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UNITED STATES NUCLEAR REGULATORY COMMISSION'S

ADVISORY COMMITTEE ON NUCLEAR WASTE

March 21, 2007

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON NUCLEAR WASTE (ACNW)

177th MEETING

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WEDNESDAY,

MARCH 21, 2007

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VOLUME II

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The Advisory Committee met at 8:30 a.m. in Room T-2B3 of the U.S. Nuclear Regulatory Commission, One White Flint North, 11555 Rockville Pike, Rockville, Maryland, DR. MICHAEL T. RYAN, Chairman, presiding.

MEMBERS PRESENT:

MICHAEL T. RYAN, Chairman
ALLEN G. CROFF, Vice Chairman
JAMES H. CLARKE, Member
WILLIAM J. HINZE, Member
RUTH F. WEINER, Member

NRC STAFF PRESENT:

LARRY CAMPER
FRANK P. GILLESPIE
BRITT HILL
ROBERT JOHNSON
MICHAEL LEE
KEITH McCONNELL
DUANE SCHMIDT
JOHN STAMATIKOS (via telephone)
REBECCA TEDESSE
DEREK WIDMAYER

ALSO PRESENT:

PAUL HARRINGTON
JOHN KESSLER
BRUCE MARSH (via telephone)
ROD McCULLEN
MEGHAN MORRISSEY

I-N-D-E-X

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P-R-O-C-E-E-D-I-N-G-S

(8:31 a.m.)

7) OPENING REMARKS BY THE ACNW CHAIRMAN

CHAIRMAN RYAN: We will go ahead and call the meeting to order, please. This is the second day of the 177th meeting of the Advisory Committee on Nuclear Waste. During today's meeting, the Committee will consider the following: update by the U.S. Department of Energy on the proposed Yucca Mountain repository design, the ACNW action plan for fiscal years 2007 and 2008, a briefing on Shieldalloy, New Jersey site decommissioning plan; and update the EPRI response on potential igneous event at Yucca Mountain and other activities of letter writing that the Committee will undertake.

This meeting is being conducted in accordance with the provisions of the Federal Advisory Committee Act. Mike Lee is the designated federal official for today's session. There he is.

We have received written comments from the Office of the New Jersey Attorney General on behalf of the New Jersey Department of Environmental Protection. However, we did not receive any written comments ore requests for time to make oral statements from members of the public regarding today's sessions. Should anyone wish to address the Committee, please make your wishes known to one of the Committee staff.

It is requested that speakers use one of the microphones, identify themselves, and speak with sufficient clarity and volume so that they can be readily heard. It is also requested if you have cell phones and pagers, that you kindly turn them off. Thank you very much.

Without further ado, I will turn the meeting over to our cognizant member for this session, Professor Hinze.

MEMBER HINZE: Thank you very much, Dr. Ryan.

8) UPDATE BY THE U.S. DEPARTMENT OF ENERGY (DOE) ON THE PROPOSED YUCCA MOUNTAIN REPOSITORY DESIGN

MEMBER HINZE: It is my pleasure to welcome Paul Harrington from the Office of Civilian Radioactive Waste Management, who will be discussing with us an update of the repository design. As I understand, you will be focusing on the surface facilities. Is that correct?

MR. HARRINGTON: Yes, it is.

MEMBER HINZE: And we welcome you here. It has been a couple of years since we have heard about this. And we are anxious to learn about the progress that has been made.

With that, please.

MR. HARRINGTON: Thank you. Thank you for having me here today. I apologize for not having been here last December. I was not in any position to fly or talk to you, but I am healed now. So we're okay.

I will go through the design changes. And this is implementation as a predominantly canister-based approach to repository operations. We'll talk about predominantly the surface because that is where the largest trains have been. Also, then we will touch on the effects on the waste package designs and the subsurface layouts that come from this, talk about the site layout and the waste-handling processes and facilities, then give you a status of where we are with development of this revised design heading toward a license application early next year.

A series of acronyms. We have a new suite of buildings.

(Laughter.)

MR. HARRINGTON: So we have a new suite of acronyms. The canister receipt and closure facility, as we will talk about, is the primary facility that will put canisters, disposable canisters, into waste packages and close and seal those waste packages for disposal.

The initial handling facility was initially conceived of as a facility that could come online appreciably earlier than several of the other waste-handling facilities. At this time we are scheduling it, really, for start of operations concurrent with a CRCF and the WHF down there at the bottom, the wet handling facility, for the proportion, nominally ten percent, of the waste stream that does not come in in disposable TAD canisters. We will do that reloading into waste packages in the wet handling facility. So those are the primary changes in facilities and acronyms, CRCF, IHF, WHF.

We are using the disposable transport, transportation, aging, and disposal canisters now. Our primary goal of that is to reduce the individual handling of bare fuel assemblies at the repository.

As you know, the several iterations of designs that we have had in the past all have been focused on receiving an individual handling each of the fuel assemblies.

We had several years ago intended to do that primarily in pools, had about five years ago shifted to a dry approach to that handling similar to

Cogema's at La Hague but most recently, October, a year and a half ago made a decision to change to a TAD canister approach.

And the effect that we will see from that is a significant simplification of repository surface facility operations. And that will really be the theme throughout this, how can we simplify repository operations?

I recognize that not all facilities would have the capability of loading TADs for a number of different reasons. So we have chosen a nominal ten percent of the waste stream to not be in TADs. If in practice it turns out that that percentage is appreciably different, we will have the capability since this is a modular set of facilities to adjust if needed the facilities that we would intend on constructing. But, as it appears to us now, ten percent is a reasonable number.

That limited quantity that would not be received in TADs would be taken into the wet handling facility and transferred in a pool to TADS, not directly into waste packages. And then those TADs would be taken over to the CRCF and put into waste packages, closed, and taken underground.

Because of that, certainly we have had to significantly reconfigure the whole waste-handling process, the facilities, and we have also somewhat changed the waste packages themselves to accommodate TADs.

The TAD canister, as we presented it in the TAD spec, is dimensionally very similar to the Navy long canister. That was really the model that we used in trying to size the TAD canister. We kept the same inventory in the TAD canister as had been the predominant waste packages, the 21-PWR, 44-BWR. That is the basic TAD canister design of this approach.

The IHF I mentioned a moment ago. The reason we looked at that initially was to begin commercial operations, waste receipt, earlier than would have otherwise been possible with some of the larger, more complex buildings.

So what we looked for was, what is a relatively robust waste form that we could handle in a building and would not need to credit ventilation systems, confinement; whereas, if we did have a drop and breach of that waste form, we would without needing to credit that confinement still not exceed off site those criteria.

Those waste forms turned out to be the Navy canisters and high-level waste glass logs. So that was the original consideration behind development of the IHF.

We have since decided that likely we will not be bringing that IHF online before the first CRCF and the WHF. So on the schedules now, you will see commencement of operations in 2017. That will be for the whole suite of facilities, those first three, which we have defined as initial operating capability. That is a DOE term for what is it that you have at start of operations.

There is a companion term: final operations capability for the full suite of facilities. We define the IOC to be that set of facilities that we would need to have to accommodate all of the waste forms. So that would include the IHF, predominantly for the naval waste forms. Those will come in a much larger, heavier, longer transportation cask than the commercial packages.

So we will dedicate the IHF to naval packages. "Dedicate" is not the right word. We will run the naval packages to IHF and not to the other buildings. That simplifies the construction of the other buildings. The roof height, crane hook height doesn't have to be as high as it otherwise would, but we would still have the capability of bringing high-level waste glass logs into the IHF if we chose to do so.

Site layout. This is the overall site layout. It is similar to before in that this is the north portal with the subsurface access through that north portal with the actual waste-handling facilities collected around the north portal.

That is the same approach as we have had in the past. It is a different suite of facilities. These are aging pads. Those are similar location to the last iteration.

But a blowup of the north portal area shows an IHF, the initial handling facility; the first CRCF; the wet handling facility; and additional CRCFs. That is so we can add CRCFs to provide additional operational throughput. We don't have to build them all initially. We can start operations with the first one.

And then as the additional ones come online, we can ramp up operational throughput. Our intent is still the nominal 3,000 MTHM commercial per year with DOE, SNF, and high-level waste added to that.

Now, because we have the three CRCFs, as I mentioned earlier, if that proportion of uncanistered, non-TAD commercial waste stream appreciably varies, we can do one of several things.

The first would be to extend the operational duration of the wet handling facility. Right now it would only need to operate for about 23 years to accommodate that 10 percent. The simplest approach for an additional waste stream up to on the order of 20 percent would be to run that facility longer. If it turned out that the proportion not in TADs was appreciably greater than ten percent, then we would, instead of building the third CRCF, build another WHF.

So the point of this discussion is just to provide flexibility. We have a nominal ten percent. And if that appreciably changes, we have the ability to react to that over time.

Yes?

MEMBER HINZE: Excuse me, Paul. Before you leave that, could you show us where the low-level waste facility is and describe that a bit?

MR. HARRINGTON: Low level waste facility will be one of these. It will not be a processing facility to turn it into solid low-level waste. It will be a collection facility and we will bring in a low-level waste-handling organization to take care of that for us.

MEMBER HINZE: Thank you.

MR. HARRINGTON: Sure. The same general location for the waste-handling, aging, and support the IHF really talked about. We have -- let me back up one -- arranged these facilities so that we can accommodate a phased construction. There is sufficient area between them to provide for security fencing, to separate the operational side from the continuing construction operation similar to the second and third power plants at the nuclear utilities who have more than one on a site, though as we look at starting operations in some of the initial facilities, we are designing in the capability to support the construction of the additional facilities simultaneous with that.

The naval NSF, the reason that we would not run them through the CRCFs, as I mentioned, is because of their much larger transportation cask. It is on the order of 30 feet long versus the 20 feet for the more commercial CSNF.

The receipt facility is not one of the initial operating capability facilities that I mentioned. Its purpose is to support the 3,000 MTHM receipt rate with an expectation that a lot of the waste forms that are going to come are going to exceed the emplacement thermal criteria. The aging system is where those packages will go.

So the receipt facility does not have a capability to actually load waste packages. What it does is simply receives a transportation cask, removes the TAD canister, and it can handle non-disposable DPCs also and puts them into aging overpacks and sends those aging overpacks out to the aging pads.

So it doesn't have a role in disposal. It does have a role in accommodating a 3,000 MTHM per year receipt rate for waste forms that exceed the emplacement thermal criteria.

The wet handling facility handles the individual fuel assemblies in the pool. The EDGF is an emergency diesel generator facility. This is a change that came about late prior to our change to TADs. Two years ago, before we were looking at the potential of oxidation of fuel in a dry environment, we thought that we likely would need only a four-hour fan operational period in the dry transfer facility. We could meet the operational goals for that system by off-site power with the required reliability.

So though we had a series of both emergency diesel generators and standby diesel generators at the facility, they had not been classified as important to safety.

That has changed. The emergency diesel generators now will be classified as important to safety. So they will be in their own facility to provide missile protection for them. The low-level waste facility we discussed just a moment ago.

The actual process, TAD handling certainly eliminates the majority of the bare fuel assembly handling for the 63,000 MTHM that equated to about 220,000 individual fuel assemblies. And we were going to handle each of those potentially four times from a transportation cask into a rack, then from a rack into an aging cask, and coming back from aging into a rack again and then into a waste package. So there was an awful lot of handling associated with that. The change to a disposable canister eliminates the large, large majority of that.

To give you a sense of which forms go where, what we are using the different facilities for, naval SNF will go through the IHF only and then to emplacement. It will not go to aging. Navy's building a storage facility at Idaho. So we will receive their packages and emplace them. There is no need for or desire to do any sort of aging for the

Navy waste stream.

High-level waste can go to the IHF or into the CRCFs to be co-disposed of with the DOE SNF. One of the waste packages is still the co-disposal package with the one DOE SNF canister surrounded by five high-level waste canisters inside the waste package.

The DOE SNF will only go to the CRCFs. It will not go to the IHF because of confinement issues. Okay? We're not needing to credit confinement in the IHF because of the waste forms that go through there and their inherent robustness.

The DOE canisters and waste forms don't have that inherent robustness. So we will run them exclusively through the CRCFs that we do credit the confinement for those facilities.

Incidentally, I talked several times about the IHF and its confinement. It certainly does have confinement. It does have HEPA filtration, fans, and all of that. The issue is we have not needed to credit that to meet those requirements. So it's not considered to be important to safety, but it is there.

The commercial SNF in TADs, the large majority of that we will expect will likely not at receipt satisfy the emplacement thermal criteria. So it will go to the receipt facility for transfer to the aging pads in the aging overpacks. When it has cooled sufficiently, it will come back into the CRCF, be loaded into the waste packages for emplacement. For those TADS that do at receipt meet thermal emplacement criteria, they can go directly to the CRCFs for loading into waste packages and emplacement.

Then, finally, the uncanistered commercial SNF either that we receive truly uncanistered has bare assemblies in a transportation cask or in non-disposable canisters. Those will go into the wet handling facility, be loaded into TADs, then, in the WHF, and if that TAD exceeds the thermal emplacement criteria, it goes to aging. If it does not, then it goes directly to CRCF and then to emplacement.

Annual capacities for the facilities. The IHF annual capacity is 40 MTHM. That really is driven predominantly by the glass logs going through there. The naval canisters have a very low MTHM per canister capacity. There is only 65 MTHM of naval fuel total spread over almost 400 canisters. So their MTHM per year through IHF on the order of 24 canisters is relatively low. So the largest part of that would be high-level waste canisters. And IHF does have the capability of emplacing. So you will see that there.

CRCF, this is predominantly the commercial

SNF. It also includes the DOE SNF and high-level waste. And it emplaces the WHF, wet handling facility, since it and the receipt facility do not do emplacement. Those are zeroed out. But that gives a sense of the annual throughput capability of those facilities also.

The reason the RF, or receipt facility, was so high. That's a relatively simple transfer of a canister from the transportation cask to an aging overpack, not a lot of complication in that facility.

The facilities themselves, a series of sketches. You will notice there are no internal access points shown. This is one of the safeguards and security requirements. So we can show external access points. But as far as how people would move around inside the building, we cannot show that. We can show what does happen inside the building, though.

The receipt happens here. This is a rail car coming in. There is an overhead crane. There is a vertically oriented shielded overpack that moves in and out from the receiving bay through an area that is underneath a transfer canal.

So the overhead crane will up-end the transportation cask and then open it, move the canisters, Navy canisters and high-level waste canisters, out of the transportation cask into the transfer cart. That transfer cart will then translate over underneath the unloading bay.

Let me just go forward one. Okay. This is a side view of that. There is a canister transfer machine that runs on rails above the unloading port to load the waste package.

So, backing up one, this movement will be done by air pallet. The canister will be put into a shielded overpack here. What we have done through this facility design is try to mirror as much as possible the Navy's canister transfer handling facility in Idaho. Some of you may remember the previous designs where we have done a lot of handling in hot cells.

One of the things we looked at, was how do we recover from operational mishaps in there, equipment failures? The Navy did not do that. Most of their handling was done in shielded overpacks so that if they actually had equipment failures, they were able to do hands-on repair of it, rather than trying to do that remotely via tooling inside of a hot cell. So we have adopted that approach. Obviously going to the canister-based approach simplifies that.

But the waste form is in a shielded

overpack throughout almost all of its handling in these facilities now. They will all continue working through here. It's transferred via that canister transfer machine into the waste package supported there.

That waste package is then translated to the closure cell there. It's in a vertical orientation. The now two lids are installed, welded, nondestructive examined. There is still the helium inerting gas inside the inner part of the waste package.

When that closure operation is completed, inspections are done. Then it is moved out and lowered down to a horizontal configuration and put onto a transport and emplacement vehicle. That's a change from our previous approach to moving the waste packages underground. We will see a graphic of that in a few minutes.

This is the down-ending area. And in the past, we had looked at doing that either by cranes, lowering them using the pivot point. One of the things that we have done here is take a page from heavy fabrication.

There are some companies that make what we had called tilt tables. They called them positioning tables. And it's a very large table, on the order of 20 feet square, that's on a curved gear rack. And that gear rack will drive it up or down. There is no potential for a crane failure, a drop, anything like that. This thing has a very controlled motion to it. So we have adopted that in the down-ending tool here.

This transportation and emplacement vehicle is a replacement for the previous shielded transfer cask and emplacement gantry. Previously we had had the shielded transporter take the loaded waste package underground to the mouth of the emplacement drift. And it had a bed plate that would extend. And then an emplacement gantry would go over that bed plate, grapple the waste package on its pallet and move down the emplacement drift.

That is an extra lift. It's additional complication. So what we have done now is shift to a rail-based system that will accept the waste package here from the down-ender and be able to actually move that waste package to its emplaced location.

So there is no more transfer of waste packages, handoffs, if you will, at the entrance to the emplacement drifts. It's a further simplification of operations.

MEMBER HINZE: There are no hot cells in

that building. Is that right?

MR. HARRINGTON: That's right. That's right. I said that the waste form is generally shielded throughout its handling in this building. The one place that it's not shielded is in making this transfer from the down-ender to the TEV, We leave that exposed there so we can do the surface examination.

One of the criteria for waste packages is that it not have any areas that might accelerate corrosion or degradation or anything. So we have to do a surface visual examination of it. So that's where we'll do that, just as the final step before taking it underground.

Other than that, it's shielded throughout its waste-handling process.

MEMBER HINZE: Is that also including a cleaning of the canister that -- cleaning of the surface if it needs it?

MR. HARRINGTON: The canisters would be received clean. I mean, they will be shippable. So we're not going to do anything to dirty them. We've not provided a cleaning process in this facility. It is simply a transfer of the canister out of the transportation cask directly into the waste package.

MEMBER HINZE: So the HEPAs will be large enough to prevent any dust from accumulating?

MR. HARRINGTON: Yes.

MEMBER HINZE: Okay.

MR. HARRINGTON: Yes. The canister transfer machines are really the same here and in the CRCF. They are very similar to what we had at Fort St. Vrain for our ISFSI.

It has a shield door, a shutter on the bottom of the canister transfer machine. It has got a grapple in it. It will draw the canister up. It will shut that shutter on the bottom of the canister transfer machine. And its transfer machine then translates over.

It will open the shutter and then lower the canister in there. So the intent is just to provide shielding around that waste form at all times through its handling process.

Wet handling facility. Its primary feature is the pool here. Incoming waste forms come in here -- this is the transportation cask area -- to unload either transportation casks that had bare fuel in them -- those transportation casks would be lowered into the pool via overhead crane for that operation -- or if it's a non-disposable canister, DPC, the canister itself would be removed from the transportation cask, lowered into the pool, and then opened underwater. We are currently intending on doing that canister opening underwater, developing the process to do that.

Then the transfer of the bare fuel assemblies themselves, either from the transportation casks or the non-disposable canister, would be done underwater into a TAD. That TAD would then be brought out. The closure area for the TAD is there. It has to be dried.

The lid is welded onto the TAD. And then it would be put into a transfer overpack for either transfer out to the aging system or over to the CRCF for placement into a waste package if it met the thermal criteria.

Those TADs would be taken back out there. That is an in and out for that facility. These are supporting HVAC, electrical, admin., those sorts of things. The key operations happen in the middle of the building there.

The CRCF is the main production facility. It in concept is very similar to the IHF but has two trains, incoming, waste forms through here, unloading of the canisters from the transportation casks into the transfer trolleys, movement of those transfer trolleys under the unloading cells, transfer of the canisters into the waste packages, closure of the waste packages, then down-ending of the waste packages for acceptance into the transport and emplacement vehicle. So it's a relatively much more straightforward operation than the handling of the individual fuel assemblies that we had had in the prior approach.

A cross-section there is fairly similar to the IHF. This is the canister transfer machines running above the canister transfer cell. Because of the additional waste forms that this facility handles, specifically DOE, SNF, and commercial, we do need to credit the HVAC, HEPA filtration, and ventilation systems.

The receipt facility is fairly simple. The incoming and outgoing waste streams are in through here, got overhead cranes to do the transfer of the canisters from the transportation cask to the aging overpack. We provide controls on lift types, et cetera, in here. And those, then, are taken via the transporter out to the aging pads.

Now, because we are using TADs predominantly, we have cut out the number of individual types of waste packages we had had in the past. It reduces it from a total of ten down to six. Also, though, one of the other lessons learned from Navy was their use of shield plugs in their canisters. It simplifies their canister closure operations. If they need to have local access during that canister closure operation, they are able to do that. So we adopted the same approach.

The TAD canister concept, one of the differences from some of the other canisters out there is the inclusion of a shield plug. And the reason for that is to lower the dose at the waste package closure area so that if we need to do some remedial operations during waste package closure, it will facilitate the ability to do that.

Also, because the DOE SNF canisters, the high-level waste canisters, the small diameter canisters do not have shield plugs in them and putting shield plugs in the individual small canisters wouldn't really be effective because of the potential for streaming, between the small canisters inside the larger waste package, we have just gone ahead and added a shield plug inside the co-disposal waste packages to reduce that waste package closure dose. It will be sitting on top of the individual small diameter canisters.

A majority of the TADs would be loaded at the utility sites. We do have the capability of loading them in the wet handling facility, in the pool. That significantly simplifies our operations, reduces our risks.

The utilities need to load individual fuel assemblies into a component, into the transportation cask or into a canister. The loading into disposable canisters we don't think significantly affects the utility operations. TAD canisters include shield plugs I mentioned.

The is the change from before. The five previous waste packages on the right were as before, but here we have the one standardized 21-PWR or 44-BWR waste package. As we go further, we may need to provide some additional TADs, but this is the standard TAD that we are looking at today. We have added the shield plug. It will reside above the individual canisters. And these are really unchanged.

We haven't changed the subsurface emplacement concept, but we have made some minor changes, though, in the layout of it. Specifically this Panel 1 used to be located a little bit further up that direction. But the position that put us in was having to back up as we came down the north ramp. This is the north portal area, from which we will do emplacement. We would have had to have backed up to have caught the first emplacement drift in that Panel 1. So we took the Panel 1 and shifted it a little further down this perimeter drift.

Overall ventilation. We still have the supply and exhaust. This is an exhaust main. The supply will still come in the leading side that has the individual drift turnouts. On the exhaust side, though, we have stepped away from having turnouts.

That exhaust main is not going to be humanly habitable. It will be very hot. So the complexity of adding turnouts there didn't make sense. So we have just made them straight runs from the emplacement drift into the exhaust main.

We will still expect to bring on the first panel, then the second panel. There is still contingency drift area at the bottom of that second panel, then the third east and west.

And, fourth, no significant changes to the overall subsurface concept. There will still be the simultaneous emplacement operations and continuation of excavation operations with the bulkheads isolating those two areas. The 41 miles of emplacement drift, that's about as it had been before.

Where are we now? We have done the basic facility layouts and material flows. We will do several iterations, two major iterations, of structural analysis for these buildings. The first one we are referring to is Tier 1. That is a lump mass model, stick model, approach to their seismic analysis. It's conservative. It's simplified from an actual finite element analysis, 3D model.

We have completed that 3D model for CRCF. We are now in the process of using that as the basis for designing the various parts of that structure.

The other facilities are following that, the IHF, RF, WHF. We are doing the systems design now. We have done a prototype waste package. That has recently been completed. We had a plan for multiple waste package prototypes and have delayed the funding for the second one from '07 into '08. That was just one of the things to try and make the best use of the '07 funding we got. We slowed that one out.

Preclosure safety analysis certainly will be different than for the previous facility design. So that, as always, is iterative with the design. The results of the PCSA are scheduled for completion in

November.

Someone had earlier asked for critical path. Because we really significantly changed the facility design, the update to the design for the new facilities combined with the preclosure safety analysis of those designs, particularly for the structural analyses, is really the critical path now.

New mechanical handling is going forward. The HVAC design is going forward now that we have done the facility layouts. We know the thermal loads that are in there. HVAC is going forward. The electrical design is going forward, looking at redundant feeds from the utility grid.

So basically we are going forward. There is a lot to do. We had been somewhat behind on schedule. We had to hire on the order of 200 people between design and PCSA to accomplish the work. BSC has met those hiring goals and are nearly back on track for production of products.

So, with that, I think I have a summary slide that really reiterates what I have said. I would be happy to go ahead and take questions, talk about things that are of interest.

MEMBER HINZE: Thank you very much, Paul, very illuminating.

I will ask Dr. Ryan to begin. I know you have another appointment.

CHAIRMAN RYAN: Thank you very much.

Paul, I second Bill's comment. This is a real interesting update to the design and seems like a real significant number of simplifications and steps in handling of fuel and all the rest.

So I think it would be helpful -- and, again, I realize you are kind of at an earlier stage and you are looking at sketches, rather than some of the details that we have heard on the previous design.

Looking ahead a bit, I think it would be useful for the Committee if somewhere down the line in this calendar year we could get an update from you on some of the details. And the details would be related to a little bit more of the handling.

You know, we get involved, for example, in some of the waste placement in the drift issues. And, you know, there is a transfer process that is going to occur, and we had questions about that.

I am not anticipating that we would have questions similar to that on a much simpler system, but it would be helpful if we could get that same kind of detailed briefing when it's appropriate for you to do that.

MR. HARRINGTON: Sure.

CHAIRMAN RYAN: That kind of leads us into thinking about what are the issues significant to safety or risk. I think about some of the work or time and motion studies that obviously are going to need to be updated based on your handling schemes, those kinds of things.

So that it will help me understand, where are you in the design process? Are you at detailed conceptual design? Are you at preliminary stages of detailed design or where are we?

MR. HARRINGTON: In DOE parlance, we have conceptual design, then preliminary design, then final design. We have completed conceptual design. And that was the critical decision 1 --

CHAIRMAN RYAN: Right.

MR. HARRINGTON: -- that we did last June-July. That was approval to then go into preliminary design. And that's where we are now.

The DOE critical decision 2 will be approval to go from preliminary design to final design. And we don't expect to do that until likely shortly after license application submittal.

Part of that CD-2, that formal process, is a fairly detailed cost analysis. So our focus for license application has been primarily on waste forms, the important to safety and important to waste isolation attributes of the design.

We have not done very much with non-waste-handling affected parts of the repository as far as -- well, low-level waste facility. That would be one. But admin. and the other support facilities, the guard shacks, all of the access things, --

CHAIRMAN RYAN: Yes.

MR. HARRINGTON: -- we haven't done any real design on that yet. I expect that we will need to do substantially more of that to meet the DOE's intentions for the level of fidelity in that cost analysis.

So I think the formal movement from preliminary to final design will follow license application.

CHAIRMAN RYAN: Does it make sense to you to think about something later in the calendar year --

MR. HARRINGTON: Oh, sure.

CHAIRMAN RYAN: -- to come back and give us an update on some of the detailed features?

MR. HARRINGTON: Sure.

CHAIRMAN RYAN: Again, it sounds exciting because you have reduced the handling. You know, I did a little sort of mental calculation on the amount of rigging that you would have to have on hand for the previous arrangements. And those were you would have to have a special rigging facility to keep track of it all.

But it sounds like it is a much simpler scheme and the wet and the dry issue seem to be clear and resolved in terms of what would need to be handled wet and how you are going to do that. So that seems to be the real advance to me.

And I think just maybe an update with the next level of detail would really help the Committee --

MR. HARRINGTON: That would be fine.

CHAIRMAN RYAN: -- understand that and maybe offer the Commission any guidance that may fall out of it.

MR. HARRINGTON: Okay. Yes. Some of those things I can talk to right now, you know, the basic TEV concept, if you would like.

CHAIRMAN RYAN: Sure.

MR. HARRINGTON: Previously we had had basically a rail-based concept for movement down, including a locomotive and the shielded transporter. So there were the concerns about runaways. What is the probability?

We had gotten to extremely high reliability needed for the braking system on that to make that be on Cat-2, beyond Category 2, then sequence to the point where we didn't believe we could likely demonstrate that sort of reliability.

The TEV is a step away from that sort of rail-based locomotive and car concept to a crane concept, where the individual wheels are each driven by motors.

So if you lose power to it, it's not a matter of losing a braking system. The thing stops. It can't move other than as it's driven. Yes, it will have a braking system also, but it's fundamentally more resistant to the potential for runaways down the ramp. That ramps on the order of a three percent slope, I think.

MEMBER HINZE: If one motor fails, all are turned off presumably?

MR. HARRINGTON: I don't know. If one motor fails, it's not going to be able to be driven.

MEMBER HINZE: I've had some experience with vehicles, with individual motors. And you can have a lot of problems if one fails and the others keep going.

MR. HARRINGTON: We will certainly design it so it is not going to hurt itself. That would be an appropriate thing to do. I don't know if we have gotten to that in the design yet.

But basically the fundamental shift there was twofold: To move away from an approach where you would have to create a braking system to something that just doesn't move unless you are able to successfully operate it and also simplification of that handoff process there at the mouth of it, mouth of the emplacement drift.

CHAIRMAN RYAN: One other area -- and, again, I am looking ahead to maybe an update as your detailed work gets underway or at least you're finishing the conceptual designs is the accident analysis piece of it or the credible operational accidents you have analyzed and what are the dose consequences and release consequences of potentials you have come up with for this substantially different design. That I think would be of interest to the Committee.

MR. HARRINGTON: That's one of the carryovers from the previous, is the probability of drop and consequence of drops of large canisters. That part translates over all of the bare field assembly handling that have been done in dry. Obviously that's just simply gone.

But we do still have the potential for drops of the individual fuel assemblies in the pool on the order of 22,000 assemblies. So the drop rate of that is now in a Cat-2 event sequence, I believe, rather than a Cat-1 that the earlier had been, simply due to the reduction in numbers.

CHAIRMAN RYAN: Right.

MR. HARRINGTON: The increase in the number of canister handlings because we have more canisters to deal with still has not moved the potential for canister drop, though, into Cat-1. I believe that is still Cat-2.

CHAIRMAN RYAN: I guess just understanding that whole profile of risk analysis would be helpful down the road.

MR. HARRINGTON: I would be happy to do that.

CHAIRMAN RYAN: Thank you. Thank you, Bill.

MEMBER HINZE: Dr. Weiner?

MEMBER WEINER: I have a couple of questions that might seem disjointed. What about material that is already canistered and sitting in dry cask storage at the utilities? How is the TAD going to interface with that? Are you going to require the utilities to recanister? What is going to happen there?

MR. HARRINGTON: That's why, part of why, we have the wet pool capability. If those canisters are not repackaged prior to shipment to the repository, we have the capability in the pool to repackage them ourselves.

DR. WEINER: Your ten percent, is that based on some assessment of what will already have been canistered and need to be recanistered or what is that ten percent based on?

MR. HARRINGTON: Everything that could be canistered would result in a number greater than ten percent. We chose that as a nominal number for operational purposes. And that's why I talked earlier about flexibility.

If in practice it turns out to be that there would be a much larger percentage, we would just not build the third CRCF. We would go ahead and build more capability for handling those if that's the way it turned out.

MEMBER WEINER: Are you having any interaction with the utilities now to go to at least something that is the same size and volume as the TAD so that anything -- at what point are you going to start requiring --

MR. HARRINGTON: We have been interacting with utilities on that, also with the fabricator industries. I saw Rod McCullen raise his hand. I would be happy to let him make a comment here, too, if he would care to give the industry perspective.

MR. McCULLEN: Yes. Rod McMullen, Nuclear Energy Institute.

We have been working with the DOE on these questions, a lot of which, to answer Ruth's question directly, given the schedule for the TADs and the rate at which we are loading casks, is probably likely that we will have somewhere a little more than 20 percent of the fuel in casks other than TADs at some point. And I would also tell you that right now it is the position of almost every utility fuel manager that they don't intend to repackage on their site.

Now, the reason why I think the question is difficult to answer is that issue is the subject of some negotiation between DOE and the utilities. And I would not want to presuppose how that negotiation would come out. It also may be the case to be the subject of litigation. Some of these existing systems may have questions as to whether or not they will be transportable. So they might have to be reloaded anyway.

So we think from our standpoint that what DOE is doing is not an unreasonable approach. They're nominally shooting for ten percent. There are a lot of questions that can't be answered without future developments we can't speak to today in terms of whether it will be 20 percent or 10 percent or some number in between, but they certainly have the flexibility to change out a CRCF with a wet handling facility.

So the going-in position is that appears to be the right amount of flexibility. And we continue to work with them. We have had a lot of interactions on the TAD. A lot of these things will require individual negotiations with individual utilities that nobody in this room can speak to.

So without presupposing how those will come out, this is probably the best approach you could have at this time.

MEMBER WEINER: Thank you.

My other question deals with how much you are considering. The FEIS for Yucca Mountain considered the preferred option, which was a 70,000

MTHM facility, but also considered additional inventory.

How is your surface facility? Is your surface facility designed to accommodate that additional inventory, modules 1 and 2, or is it specific to the 70,000 metric tons of facility?

MR. HARRINGTON: It is certainly not limited to the 70,000-ton. It's sized so that we could accomplish receipt and emplacement of 70,000 tons in 50 years.

If that number were to change, then either you could run that same set of facilities for a longer duration to accommodate a greater inventory or you could build additional modules if, for some reason, there were a need to do it in the same duration or shorter. But that is one of the benefits of having the modular approach.

MEMBER WEINER: So you could simply add modules, change the function of some modules just to accommodate the additional --

MR. HARRINGTON: Or run them for longer durations. Either one would work.

MEMBER WEINER: Finally, what about the DOE material that's stored at places like INL that is already canistered? Is that going to give you a problem with interfacing with the TADs or can you accommodate that?

MR. HARRINGTON: No. I might back up a few slides. Here.

MEMBER WEINER: Oh, okay. So you --

MR. HARRINGTON: These are those.

MEMBER WEINER: So you have already taken those into account?

MR. HARRINGTON: Right. High-level waste has been generated at West Valley. Savannah has done some. INEL and Hanford are both looking to create high-level waste glass logs. So canisters exist for those.

DOE has been designing up at Idaho the standardized DOE SNF canister. Some are 18. Some are 24-inch diameter by 10 and 15 feet long. We accommodate that.

Hanford loaded primarily the end reactor fuel into the multi-canister overpacks the MCOs. We have designed for that. That is this one here. That is the end reactor fuel. So our designs accommodate those canisters.

MEMBER WEINER: I see. Thank you.

MR. HARRINGTON: Okay.

MEMBER HINZE: Dr. Clarke?

MEMBER CLARKE: Thanks, Ruth. Thanks for that line of questioning. I would have asked it if you hadn't. But it sounds like from your response, really, and the response from the Energy Institute, that this ten percent is a likely range of fuel that would be commercial.

MR. HARRINGTON: We think so, yes.

MEMBER CLARKE: It would come in. It have to go to the wet handling facility or something, I guess, to be repackaged. I that --

MR. HARRINGTON: Yes.

MEMBER CLARKE: Is that fair?

MR. HARRINGTON: Yes.

MEMBER CLARKE: It's a fair understanding? An observation, I guess, is that this has to a systems engineer's dream project. Making all of these pieces fit together not only for the surface facilities but I was going to ask you about the repository itself.

And you said that the way you are approaching it you believe has sufficient flexibility to hand what actually could happen, as opposed to your operational goal of 90 and 10. You believe you have accommodated that in your approach?

The repository is going to be constructed in a phased manner as well.

MR. HARRINGTON: You are referring to the subsurface parts? Yes, that's right.

MEMBER CLARKE: And that, of course, will have to have -- whatever happens at the surface ideally. And that linkage is there?

MR. HARRINGTON: Yes. One --

MEMBER CLARKE: I guess what I was going to ask, though, is are you running different scenarios to see how they play out on the surface, how they play out in the repository construction as well?

MR. HARRINGTON: Yes. We have something called the total system model. Are you familiar with that? Have you heard of that?

MEMBER CLARKE: I've heard the term. We haven't been briefed on that.

MR. HARRINGTON: Okay. Chris Koots runs that with the systems engineering folks here in D.C. And they model waste receipt throughputs through the facilities and emplacement. So I understand that you are soon going to be getting a briefing from him on TADs specifically. It might be of interest to you also to have him talk about the total system model.

MEMBER WEINER: That's a very good --

MR. HARRINGTON: That would be probably really helpful.

But yes, we are using that.

MEMBER CLARKE: And that model does include the repository construction as well as the surface facilities?

MR. HARRINGTON: I am not sure if they look at the construction parts of the subsurface, but they certainly --

MEMBER CLARKE: They don't go with --

MR. HARRINGTON: -- do the emplacement parts of it.

MEMBER CLARKE: Yes, assuming it is there to --

MR. HARRINGTON: Yes. We just need to build it rapidly enough to support the emplacement that that model says.

MEMBER CLARKE: Okay. And the other question, you had a slide. I think it was 12. Right. That was facility annual capacities do reflect the magma 90/10 operational goal. Is that?

MR. HARRINGTON: Yes. Yes. That's what drives that WHF capacity on this, is an expectation of that ten percent through there.

MEMBER CLARKE: Okay. And another question that may not be a fair question for you, but you mentioned canister shield at Idaho. They also had calcine material in bins. Does that factor into this or is that a --

MR. HARRINGTON: It does. There is some interest in sending calcine directly to the repository without vitrifying it. And that is not a waste form that we have modeled. It may present some challenges or it may not. Right now I think we think it probably would, but we have not made the decision to do that.

MEMBER CLARKE: Okay.

MR. HARRINGTON: So if it comes about that that is a waste form we would have to deal with, then we would simply have to roll it into the pre and post-closure analyses and see how it affected performance.

MEMBER CLARKE: It was a very helpful presentation. Thank you.

MR. HARRINGTON: Thank you.

MEMBER HINZE: Allen Croff?

VICE CHAIRMAN CROFF: Thank you.

Can you give me an idea of the overall dimensions of a CRCF?

MR. HARRINGTON: That was on the order of 350 by 350 feet. It is actually quite a bit smaller than the old dry transfer facility had been, which was on the order of 500 feet square.

VICE CHAIRMAN CROFF: How tall?

MR. HARRINGTON: Oh, height? Sixty to 70, something like that. It's a big building.

VICE CHAIRMAN CROFF: Yes, it is. Second, you said that a lot of the commercial spent fuel you would initially receive would be too hot to be in place. So you put it out on the aging pads for some amount of time.

Does this mean that in the initial operations of the repository, that mostly high-level waste and naval reactor spent fuel and DOE spent fuels would be emplaced in preference to commercial spent fuel?

MR. HARRINGTON: That would depend upon what it is the utilities send to us. They have some flexibility on what they choose to send. We have the ability to accommodate it, whether or not it would be cold enough to emplace or if not, then go ahead and put it on the aging.

VICE CHAIRMAN CROFF: Okay. So you haven't formulated an expectation?

MR. HARRINGTON: Well, the total system model that I mentioned a moment ago, they have done a number of different runs in there looking at different receipt scenarios.

And I guess I would ask Chris to talk to that in more detail, but what I have seen of that shows that we have the flexibility to accommodate a range.

VICE CHAIRMAN CROFF: Okay.

MR. HARRINGTON: I don't know that we have actually defined a single expected range.

VICE CHAIRMAN CROFF: Okay.

MR. HARRINGTON: For analysis purposes, we look at youngest fuel first, five-year-old, because that's kind of the bounding in terms of max thermal output. But as far as what we will actually get, it will be something different than that.

VICE CHAIRMAN CROFF: And the rules are still that it's utilities' choice what they send, not your choice?

MR. HARRINGTON: As long as it satisfies the standard fuel definition in 9.61, I believe they have the ability to pick and choose what of their fuel they will send.

VICE CHAIRMAN CROFF: Okay. Thanks.

MEMBER HINZE: A few questions, Paul, if I may. Has the repository footprint changed in any way?

MR. HARRINGTON: The subsurface?

MEMBER HINZE: Yes.

MR. HARRINGTON: Not in the last year or two. I'm trying to think how long ago it is you have heard. Let me go to --

MEMBER HINZE: It's been a couple of years, six I think. Oh, that's not six.

MR. HARRINGTON: Depending upon how far back you've heard, we at one point had looked at going further south than the south portal. I think we refer to that as the beaver tail. That's no longer in consideration.

This has been extended more to the north than it had been several years ago. Several years ago it didn't go as far north of the existing north ramp curve.

MEMBER HINZE: Right.

MR. HARRINGTON: So this has been basically out for quite a while, but I think we have truncated a little bit on the south and extended a little bit to the north from where we were maybe three years ago.

MEMBER HINZE: Did you happen to have in your memory bank the square kilometerage, how many square kilometers?

MR. HARRINGTON: No.

MEMBER HINZE: That would be useful information to us as we look at some of the disturbing events. What about the setback distances? And what about the flexibility in construction for setback distances from faults? Are there any provisions for this?

MR. HARRINGTON: Oh, certainly we have the provision for doing so. We are going with a full drift liner now with the perforated stainless steel Bernauld sheet held in by rock bolts, -- I am not sure if you had heard that before or not -- rather than the previous rock bolts and wire mesh and all of that.

One of the reasons for doing that was to provide a more robust ground support for the preclosure so that we would not need to do setbacks from faults and be as concerned over potential fractures, but that may still be an issue for post-closure.

So I am not sure, frankly. We have the capability certainly of doing setbacks as we deem necessary from disturbed areas.

MEMBER HINZE: As the excavation proceeds?

MR. HARRINGTON: During emplacements. Yes. During emplacement, we will run the TBM through there.

MEMBER HINZE: The setback from the Gostand fault -- and there are some faults up there north of the north ramp -- the setback distances --

MR. HARRINGTON: Oh, I'm sorry. I thought you were talking about setback from fractures, significant fractures, in the middle of the emplacement drift.

MEMBER HINZE: I am, both in the margins and within.

MR. HARRINGTON: The overall emplacement area has been selected to provide the setback from the major faults. And those are basically what are bounding it on the east and west. On the north, it's water table. And on the other end, I think it was overburden. The sides are dictated by the major faults.

In addition to that, we had also talked about the potential of not putting waste packages adjacent to a fracture. Certainly we have the capability of observing those and deciding where we are going to put and where not to put waste packages.

MEMBER HINZE: Going back to one of the questions that Dr. Clarke asked, you will, as I understand it, be doing some excavation after the surface facilities are constructed. Is that correct?

MR. HARRINGTON: Yes, yes.

MEMBER HINZE: And will you be moving the excavated material out of the north ramp or only out of the south ramp? You understand where I am going.

MR. HARRINGTON: Yes. This, the north ramp, is the emplacement area. Excavated fill will come out of the south ramp and also the additional new north construction ramp.

MEMBER HINZE: Okay. So there will be a north construction ramp.

MR. HARRINGTON: Yes, yes.

MEMBER HINZE: Okay. Very good. Let me ask you about what is the status of the plans for closing the repository? Are there any changes there? Is this going to be in the license application? What about the stemming of the ramps, et cetera?

MR. HARRINGTON: We have to as part of the license application address plans for closure. So we will have discussion in there on how to do sealing of the access mains, ventilation shafts, bore holes, anything that might penetrate the area.

MEMBER HINZE: That is something that I think the Committee would be interested in hearing about it if that is possible in the next near term.

Let me ask you about figure 6. Why are

there two aging pads?

MR. HARRINGTON: Just simply capacity versus topography.

MEMBER HINZE: Will there be excavation necessary. If I have my geography correct, the aging ramps appear to be in the sloping side of Yucca Mountain. Will they be excavated then?

MR. HARRINGTON: There will be some cut and fill to create those, yes.

MEMBER HINZE: And the particular sites that you have for the aging pads, the last time I heard there were investigations underway pertaining to the possible ground motion associated with those sites. Has that been completed? And what have the results been?

MR. HARRINGTON: We have ground motions that we are using for our design bases now. And, in addition to that, we are doing more geotech investigation work. We have just received last week, I believe, several drill rigs. I don't remember if it's three or four. And we have about 50 additional bore holes that we intend on doing.

MEMBER HINZE: Ah. Okay. Will those be vertical holes or will there be any slanted holes?

MR. HARRINGTON: I don't know. I don't

know.

MEMBER HINZE: Okay. Peace. Let me ask you about OSTI. We had a presentation, a very interesting presentation, nine months ago from OSTI in which they talked about some developments or some research pertaining to TADs. Has any of that interfaced with your designs?

MR. HARRINGTON: You said Aussie?

MEMBER HINZE: OSTI.

MEMBER WEINER: The Office of Science.

MEMBER HINZE: The Office of Science and Technology International.

MR. HARRINGTON: Okay. Obviously not, not that I know of.

MEMBER HINZE: Okay. They had a very interesting presentation about something using something other than alloy-22 and looking at the TADs. And this is very interesting.

MR. HARRINGTON: A couple of things. One, the TADs themselves would not be alloy-22. Just the waste packages are the 316 nuclear grade internal structural member surrounded by the LA-22 long-term corrosion barrier, but the TADs themselves were not alloy-22.

MEMBER HINZE: Right, right.

MR. HARRINGTON: We have within our own, within RW, the science and technology organization group, looking at different materials. That will not be developed to the extent sufficient to support the license application. So we are going forward in the LA with the materials that we have been analyzing. That is not to say that we are shutting off all future evaluation of potential alternate materials.

MEMBER HINZE: A question about natural disturbances. What is the status of the plans that are being made for natural disturbances in the preclosure period?

And I am talking about seismic activity. I am talking about volcanic activity. What considerations are being made in the design for the possibility of seismic activity and volcanic activity?

MR. HARRINGTON: Well, we are certainly designing the preclosure facilities for seismic ground motions. We had developed an approach for determination of what those seismic ground motions were. Through additional interactions with NRC staff, we have revised that approach.

The values that we are using as the basis for seismic design of the facility is on the order of about 7/10g, vertical and horizontal, for what we're referring to as design basis ground motion to ground motions.

We are evaluating the performance of the structures for higher ground motions than that on the order of about 1.2g vertical and horizontal. So yes, we are designing for seismic ground motions.

MEMBER HINZE: And the methodology that the NRC has proposed in their ISG-1, that is an acceptable methodology to the Department of Energy or one you are using?

MR. HARRINGTON: I don't know that we have provided our comments back on that. We haven't that I -- Buck is saying, "Yes, we have."

MEMBER HINZE: Yes.

MR. HARRINGTON: The seismic folks on the scientific side of the organization are doing those interactions. Basically I'm just using the output that they give me for facility design.

MEMBER HINZE: You're our window to DOE.

MR. HARRINGTON: Okay.

MEMBER HINZE: So that is why I am asking you these questions.

MR. HARRINGTON: Okay.

MEMBER HINZE: Let's go to the volcanic. There has been -- I don't know the proper term. It is a concern but questions raised about the possibility of preclosure of volcanic activity that might lead to lava flows or ash weighting down the roofs and also ash getting into the HEPAs. How is this entering into the design considerations?

MR. HARRINGTON: Ash fall on the roofs is one of the event scenarios that the PCSA folks are looking at. So that is addressed in the preclosure safety analysis. And it's one of the dead loads, live loads/dead loads, that the facility has to be designed for.

We are not looking at magma intrusion into the repository during preclosure period as a category 1 or 2 event sequence. I think we believe that's a beyond Cat-2 event sequence.

MEMBER HINZE: How about HEPA? How about the filters, the ventilation system?

MR. HARRINGTON: The ventilation system is having to be designed to accommodate that, I believe.

MEMBER HINZE: That's part of the PCSA.

MR. HARRINGTON: PCSA, preclosure safety analysis, yes.

MEMBER HINZE: Right. Okay. I think that is all of my questions. Are there any further questions by the Committee? Allen?

VICE CHAIRMAN CROFF: Paul, you raised a thought in answering another question. And that is, as I understand it, Sandia was named RW's lead lab or something like that --

MR. HARRINGTON: "Lead lab" is the term.

VICE CHAIRMAN CROFF: -- a while ago. Is it reasonable at this point to ask them to come in and tell them sort of what is going on in technology space related to the repository?

MR. HARRINGTON: Oh, I'm sure they would be interested in doing that.

VICE CHAIRMAN CROFF: I suspect that is something we would be interested in.

MEMBER HINZE: Absolutely.

MR. HARRINGTON: Okay.

MEMBER HINZE: Dr. Weiner?

MEMBER WEINER: What are the dimensions of the TAD and the thickness of the --

MR. HARRINGTON: We basically pick the TAD to be nominally the same size as the naval long waste package. And that is about two meters in diameter and about six and a half meters long, in that range, as best I can recall offhand.

MEMBER WEINER: And how thick a shell is it? How thick a shell is it going to be? In other words, what is the difference between internal and external?

MR. HARRINGTON: That is a dimension that the TAD vendors will come up with. We are not designing it for them. We gave them a performance spec, said, "Here is it what it has to do, drop heights, those sorts of things." They will go ahead and size it as they need to meet that performance spec.

MEMBER WEINER: Thanks.

MEMBER CLARKE: Please?

MEMBER HINZE: Jim?

MEMBER CLARKE: Thank you, Bill.

Just a quick follow-up. And I am sure I know the answer to this, but I just thought I would ask. That range of 10 to 20 percent of material that might not come in on TADs, commercial spent nuclear fuel, includes not only what is in dry cask storage now but what is projected to be in dry cask storage by 2017. Is that fair?

MR. HARRINGTON: I believe that's accurate. That is part of our interest in getting the TAD spec out there so that it can be used by industry.

MEMBER CLARKE: But you have got projections of what will happen, what additional fuel will have to come to dry cask storage in the interim between now and whenever it does store, but it would go --

MR. HARRINGTON: Okay. Other than Rod's 20 percent number, I don't know of a different --

MEMBER CLARKE: That won't be available for some time. Is that correct?

MR. HARRINGTON: That's right, probably several years.

MEMBER CLARKE: So, in addition to what is in dry cask storage, now is reasonable to assume there would be additional dry cask storage by the time the repository referenced.

MR. HARRINGTON: That's right.

MEMBER CLARKE: That fuel might be in DPCs or something else.

MR. HARRINGTON: That's right.

MEMBER CLARKE: So I am just wondering how good that range is. But it wouldn't be 50 percent. I mean, you know, the 10 to 20 --

MR. HARRINGTON: Yes. I think Rod --

MEMBER HINZE: I think Rod's --

MR. McCULLEN: Yes. The expected loading of dry cask storage is a very known parameter in industry. You know, licensing activities go on well in advance, plans for that, when pools are going to need the additional capacity. So that 20 percent roughly is based on an industry expectation of those known parameters and kind of a rough idea of when we think the TAD might be available.

MEMBER HINZE: Thank you. Mike?

MR. LEE: Yes. First of all, thank you very much for coming a long way and briefing the Committee in I think a very useful briefing. The first question I have is, this morning you have described operations and designs.

And it sounds like for the most part, that you are using off-the-shelf technologies. Are there any technologies that DOE thinks it has to develop or acquire in order to satisfy any design visions or like, for example, this transportation device that is going to move the TAD from the surface facility underground. Is that something that you think is off-the-shelf or is that something that is going to be kind of procured, developed and procured?

MR. HARRINGTON: Probably the most unique actual application will be the waste package closure system. And we have actually had Idaho working on that for us for several years. So that one is in process.

Most of the major pieces of equipment we think we can likely buy either the component itself or the fabrication of the component is not extraordinary. The TEV, transportation and emplacement vehicle, nobody has anything quite like that out there now.

But the mechanisms that will be in there are current technology. One is crane technology. It's motor controls, those sorts of things. The fabrication of the component will look different than what has been there before.

The canister transfer machine, those exist now. I don't know if they are out there for the size we'll look at, but certainly there are canister transfer machines that will do essentially the same thing we need to have done.

Here, the fuel handling machine in the pool. I would expect just simply go buy one. There is no real developmental effort there.

MR. LEE: Yes.

MR. HARRINGTON: The cranes we will go buy what are considered elsewhere to be single failure-proof cranes. We won't get to credit them as that. We will have to do failure probability evaluations.

But the waste package closure is probably the most technologically developmental product that we will have to come up with.

MR. LEE: My second question is one or two briefings back, there was someone from DOE who talked about the possibility of using the Atlas facility in north Las Vegas for some development proof of concept types of activities related to waste handling and waste operations. Are there any plans like that still underway?

MR. HARRINGTON: No.

MR. LEE: Okay. And the last question I have is, does the staff owe you anything in terms of guidance or whatever on preclosure issues? Do you think you have enough from the staff right now?

MR. HARRINGTON: No. I think over the last couple of years, we have come to a mutual understanding of what is required. And it's more than we had expected several years ago, but I think we are very clear on what it is and are intending on delivering that.

MR. LEE: Thank you.

MEMBER HINZE: Further questions?

MR. HAMDAN: I have a question.

MEMBER HINZE: Latif?

MR. HAMDAN: Yes. At this stage of the

project and in the preliminary design space, what are the most challenging issues that you find? Where are the bottlenecks? You mentioned you are in the preliminary stage of design. What is broke, let's say?

MR. HARRINGTON: The structural design of the facility, this is really the current critical path. I talked a little bit earlier about the Tier 1 lump mass model. We do that.

We do the seismic fragility analysis of the structure. We will then have to convolve those two to end up with the overall probability. Post-LA submittal, we will do the 3D evaluation of the structural capability. But based on the inherent conservatism in the 2D, we think that is a reasonable approach to take.

That is the critical path. It is the most time-consuming right now, just a lot of structural design work to be done.

MR. HAMDAN: Thank you.

MEMBER HINZE: Additional questions?

(No response.)

MEMBER HINZE: If not, then thank you very much, Paul. This has been very illuminating and very helpful to us. And we appreciate you coming.

MR. HARRINGTON: You are welcome. And I will plan on coming back.

MEMBER HINZE: I will turn the meeting back to the Vice Chairman Croff, who will move us out.

VICE CHAIRMAN CROFF: Thanks. We will take a 15-minute break here and reconvene and talk about our action plan.

(Whereupon, a luncheon recess was taken at 10:17 a.m.)

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

(1:00 p.m.)

VICE CHAIRMAN CROFF: Chairman Ryan has a meeting at 1:00 o'clock. He won't be here for about another half-hour. So I'm going to open it as Vice Chair and promptly turn it over to Jim, who is going to run this meeting. Go ahead.

MEMBER CLARKE: Thank you, Allen.

10) BRIEFING ON SHIELDALLOY, NEW JERSEY SITE DECOMMISSIONING PLAN

MEMBER CLARKE: Our presentation for this first afternoon presentation will be given by Ken Kalman. Ken is in the Materials Decommissioning Branch, Division of Waste Management and Environmental Protection in the Office of Federal and State Materials and Environmental Management Programs.

Ken is the NRC project manager of the Shieldalloy Metallurgical Corporation site in New Jersey. And I understand that Rebecca Tedesse --

MS. TEDESSE: Yes.

MEMBER CLARKE: -- will be delivering some opening remarks as well. So thank you.

MS. TEDESSE: Good afternoon. My name is Rebecca Tedesse. I am the Branch Chief for the Materials Decommissioning Branch. It is our pleasure to brief you today on the decommissioning plan for Shieldalloy Corporation complex decommissioning site.

We preface our remarks today with the following. First, the staff is in the initial stages of our review of the decommissioning plan. Secondly, the Shieldalloy proposal is complex, requiring the involvement of integrated of a number of technical disciplines for the review.

Therefore, our assessment of the Shieldalloy decommissioning plan is under development. And we expect to issue a request for additional information at the end of April.

Though this limitation exists, we are prepared to provide the Committee with an overview of the site and the proposed decommissioning plan. Shieldalloy has submitted a proposal to decommission its Newfield, New Jersey site. Its proposal includes releasing a majority of the site for unrestricted use with the remainder of the sites proposed for restricted use.

That portion of the site proposed for restricted use would contain contaminated material, consolidated, shaped, graded, and covered with engineering barrier. The restricted portion of the site would be maintained and monitored under restricted use conditions specified by the NRC.

And, with that, I will turn it to Ken Kalman, the project manager.

MR. KALMAN: Okay. And if you would skip ahead to slide number 3? I am going to begin my presentation by giving a discussion of Shieldalloy's operations. Then I will discuss the history of submittals and reviews of Shieldalloy's decommissioning plan and will also discuss Shieldalloy's proposal and concluded with the projected time frame of our activities and the current status of our review and also let you know what we have done to enable stakeholders to get more information to submit their comments to us.

If you would go up to slide number 4, please? Okay. First let's get oriented. This map shows the location of the site. The site is comprised of approximately 68 contiguous acres to the northeast of the intersection of West Boulevard and Weymouth Road. There is also approximately 20 acres of farmland to the southwest that was not a part of Shieldalloy's metallurgical process.

Slide 5. This aerial photos shows the site. The process buildings are on the west. And the slag pile is on the east.

Slide 6. Okay. I will briefly summarize the operations at the site. From 1995 to 1998, one of the raw materials that Shieldalloy used was a niobium ore called pyrochlore. This ore contained natural uranium and thorium in concentrations greater than 0.05 percent, regulated source material. So we licensed Shieldalloy to possess up to 45,000 kilograms of uranium and 303,050 kilograms of thorium.

Slide 7. As a result of its metallurgical operations, Shieldalloy generated 18,000 cubic meters of slag and 15,000 cubic meters of baghouse dust containing uranium and thorium. Slag is the vitrified matter that remains after metal is extracted from its ore. Baghouse dust is the particulate matter that is trapped in the sacs.

In August of --

MEMBER WEINER: Could I ask a question?

MR. KALMAN: Sure.

MEMBER WEINER: Is the concentration in the slag, of uranium and thorium in the slag, the same as the concentration in the baghouse dust?

MR. KALMAN: It's roughly the same. I believe the concentration is a little bit higher in the baghouse dust.

MEMBER WEINER: Both?

MR. KALMAN: Right. Okay. In August 2001, Shieldalloy notified NRC that it ceased operations and intended to decommission the site. After terminating its operations, Shieldalloy was within its license limit for possession of uranium and thorium.

During its operations, Shieldalloy planned to sell the slag and baghouse dust for its extractable uranium content. However, Shieldalloy was unable to find a buyer, but Shieldalloy contends that the material still has some economic value. The slag can be used as a fluidizer by the steel industry. And the baghouse dust could be substituted for lime in the production of cement.

Slide 8, please. Before moving on, I would like to take a brief look at the slag pile. This photo was taken at the northwest corner of the pile. The yellow and magenta radioactivity material sign on the bottom of the left side of the photo is close to six feet tall.

If you go on to slide 9, here we have one of our inspectors measuring exposure rates of the slag at that sign. The photo gives you a better idea of the size and the appearance of the slag.

And if you go to slide 10? Then this

photo shows the bags that were used to collect the particulate and baghouse dust. The bags are like this really at the bottom of the screen.

Slide 11. Okay. Now I will discuss the history behind the submittals and the reviews of Shieldalloy's decommissioning plan. When we receive a decommissioning plan, the NRC staff first performs an acceptance review to determine whether sufficient information has been provided for us to move ahead with our detailed technical review.

During our acceptance reviews, there were several open-to-the-public meetings and telephone conferences. The New Jersey Department of Environmental Protection and several local stakeholders observed these meetings and were afforded the opportunity to ask questions.

The first decommissioning plan was submitted in August of 2002 and rejected in February of 2003 because it was deficient in providing the NRC staff with sufficient information to conduct a detailed technical review.

After several meetings with Shieldalloy, we realized that Shieldalloy needed additional guidance on the long-term control license. So we developed interim guidance and provided it to

Shieldalloy in May of 2004.

Slide 12. Shieldalloy used the interim guidance to develop a revised decommissioning plan, which was submitted to the NRC in October of 2005. However, the NRC staff rejected that plan also in January 2006 because it still didn't provide us with enough information in several key areas. These included dose modeling, surface water hydrology and erosion protection of the slag pile, Shieldalloy's long-term control approach for restricting future use of the site and establishing some institutional controls, and Shieldalloy's rationale for its alternative approach for meeting the regulatory requirements for financial assurance.

Slide 13. We then met with Shieldalloy in March of 2006 in an open-to-the-public meeting to discuss the aforementioned deficiencies. In June of 2006, Shieldalloy submitted supplemental information that responded to our need for additional information. In October of 2006, we accepted the revised decommissioning plan as supplemented for our detailed technical review.

Slide 14. On November 16th, 2006, the NRC published a Federal Register notice announcing its receipt of the decommissioning plan and the opportunity to request a hearing. The cutoff date for requesting a hearing was January 16th, 2007. And a cutoff date for submitting comments on the decommissioning plan was March the 16th of 2007.

On December 5th of 2006, we held a decommissioning information meeting near the site in Newfield, New Jersey, where we discussed our review process. There were over 150 local stakeholders in attendance. They expressed their concern with Shieldalloy's proposal to leave the radioactive slag and baghouse dust on site.

As Shieldalloy's proposed is for restrictive use decommissioning, we are also preparing an environmental impact statement that will enter into our decision on the proposal. Consequently, we held an environmental impact statement scoping meeting in Newfield on December 12th of 2006. Again, the stakeholders, including Senator Menendez, voiced their concerns with the proposal to leave the material on site.

Slide 15. I will now briefly discuss Shieldalloy's proposal for decommissioning the site. My discussion will focus on the 67.7-acre portion of the site where metallurgical activities were conducted.

This is the area where Shieldalloy conducted its metallurgical processes. The western portion of this area is comprised of parking lots, administrative offices, and manufacturing buildings. This area is mostly covered with asphalt or concrete.

Most of this area was not impacted by license operations. However, buildings that were impacted were remediated as necessary and were surveyed to meet the NRC's criteria from restricted use.

This photo gives you an idea of what the process area looks like.

Okay. Let's go to slide 17. The storage yard in the eastern portion of the site is used to store materials generated during manufacturing operations, such as slag, baghouse dust, excavated soils, and other materials.

The contaminated slag pile is a prominent feature of the site. As I noted earlier, there are approximately 18,000 cubic meters of slag and approximately 15,000 cubic meters of baghouse dust stored on site. Region I inspections have confirmed that operational exposure limits are being met.

Slide 18, please. In developing its decommissioning plan, Shieldalloy considered several options for decommissioning the site. These included license continuation, off-site disposal and license termination, and on-site stabilization and long-term control. After conducting a cost-benefit analysis, Shieldalloy proposed the use of on-site stabilization and long-term control.

Slide 19, please. The proposal entails releasing most of the site for unrestricted use and consolidating all the licensable residual radioactive material in a portion of the storage yard in the eastern side of the facility. The radioactive material would then be shaped, graded, and covered with an engineered barrier so as to minimize the potential exposure of members of the public to radioactive material.

VICE CHAIRMAN CROFF: Excuse me.

MR. KALMAN: Yes?

VICE CHAIRMAN CROFF: Maybe we had better stop for just a minute and let Ron do his thing there. Dialing is going to be distracting. We will have a short hiatus here.

(Whereupon, the foregoing matter went off the record at 1:11 p.m. and went back on the record at 1:13 p.m.)

MEMBER CLARKE: I'm sorry, but if I could ask you one more time to give us your name?

MS. GOODMAN: Are you talking to me?

MEMBER CLARKE: Yes.

MS. GOODMAN: Okay. Sorry. Jenny Goodman.

MEMBER CLARKE: Okay. And you said there was another person on the line as well?

MS. GOODMAN: Yes. Patricia Gardner.

MEMBER CLARKE: Okay. You have joined us in progress. Ken, let me turn it back to you.

MR. KALMAN: Okay. Jenny, this is Ken Kalman. I am pretty much giving the same presentation I gave during the March 5th public meeting.

MS. GOODMAN: Okay.

MR. KALMAN: Okay. And I am almost finished with it.

MS. GOODMAN: That's fine.

MR. KALMAN: Okay. So we're on slide 19. And I'm talking about Shieldalloy's proposal. The proposal entails releasing most of the site for unrestricted use and consolidating all licensable residual radioactive material in a portion of the storage yard in the eastern side of the facility.

The radioactive material would then be shaped, graded, and covered with an engineered barrier so as to minimize the potential exposure of members of the public to radioactive material.

This area would be subjected to long-term maintenance and monitoring under restricted use conditions. And financial assurances would be provided for these activities.

Slide 20. Shieldalloy has performed radiation dose analyses for both the unrestricted and restricted areas of the site using a variety of scenarios. Shieldalloy used two scenarios in its estimates for the dose of the unrestricted area and both for one millirem per year. Shieldalloy used eight scenarios for the restricted areas, and the doses ranged from one to 21 millirem per year. These doses are lower than our limit of 25 millirem per year. These scenarios included scenarios for restrictions remaining in place and conditions where the institutional controls fail.

It is important to note that these estimates have not yet been reviewed by the NRC staff. And as part of our detailed technical review, we will be performing our own independent dose analysis.

Slide 21. Just to give you a rough idea of the time frames we are dealing with as part of our decommissioning plan review process, we will be transmitting requests for additional information to Shieldalloy by April 30th of 2007. We anticipate completing our detailed technical review and our safety evaluation report in October of 2007. And we then anticipate completing our environmental impact statement in 2008.

If NRC approves the proposal, Shieldalloy anticipates completing its decommissioning in 2011. And NRC would then complete its licensing action in 2012.

Slide number 22. Throughout this process, we have made provisions for stakeholders and other interested parties to get more information on Shieldalloy decommissioning.

As we move forward with our review, copies of documents relating to Shieldalloy will be housed in the public library in Newfield. In addition, we are maintaining Web sites where information can also be obtained.

Slide number 23. As noted earlier, there were two important dates for the stakeholders. The cutoff date for requesting a hearing was January 16th, 2007. And the cutoff for submitting comments on the decommissioning plan was March 16th, 2007. We will address these in our safety evaluation report.

Slide 24. To date we have received comments on the decommissioning plan from the Sierra Club and the U.S. Environmental Protection Agency's Region 2 office.

We also received comments from the New Jersey Department of Environmental Protection, which I did not find out about until after I had already sent these slides out to be copied. So you may want to pencil "NJ DEP" on page 24 of the slides before you.

We are currently in the process of setting up a meeting with the EPA Region 2 office to discuss their comments.

Slide number 25. In addition to the comments, we have also received some related requests, including seven requests for hearings, a petition for rulemaking on guidance that was provided in NUREG-1757, and a motion for stay that was filed in the U.S. Court of Appeals for the Third Circuit. The NRC attorneys are responding to these actions as appropriate.

In concluding my presentation, again I thank you for the opportunity to brief you on the Shieldalloy decommissioning plan. And if you have any questions, we are here.

MEMBER CLARKE: Ken, thank you. Rebecca, thank you as well. The Committee, as you know, is interested in the decommissioning of complex sites. And this briefing is helpful.

At this point let me turn to the Committee and see if we have any questions. Allen, would you like to start?

VICE CHAIRMAN CROFF: Yes, as long as I can talk. Can you be a little more quantitative on the uranium and thorium concentrations in the slag and baghouse dust?

MR. KALMAN: I've got enough right now.

MS. TEDESSE: Unfortunately, our health physicist was stuck in the ops plan. He should be in any time. But I think, Robert, do you have anything?

VICE CHAIRMAN CROFF: Okay.

MR. McCONNELL: We'll get back to you. There is an exercise going on. And the health physicist who was to be here is involved in that exercise. And so we are a little bit shorthanded.

VICE CHAIRMAN CROFF: Could you talk just a little bit more about the area around this site? How populated is it? I mean, is it an industrial-farmland mix, whatever?

MR. McCONNELL: It's a mix. If you go

back to slide number 3 or 4 --

MS. TEDESSE: Could you go back to it? Slide 5.

VICE CHAIRMAN CROFF: No. You are going to have to stay up there near the microphone. Use the pointer.

MR. KALMAN: Okay. Right here is Weymouth, and this is West. As you go further down West in this area to the north, you will find a little bit of light industry. Down here south of Weymouth is residential. There are actually some new homes going up in this area down here.

VICE CHAIRMAN CROFF: Okay.

MR. KALMAN: Over here, where you have got the 20-acre portion of the site, that is primarily farmland.

VICE CHAIRMAN CROFF: Okay. Thanks.

MR. KALMAN: And also as you go up here north of the site, it is also residential. And this is the area where it is pretty much the center of Newfield, where the high school is.

VICE CHAIRMAN CROFF: Are there any creeks or anything running along or through?

MR. KALMAN: Right here you have got the Hudson branch.

VICE CHAIRMAN CROFF: Okay. You mentioned trying to sell the slag and baghouse dust or not you but Shieldalloy and they were unsuccessful. Why were they unsuccessful? I mean, if there's a market for it, why didn't it sell?

MR. KALMAN: Part of it is they were just having a little bit of difficulty getting the interest in it. You know, people are a little bit concerned about picking up material that's been slightly radioactive.

VICE CHAIRMAN CROFF: Oh, okay. So there is a market for similar materials that generally don't have uranium and thorium in them or not much?

MR. KALMAN: Right.

VICE CHAIRMAN CROFF: Oh, okay. And on the stabilization, the proposed stabilization on site, how are they proposing to stabilize it?

MR. KALMAN: What they would be doing is the material in the slag pile will be shaped in sort of basically like a rectangular shape. It would have roughly eight-acre footprints.

And what they would be doing, they would be taking their slag. As you recall from those pictures, you get some pretty big particle, you know, chunks of slag there.

VICE CHAIRMAN CROFF: Right.

MR. KALMAN: I believe part of their proposal would be to crush some of that down into smaller pieces and then bulldoze everything together. They would also be using the baghouse dust to help fill in some of the voids. And then they would be covering it with layers of soil and riprap to prevent erosion.

And, as I said, the footprint would be about eight meters. And the pile itself would be about 30 feet tall.

VICE CHAIRMAN CROFF: Eight meters?

MR. KALMAN: Eight acres. Sorry.

VICE CHAIRMAN CROFF: Eight acres. Okay. That sounds a little better. Okay. I think I'll pass at this point?

MEMBER CLARKE: Okay. Bill?

MEMBER HINZE: While you have that up there, could you explain? Are we looking at several dumps? What is the character of the site from a topographic, geomorphic, geologic, hydrologic viewpoint before the dumps were put on the site?

And my experience with these dumps is that they usually put them in what starts off as holes in some kind of depression in the Earth. Is there a flat area where they are filling up a depression? What is the geology of the site?

MR. KALMAN: Well, it's basically all pretty flat. It is all pretty flat land. I mean, this area is only about 40 miles.

MR. HARRINGTON: "Pretty flat"? What does that mean? I'm sorry. I am going to push you on that.

MR. KALMAN: There are probably only maybe about a 20 or 30-foot variations in tomography.

MEMBER HINZE: But is the site of the dump a depression that would be 8 feet, 10 feet, or is it flat across that --

MR. WIDMAYER: They just piled it on top of the surface, right? They just piled it on the surface.

MEMBER HINZE: But did it start off as a depression? The original --

MS. TEDESSE: No.

MR. KALMAN: No.

MS. TEDESSE: It was just a flat surface --

MEMBER HINZE: Just a flat surface. Okay. And how many dumps are there? And currently are the ore and the baghouse dust in separate dumps?

MS. TEDESSE: They're right next to each other. Basically there is the slag piles, and then there is the baghouse dust. And they are right next to each other.

MEMBER HINZE: And what is the size of the dumps? What is the size of the dumps? How long? How high are they?

MS. TEDESSE: Robert, do you think you can answer that, please?

MR. CAMPER: I will venture a guess, just a recall. I was up at the site. It is probably about 80 feet high. It is probably about a football field and a half in length and probably a football field in width, give or take.

MEMBER HINZE: Thank you.

MR. CAMPER: I'm sorry. Larry Camper.

MEMBER HINZE: In order to get an understanding of this, one needs to have a view of what the problem really is from a physical standpoint.

As I understand it, Ken, you originally rejected the decommissioning proposal for several reasons, including site characterization of the hydrology and erosion. Is that correct?

And then subsequently you have obtained additional information. And you have now accepted that for detailed technical review?

(No audible response.)

MEMBER HINZE: Okay. That's where we're at. Can you give us some insight into what were the problems originally and how they were remedied by Shieldalloy in the areas of hydrology and erosion?

MR. KALMAN: Well, as Rebecca pointed out, we are kind of early in our technical review, but I think, Robert, would you be able to field some of that?

MR. JOHNSON: Robert Johnson. I can mention a few things.

The original DP rejection was also based on lack of a plan for institutional controls and the associated financial assurances that go along with the trust fund.

MEMBER HINZE: Dose modeling and so forth, right?

MR. JOHNSON: And then there was also dose modeling and other technical issues. But there was also lack of public involvement that is required under the license termination rules. So these were all other reasons, too, why the original plan was rejected.

And the proposed DP, revised DP, came

back. And we had problems with erosion there on the cover design. And that's where erosion came in. You know, that wasn't an original one.

So how they have addressed those with respect to institutional controls, of course, they have proposed the long-term control license. With respect to financial assurance, you know, they have revised their cost estimate that we will be reviewing for the trust fund that would take care of monitoring and maintenance.

For the erosion control issue, they have proposed a riprap cover erosion, protection cover consistent with our guidance, decommissioning guidance, as well as our milltailings guidance.

And so in a nutshell, the dose modeling and all of that I can't speak to. You know, those were other issues that --

MEMBER HINZE: Well, I don't want to ask questions that I shouldn't ask, but the hydrology interests me, of course, as I think it should. And I am wondering, what is the hydrology here? Are we talking about a groundwater table that is relatively close to the surface? Do we have any perching? Do we have a confined aquifer? What kind of potential metric surfaces do we have leading to the creek, et cetera?

MR. McCONNELL: Dr. Hinze, when we come back and talk to you after we have developed our request for additional information -- I am Keith McConnell of the NRC -- we will be able to answer all of those questions, if you don't mind.

Again, I think our goal at this meeting was to try to just give you an introduction to the site and realizing that is kind of like opening the gate.

(Laughter.)

MR. McCONNELL: But we will back, I think. And, you know, we will have the right people here and be able to answer your questions.

I would like to respond to one comment or question about the commercial use. One of the applications that the licensee did try to or one way they tried to sell this material was to sell it as alternate feed in a uranium mill. But they were told that the refractory nature of the slag made it so expensive to remove the uranium out of the slag that it just wasn't commercially viable in that particular circumstance. And I think they have looked at other options in selling it overseas but haven't been successful in that regard.

And I don't mean to interrupt you, but we also have our health physicist here. And he can now respond, I think, to the other question on the concentration of the slag if it's appropriate.

VICE CHAIRMAN CROFF: Do it.

MR. SCHMIDT: Hi. I am Duane Schmidt of the NRC.

I don't have the figures in front of me. So I am going somewhat from memory. But from what Shieldalloy had included in their decommissioning plan, for the slag materials, they were estimating average concentrations on the order of 200 picocuries per gram -- I think it was a little bit less than that -- for each member of the uranium series and the thorium series, U-238 series and thorium-232 series.

We I believe already have RAIs asking about those numbers because I think there is additional information out there. And, frankly, it's a little bit odd that the numbers are exactly the same for uranium and thorium. So there is more to come on the details.

MEMBER HINZE: Okay.

MR. SCHMIDT: The baghouse dust, the value that they have in the DP I believe was ten picocuries per gram, again for each of the uranium and thorium chain members.

And I don't know. There was another question that I could at least help a little bit on. I think Dr. Hinze was asking about the size of what we're talking about here.

The volumes of contaminated slag and contaminated baghouse dust, again, as best I recall, are somewhere on the order of 20,000 cubic meters of each of those, so the slag pile and the baghouse dust pile.

They have an additional contamination, which they had done some cleanup of the Hall Road that they had found to be contaminated. And that's a fewer or several thousand cubic meters, I believe, but at least order of magnitude.

MEMBER HINZE: Is this a unique site?

MS. TEDESSE: Yes.

MEMBER HINZE: In the United States?

MR. McCONNELL: Well, unique in what terms? It's not the only slag site.

MEMBER HINZE: In terms of the slag and the baghouse dust.

MR. McCONNELL: There are other sites with slag. In fact, Shieldalloy has a sister facility in Ohio that --

MEMBER HINZE: That's what I was wondering about.

MR. McCONNELL: -- that is now regulated by the State of Ohio as one of our agreement states. So it's not unique in those terms. It's unique in the sense that for us, this is the first time a licensee has requested a long-term control license as the administrative measure in the institutional control.

MEMBER HINZE: How is that handled in Ohio, then? Is that a long-term or is it still operating or --

MR. JOHNSON: We have interacted a little bit with the State of Ohio on their site. And they are approaching the institutional control the same way. They are using a long-term control license. They don't call it that, but it's a decommissioning long-term control license.

They don't release the site for restricted release. You know, they keep the site under a license and do the inspections and have conditions in the license that limit the use of the site.

So it's very similar. And when we proposed the long-term control license to the Commission, we referenced their use of that site and the Commission's approval of that approach when Ohio became an agreement state in 1999.

MEMBER HINZE: That's helpful. Thank you. I will pass.

MEMBER CLARKE: Thank you, Bill.

MEMBER WEINER: Just tell me if you can't answer the question. What is the technical basis for the primary concern that the public has about this site?

MR. KALMAN: I think it's mostly just a concern over exposure over the long term.

MEMBER WEINER: Just about the fact that there is a long-term site there?

MR. KALMAN: Yes. Well, that's one part. And subordinate to that would be the economic impact. You know, leaving this material on site would be taking land out of their tax basis. It would be discouraging other businesses from developing.

MEMBER WEINER: Could anything be developed? I mean, I simply don't know. Under a long-term license like that, could there be other development on the site?

MR. KALMAN: Robert?

MR. JOHNSON: Robert Johnson.

Just keep in mind that part of the site that would be under the long-term control license is only the eight acres where the disposal pile is. And the rest of the site, the 60 acres, would be released for unrestricted use.

So what remains under the license is basically the covered slag --

MEMBER WEINER: I see.

MR. JOHNSON: -- with not much obviously space for any other use at all.

MEMBER WEINER: I'm sorry.

MR. CAMPER: Larry Camper, NRC.

In answer to your question, there were two things I think that came through resoundingly clear in the public meeting that we had in Newfield along the lines of concerns. The first is the fact that the slag is radioactive. It contains uranium and thorium and is going to stay there. And, therefore, it is viewed as a low-level waste site by the local citizens. And they, by and large, cannot comprehend how it can possibly stay there.

With regards to technical concerns, a striking technical concern that we did here is that the period of performance for our rule is 1,000 years. But, yet, these isotopes have half-lives considerably longer than that. And, therefore, how can one possibly evaluate those particular radionuclides given that period of performance? So that was a technical question that we were challenged with.

MEMBER WEINER: How much does the concentration in the slag differ from the concentration in the soil, concentration of uranium, for example, in the soil? Is this very different? Is it markedly different? Not different? Twice as much, whatever?

MR. SCHMIDT: Duane Schmidt.

MEMBER WEINER: You have uranium in the soil. I mean --

VICE CHAIRMAN CROFF: Ruth, you have got somebody over here who is trying to answer.

MEMBER WEINER: Thank you.

MR. SCHMIDT: Are you talking about background concentrations in the soil?

MEMBER WEINER: Yes, basically background concentrations.

MR. SCHMIDT: I mean, if we go with the numbers of around 200 picocuries per gram in the soil, at least, you know, typical site, background would be on the order of one picocurie per gram for uranium and for thorium, really. So a couple of hundred times background in the slag, yes.

MEMBER WEINER: Go ahead.

MEMBER HINZE: Excuse me. Is this in the crystalline bedrock area of New Jersey? What is the basic geology here?

MR. McCONNELL: I think it is in the coastal plain.

MEMBER HINZE: Coastal plain?

MR. McCONNELL: Yes.

MEMBER HINZE: Okay.

MR. McCONNELL: And that's my recollection.

MEMBER HINZE: Okay. Because there is a great deal of difference in terms of the background.

MEMBER WEINER: Yes.

MEMBER CLARKE: The decommissioning plan has background information on geology, seismology, groundwater hydrology, surface water hydrology design, background sort of factual information in the decommissioning plan.

MEMBER WEINER: Can I ask a couple of more?

MEMBER CLARKE: Sure.

MEMBER WEINER: Are the slag and the baghouse dust relatively homogeneous in concentration of uranium and thorium or are there some chunks of it that have more and some less?

MR. SCHMIDT: Again, Duane Schmidt. Actually, at this point I am unclear on that myself. The data in the DP is fairly or the numbers, I should say, in the DP are fairly limited. And I don't have in front of me yet the sources of that average concentration. You know, we can speculate, but I don't know.

MEMBER WEINER: Where I was kind of going with that, if the problem is leaving this material in place, is there some of it that could be sent to a disposable facility and leave some of it in place? But if it's homogeneous, that isn't going to make any difference.

MR. SCHMIDT: I think in terms of, for example, the slag itself, at least I don't know yet, but, as Ken might have pointed out before, the slag pile is fairly distinct from the baghouse dust.

And the concentrations are definitely significantly different between those two sources. So there might be something along those lines, at least, in terms of the different materials.

MEMBER WEINER: Thank you.

MEMBER CLARKE: Any other questions from the Committee?

VICE CHAIRMAN CROFF: I've got one if you don't mind. The baghouse dust, I am assuming it's dust-like. What is it contained in?

MR. KALMAN: Well, right now -- could we go back? I forgot what slide it was. Can you see on the slide there? You know, it's pretty much just laying out on its own.

What happens with this material is it's fairly granular. You know, it doesn't appear to be respirable material. It's fairly large particles. No, that's not it. It's towards the end.

And with this material, you know, when it's sitting out in the open and as rain gets to it, it tends to actually form a crust over the top of it.

VICE CHAIRMAN CROFF: That says "particulate bags." Does that mean the particles are in a bag?

MR. KALMAN: You can see it. These bags have been opened.

MEMBER WEINER: Yes. You can see it easily in here.

VICE CHAIRMAN CROFF: Okay. And the bags are porous, right, to perform their function? Right? All right. That's what I wanted to know.

MEMBER CLARKE: We appreciate you are early in your technical evaluation. This briefing has been helpful. Derek?

MR. WIDMAYER: Yes. I have like 100 questions that I was going to ask, but -- that was supposed to be funny. I do have one. This being a proposal for restricted release, doesn't this trigger the infamous EPA memorandum of understanding? And I was wondering what was going on with that.

MS. TEDESSE: Yes, it does. And, again, since we are in the early process, once we have the RAIs, we are going to meet with Region 2 of EPA and discuss some of their questions. And then we will have a formal consultation with them.

MR. WIDMAYER: Okay. So you mentioned the meeting with Region 2 earlier. That's what that meeting is about?

MS. TEDESSE: Well, the MOU is with the headquarters, but yes, you know, the regions will -- Region 2 has oversight over the New Jersey. I will meet with them, but it's the beginning of that meeting that we will have a formal consultation at the beginning, at the finish of the DP as well as when we release it. It will be both.

MR. WIDMAYER: Okay. Thanks.

MEMBER CLARKE: Latif?

MR. HAMDAN: Yes. You mentioned economics and the aesthetics for the neighborhood or the area, but what are the health and safety impacts, whether they are real or perceived?

MR. KALMAN: Well, I don't think we would know that until after we had done risk assessment.

MR. HAMDAN: Okay.

MR. WIDMAYER: The presentation gave an indication of what was in the DP, that Shieldalloy, their calculations.

MS. TEDESSE: We are early in --

MR. HAMDAN: What's at risk? That's what I am trying to say.

MS. TEDESSE: I guess I don't understand "at risk."

MR. HAMDAN: What are the safety issues? And what are the issues at this site? Is it the groundwater, drinking groundwater? What is it?

MR. McCONNELL: This is Keith McConnell.

I think that the issues of concern certainly to the residents are twofold: one, that the material could blow off site and be respirated. And there would be a short term more or less before the decommissioning takes place.

And then in the long term, obviously if water percolates through the material and it's leachable, which is still a subject of our review, of course, it would get into the groundwater pathway and then out to the residents. So in terms of exposure scenarios, those are the exposure scenarios that I think are of concern right now.

MEMBER CLARKE: Any other questions from the staff? Dr. Ryan, do you have any questions?

CHAIRMAN RYAN: No thank you.

(Laughter.)

MEMBER CLARKE: Keith, Robert --

MR. McCONNELL: I would just add one thing. For your information, there is other contamination at this site that is not regulated by the NRC. There is chromium in the groundwater, which the state and EPA are handling right now.

So, I mean, that's another aspect of I think the citizens of the area's concern, that there is this existing contamination. I think from their perspective, that is sufficient. They don't want any more contamination of groundwater in that area is part of their concern.

MEMBER CLARKE: Okay. Well, again we thank you. And we look forward to learning more when you come back. Thank you very much.

VICE CHAIRMAN CROFF: Okay. With that, I, too, thank you. And we will look forward to hearing from you when you are further along in your review.

With that, we will take a 15-minute break. We want to start the next session on time.

(Whereupon, the foregoing matter went off the record at 1:43 p.m. and went back on the record at 1:59 p.m.)

CHAIRMAN RYAN: The cognizant member for this presentation is Professor Hinze.

MEMBER HINZE: Thank you very much, Dr. Ryan.

CHAIRMAN RYAN: Thank you.

MEMBER HINZE: We should have two groups on the bridge, Professor Marsh from Johns Hopkins University. Professor? Let's hear Professor March. Are you on there?

MR. MARSH: I am here.

MEMBER HINZE: Very good. How about the center?

(No response.)

MEMBER HINZE: So we will, then, hold that in abeyance. And I will proceed, then.

CHAIRMAN RYAN: May I suggest, Professor Hinze, that we want to call the center and see if they are ready to call in?

MEMBER HINZE: Has that been done?

CHAIRMAN RYAN: I don't mind taking two minutes and having a courtesy call in to them to see if they are okay.

(Whereupon, the foregoing matter went off the record briefly.)

CHAIRMAN RYAN: We'll just hold the record for a minute here and take a short pause to see if we can get the center hooked in.

(Whereupon, the foregoing matter went off the record at 2:00 p.m. and went back on the record at 2:03 p.m.)

CHAIRMAN RYAN: Thank you.

MEMBER HINZE: Thank you very much, John.

11) UPDATED EPRI RESPONSE ON POTENTIAL IGNEOUS EVENT AT YUCCA MOUNTAIN

MEMBER HINZE: With a brief background on this presentation, the Electric Power Research Institute prepared documents in 2004 and 2005 on the extrusive and intrusive igneous activity scenarios. These have been reviewed and in a report that has been released by the Center for Nuclear Waste Regulatory Analysis.

And we have EPRI requesting that they give an updated response on that in answer to that review paper by the center. Professor Morrissey from Colorado School of Mines, a consultant to EPRI, as I understand it, will be making the presentation.

Please?

MS. MORRISSEY: Thank you in giving us an opportunity to respond to NRC's review of our work. I want to acknowledge a few of my collaborators on this igneous consequence analysis. The outline of the presentation follows the outline of the sections from the NRC review. And so I will go over each one of these, discussing some of the issues and the comments, and hopefully to clarify the concerns that NRC has with our work.

To start off with, the NRC reviewers stated that EPRI asserts that the magma at the tip of the ascending column -- as we go along, I am assuming that you have read our reports or understand about the magma coming up through the Earth and you will get the gist of this as I go through it. So NRC's review states that EPRI asserts that the magma at the tip of the ascending column just prior to and at the point of intersection with a drift will be degassed.

And EPRI concludes that the intruding magma will be at a relatively low temperature, 975 to 1010 degrees C with a high viscosity of 10^5 to 10^7

pascal seconds and rheology characteristic of an aa flow. And these suppositions appear to be inconsistent with the fundamental physics of volatile-rich magma ascent.

Well, EPRI's igneous scenario is a conceptual model that continues to evolve as we learn more about what happened at Yucca Mountain. It's based on observations made in the field and on well-accepted theory of basaltic volcanism, which we adapt to what we see and what we understand at Yucca Mountain.

Like all stakeholders, EPRI believes that Lathrop Wells is the best analog for future volcanism at Yucca Mountain in the next million years. And, with that said, we use a lot of the data that DOE has published regarding the physical volcanology and the geochemistry at Lathrop Wells and other quaternary volcanoes in the area. And our eruption sequence that we anticipate follows that at Lathrop Wells. And this is based on Valentine and others' work in 2005, which is an update from previous DOE work on their conceptual model and physical volcanology.

Initially we expect fissure eruption with lava fountains, Strombolian events that form the lower part of this cinder cone here at Lathrop Wells. This is followed by or happening concurrently while the Strombolian event is happening.

Are these lava flows that come out the northern end? This is followed by a tephra ejection, continuous tephra ejection that forms the later of the upward part of the cone and produces the tephra fallout deposits that we see around Lathrop Wells. And concurrently there are also additional lava flows coming out the southern end of it.

So we have these four different stages in different types of lava, Strombolian eruption, different types of magma coming out of the Earth. And we use this to infer what we think might happen at the repository level when a dike intersects the drift, the repository, and what we expect to happen when that magma comes up and intersects with the drift.

So we look at the style of eruption at the surface. We bring it back down into the column, into the magma column in the dike. And we look at the rheology that is associated with that eruption style.

So to focus back on why we said we expect degassed magma at the tip of the magma column, well, we look at the initial stage of magma rising through the crust. And we use the model. We adapt the model by Lister and Kerr. And this was what was discussed in the final report for the igneous consequence panel.

And what was discussed by Alan Rubin there was a dike propagating up, leading with a crack tip. This crack tip is a void that is under vacuum, essentially zero pressure, very, very low pressure, relative to the magma-filled dike below.

But it is also connected to the magma column. So if you look at the solubility diagram of water in basaltic magma -- and this is taken out of the Detournay and others, the igneous consequent review panel final report -- it shows water solubility as a function of pressure or depth. We can relate pressure and depth together. And this is for basaltic magma containing 3.7 weight percent.

This is what Frank Perry used. It's a little bit lower than what is expected at the higher end for water in basalts at Lathrop Wells or at Yucca Mountain.

So, as you can see in this diagram, at 100 megapascals, you get the 3.7 weight percent water in basalt. And as it moves up through the Earth or lower pressure, it decompresses and it releases that water. So if you look when it's really, really low pressure, there is no water remaining in the magma. Okay? And so at the tip, we expect it to be when it's depleted with water at the very tip here connected to the crack tip.

We are not saying that all this magma here is crystallized, depleted. We are just saying that the magma itself will be depleted in water because based on solubility laws, that is what we expect.

We also expect because of the rheology, the first part of an eruption at Lathrop Wells, we see Strombolian activity. We see fire fountains. We expect bubbles to be there, a lot of gas at the top, but the magma that is around those bubbles will be depleted in water. So that is where we said that.

So here is our conceptual model of what we expect the magma in the dike to look like with depth. Okay? This is based on if you have magma rising with 3.7 or 4.5 weight percent water, as it's rising through the Earth, as you can see by this diagram, it starts to release water.

So as that water is released, you start to nucleate bubbles. And those bubbles will start to grow because they are in a very low-viscosity magma at these depths. Okay?

And as they rise, they start coalescing to form these different flow regimes that volcanologists have all more or less established as being the flow regimes that produce lava fountaining, these annular flows, which is these large bubbles surrounded by magma.

So this is like a dispersed flow that's coming up. Below that, we have these slug flows. So you start to nucleate bubbles at the bottom. Okay? It's rising up.

Those bubbles are able to rise through the magma and grow and coalesce and form these slugs, these annular flows. And you get these different eruption styles once the magma makes it to the surface, right next to the surface.

So here we expect the viscosity of the magma as it is rising from the source depth to be around between the order of magnitude of 10 to 100, so right about 40 pascal seconds based on this diagram, which is from Maurass and McBirney for a crystal-free magma at various temperatures but containing water. Okay? So if we assume the maximum water that is measured for Lathrop Wells magmas, we have a 4.6 weight percent water.

So down here at, say, 1,000 degrees C, our viscosity initially will be about 40 pascal seconds. And as the magma rises through this surface through the cracks, back here you will notice that it starts to exsolve water. Okay? And as that water is released from the magma, the viscosity will start to increase with depth as it's rising through the surface. Okay?

So we expect the magma initially here will have a viscosity around 40 pascal seconds to about a little over 100 as it's rising and it's from these bubbles. Okay?

So what I show here is -- jump to the next slide -- this model requires it to be a low-viscosity magma for the bubbles to coalesce. And this is a diagram from Vergniolle and Jaupart in 1986. And it talks about bubbles and viscosity and bubbles that can grow in a low-viscosity melt and bubbles that grow in a high-viscosity melt but cannot ascend.

So this is a bubble rise velocity versus bubble diameter. And these are viscosity lines. These blocks here, those are just observations made for dissidic magmas and basaltic magmas at certain volcanoes. But what we are interested in here is these low viscosities that we're talking about for this, for the magma coming to the surface, for bubbles to grow, nucleate, grow, and coalesce to form these slug flows that have been interpreted as the way Strombolian eruptions occur and lava fountaining occurs.

So initially we require that this be a low viscosity. And that is based on the volatile composition, but as you get to the surface down below, you are degassing the magma, this column of magma. So you are starting to crystallize, too, the magma below, which is how we transition into an aa flow.

So initially we have the lava fountaining, and then we have the Strombolian eruption and followed by a period of lava flows. And that is more or less degassed lava.

And if we back up to the solubility diagram, what we expect to see at repository depths is a magma that contains less water than it did originally. So we can say it relatively depleted.

So at repository depths, the water that is going to be contained in the magma still would be up to one weight percent or less. Okay? And that is what we define as a relatively depleted compared to what you see that source in there that is coming up and releasing. Okay?

The viscosities for -- I have a slide here. Initially we expect viscosities for the initial part of the eruption for lava fountaining and Strombolian activity to be 10 to 10^2 pascal seconds.

Again, the violent Strombolian eruptions based on the physical volcanology that Valentine and others described in their paper, this material is very crystalline-rich.

And even in their paper, they say that this magma will have a higher viscosity than earlier magmas to obtain such fine tephra, such fine fragmentation. So if you account for the smaller size bubbles and the crystals in it, you raise the viscosity up by an order of magnitude or two.

So we believe this is a fairly reasonable viscosity for the Strombolian event, but when it comes to the aa flows, the lava flows that come out, the viscosity is a range between 10^3 and 10^6. And that is based on if you do not account for the crystals in the magma at, say, a low pressure at the repository level, your viscosity initially will be around 10^3, 10^2, 10^3. You bring in some bubbles. And you bring in the crystal. And you start to crystallize the material. You start to go up this curve here, which is based on the Roscoe-Einstein equation, which is viscosity as a function of crystallization.

So as you start to crystallize the magma, you are going to start to raise its viscosity. So this is a reasonable range for viscosities of lava that is coming out. This is before it starts to really get crystallized and it stops.

Once it stops flowing and it is starting to cool, then we go to the lower curve, which is for solidifying magma. And the viscosities really go up exponentially to several orders of magnitude.

So our expected model, then, of what we expect the magma-drift interactions to be, we look at it more of a three-dimensional picture, as opposed to this 2D picture back here, where we are just considering this part in the more active part of the dike system that eventually forms the conduit system because, as we have all heard, the transition from a fissure eruption to a conduit eruption occurs because you start to cool down and freeze the thinner parts of the fissure. Okay? So they come to a thermal -- they are thermally arrested, so to speak.

So if we account for that, so say this, the widest part of the dike would go back to what we envision here in our model. We start off with an annular flow regime to a slug flow regime to this foam crystalline regime down to a bubbly flow. And that's what we envision here.

So if a dike intersects the drifts, the drifts that intersect this part of the dike, we expect to have the spatter, bombs, and ruptured products that we see at the surface to be similar to the lava fountaining and Strombolian.

So we get packages coated with spatter and bomb material, parts that are intersected by the side, where we get more crystalline, cooling magma that is representative of like an aa flow. We get aa flows that once you decompress it rapidly, you are releasing any volatiles in there which will induce quenched crystallization, which rapidly crystallize and increase the viscosity again to slow down these flows. And they won't go -- we anticipate that they won't fill up or won't go down the drift that far.

Now, in this, the third type of drift, we are on the edge of the thin dike, where it is more or less cooled and crystallized. So it's very, very viscous, kind of a chilled lava plug.

So we are envisioning these drifts to be plugged up by lava, this very crystalline mush. In a later stage, as the eruption continues, the magma continues to come up, well, the drift that was plugged before us remains plugged.

The drift that had some partially filled with aa, it has additional aa flow coming through. But because we have a narrower -- the drift is partially filled, we have less volume to fill. So that is going to chill up quickly, fill up quickly. And down here we are anticipating like the tephra, the fragmented material coming in.

So we are looking at this as not just a uniform lava flow that is low viscosity filling up the drifts and moving it through as envisioned by NRC. We are thinking about it in more realistic capacity of what we understand about dikes and when they transitioned to conduits and what would happen if such a system did actually come through the repository and emplacement drifts.

So our model is continually evolving based on what we are learning from the physical volcanology at Lathrop Wells, our understanding of dike systems and conduit systems and how magma tends to release its volatiles and crystallize.

And so we think this is more consistent with the fundamental physics of a volatile-rich magma ascending to the surface than what has been proposed by Woods and others, who assume a constant viscosity of 10^2 pascal seconds and filling all the emplacement drifts.

So the next section is on heat loss. The NRC reviewers state that EPRI concludes that the physical property of magma entering the drift is similar to a lava erupting at the surface. EPRI's conceptual model entering a drift is derived from inappropriate analogy to the cooling of degassed basalt lava flows at the Earth's surface.

And here are some of the inappropriate analogs that NRC stated, that EPRI cites descriptions on intact cars, gas tanks, and water tanks entrained in lava flows from the igneous consequence review panel.

But if you check page 30, they state that Hawaiian lava flows tend to burn non-metallic materials and there is very little what they call dismemberment of metallic materials. And if you participated or attended any of the igneous review panel workshops, Larry Mastin did this section. And he showed some wonderful pictures of cars and lava flows that were really untouched. And so talking to him, that was part of this whole section here.

Then EPRI cites Lore and others as a basis for their assertion that radiative cooling dominates at the surface of the magma flow into the drift and conductive heating at its base.

Well, in reality, what EPRI said was "We recognize that the Lore curves show radiative cooling at the top being dominant in the curves, and the basal curve in their calculation was solely conductive heating." And we said that we used the basal temperature curve for conductive cooling that EPRI asserts will be one of the dominant modes of heat transfer. We never said that radiative cooling is the dominant mode of cooling inside a drift. We never said that.

Okay. So here are some examples of chilled lava flows. Even in NRC's review, they say that the chilled lava that forms is a good insulator and it does form, in fact. Okay? So here are some good examples.

Here is something that Bruce Marsh included in one of his presentations of a crucible that was dumped in molten magma pulled out. And you can see how a chilled margin forms along that cold container.

So looking at aa lava flows, the lava flows that we expect to occur at Yucca Mountain and expect to fill the drifts and all, we look at the quaternary lavas. They are characteristic of aa lava flows. They are very short in length, less than two kilometers. Okay?

Here is a picture of an aa lava flow.

They form levees. Okay? And in the interior is where the lava is hottest. On the margins, you see these fairly thick crystal, chilled margins occurring.

Here is the Lore and other curves. And it shows that when they put all of the various modes of heat transfer, when magma contacts a cold substrate, the temperature becomes the average of the two materials. And you can see it drops it to about 700 degrees C. Okay?

Here if you consider a radiated coolant the surface, it drops it way down. We do not consider this. We consider conduction. Okay?

And so when you look at the characteristic of aa lava flows, the basal crust forms by the overriding clinkers that form. And it's like a tractor, a Caterpillar tractor. It moves, and it's continually moving and bringing the top crust down to the bottom. And it's moving over.

At the same time, the main mode of heat transfer at the front and the base of it is forced convection and conduction with the contact temperature being around 700. This also considers conduction and convection. I said just convection. It's conductive and convective heat transfer. Okay?

And another thing, this is Cas and Wright, but this was also -- the citation is Pinkerton and Sparks. And it discusses how when a magma has like about one weight percent water. When it decompresses, you rapidly under-cool it, which causes, induces quenched crystallization. Okay? And you get this rapid increase in viscosity and development of high yield strength. And it explains some of what you see with aa flows. Okay?

So these chilled margins are very characteristic. They form rapidly. And to get an aa flow to move far, you need to destabilize the toe. And many toes it is the case when you reach a slope and gravity forces it to fall apart, well, in the drifts, we are not going to have gravity playing a role in it. Okay? It's a horizontal tube.

So what is the likelihood that a flow in a drift will -- another concern of NRC's was, what is the likelihood that a flow in a drift will melt the existing chilled crust? Well, from the examples, we know that when lava contains a cooled surface, it is going to create a chilled margin. Okay? We see that with all lava flows.

NRC's concern was that when additional lava flows move through, they will heat up and remelt the chilled margin, which is what we say will protect and tune the waste package.

Well, if we look at eruption discharge rates that control small-volume aa flows, here is a curve of the mean discharge rate as a function of final flow length for single lava flows. These are for Etna, Kilauea, Mauna Loa collected over the years. And you see these short flows have the mean discharge rate of less than .1 cubic meters per second.

If you consider that flowing into a drift, then you account for the diameter is going to be what's left if you subtract the waste package out, 1.6. So the velocities that we expect for these flows are very, very low.

And if you look at the -- this is a curve. These curves are temperature as a function of distance in a dike that is two meters wide. And it accounts for convection and conduction in the dike.

And, as you can see, very low, low velocities will allow that boundary layer to occur. It won't remelt. It's not hot out because you need invection. You need lateral convection to bring the heat from the center of the flow to the side of the flow. These flows are not going to be that high.

This mixing cup temperature up here shows if a magma comes into a dike at 1,200 degrees C and its velocity is 2.7 or greater, then you are going to remain at the boundary at this very high temperature. Okay?

So this curve is indicating that there is not enough heat transfer to melt the chilled margin. So you are going to have a boundary layer forming for these very low-velocity flows. So we still believe that we are not going to be melting back this protected chilled layer.

So lava flows inside a drift will be slow-moving, much less than ten meters per second, which NRC used in their 2002 report in the aa model. And they are crystallizing flows because they will be decompressing from ten megapascal to the atmosphere, very low pressure expected inside a drift.

Additional flows entering a drift will not melt any lava or chilled lava inside the drift on waste packages. Slow-moving flows will lose heat faster. Thus, the viscosity will increase, terminating the flow earlier than less viscous melts, as suggested by NRC.

So now turning to the in-drift thermal calculation that EPRI did, NRC listed eight deficiencies in EPRI's model approach. And it included unsupported assertions that the magma extends

20 meters into the drift, that laminar and turbulent flow -- they did not state whether it was the magma or the water -- and convective heat transfer as a viable, but that is included in the model. And phase change or solidification wasn't included. But I am not sure what they were discussing, whether they were talking about magma or hydrous phases.

Well, the intent of EPRI's approach was -- and here, as we stated on page 19 of our report in 2005 -- that EPRI opted not to initiate an integrated analysis or about magma coming in and emplacing. We were more or less doing a similar approach that DOE did in 2003, but we did it with updated data on basaltic magma, the lower temperatures and then temperature curves that we had from Lore and others. And we also accounted for porosity of the wall rock, fractures in the basalt. Okay?

So, in other words, the in-drift calculation performed by EPRI reanalyzed that the thermal effects of the liquid water vapor phase inside a drift on the waste packages and in the wall after emplacement and solidification of the magma.

So this was our intrusive scenario. After the magma was intruded into the repository drifts, it accounted for after emplacement what would happen to the waste packages after the magma intruded. So we account for direct contact with the waste package of magma and then indirect contact, the blue and green zones.

The blue zone accounts for the thermal impact, the ones that are really close to the magma. It is going to experience a lot of heat coming off that magma. Okay? And further away we account for the volatiles that come off the magma in this enclosed drift.

So this calculation did account for convective and conductive heat transfer of water, both liquid and steam, below the critical temperature. It did account for above the critical temperature but only in conductive heat transfer. It accounted for fracture network in the solidified basalt to account for any leakage or once it cooled, does water permeate through?

We use the temperature curve, the basal curve, the conductive and convective temperature curve from Lore and others. And then that was at 1,200 degrees C. So we still used a higher temperature for that, too. So it was more of a conservative approach than in the extrusive. So then we also considered realistic boundary conditions and initial conditions.

So here is a schematic of what the computational domain looked like. So you had a closed, porous, and we had the tough rock. We had the waste packages lined up. And we had water coming off magma.

MEMBER HINZE: I am having a hard time reading those. Could you --

MS. MORRISSEY: This one? This is rock. This says, "Drift." And this says, "Magma." So this is the magma. So essentially this box here if you just --

MEMBER HINZE: Okay.

MS. MORRISSEY: Right there. That was the analysis.

MEMBER HINZE: That writing below the drift there, it looks like it is on my --

MS. MORRISSEY: What's that?

MEMBER HINZE: Beneath the word "Drift" within the --

MS. MORRISSEY: "Rock."

MEMBER HINZE: "Rock." Okay.

MS. MORRISSEY: "Rock" again. Yes.

Okay. So essentially a lot of NRC's concerns I think are because we use words like "emplacement" of the magma. Well, this is after the emplacement of the magma. So this is after things have settled down. Nothing is moving, like the magma has started to solidify. What happens after that? And so this is something that DOE did.

So a lot of the deficiencies that NRC listed must be really a misunderstanding of the problem, the approach to the problem. So they offered a lot of good ideas for a type of calculation that could be done if you want to look between what happens during emplacement of lava and the waste packages. But we don't feel that is necessary at this time.

So now we are going to the issues in the magma dynamics section. The first was nozzle geometry. NRC states that the geometric condition of the dike-drift in the work we did on magmatic material coming into a drift, they said it cannot be adequately modeled as a nozzle flow problem. And no rationale is provided to explain the significance of this divergence. This divergence is right here.

Well, what we did in our 2004 report was to analyze the work in the Woods and all model. And our rationale for this converging/diverging nozzle was based on their configuration of their work.

So the rationale is we were redoing their work but in a two-dimensional form. They did the dike, the dike-drift interaction. Their dike, it was a one-dimensional model where they accounted for the vertical flow of the dike into the drift by accounting for gravity. What we did, we did it to the actual 2D model of the same problem. Okay? So our nozzle is based on their concept.

And the rationale for nozzles is magmatic systems is based on what we see in the field. Pollard and Delaney studied dikes throughout the Southwest. And they found that they pinch and swell. So that's the rationale for doing a nozzle-type approach.

Sue Kieffer, my adviser who is on the National Academy, did a classic paper on geologic nozzles in many different geological environments. And one was Mount St. Helens. One is Old Faithful. And the other one is hydrologic jumps in the Colorado River. Okay? So diverging/converging nozzles are well-modeled and have been used quite extensively in geological environments and in volcanoes.

Here is another piece of work that I did. I am going to show you how this is applicable to this right here. This is work I did on my Ph.D. It was trying to understand long-period seismicity.

What triggers long-period seismicity in volcanoes, you have a crack. You have a converging nozzle. And you push steam through there. You have steam flowing through here. Okay?

It gets to this point of divergence/convergence. It chokes. And you set up a supersonic flow here. And downstream is sonic. And you set up this, as I will show you later, pressure step.

And so if you fluctuate this pressure step by fluctuating the outlet pressure, you can cause long-period seismicity. So this is a numerical model that was strictly steam flowing through this diverging nozzle. Okay? And you will understand why I am showing this later.

Going back to some of the issues that NRC had with using a multi-phase flow and initial conditions, NRC asserts that EPRI's flow does not appear to be consistent with fundamental physical and chemical processes of volcanic eruptions.

Well, a fluid containing a high-pressure gas is treated as compressible. So if you have high-pressure gas and it is in a conduit, you have to consider the compressibility of it. Okay? The physics of a compressible fluid is either a pure gas or gas and particle mixture. And it will behave similarly.

This particle mixture will behave similarly to a pure gas with the only difference being the sound speed, the rate of change in the flow properties and the magnitude.

So there have been many fluid dynamic models that use this approach of multi-phase. It's called pseudo-gas, where you mix fine grain particles with a gas. And if you do a piercing, it is all steam. The sound speed is about 900 meters per second.

But if you start adding particles to it, you start dropping the sound speed. It becomes less compressible. Okay? So the only difference is your mock number goes up and your pressure ratio goes up. And I will show you that later.

But with the Woods and other model, they use a homogenous flow, which contains magma, gas, and bubbles. But these bubbles and gas in the magma do not separate. Same thing in a pseudo-gas is the particles and the gas do not separate. So you are treating the fluid as more or less like a single phase. Okay?

And the main difference between these two approaches is the heat transfer and the mass transfer coupling relationships. Okay? So the main difference is we used a pure gas, pure steam in our calculations.

If we added particles to simulate a pyroclastic flow type fragmentation of the magma, there is little difference in the physics. The main difference shows up in the magnitude of the pressure and some of the rates. But the physics is essentially the same.

Here is the result from the Woods and all model, the one-dimensional model. What you see here is the flow into the drift from that narrow constriction of their model. Okay? So this is not the dike. This is the fluid entering the drift from the dike. Okay?

So their model accounts for magma and gas exsolving with time, with pressure. Okay? But it's a homogenous flow. And it's a closed system. Okay. So you're funneling this fluid in there that's compressible. Okay? And what you're doing is because it's a closed system, you are essentially filling it up with fluid. So it's pressurizing by itself.

The shockwaves you see here, I'm going to move on to this slide right now. If you inject a high-pressure fluid into air, you are going to send that initial shockwave. That is what you see here.

So this is an air shock moving through the air ahead of the fluid. So the fluid finally -- down here you don't see it. The fluid finally that's moving through the dike reaches the end. The fluid finally reaches the end. The air shack is now moving through the magmatic fluid. But what is happening here is you get a supersonic flow. You have got a shock, a normal shock, here. This is all subsonic.

And you have got this little shockwave moving ahead that was moving ahead initially reflecting back and forth. And it just increases the pressure in the fluid just by little steps, not orders of magnitude, like they say in their paper. What is increasing this from essentially zero to ten megapascal is just you are filling it up with steam.

Over here the reason I showed you this is this is the Woods and all approach with using this homogenous fluid. Well, over here, what I did in my dissertation was the same what I showed back here, the same setup.

Woods and all, they're showing the pressure from here right along the streamline here, right in the center part of the flow. That is their one-dimensional calculation. Okay. So it's in this box here.

What I am going to show you is

two-dimensional right through here, steam through the same nozzle. So this is a single phase versus their homogenous flow. And so this is the flow field along the wall. This is through the inlet. Okay?

And what we did here is we initially let the initial conditions -- we achieve steady state conditions here. These are non-steady state. Okay? So at these different pressure ratios, we get an initial shock. Okay?

This is a normal shock forming. And then you get subsonic flow further down. You get this nice pressure gradient. And, as you increase, as you lower the pressure, you can move that shock front further down. So you lower, lower the pressure. And you can move that shock front down. But then as you increase the pressure, you can also bring it back to the point where it is no longer there.

So what I am showing here is essentially the same physics going on in a single phase calculation versus their homogenous flow. So there is no difference in the physics between these two models. Okay? The physics are the same.

So the work that EPRI did on the numerical model, this is really dark -- it is very light on my screen -- does use steam going into air. So these calculations, more or less the physics are the exact same as what they did in Woods and all. So we feel that the physical and the chemical processes that we have used in the multi-phase flow exactly the same as what you expect in homogenous flow.

So there is nothing wrong with what we did in our calculations. Our calculations essentially show what would happen when you inject a high pressure fluid into a horizontal drift. And what you see is you get this vertical momentum coming up and you get the fluid deflecting off the drift roof.

You get this pressure concentration, which if we had an elastic medium here, it would show a crack opening up and moving up because this pressure here is about -- it's over five megapascal. So that's enough to hydrofract the rock and favor the continuation of the dike moving up.

And essentially it's a closed system. It's a closed drift. On one side, we have the waste packages. The other side is empty. This just shows --

(Whereupon, the foregoing matter went off the record briefly.)

MS. MORRISSEY: The figure on the right would be we accounted for a crack. And it just shows how you can alleviate some of the pressure building up inside the drift because the Woods and all model, it's a closed system essentially. There is no permeability. There are no refractures. And so this other calculation just shows what would happen if you -- yes.

Then, in summary --

MR. GILLESPIE: We are up and running again.

MS. MORRISSEY: Okay. So these are just results from a couple of simulations we did, one with closed system, just closed drift; and then one when we put a little -- you know, the crack tip moving above it. And so it quickly fills up. And it's moving up. And it's relieving mass from the system.

So if you account for more sources of relieving pressure from the drift, the pressures won't build up as high as expected. Okay. You account for the permeability in the fractures in the rock. It will alleviate some of that pressure from the gas moving through the drifts.

So, in summary, EPRI believes that the conceptual model that we have derived and the analysis conducted by EPRI since 2004 are based on observations made routinely at volcanoes and on data from appropriate analogs of future Yucca Mountain volcanism.

Contrary to the position put forward by NRC and the consultants, EPRI's analyses are consistent with fundamental physical and chemical processes and EPRI's igneous consequences at Yucca Mountain are indeed technically defensible.

So if there are any questions, anything you would like me to explain?

MEMBER HINZE: I sense that we may have a question or two, but first I want to thank you for a very clear and informative presentation and thank EPRI, too, for their contributions in this regard.

MS. MORRISSEY: Okay.

MEMBER HINZE: The way we will work this is that we will ask the Committee for any questions. And then we will move to those on the bridge. And then we will open it up to the rest of the group. Questions by the Committee? I'm passing on --

CHAIRMAN RYAN: No. Thank you.

MEMBER HINZE: Ruth?

MEMBER WEINER: This was an excellent presentation. And it's a great deal to digest. Let me just ask one. Is there any way in your calculation that the magma moving out of the -- or hitting a waste package could mechanically or some combination of mechanically and thermally disrupt that package? Is there some way to alter some of the calculations that you did to show that? I would just like you to expand on that a little bit.

MS. MORRISSEY: We did a calculation when we considered -- let me go back, initial slide. Go back. I'm almost there. Here.

MEMBER HINZE: For the benefit of those on the bridge, we are looking at figure 6.

MS. MORRISSEY: Yes, figure 6. We did a calculation in which we considered this scenario, the impact of a waste package right where the dike intersects. And those calculations, those mechanical calculations showed it dented, but the canister never failed. Okay?

Similar calculations could be performed, but that hasn't been done.

MEMBER WEINER: Do you have any --

MS. MORRISSEY: We felt this was the most direct impact, this was the most high-risk scenario.

MEMBER WEINER: Do you have any sense of what that impact, either the impact speed of the magma slug or the force on the package, would be to actually disrupt it greater than what your calculations --

MS. MORRISSEY: We did a calculation of 100 meters per second. And that is pretty extreme. And it deformed structurally and all, but it didn't ever -- you know, the calculation showed a number of them failed. So it was an extreme case that we felt. So even 100 meters per second was pretty --

MEMBER WEINER: Thank you. That's all I have right now.

MEMBER CLARKE: Thanks, Bill.

Maybe to ask Ruth's question another way, what would have to happen to --

MS. MORRISSEY: What would have to happen?

MEMBER CLARKE: What would have to happen to damage a package to the extent that you would have premature corrosion or release or there would be consequences?

MS. MORRISSEY: John Kessler when it comes to corrosion issues, I think he is --

MR. KESSLER: Well, I am not an expert on anything. John Kessler from EPRI. But I do happen to have a look at what other people have done in our work. That is Fraser King's area on the interaction with the waste package.

For the igneous eruption scenario, which is what Meghan just referred to, indeed we show that the package dented, even at this 100-meter-per-second magma jet essentially hitting right in the middle of the waste package.

For the igneous intrusion scenario, which was most of what Meghan was talking about with the rubble moving down, indeed we do have waste package failures that are due to thermal over-pressurization concomitant with the reduction in the structural properties of the metal as you increase in temperature. Indeed we do have failure of the waste packages under those conditions. And we do account for those in our igneous intrusion scenario.

MEMBER CLARKE: That's helpful. Thank you.

MEMBER WEINER: Could I ask a follow-up question, then?

MEMBER HINZE: Into the microphone, please.

MEMBER WEINER: Yes. Sorry.

MR. KESSLER: That's okay. I'll listen to your head.

(Laughter.)

MEMBER WEINER: Okay. So in the intrusion scenario, if you get an actual rupture of the waste package, could you calculate or model what happens to a fuel rod, what happens to the fuel pellets themselves? Do you have any idea of what kind of particles you could get out of that? I don't --

MR. KESSLER: We did that. That is in the igneous eruption report. We made assumptions that even -- we did a whole bunch of what I call -- and even if we're wrong about, you know, what would happen next, that is all in the igneous eruption report, where we have a chapter on even if we do have a waste package failure, how is it the magma would interact?

And if it did get to the waste particle, to the UO_2 pellets, what would we expect to happen in terms of what would actually get lifted up to the surface? And even if that did happen, even though we don't think it will very much, what will be the particle sizes that we will get at the site boundary?

So we have all of those "even ifs." And what we showed was that when we go through all of those levels of conservatism, we can back-calculate if you add in all of those conservatisms right back to what DOE got for an answer. So that is in our igneous eruption report.

MEMBER WEINER: So that when you do that, you are basically repeating the DOE assumptions?

MR. KESSLER: Yes.

MEMBER WEINER: Thank you.

MEMBER HINZE: With that, we will move to the bridge. And I will ask John Stamatikos and his group at the center if they have any questions or comments.

MR. STAMATIKOS: Well, we have lots of questions that we are not going to pursue at this point, Bill. I just would comment that almost all of Meghan's presentation, it looks like they're from material that is in EPRI 2006, which no one has, and that our review is on the prior two EPRI reports.

MS. MORRISSEY: Right. Like I say, our work continues to evolve. And even in the 2004 report, it may not have been stated so clearly, but we did discuss a lot of the rheology issues of magma and what we expect as a sequence of, you know, drift interactions.

So it's there, but it's not as clear as 2006 because, as you know, with time, everything gets to be updated and issues get to be clarified.

MR. KESSLER: John Kessler, EPRI.

It's true, John. You didn't see that latest work because it came out very late last year. In fact, some of it we just attached to the letter to ACNW as an appendix for a letter, even this year.

So, indeed, we have done some new work. We will make that available to you if you haven't seen it. We're happy for you to take a look at that and look at that as well.

MR. STAMATIKOS: We haven't seen it. And so we would be glad to take a look at it.

MEMBER HINZE: Do you have any further comments or questions at this point, John?

MR. STAMATIKOS: No, nothing else from here.

MEMBER HINZE: All right. Professor Marsh?

MR. MARSH: Yes. Professor Hinze, thank you very much. Thank you, Meghan, for an informative presentation.

I just was curious overall what general things -- in your slides and things you have quite a number of references. Would it be possible that we could actually get the bibliography on these?

MS. MORRISSEY: Absolutely, yes.

MR. MARSH: Okay. And the other thing, on slide 14, for example, when you are talking about the effect of magma on cars, gas tanks, et cetera, in reference to this Detournay report and things, I noticed in Detournay, *et al.*, they mention Thornberg, a Carl Thornberg reference in 1993.

MS. MORRISSEY: Yes, yes.

MR. MARSH: But that reference, you know, there is nothing in the bibliography. That reference --

MS. MORRISSEY: Right. That was a personal communication between Mastin and he. And he gave me an "Oops." He said I should have put a personal communication in there.

MR. MARSH: Okay. But Detournay, *et al.*, they reference Thornberg 2003.

MS. MORRISSEY: That should have been a personal communication after that.

MR. MARSH: Okay. And then you had some personal communications with Larry Mastin, I guess, here.

MS. MORRISSEY: Right, right.

MR. MARSH: Two thousand seven? If you could detail that out a bit, that would be very interesting, I think. I think it would be interesting for all of us to see some sort of a compilation maybe we can all contribute to to see some of these effects. I think they would be educational for all of us.

MS. MORRISSEY: Oh, sure, sure, sure.

MR. MARSH: It seems like you're on top of it a bit. And so it would be interesting. That --

MS. MORRISSEY: Yes. Larry gave me -- yes. He gave me quite a few references on that with images and stuff from various volcanoes.

MR. MARSH: Okay. Thank you, Meghan.

MS. MORRISSEY: Sure.

MR. MARSH: That's all I have.

MS. MORRISSEY: Okay.

MEMBER HINZE: Okay. Thank you, Bruce.

Questions? Dr. Hill?

DR. HILL: Britt Hill, NRC staff. Can we go back to slide 6, please? I would just like to follow on with one of Dr. Weiner's questions. For the analysis that was done for the volcanic disruption scenario, what was the temperature of the waste package in these mechanical analyses?

MS. MORRISSEY: That we used at the time, 1,200 degrees.

MR. KESSLER: No.

MS. MORRISSEY: For the mechanical ones in --

MR. KESSLER: John Kessler, EPRI.

No, Britt. For that one, we assumed the waste package was at the ambient temperature of the drifts prior to interaction with the magma. So that had, for example, the mechanical properties of the alloy-22 at what, 100 to 200 C., something like that, rather than the much higher temperature mechanical properties.

MS. MORRISSEY: I'm sorry. I misunderstood.

DR. HILL: So what we have is apparently a range of outcomes from taking a cold canister and putting it into a conduit versus the intrusive scenario, where the magma has been allowed to come in contact with the waste package for a while. And then there is a mechanical failure.

MS. MORRISSEY: Right.

DR. HILL: So I think it is pretty important to understand that if a conduit opened instantaneously and tried to entrain a waste package, there may not be much significant damage, but if a conduit opened progressively during the course of an eruption, say, over a period of days to weeks, the response of the waste package in the conduit may be more like the intrusive scenario that EPRI analyzed, rather than the volcanic scenario in that report. Would that be a fair statement?

MR. KESSLER: John Kessler, EPRI.

I am not sure. I am trying to understand.

Part of the problem is we have these scenarios in terms of what happens when and what progresses when and what temperature the waste package was in.

I know the core of your question, Britt. For the igneous eruption scenario, we made the assumption that after the initial entry of the magma into the drift that slams that waste package at 100 meters per second against the roof, that waste package gets moved to the side.

And there is nothing more that is going to make it out the eruption. If anything, it is going to get shoved down the drifts and we'll worry about it for the intrusive scenario. So that was conceptual modeling assumptions we made specifically when we looked at and separated out the igneous eruption case.

So in that case, for the igneous eruption, we only looked at the case where the waste package in that case was roughly at the temperature of the repository prior to the dike coming into that very initial contact with the drift.

Then for the intrusion scenario work, we did indeed look at waste packages that came fully up to the temperature of the magma.

DR. HILL: Okay. That again is an important distinction when we try to compare different scenarios, say, between the NRC scenario and the EPRI scenario for the NRC's volcanic disruption scenario, conduits, the volcanic feeder conduit, widened progressively over the course of the eruption to tens of meters in diameter. So they would be affecting waste packages that had been exposed to magma during the initial interaction, but the conduit itself doesn't form until perhaps days later.

So that's the fundamental difference, then, from the EPRI analysis, where there are volcanic scenarios, looking at only the package affected by the initial interaction.

MR. KESSLER: Interesting scenario. And what is NRC's model that has this widening? How is it widening?

DR. HILL: That is based on the rock record in things like Valentine and Groves, 1996 and Dubick and Hill, where you look at --

MR. KESSLER: Then answer my question very carefully. Where do the waste packages go during the widening?

DR. HILL: They behave like wall rock.

MR. KESSLER: So they sit there?

DR. HILL: The conduit is -- well, there is not much room to move these around, especially if the drift has magma in it. And so as the conduit widens and erodes the wall rock, it incorporates the waste package in a similar manner to wall rock.

MR. KESSLER: Okay. Thank you.

DR. HILL: And, to complete that, the basis for that is how we look at rock fragments coming out in analogue eruptions. And you see this progressive incorporation of rock through the course of the eruption in the tephra deposits at real volcanoes.

MEMBER HINZE: Further questions?

(No response.)

MEMBER HINZE: I want to apologize to the Committee. We are overtime. I am going to take the Chairman's privilege of just asking one question. And I think that I was having a late-in-the-day moment. On figure 27, did I hear you talk about a dog-leg scenario?

MS. MORRISSEY: No. This is --

MEMBER HINZE: Pressure is such that you would --

MS. MORRISSEY: Okay. No. No. I wasn't talking about a dog-leg scenario. What I was talking about here, this is the -- you know, again, back to the Woods, *et al.*, model, where if you bring a dike, intersect to the drift, you know, it doesn't continue up. The dike doesn't continue to propagate to the surface. It stops. And everything shoots into the drifts. Okay? And that is just this scenario.

This scenario shows you what would happen if that dike in the early stages continued to the surface. Okay? That's all it was.

MEMBER HINZE: Thank you very much.

I want to remind all of us that there is a full transcript of Meghan's presentation. And the ACNW will make that available just as soon as possible to anyone that's interested. And with that, I turn it back to you.

Thank you very much, Professor Morrissey.

CHAIRMAN RYAN: Bill, if you had any other unaddressed questions, don't hesitate to add one or two more if you like.

MEMBER HINZE: That's fine.

CHAIRMAN RYAN: Are you sure? All right.

With that, I thank you, Meghan, for your presentation and thank everybody for the discussion. We are scheduled for a 15-minute break. So we will reconvene at 3:25.

(Whereupon, the foregoing open session was concluded at 3:09 p.m.)

CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of:

Name of Proceeding: Advisory Committee on Nuclear Waste 177th Meeting

Docket Number: n/a

Location: Rockville, MD

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission taken by me and, thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings.

Charles Morrison
Official Reporter
Neal R. Gross & Co., Inc.

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Updated EPRI Response on Potential Igneous Events at Yucca Mountain

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Presented to the Advisory Committee on Nuclear Waste,
March 21, 2007

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- Graham Smith Ph.D., Enviros Ltd.
- Wei Zhou Ph.D., Monitor Scientific LLC

Outline of Presentation

Nature of Magma in the Drift

- Magma solubility
- Gas escape
- State of magma upon intersection with a drift

Heat Loss

- Development of a chilled layer
- Magma solidification
- In-drift thermal calculation

Magma Dynamics

- Multiphase flow and initial conditions
- Nozzle geometry

Nature of Magma in Drift

NRC Reviewers:

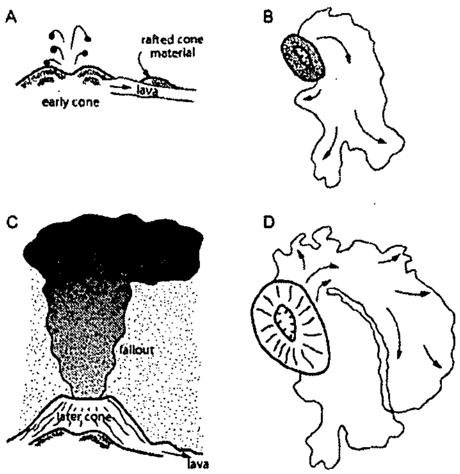
"EPRI asserts that the magma at the tip of an ascending column just prior to and at the point of intersection with a drift will be degassed".

"EPRI concludes that the intruding magma will have a relatively low temperature (975-1010°C), high viscosity 10^5-10^7 Pa-s, and rheology characteristic of an *aa* flow".

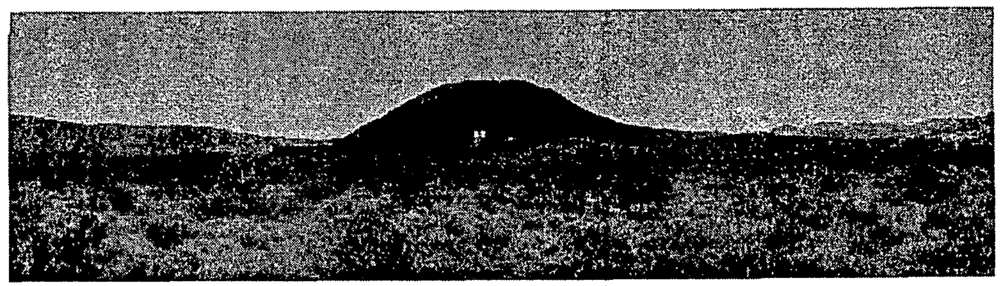
"These suppositions appear to be inconsistent with the fundamental physics of volatile-rich magma ascent ..."

Nature of Magma in Drift

'Reasonably Expected' Volcanic Scenario for YMR (EPRI, 2004):



(Valentine et al., 2005)



Lathrop Wells basalt center-best analog for future volcanism.

A. Lava fountains and Strombolian eruptions - early cone building phase.
B. <u>Northern aa lava flows</u>
C. Tephra ejection - late cone building stage
D. <u>Southern aa lava</u> flows

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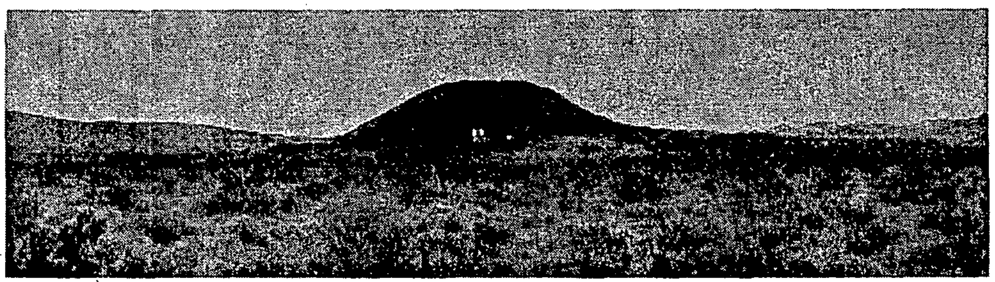
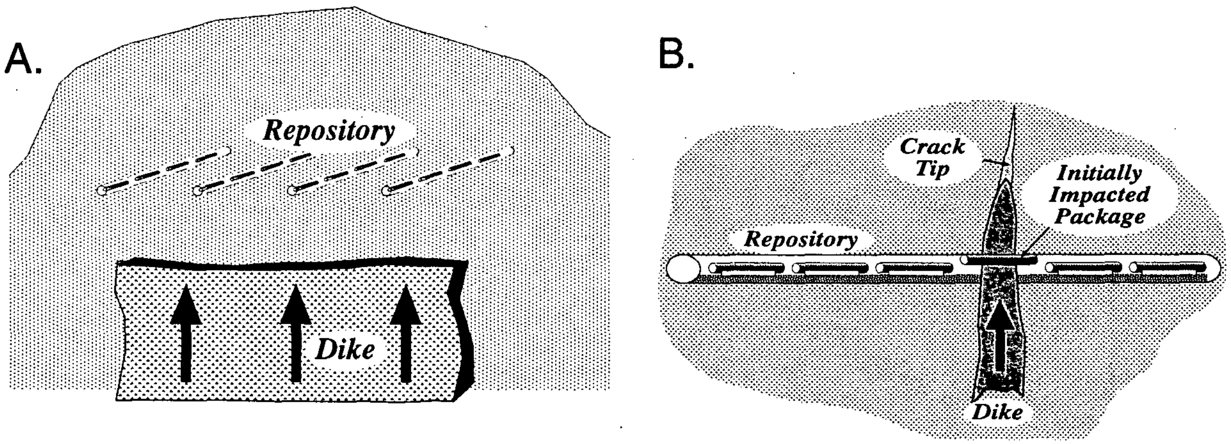
Nature of Magma in Drift

- Dike propagation and interaction with repository

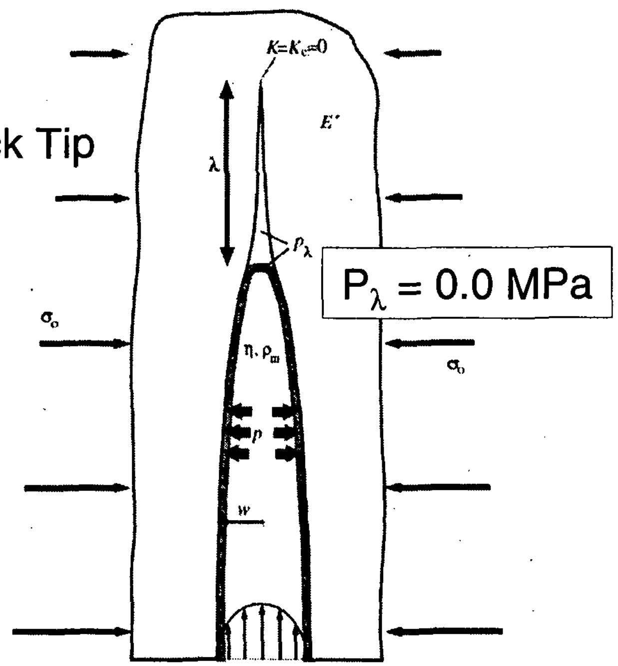




Nature of Magma in Drift

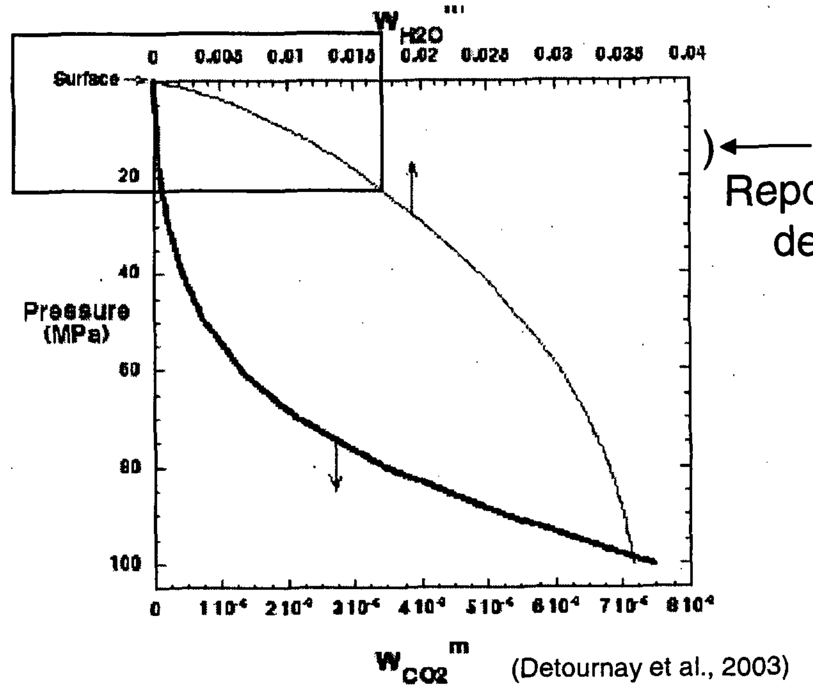
- Dike propagation and interaction with repository

Crack Tip



(Lister and Kerr, 1991; Rubin, 1995; Detournay et al., 2003)

Wt% H_2O in magma as a function of pressure



(Detournay et al., 2003)

✓*Near crack tip (P=0 MPa) magma will contain very little H_2O*

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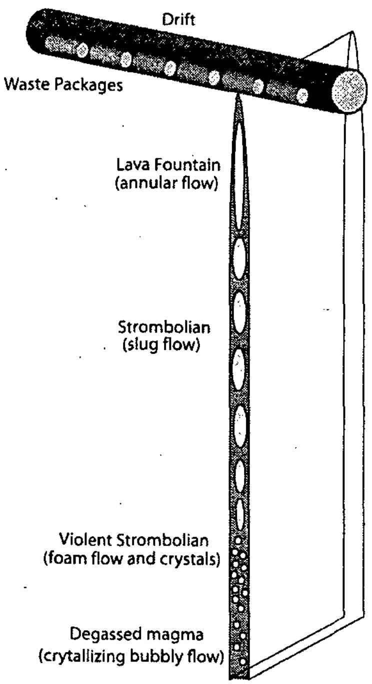
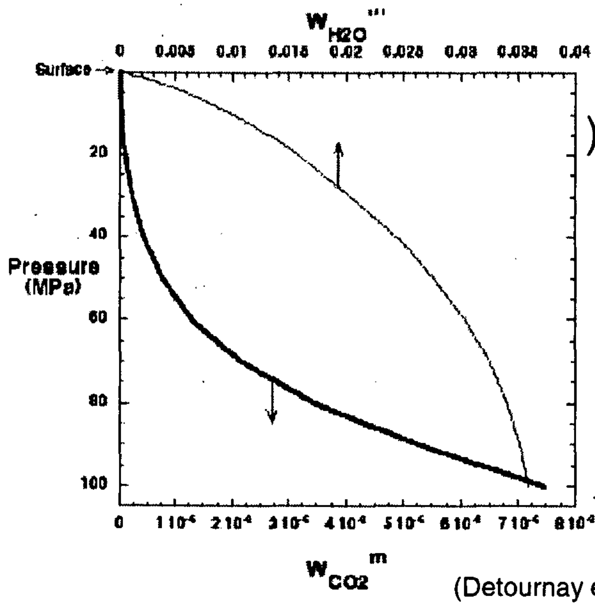
Nature of Magma in Drift

- Conceptual model of flow regimes prior to intersection with a drift. White areas denote gas phase and grey denotes liquid magma.



(EPRI,2004; 2006 - not to scale)



(Detournay et al., 2003)

Repository depth

4-5 km

✓*As magma migrates toward the surface it will exsolve gases.*

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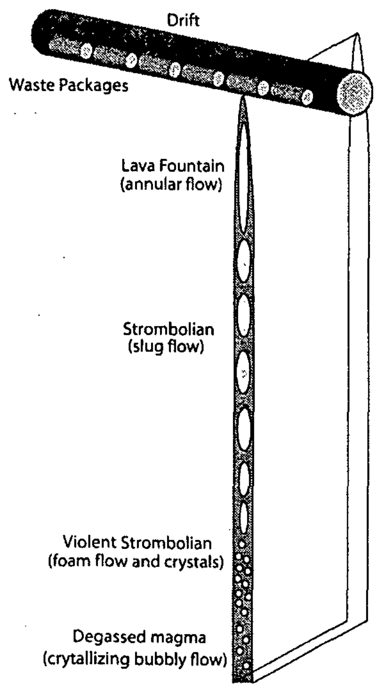
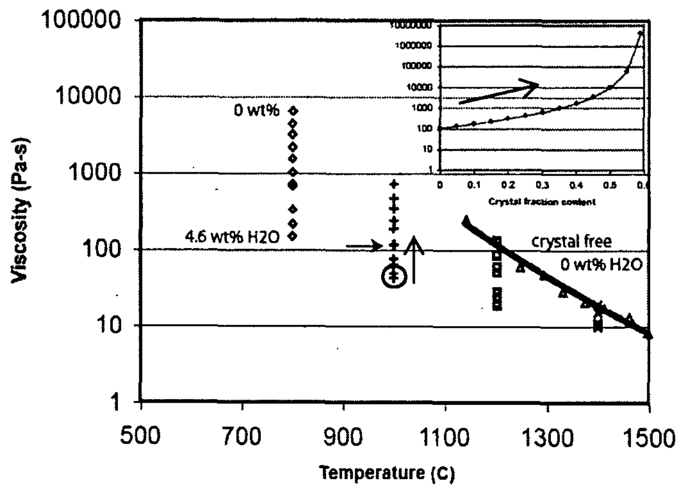
Nature of Magma in Drift

- Flow regimes require bubbles to nucleate, grow and coalesce.





(EPRI, 2006)

Magma viscosity as a function of H_2O and crystal content. Many small bubbles may increase viscosity by an order of magnitude.

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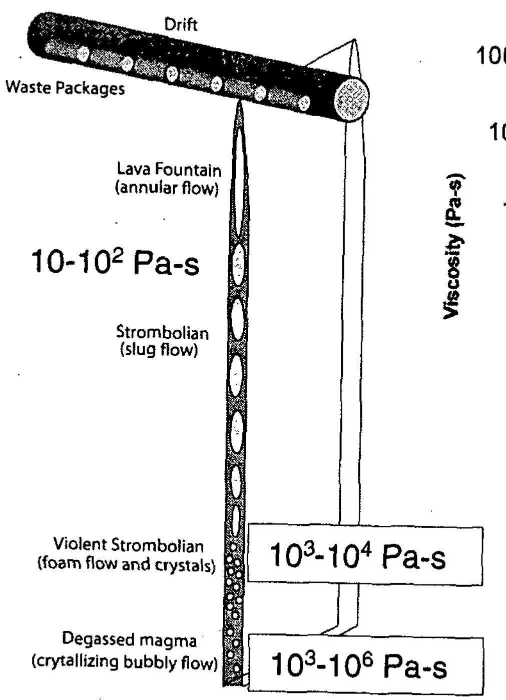
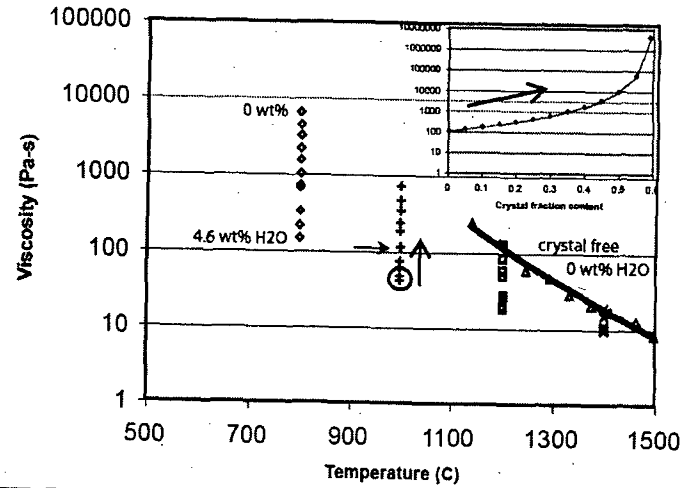
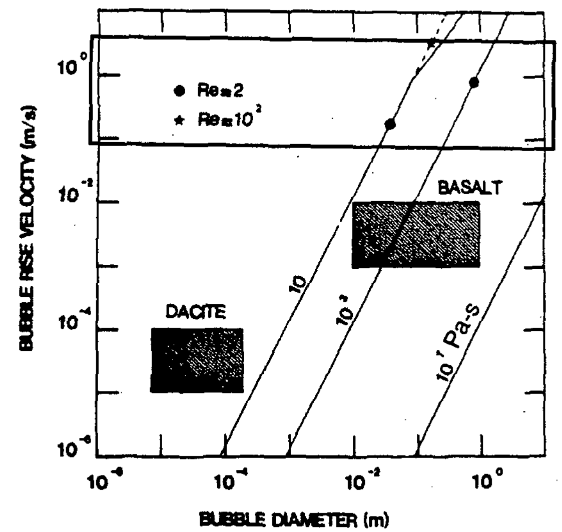
Nature of Magma in Drift

- Flow regimes require bubbles to nucleate, grow and coalesce.







(Vergniolle and Jaupart, 1986)

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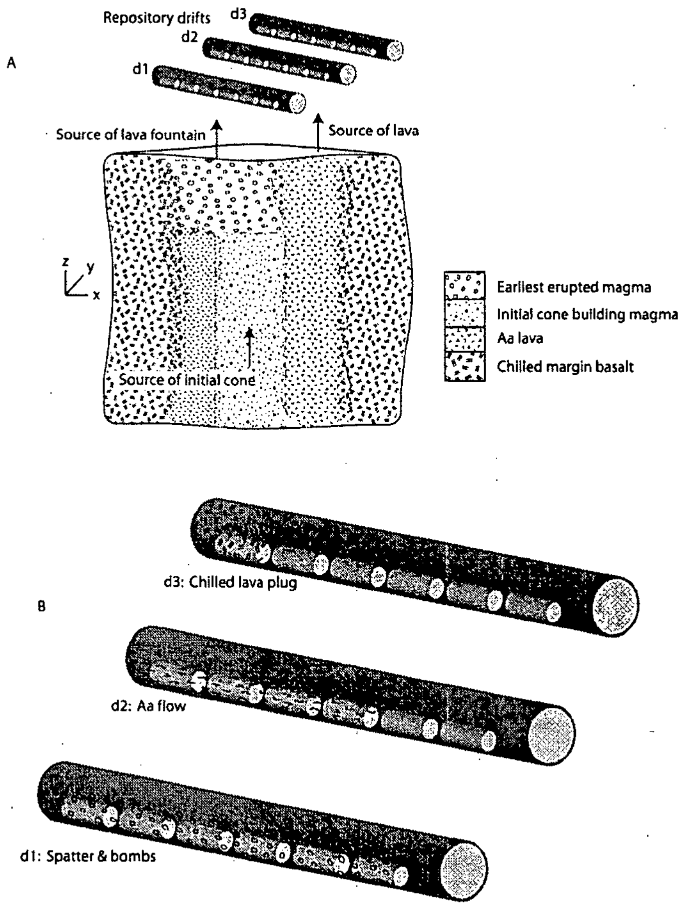
Nature of Magma in Drift

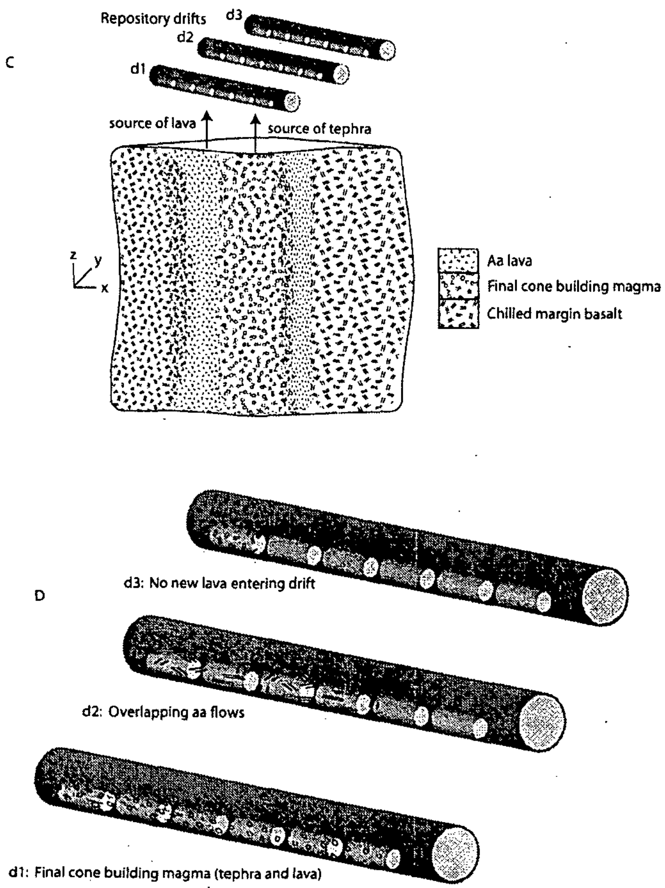


(from EPRI, 2006)

Three possible scenarios of initial magma-drift interaction:

1. (d1) spatter and bombs coat waste packages and pooling of magmatic material on drift floor.
2. (d2) aa lava flow entering drift entombing waste packages.
3. (d3) slow moving crystallizing lava from margin on dike forming plug sealing drift from dike.

Nature of Magma in Drift



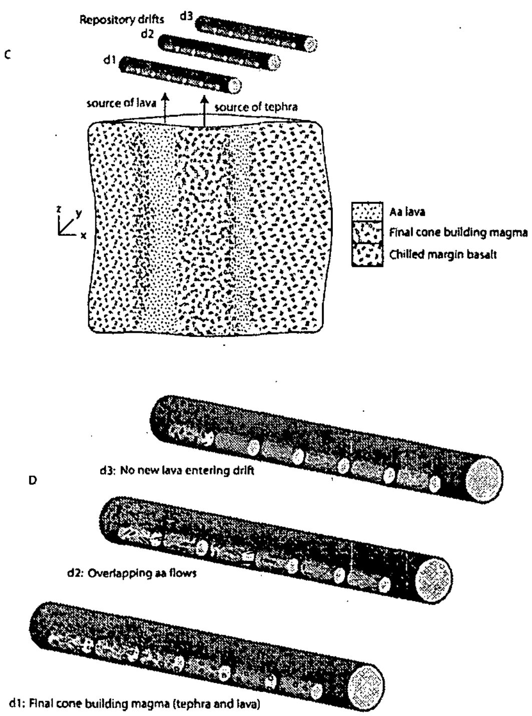
(from EPRI, 2006)

Three possible scenarios of late stage magma-drift interaction:

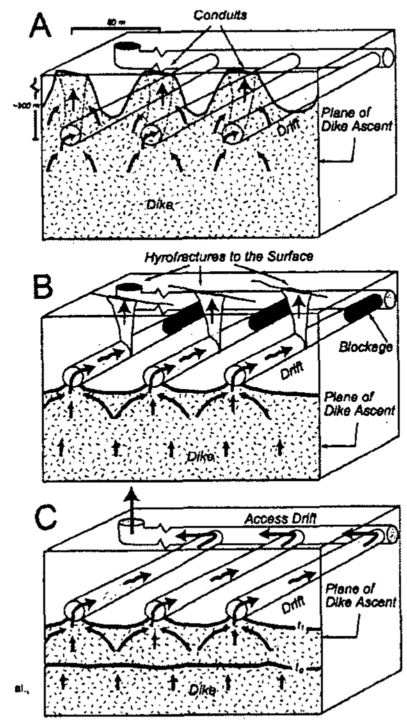
1. (d1) pyroclastic material entering drift containing spatter covered waste packages.
2. (d2) more lava entering drift already partially filled with lava.
3. (d3) no additional material - sealed drift.

Nature of Magma in Drift

✓ EPRI's conceptual model is consistent with fundamental physics of volatile-rich magma ascent. EPRI believes this model to be more realistic than that proposed by Woods and others (2002) whose model assumes magma enters the drifts with a constant viscosity of 10^2 Pa-s.



(from EPRI, 2006)



(from Woods and all, 2002)

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Heat Loss

NRC Reviewers:

"EPRI concludes that the physical property of the magma entering the drift is similar to a lava erupted at the surface".

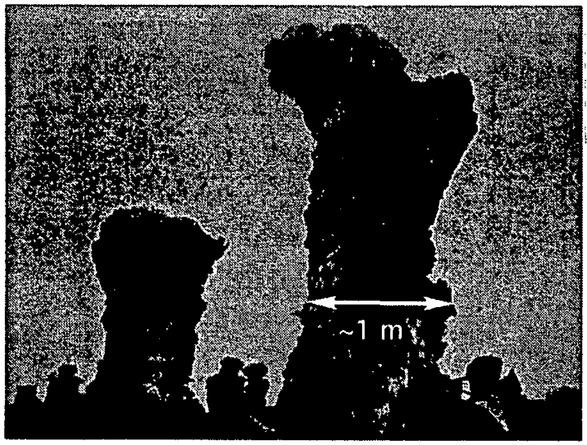
"EPRI's conceptual model entering a drift is derived from inappropriate analogy to the cooling of degassed basalt lava flows at the Earth's surface".

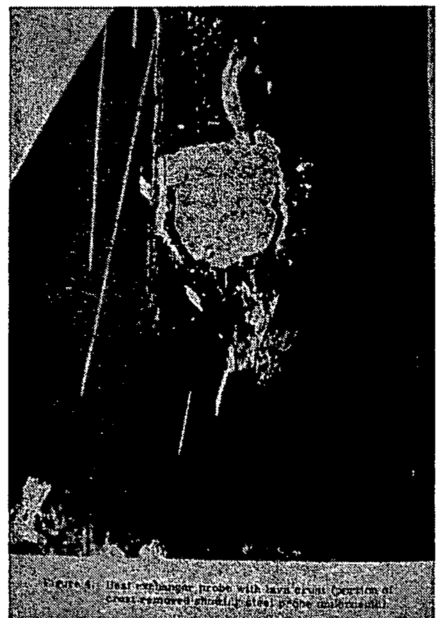
Examples of NRC asserted inappropriate analogies:

- EPRI cites descriptions of intact cars, gas tanks, and water tanks entrained in lava flows from ICRP" (in reality NRC should recheck p. 70, Detournay and others, 2003; Mastin 2002; 2007 personal communication).
- EPRI cites Lore and others (2000) as a basis for their assertion that radiative cooling dominates at the surface of the magma flow *into the drift* and conductive heating at its base" (in reality EPRI stated that EPRI (2004, p. 5-1; 2005, p. 17) used the basal temperature curve for conductive cooling that EPRI asserts will be one of the dominant modes of heat transfer).

Heat Loss

Chilled lava engulfing cars, trees, metal objects, …. EPRI believes that lava entering a drift will create a protective chilled contact crust.





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Heat Loss

- Aa lava characterize flows observed in Yucca Mtn .
- Small volume, short in length (< 1-2 km) .

Figure 48. As flowing aa lava cools, degases, and becomes more viscous, the hardened crust on the flow surface breaks up into rubble and gives the flow a rough, clinkery appearance. The flow shown is about 8 feet high.
Photo by G. W. Tribble, U.S. Geological Survey

Table 4.1 ACNW, pg 60

Volcano	Age, Ma	Rock Type[a]	Volume, km^3	Fissure Length, km	Lava Flow Length, km	Maximum Lava Effusion Rate,[b] m^3/s	Brief description
Thirsty Mountain	4.63 ± 0.02[c]	Basaltic trachyandesite	2.28	5[d]	6	80	Broad shield volcano consisting of stacked lava flows and a central remnant of pyroclastic (near vent) deposits.[c]
Pliocene Crater Flat (aka Southeast Crater Flat)	3.73 ± 0.02[c]	Basalt	0.56	3.6	4	40	Low shield volcano, now broken by normal faults and partially buried by alluvium, with multiple lavas and pyroclastic vent facies exposed.
Buckboard Mesa	2.87 ± 0.06[c]	Basaltic trachyandesite	0.84	2.5	7.3	100	Large lava field with remnant of a main pyroclastic cone in northern part, fissure inferred from ridge of lava and pyroclastics that extends SE from main cone.
Black Cone	0.986 ± 0.047[e]	Trachybasalt	0.06[c]	0.6 (1.8)[f]	1	0.9	Pyroclastic cone remnant preserving Strombolian and violent Strombolian facies, and two lava fields that vented from the base of the cone.[c]
Red Cone	0.977 ± 0.027[e]	Trachybasalt	0.06[c]	0.5 (1.6)[f]	1.4	3	Pyroclastic cone remnant preserving Strombolian and violent Strombolian facies, and two lava fields that vented from the base of the cone.[e]
SW Little Cone	1.042 ± 0.045[e]	Trachybasalt	0.03	0.3 (0.8)[f]	0.7	0.4	Pyroclastic cone remnant, open to the south, with single lava field mainly buried by alluvium.[e]
NE Little Cone	1.043 ± 0.045[e]	Trachybasalt	Included with SW Little Cone	0.2 (1.8)[f]	1.8	4	Pyroclastic cone remnant, open to the south, with single lava field mainly buried by alluvium.[e]
Makani volcano (aka Northernmost)	1.076 ± 0.026[e]	Trachybasalt	0.002[e]	0.4	0.4	0.1–0.2	Small lava mesa with pyroclastic deposits marking location of short fissure.[e]
Little Black Peak	0.323 ± 0.027[e]	Basalt to trachybasalt	0.014	0.4 (1)[f]	1.3	2	Pyroclastic cone with lavas that extend from its base.
Hidden Cone	0.373 ± 0.042[b]	Basalt to trachybasalt	.03	0.3 (0.8)[f]	1.6	4	Pyroclastic cone on side of butte with two lava field extending from its base.
Lathrop Wells	0.076 ± 0.005[g]	Trachybasalt	0.09[h]	0.8 (1.8)[f]	1.6	4	Single pyroclastic cone with two lava flow fields that vented from the base of the cone.[h]

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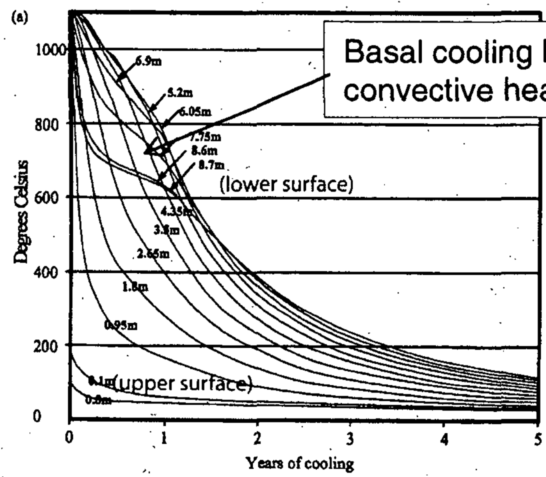
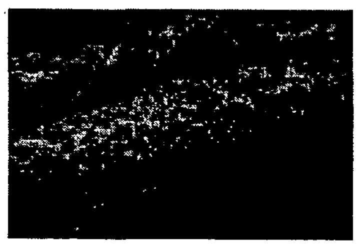
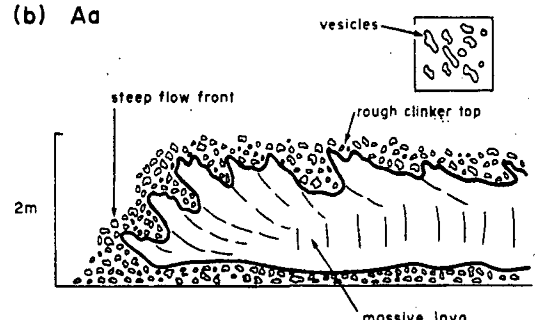
Heat Loss



Basal cooling by conductive and convective heat transfer.

✓ Temperature-time profiles calculated by a 2-dimensional viscoelastic stress model for cooling basalt with an initial temperature of 1100°C (from Fig. 7A, Lore et al., 2000). (Fig. 7 EPRI 2005)





(Cas and Wright, 1987)

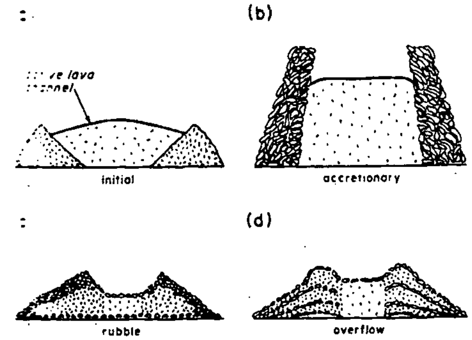


Figure 4.9 Cross sections through four different types of ... observed on Mt Etna. Heavier stipple is massive ... sparsely stippled areas represent flowing lava. (After ... et al. 1976.)

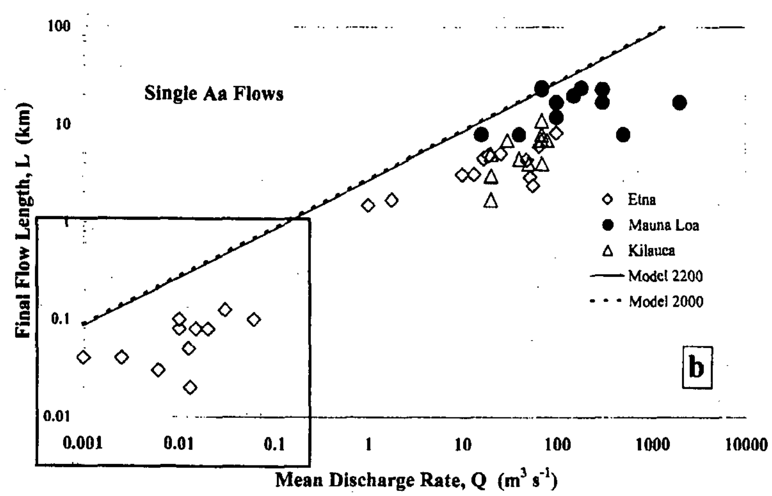
Characteristics of aa lava:

- Basal crusts form by the flow overrunning clinkers which have tumbled from the flow front rather than solely by conductive thickening. The main modes of heat transfer at the front and base are forced convection and conductive with contact temperatures at 700+/-200°C. (Harris and Rowland, 2001).
- The thickness of the basal layer of an *aa* flow is 10% the total thickness of the flow (Harris and Rowland, 2001).
- Degassing of the lava leads to considerable under cool, rapid growth of quenched crystallites, a rapid increase in the viscosity and the development of a high yield strength (Cas and Wright, 1987).

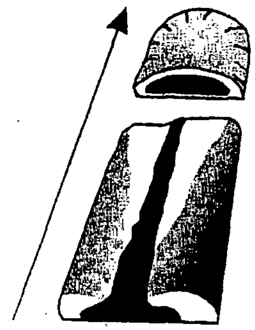
Heat Loss

What is the likelihood that a flow in the drift will melt existing chilled crust? NRC states it will melt because the flow rates will be sufficient to reheat and melt the material.

- Eruption discharge rate controls the flow length of small volume flows.



(Fig. 8b in Encyclopedia of Volcanoes, Kilburn, 2000)



Crystallized margins forming clinkers

(Fig. 1 in Encyclopedia of Volcanoes, Kilburn, 2000)

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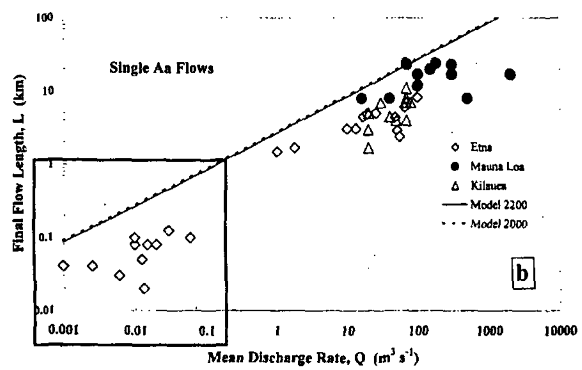
Heat Loss

- Velocity of aa lava flows entering drift.



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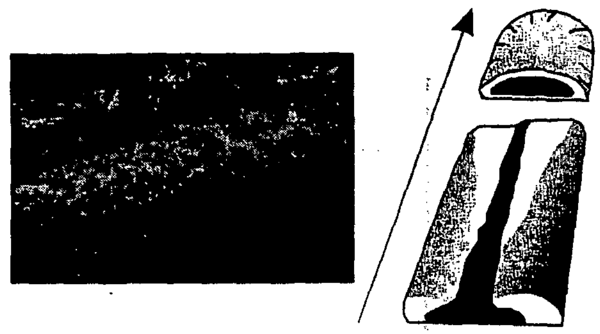


Crystallized margins forming clinkers

(Fig. 1 in Encyclopedia of Volcanoes, Kilburn, 2000)

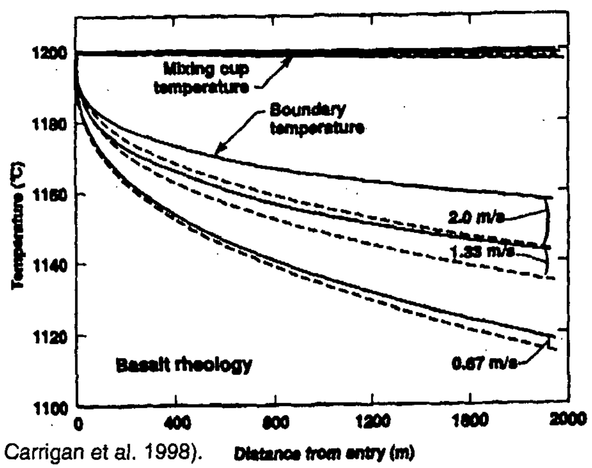
Velocity of lava entering a drift:

$Q = 0.001\text{-}0.1\ m^3/s$

$Q = \text{area} * \text{velocity}$

$Q = \pi r^2 * \text{velocity}$, r = radius of drift (-wp) (1.6 m)

Velocity = 0.00012 - 0.012 m/s



(From Carrigan et al. 1998).

(EPRI, 2004 p. 3-13)

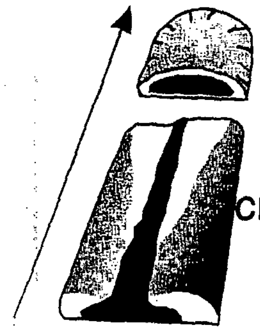
Heat Loss

- Aa lava flows entering drift.

✓ *Lava inside a drift will be slow moving (< 10 m/s), crystallizing flows.*

✓ *Additional flows entering a drift will not melt all chilled lava inside drift.*

✓ *Slower moving flows will lose heat faster thus viscosity will increase terminating the flow earlier than less viscous, more fluid lavas as expect by NRC.*



(Fig. 1 in Encyclopedia of Volcanoes, Kilburn, 2000)

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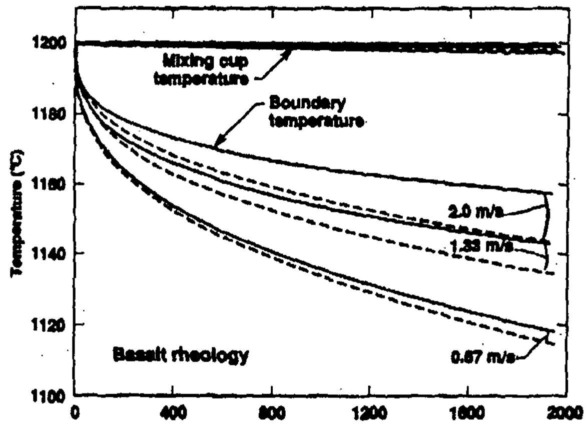

(From Carrigan et al. 1998).

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Heat Loss

- In Drift Thermal Calculation

NRC listed 8 deficiencies in EPRI's model approach including unsupported assertion that magma extends 20 m into drift; laminar/turbulent flow (magma or H_2O?); convective heat transfer viable mode (included in model); phase change or solidification (magma or hydrous phases?).

Reason for EPRI's model approach:

" EPRI has opted not to initiate an integrated analysis on the potential extent of magma intrusion into an emplacement drift. Instead, EPRI analysts have applied expert judgment to existing analyses by the DOE OCRWM (2003) and independent researchers. ... EPRI believes that newer, more representative (updated) data for the basaltic magma ... should be substituted for the more conservative data assumed in OCRWM (2003)". Pg. 19, EPRI 2005

In other words, the in-drift thermal calculation performed by EPRI analyzed the thermal effects on liquid water and vapor phase inside of drift ,on waste packages and in wall rock after the emplacement and solidification of magma inside a drift.

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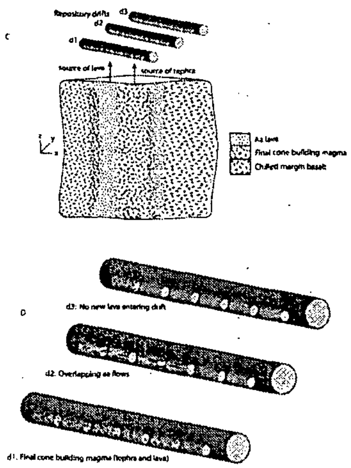
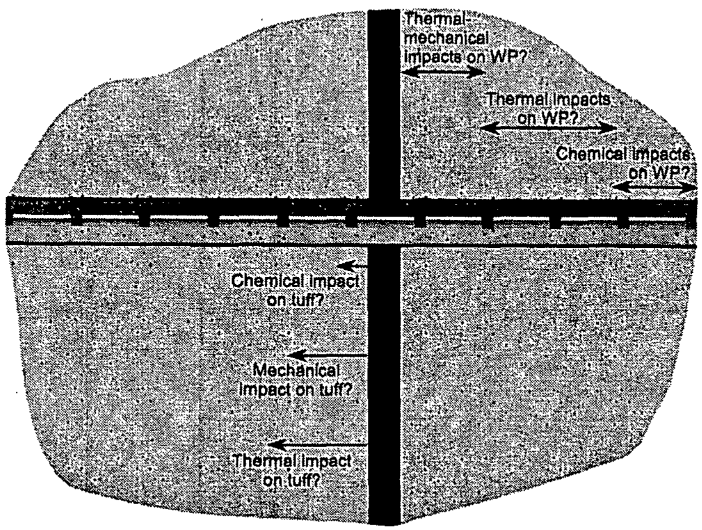
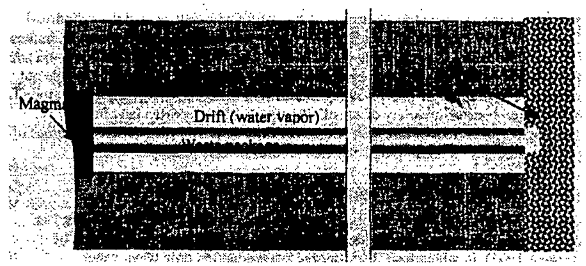
Heat Loss



In Drift Thermal Calculation

- T2HT, a version of TOUGH2.
- Convective and conductive heat transfer.
- Fracture network in solidified basalt.
- Temperature curve at the base of cooling lava (Lore et al., 2000).
- Considered reasonably realistic boundary and initial conditions.

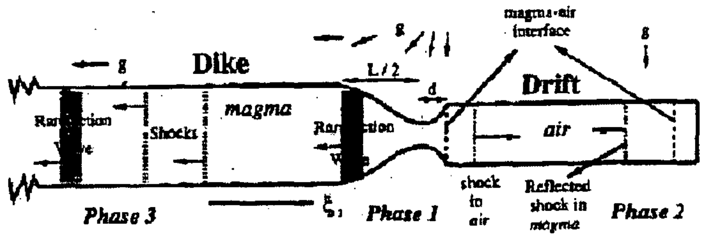




Magma Dynamics

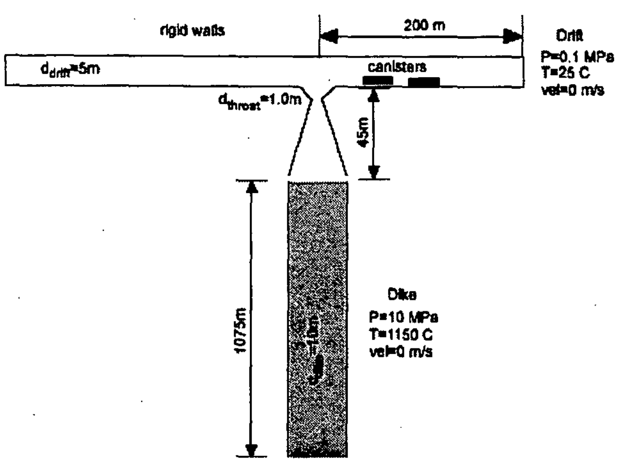
- Nozzle Geometry

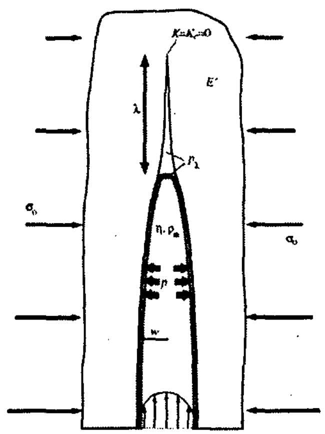
NRC states that "the geometric condition of the dike-drift cannot be adequately modeled as a nozzle flow problem. No rationale is provided to explain the significance of this divergence".



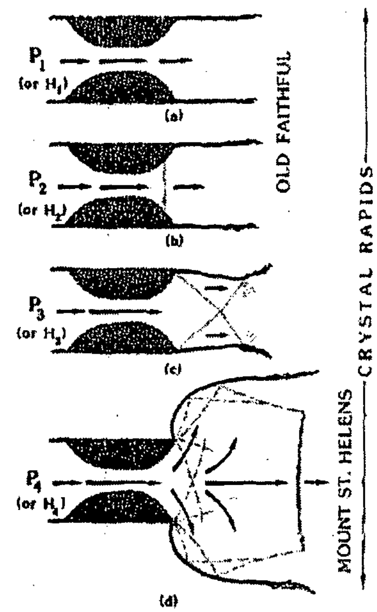
(from Figure 3 in Bokhove and Woods, 2002).

Examples:





(Detournay et al., 2003)



(Fig. 2 in Kieffer, 1988 Geologic Nozzles)

Magma Dynamics

- Nozzle Geometry

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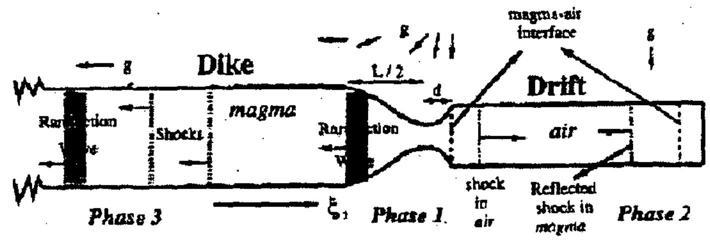

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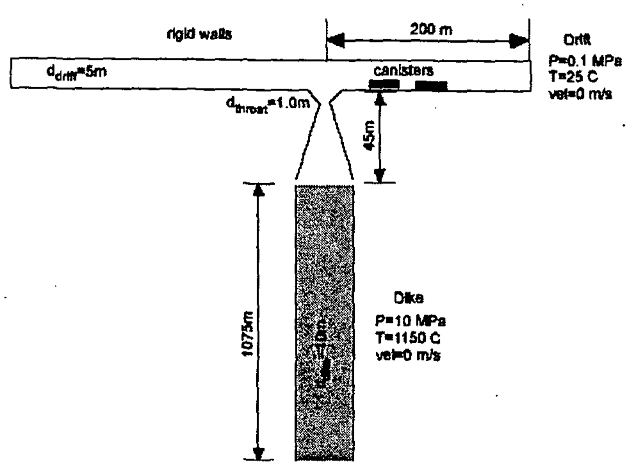

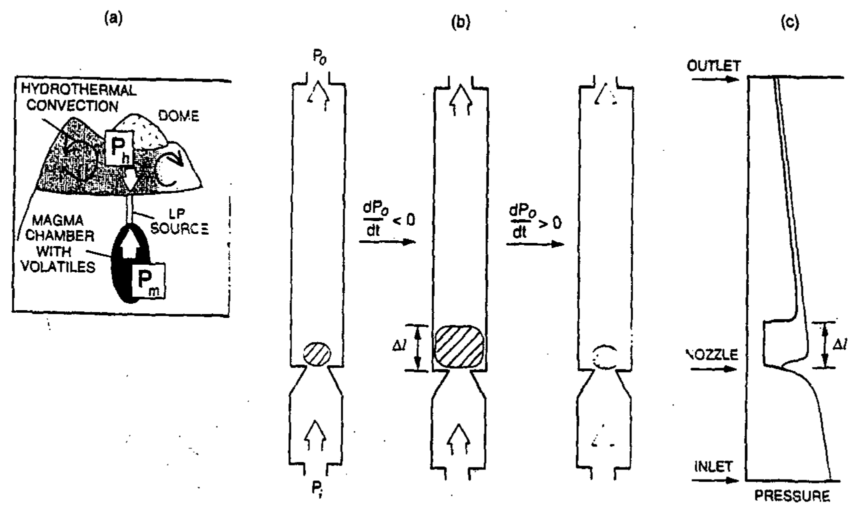

(Fig. 3 in Morrissey and Chouet, 1997, DASH).

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Magma Dynamics

• Multiphase flow and initial conditions

NRC: "EPRI's flow field does not appear to be consistent with fundamental physical and chemical processes of volcanic eruptions".

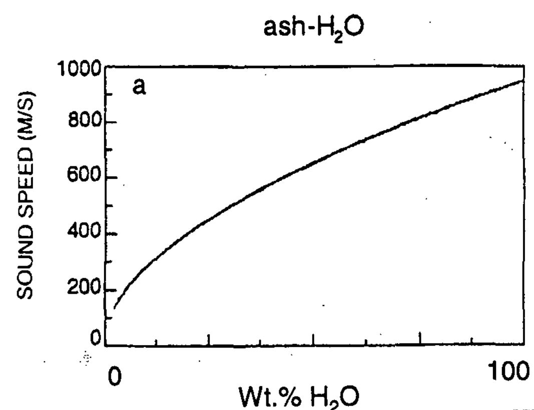
A fluid containing a high pressure gas is treated as compressible. The physics of a compressible fluid that is either a pure gas or a gas and particle (fragmented magma) mixture will behave similarly with differences in sound speed, rates of changes in flow properties and magnitude.

Woods et al. model: homogenous flow (magma, gas and bubbles move at same speed, bulk density term and solubility eqn; constant viscosity for magma (10 Pa-s)). Thermal eqm.

SAGE: multiphase compressible flow (steam, magma, air) viscosity and turbulence are not constant terms. These are calculated at every time step. Multiple heat transfer modes included.

$$\frac{p}{p_i} = \left(1+\frac{\gamma-1}{2}M^2\right)^{-\gamma/(\gamma-1)}$$

M = Velocity / sound speed



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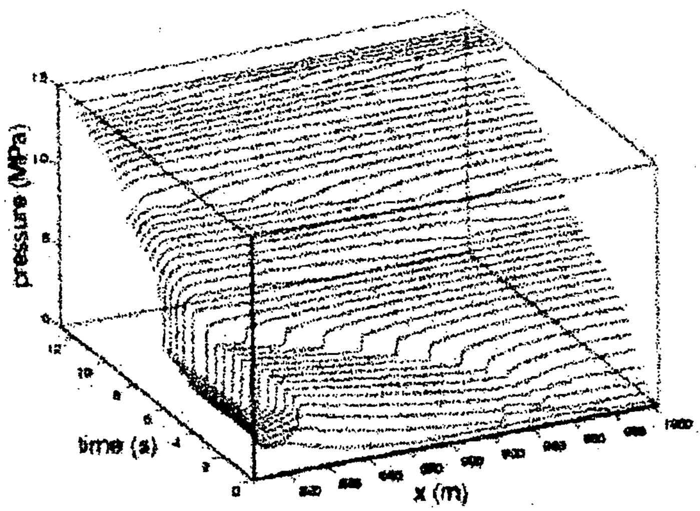
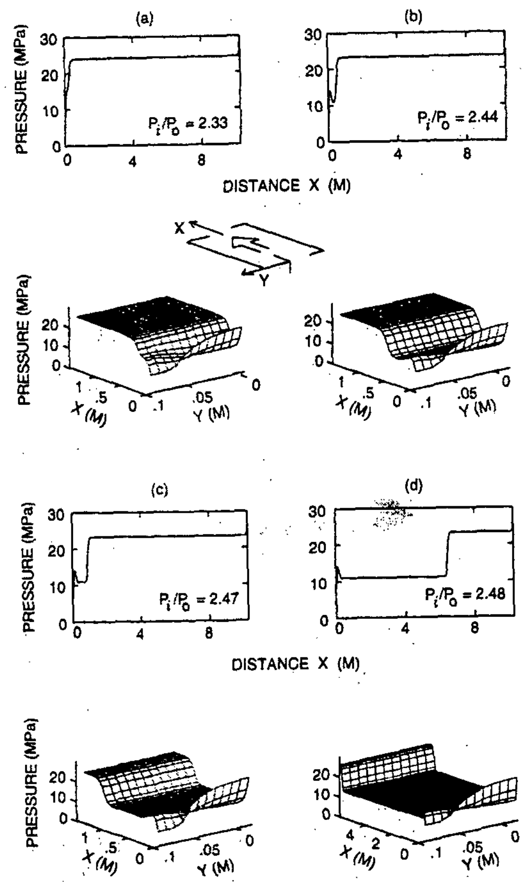
Magma Dynamics

- Multiphase flow - Compare homogeneous vs multiphase flow (SAGE, DASH)

✓ Very little difference in the fundamental physics



Homogenous flow
(Fig. 1, Woods et al., 2002)
1-D calculation



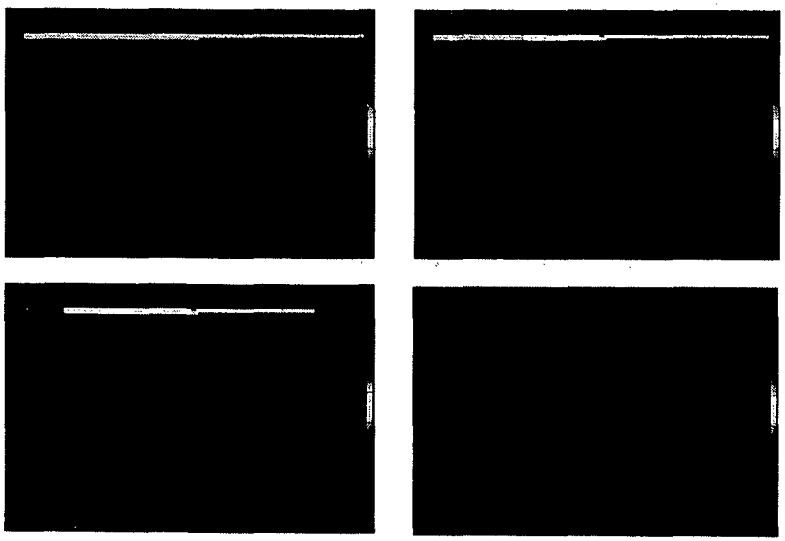
Single phase 2-D compressible flow (DASH)
(Fig. 7, Morrissey and Chouet, 1997)

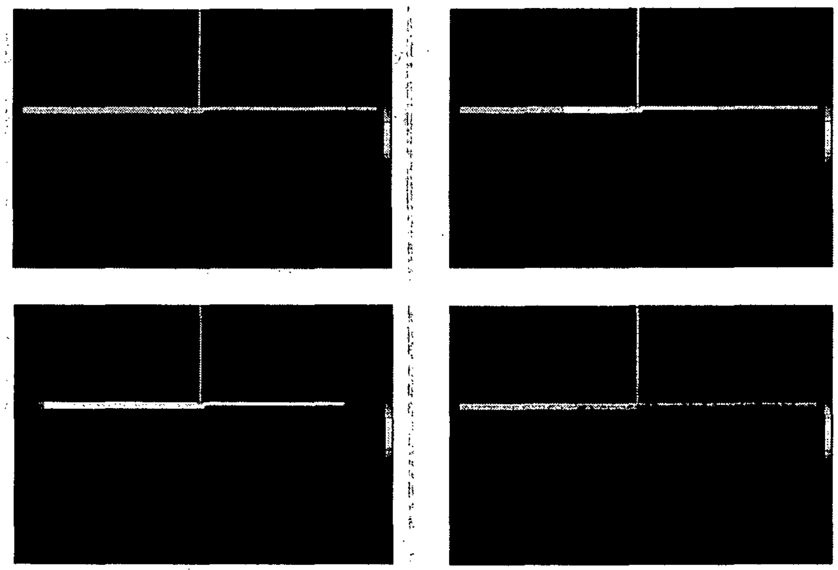
Magma Dynamics

- Snapshots of pressure inside drift (SAGE)

  Initial velocity = 0 m/s (dike ascent < 10 m/s)

  Initial pressure in dike 10 MPa; 0.1 MPa





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Summary

EPRI believes that the conceptual model derived and analyses conducted by EPRI since 2004 are based on observations made routinely at volcanoes and on data from appropriate analogs of future Yucca Mountain volcanism. Contrary to the position put forward by the NRC and their consultants, EPRI's analyses are consistent with fundamental physical and chemical processes and EPRI's igneous consequences at Yucca Mountain are indeed technically defensible.

U.S.NRC

UNITED STATES NUCLEAR REGULATORY COMMISSION

Protecting People and the Environment

United States Nuclear Regulatory Commission

SHIELDALLOY METALLURGICAL CORPORATION DECOMMISSIONING

ACNW BRIEFING

March 21, 2007

Ken Kalman

Project Manager

Materials Decommissioning Section

Division of Waste Management and Environmental Protection

Office of Federal and State Materials

and Environmental Management Programs

U.S. Nuclear Regulatory Commission

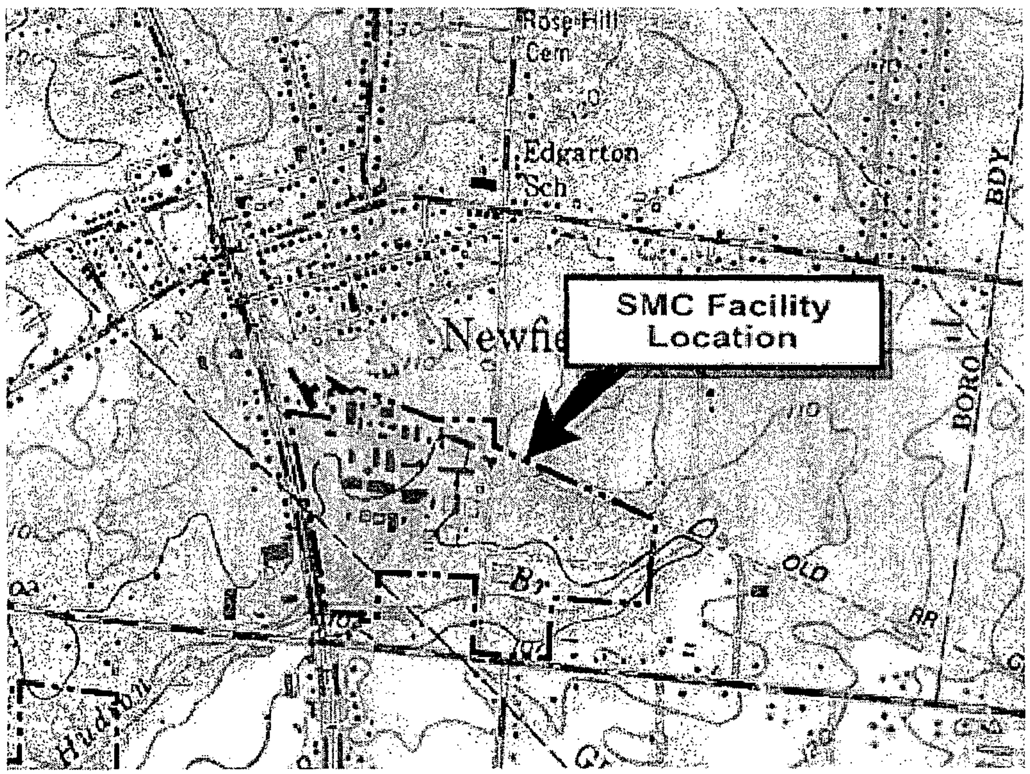
Washington, DC 20555

United States Nuclear Regulatory Commission

OVERVIEW

- Operations
- Decommissioning Plan Submittals and Review
- Decommissioning Proposal
- Projected Timeframe
- Get Information /Submit Comments

Location of Shieldalloy Site



Aerial Photo of Shieldalloy Site

OPERATIONS

- 1955-1998 - Shieldalloy used niobium ore (pyrochlore)
- Contained natural uranium and thorium in concentrations that we regulate
- Licensed to possess uranium (45,000 kg) and thorium (303,050 kg)

OPERATIONS

- Generated slag (18,000 m^3) and baghouse dust (15,000 m^3) containing uranium and thorium
- August 2001 - Shieldalloy notified NRC that it ceased operations and intended to decommission
- Within its licensed limit for uranium and thorium
- Plans to sell slag and baghouse dust for uranium content failed

Northwest Corner of Slag Pile

NRC Inspector Checking Exposure Rates of Slag Pile

Particulate Bags

SUBMITTALS AND REVIEW

- Acceptance Review / Detailed Technical Review
- August 2002 - Decommissioning Plan submitted
- February 2003 - Decommissioning Plan rejected
- May 2004 - NRC provided interim guidance on Long Term Control License to Shieldalloy

United States Nuclear Regulatory Commission

SUBMITTALS AND REVIEW

- October 2005 - Revised Decommissioning Plan submitted
- January 2006 - Revised Decommissioning Plan rejected
- Dose Modeling
- Surface Water Hydrology and Erosion Protection
- Long term Control Approach and Institutional Controls
- Financial Assurance

SUBMITTALS AND REVIEW

- March 2006 - Open to the public meeting held to discuss deficiencies
- June 2006 - SMC submitted supplemental information
- October 2006 - Decommissioning Plan, as supplemented, was accepted for detailed technical review

SUBMITTALS AND REVIEW

- November 16, 2006 - Federal Register Notice Opportunity to Request a Hearing (January 16, 2007) and comment (by March 16, 2007)
- December 5, 2006 - Decommissioning Information Meeting
- December 12, 2006 - Environmental Impact Scoping Meeting

United States Nuclear Regulatory Commission

DECOMMISSIONING PROPOSAL

- 67.7 acres for metallurgical activities and 19.8 non-contiguous acres of unaffected farmland
- Process area comprised of parking lots, administrative offices, and manufacturing buildings
- Impacted buildings remediated for unrestricted use

Process and Warehouse Buildings

DECOMMISSIONING PROPOSAL

- Storage yard contains slag, baghouse dust, excavated soils and other similar materials
- Slag (18,000 m^3) and baghouse dust (15,000 m^3) contain uranium, thorium and associated decay products
- NRC Region I inspections confirmed that operational exposure limits are being met

DECOMMISSIONING PROPOSAL

- Shieldalloy considered; license continuation, offsite disposal and license termination, and onsite stabilization and long term control

- Shieldalloy proposed onsite stabilization and long term control based on its cost/benefit analysis

DECOMMISSIONING PROPOSAL

- Release most of the site for unrestricted use
- Consolidate licensable material in storage yard
- Minimize exposure with engineered barrier
- Long term maintenance and control
- Financial assurance

United States Nuclear Regulatory Commission

DECOMMISSIONING PROPOSAL

- Shieldalloy dose analyses are 1 mrem per year for unrestricted areas and 1-21 mrem per year for restricted areas
- Natural background radiation is 360 millirem per year
- NRC staff to review Shieldalloy's estimates and conduct an independent dose analysis

PROJECTED TIMEFRAME

- April 30, 2007 – Request for additional information
- 2007 - NRC staff completes its detailed technical review and Safety Evaluation Report
- 2008 - NRC staff completes Environmental Impact Statement and licensing decision
- 2011 Shieldalloy completes its activities (if proposal is approved)
- 2012 NRC completes licensing action

INFORMATION

- Newfield Public Library
- NRC Public Web Page - http://www.nrc.gov
- Decommissioning Web Page - http://www.nrc.gov/info-finder/decommissioning/index.html
- Shieldalloy Web Page – http://www.nrc.gov/info-finder/decommissioning/complex/shieldalloy-metallurgical-corporation-smc-.html

COMMENTS

Request Hearing by January 16, 2007

Submit Comments by March 16, 2007

By mail at:

Chief, Rules and Directives Branch
Division of Administrative Services
Mailstop: T-6D59
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

E-mail at: ShieldalloyDP@nrc.gov

COMMENTS

Comments received from:

- Sierra Club
- U.S. EPA (Region 2)

NRC/EPA meeting planned to discuss comments.

OTHER ACTIONS

- 7 Requests for Hearings
- Petition for Rulemaking on NUREG 1757
- Motion for Stay filed in US Court of Appeals for the Third Circuit

NRC Attorneys are responding as appropriate

U.S. Department of Energy
Office of Civilian Radioactive Waste Management

www.ocrwm.doe.gov

Status of Yucca Mountain Repository Design

Presented to:
Advisory Committee on Nuclear Waste

Presented by:
Paul Harrington
Acting Chief Engineer
Office of Civilian Radioactive Waste Management
U.S. Department of Energy

March 21, 2007
Rockville, MD

Outline

- Summary of design changes
- Site layout
- Waste handling process and facilities
- Waste packages and canisters
- Subsurface facilities
- Design status
- Summary

Acronyms

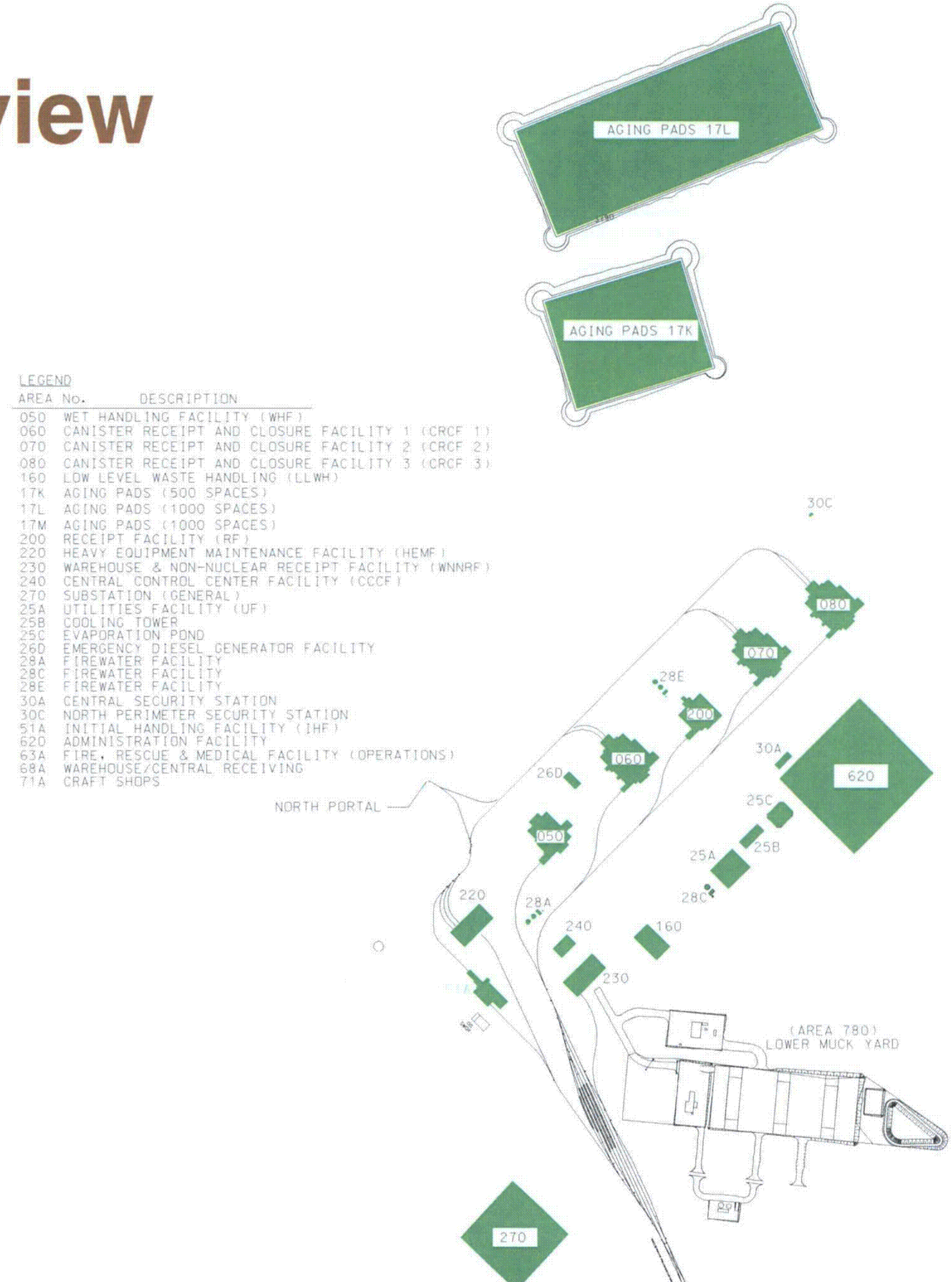
CRCF	Canister receipt and closure facility
CSNF	Commercial spent nuclear fuel
DHLW	Defense high level radioactive waste
GROA	Geologic repository operations area
HEPA	High efficiency particulate air (filter)
IHF	Initial handling facility
ITS	Important to safety
MCO	Multi-canister overpack
QARD	Quality assurance requirements and description
RF	Receipt facility
TAD	Transport, aging, and disposal
WHF	Wet handling facility

Summary of Design Changes

- TAD canisters utilized
- TAD canisters reduce handling of individual CSNF assemblies at repository
- Operational goal is 90% of individual CSNF assemblies loaded in TAD canisters by utilities
- Limited quantity of uncanistered individual CSNF assemblies to be loaded into TAD canisters at the repository
- Reconfigured waste handling process and facilities
- WP configuration suite revised for TAD canisters
- IHF added

Site Layout

Site Overview



Site Overview (Continued)

New Facilities

IHF - Initial Handling Facility

WHF - Wet Handling Facility

CRCF 1 - Canister Receipt and Closure Facility 1

CRCF 2 - Canister Receipt and Closure Facility 2

CRCF 3 - Canister Receipt and Closure Facility 3

RF - Receipt Facility

LLWF - Low Level Waste Facility

EDGF (26D) - Emergency Diesel Generator Facility

Previous Facilities

HEMF - Heavy Equipment Maintenance Facility

CCCF - Central Control Center Facility

WNNRF - Warehouse and Non-Nuclear Receipt Facility

Utility, Security, and Administration Facilities

Site Layout Changes

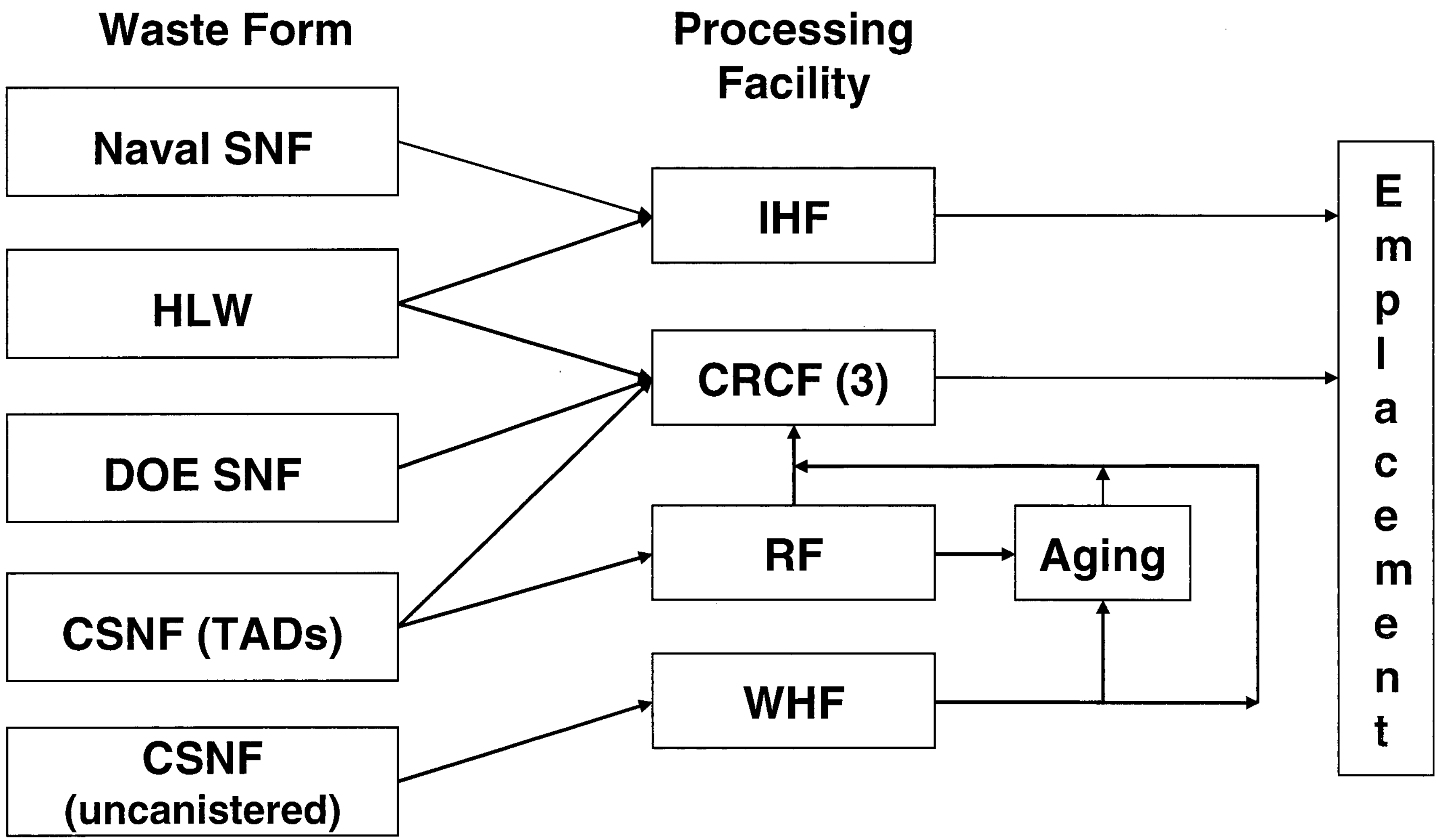
- Waste handling, aging, and support facilities in same general location as previous layout
- IHF allows canisterized waste (HLW and naval SNF) receipt and emplacement with minimal impact to construction of other waste handling facilities
- CRCFs handle all canisterized waste except naval SNF
- RF removes canisters from transportation conveyance and places into aging overpack or site transfer cask
- WHF handles uncanisterized fuel (individual fuel elements)
- EDGF and LLWF round out new facilities

Waste Handling Process

Waste Handling Changes

- TAD canister eliminates majority of individual CSNF assembly handling at repository
- Remaining uncanistered individual CSNF assemblies handled and loaded into TAD canisters underwater in the Wet Handling Facility

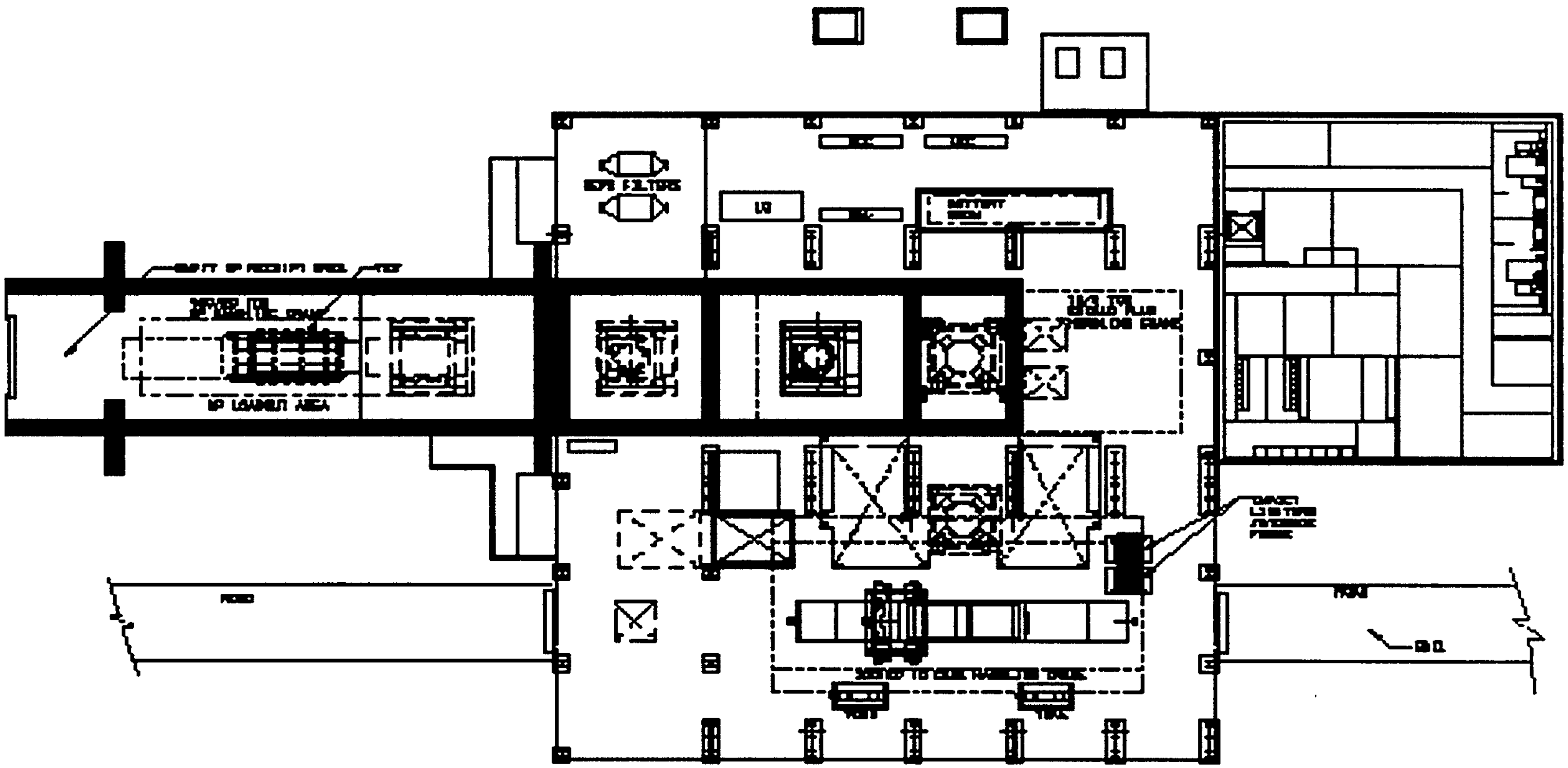
Waste Form Processing Overview



Facility Annual Capacities

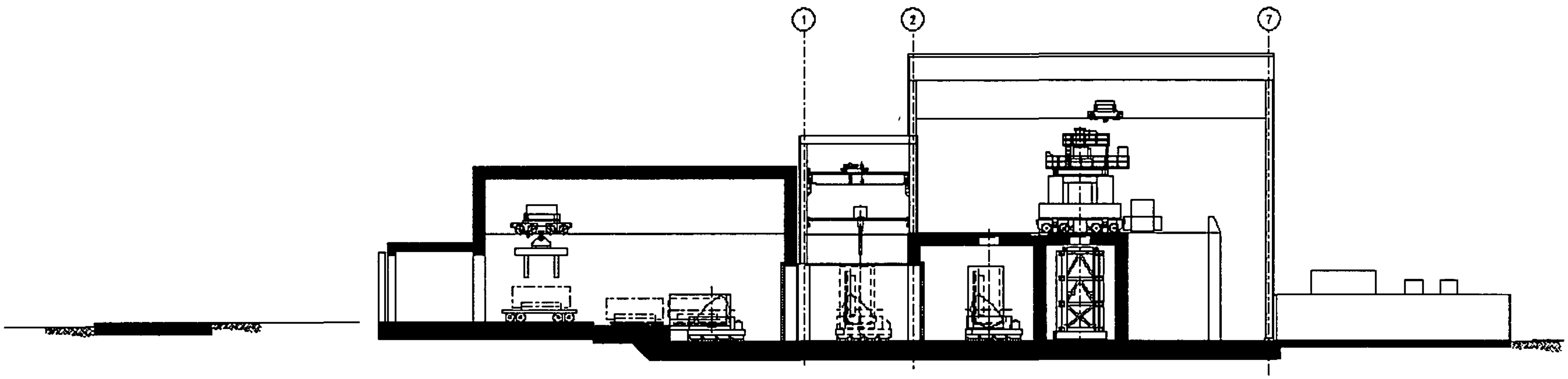
	MTHM	
Facility	Receive	Emplace
IHF	40	40
CRCF	1200	1200
WHF	340	0
RF	2300	0

Waste Handling Facilities



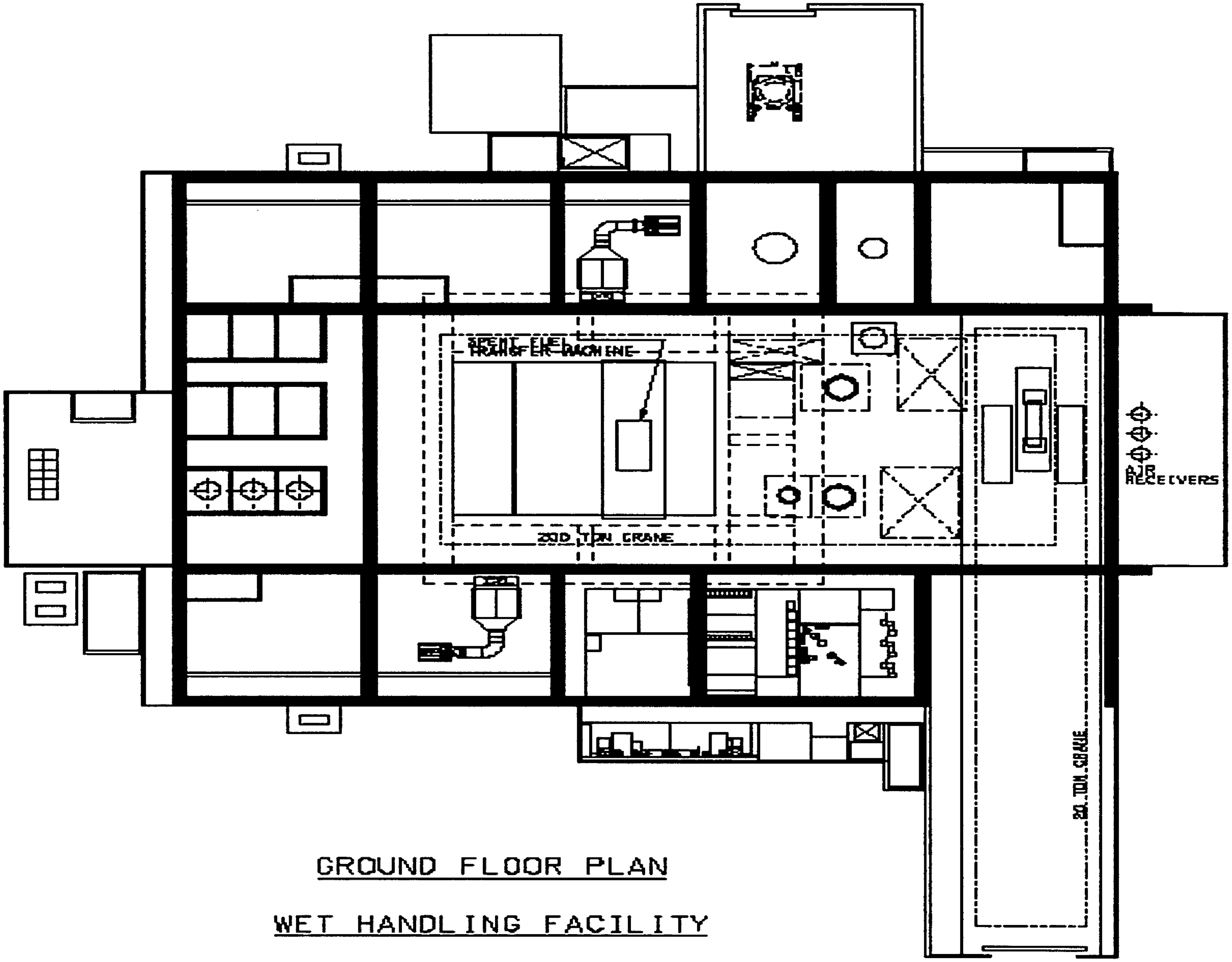
Ground Floor Plan

Initial Handling Facility



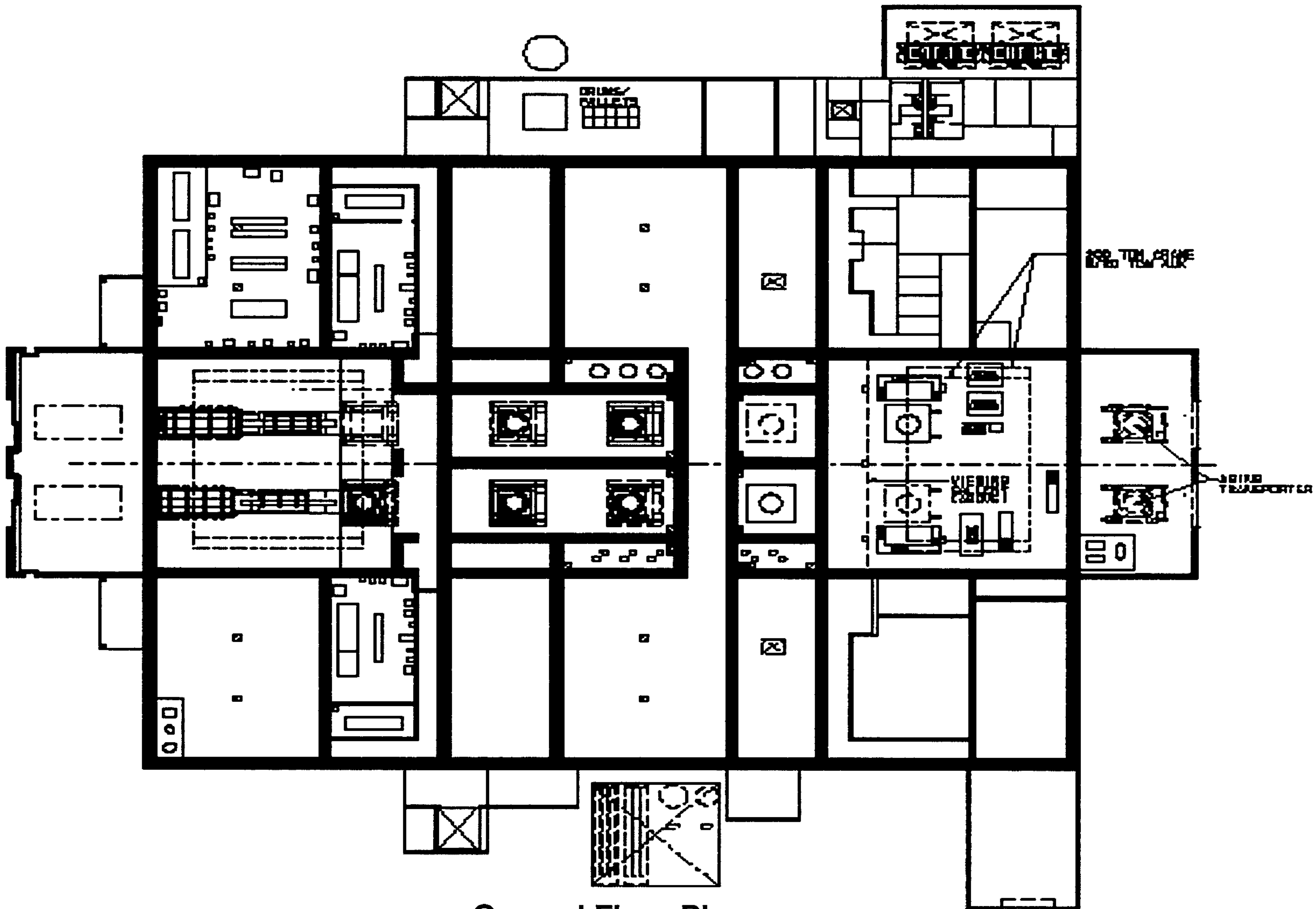
SECTION A

INITIAL HANDLING FACILITY

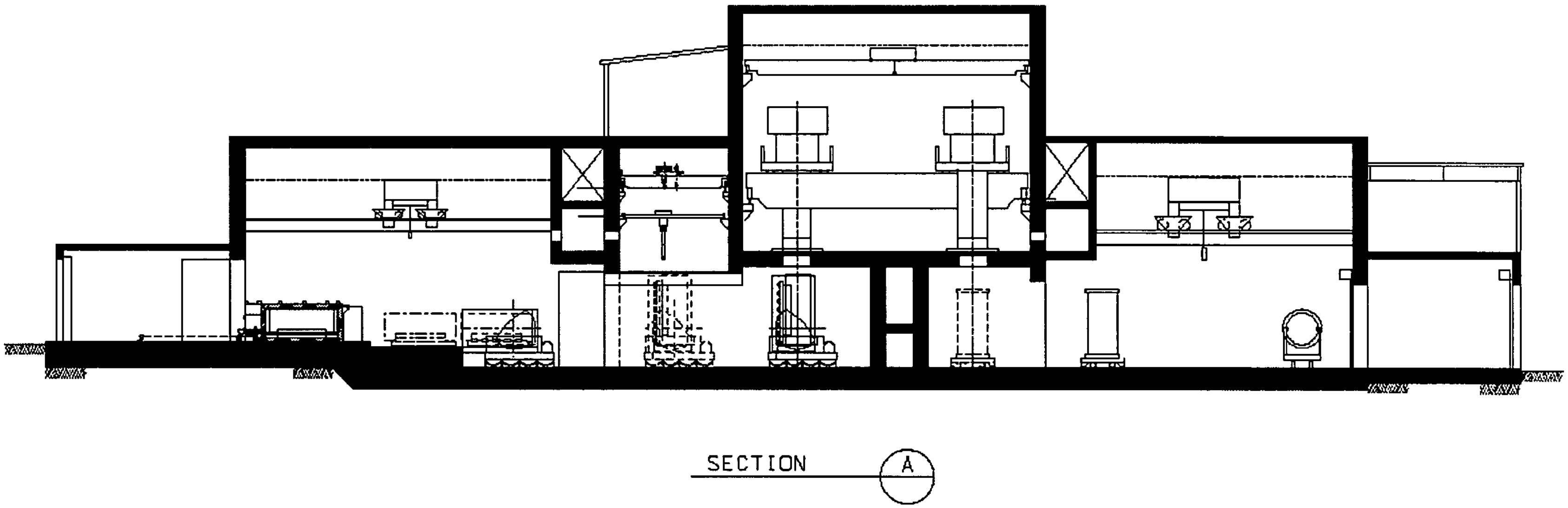


GROUND FLOOR PLAN

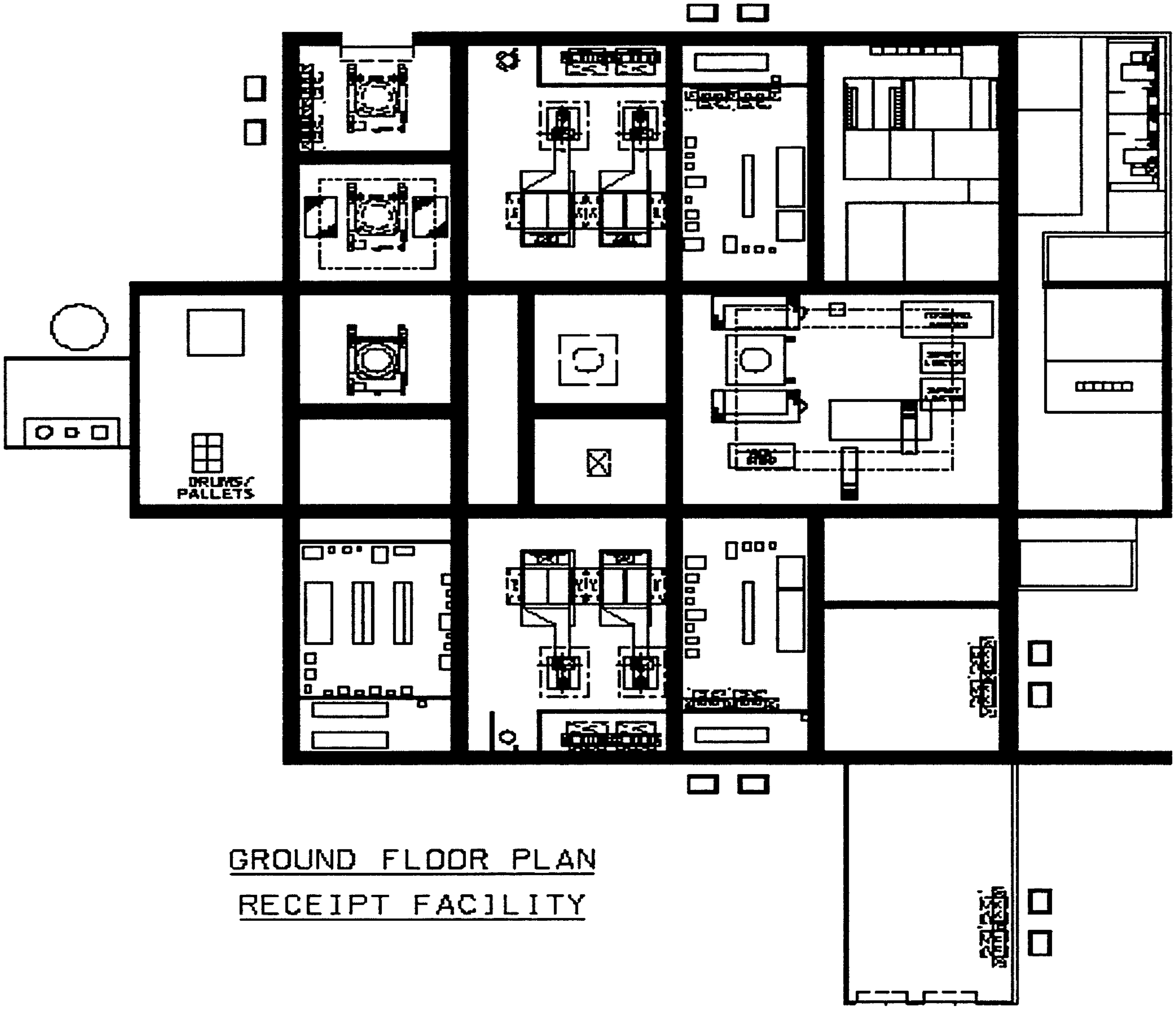
WET HANDLING FACILITY



Ground Floor Plan
Canister Receipt and Closure Facility



CRCF SECTION



GROUND FLOOR PLAN
RECEIPT FACILITY

WPs and TAD Canisters

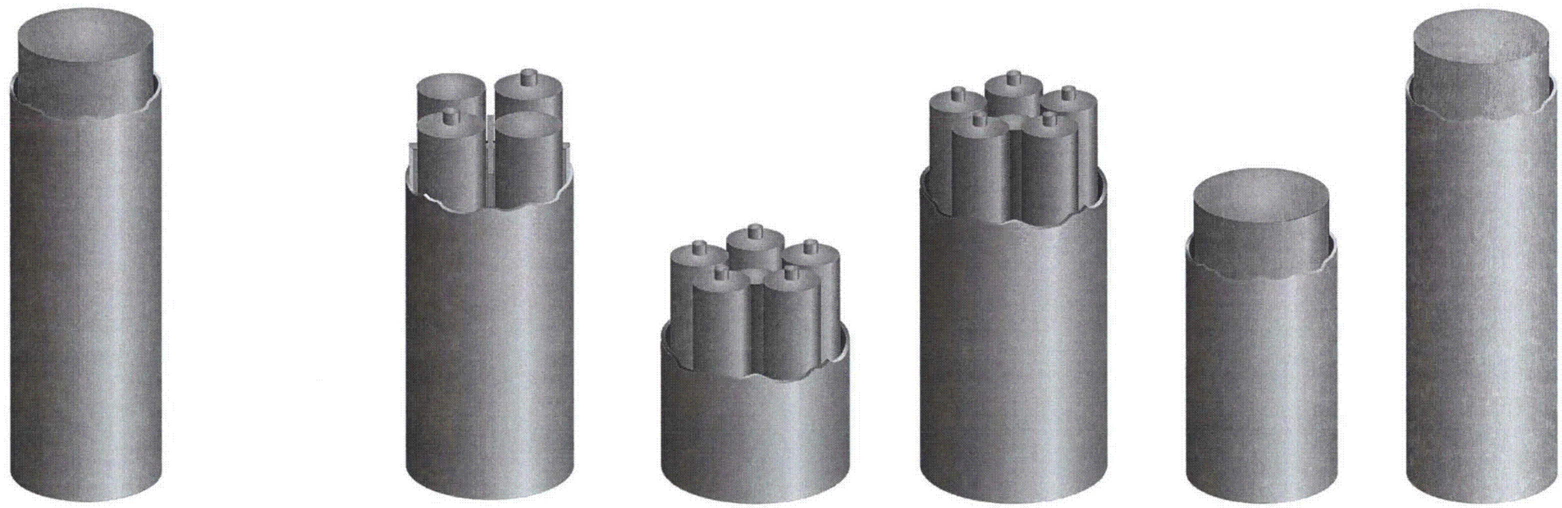
WP and TAD Canister Changes

- Utilize TAD canisters for majority of individual CSNF assemblies
- TAD canisters reduce WP configuration suite from 10 to 6
- Shield plugs added to WPs used for HLW and DOE SNF to allow for standard closure cell configuration

TAD Canister Key Features

- Majority of TAD canisters loaded at utility sites
- Some TAD canisters loaded at repository
- Significantly reduces individual CSNF assembly handling at repository
- Simplifies repository design and operations
- Reduces risk at repository
- TAD canister includes shield plug

Waste Package Configuration Suite



TAD
21-PWR
44-BWR

2-MCO
2-DHLW Long

5-DHLW/DOE
SNF Short

5-DHLW/DOE
SNF Long

Naval
SNF
Short

Naval
SNF
Long

Shield plugs are integral to canister design (TAD 21-PWR 44-BWR)

Shield plugs added to waste package design (2-MCO 2-DHLW Long; 5-DHLW/DOE SNF Short; 5-DHLW/DOE SNF Long)

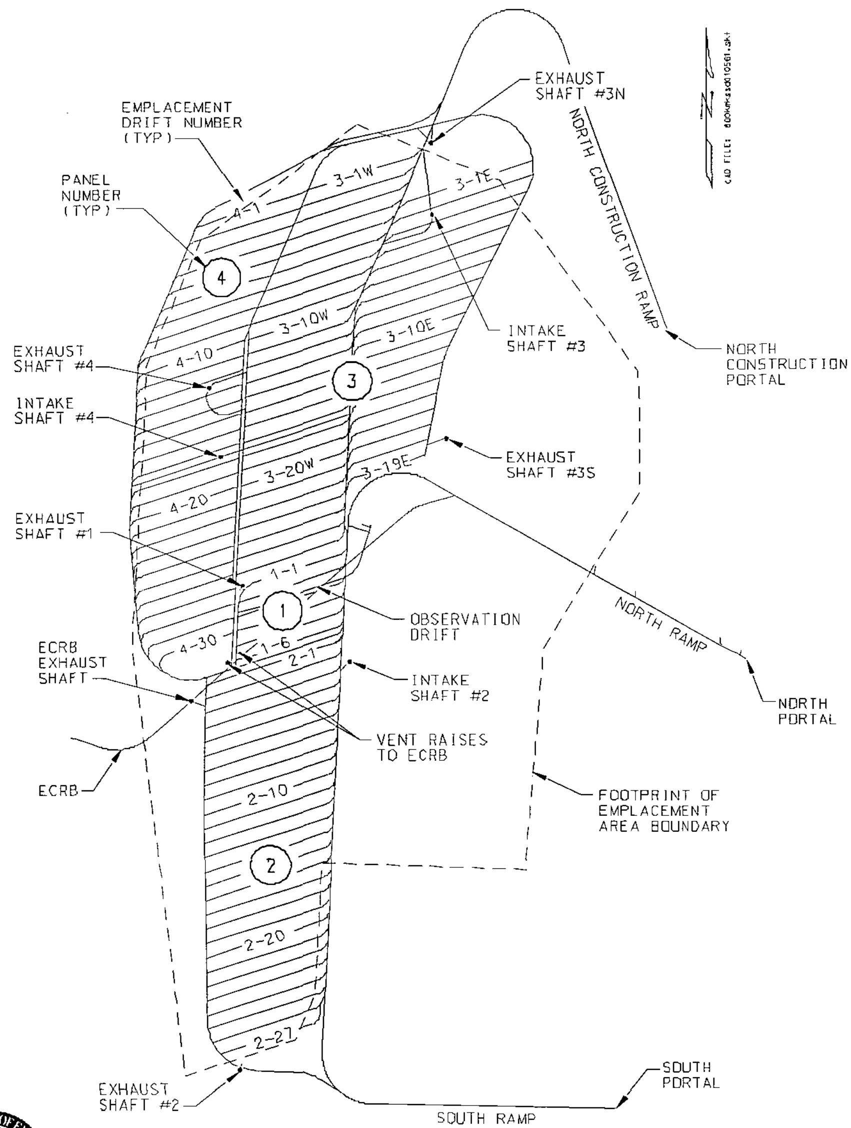
Shield plugs are integral to canister design (Naval SNF Short; Naval SNF Long)

Subsurface

Subsurface Changes

- No changes in overall emplacement concept
- Minor changes in layout

Subsurface Layout



- **Panel numbers represent the proposed construction & emplacement sequence**
- **Sequence:**
  - **6 drifts in Panel 1**
  - **27 drifts in Panel 2**
  - **45 drifts in 3E & 3W**
  - **30 drifts in Panel 4**
- **Total emplacement length available is approximately 41 miles (66 km)**

Design Status

Design Status

- Basic facility layouts and material flows completed
- Completed CRCF lumped mass structural model; others in process
- Structural and systems design in process
- Preclosure safety analysis update has begun based upon revised facility designs; will include more developed equipment reliabilities

Summary

- Use of TAD canisters simplifies waste handling
- Operational goal of 90% of individual CSNF assemblies loaded in TAD canisters by utilities
- Wet handling of remaining individual uncanistered CSNF assemblies
- WP configuration suite simplified
- Design for LA is progressing