson, Westinghouse Hanford Company.

I want to make a comment about the larger waste packages. You've got one design in here of 22 spent fuel assemblies. The reference design with the seven assemblies, you're talking about peak temperature within the package of 250 degrees C.

Have you done any calculations on what the peak fuel temperatures will be in the package of 22 assemblies?

DAVID STAHL: Yes, we have. It is actually less, because you are able to reject more heat.

CHUCK WILSON: You're putting more fuel assemblies in a more concentrated location and you have a lower temperature?

DAVID STAHL: That's correct, because you have convective effects, at least in the early period before backfilling. We have not done an analysis to determine what happens --

CHUCK WILSON: You're talking about the surface of the canister.

DAVID STAHL: Surface and the centerline.

CHUCK WILSON: The centerline is cooler when you have more assemblies in the package, because you're saying you have convection within the package?

DAVID STAHL: On the outside.

CHUCK WILSON: So you're taking
heat away from the outside surface of the package?

DAVID STAHL: Yes, sir. In the
vertical emplaced bore hole design, there is no
convective heat transfer. It is purely for the
most part radiation and conduction.

CHUCK WILSON: That's because you
have a permeable backfill.

DAVID STAHL: We have, you have no

backfill. It is a one inch air gap.

CLARENCE ALLEN: No ventilation.

DAVID STAHL: It's sealed, bore
hole design.

CHUCK WILSON: Basically that was
my question on this first one. I wasn't clear how
you got to that point.

But a thermal analysis has been done,
is what you are saying?

DAVID STAHL: A preliminary thermal
analysis has been done. Basically we have used the
21 PWR configuration because it is similar to the
BR-100 design cask that BMW is evaluating, so we
used those thermal codes.

CHUCK WILSON: Would you care to
mention the kind of numbers that you have for the

peak raw temperature --

DAVID STAHL: I knew you were going to ask me that. But do you have the number Tom gave?

CHUCK WILSON: No, I don't think we have a specific number.

DAVID STAHL: We do have the data, and I can show it to you, but I don't --

CHUCK WILSON: I can talk about

that later. But 250 degrees C, your borderline numbers, you really start going through fast oxidation.

DAVID STAHL: If oxygen is present, yes.

CHUCK WILSON: If a canister breaches.

WILLIAM BARNARD: Bill Barnard, from staff.

You mentioned this umbrella concept was developed largely based upon some heater tests in G tunnel.

DAVID STAHL: Yes. And the geologic, hydrological model.

WILLIAM BARNARD: How large were

those G tunnel tests? Was that just a single heater?

DAVID STAHL: That was a single heater, it ran for I think three or four months, heating up, and they held it at temperature, and then cooled down. It was a thermally driven test to look at the effects of moisture in the tuff rock.

WILLIAM BARNARD: When were those tests conducted? Do you remember?

DAVID STAHL: Oh, they were completed two or more years ago, and they have been well reported by Lawrence Livermore. We can get you some references if you need it.

WILLIAM BARNARD: Like 1990; '89, '90?

DAVID STAHL: I think so, yes.

WILLIAM BARNARD: Two years after the SCP was published?

DAVID STAHL: I think they began in 1988.

ELLIS D. VERINK: I think that we visited the site and saw those tests.

JACK PARRY: That's right.

CARL JOHNSON: Carl Johnson, state

of Nevada.

I sense a little confusion, at least on the part of the some of the Board members here on schedules and how the waste package design fits into this, the drift emplacement design.

Let me make a couple of points to hopefully add some clarification, or it may confusion things a little bit more.

One is, if we look at the current design schedule for the exploratory study facility

and if DOE gets all of the money that they desire in order to do that, that work is to be completed, the excavation to the underground and the excavation by I think around '96. Now, that is supposed to be constructed to a repository design size.

Now, I don't know how then that fits with this schedule here of looking at not only the drift emplacement concept but also the various canister materials and that sort of thing.

And the second point is that last week John Bartlett, the Director of OCRWM, announced to the utility industry at a meeting a new repository plan in which one of the points within that plan is to emplace waste underground prior to the end of characterization.

So I don't see how the current design of the waste package, drift emplacement design concepts all fit with this plan that is now the guiding plan at least to the utilities that we're going to emplace waste prior to the end of characterization, ostensibly under the view that it will be for test and evaluation purposes.

So I just want you all to keep that in mind.

DAVID STAHL: Let me just comment briefly on your first point. Certainly as far as the waste package repository and ESF is concerned, we do have an integrated schedule. As far as Dr. Bartlett's remarks, I would have to refer to the DOE to respond to those.

WILLIAM BARNARD: Carl, did John make these comments in Chicago?

CARL JOHNSON: As I remember, I wasn't at Chicago, but the comments were very brief, briefly referred to, but not in the detail that was talked about at the utility executives conference which took place in Washington, D.C., the first part of last week.

DAVID STAHL: Oh. All right.

ARDYTH SIMMONS: Ardyth Simmons, DOE. I can't comment on the exact wording of what Dr. Bartlett said because I was not there at the conference.

I can only tell you that a range of different possibilities was discussed for possible changes to the program in terms of ways of perhaps improving the program. This was one of the concepts that was discussed.

But it has not at this time been accepted as the plan. It is one of about half a dozen concepts that's being considered. That I can verify.

If you would like the exact remarks that were made, I'm sure that we can get you those, as well, to add to the record.

ELLIS D. VERINK: Any other questions or comments? Well, many thanks. We appreciate it very much. And thank you all for your participation today. This closes today's activities.

MICHAEL CLONINGER: Excuse me. I have a question.

ELLIS D. VERINK: Oh. All right.

MICHAEL CLONINGER: Michael Cloniger. I'm asking these questions as a private citizen, taxpayer and nuclear ratepayer, since it's after hours.

You mentioned, David, that you are embarking on the design, waste package design process. Yet to my understanding we have not yet defined with the Nuclear Regulatory Commission what constitutes containment failure, nor the definition of substantially complete containment.

With regarded to controlled release, we have not confirmed with the Nuclear Regulatory Commission what the boundary is of controlled release.

So how can you proceed with design in that context?

And furthermore, I would like to ask what kind of resources you are spending on, one, defining those boundaries and regulation requirements with the NRC and, two, the design itself.

DAVID STAHL: Let me address the first issue, having to do with the definition of substantially complete containment. This is one issue which is part of a totality of issues that are part of the issue resolution process.

That's an effort that's going on right now with DOE and the M & O, and specifically in regards to substantially complete containment, we have generated a draft position paper which we will process through to the Department of Energy for review and concurrence before we introduce that to the Nuclear Regulatory Commission.

So our aim is to try to resolve that. Our goal is to do that by October of '93, before we are well into the design phase, the advanced conceptual design phase. So we don't believe that will be an impediment to the design process. The same is true for the boundary of EBS. I think we're pretty well along on that.

In regard to the resources that are being put to the issue resolution process, it's a fairly small effort in regard to substantially complete containment, but I know that there are many other people and resources being put to the total effort, and perhaps Linda Desell from the regulatory side of DOE can respond to that.

LINDA J. DESELL: Linda Desell,

Department of Energy.

I don't have a specific breakout by issue for cost. The issue resolution, or the money to be spent for that, for the coming year and for this year, is still a little bit to be determined. It's an effort we initiated this year and our exact costing on it is not yet complete. However, we could provide it to you once the budgeting process is complete, if you would like it.

Thank you.

DAVID STAHL: Michael, if I could just respond to the last part of your question, the

total waste package effort. The budget is uncertain for FY '93, but we believe it will be an increase over what we have in FY '92.

WILLIAM BARNARD: That's assuming you get 392 million dollars?

DAVID STAHL: No. We believe even in the base case we will receive an increase.

WILLIAM BARNARD: Okay.

CARL JOHNSON: Let me provide some -- Carl Johnson, state of Nevada -- provide some additional comments, I think, in closing, and I believe Ellis was about ready to close the meeting here.

We've heard some confusion here today on a couple of things. One, just in the last few minutes, and some earlier on as to the amount of high-level waste vitrified canisters that the repository is going to see from Hanford. It can vary anywhere from what DOE has proposed of 1200 to as much as 200,000.

I would like to request that the Board consider inquiring further into both of these issues so we can hopefully get our arms around what this total program is and what its true schedule is.

DAVID STAHL: Carl, let me respond to the first part of what you said. The Nuclear Waste Policy Act mandated that the repository contain no more than 70,000 metric tons of high-level waste, of which 63,000 tons, metric tons, is spent fuel and 7,000 metric tons is high-level waste glass.

The mission plan amendment, there was a delineation of the breakdown of the 7,000 metric tons of high-level waste glass that contains the 300 canisters that I mentioned from West Valley, the 12 or 1300 canister Hanford and the balance from Savannah River laboratory.

Now, if there are other canisters, it would either have to be at another repository, a second repository, or an expanded repository at a potential site of Yucca Mountain if the Nuclear Waste Policy Act were amended to allow more high-level waste to be in-place.

ROBERT COOK: This 7,000 tons is based on an equivalent heavy metal that the waste is derived from. If you have got 200,000 canisters or 1200 canisters, it's all coming from the same amount of waste.

DAVID STAHL: No.

ROBERT COOK: Yes.

DAVID STAHL: There is potentially more waste.

ROBERT COOK: No. The equivalent heavy metal is the same.

DAVID STAHL: No.

ROBERT COOK: It's the same amount. There wasn't any restriction in the mission plan on total tonnage of the glass.

DAVID STAHL: I see what you are saying.

ROBERT COOK: It was the tonnage of the equivalent heavy metal of the fuel that the waste was derived from.

DENNIS PRICE: But the impact on the repository is certainly different.

DAVID STAHL: Yes. Certainly given that, we are anticipating something like 14,000 canisters of the current design. Of course, if we had four in the package, it would be one-fourth of that. Yes. We would need more room to accommodate additional canisters at more expense.

ELLIS D. VERINK: I don't see any arms waving in the air. Maybe at this time I will

want to thank the speakers and the organizations they represent for their parts in this today, and thank you very much.

See you around.

(5:15 p.m.)

* * *

STATE OF OREGON)
) ss.
County of Umatilla)

I, WILLIAM J. BRIDGES, do hereby certify that at the time and place heretofore mentioned in the caption of the foregoing matter, I was a Registered Professional Reporter and Notary Public for Oregon; that at said time and place I reported in stenotype all testimony adduced and proceedings had in the foregoing matter; that thereafter my notes were reduced to typewriting and that the foregoing transcript consisting of 301 typewritten pages is a true and correct transcript of all such testimony adduced and proceedings had and of the whole thereof.

WITNESS my hand at Pendleton, Oregon, on this ___ day of May, 1992.

WILLIAM J. BRIDGES
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