UNITED STATES
NUCLEAR WASTE TECHNICAL REVIEW BOARD

STRUCTURAL GEOLOGY & GEOENGINEERING

PANEL MEETING

EXPLORATORY STUDIES FACILITY DESIGN REVIEW

September 18, 1991

St. Tropez Hotel

Las Vegas, Nevada

BOARD MEMBERS PRESENT

Dr. Don U. Deere, Chairman,
Nuclear Waste Technical Review Board

Dr. Clarence Allen, Chair,
Structural Geology & Geoengineering

Also Present

Mr. Russell K. McFarland, P.E., Senior
Professional Staff

Dr. Edward J. Cording, Consultant

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P R O C E E D I N G S

8:30 a.m.

DR. DEERE: Good morning ladies and gentlemen. I am Don Deere, Chairman of the Nuclear Waste Technical Review Board. I wish to welcome all of you to this meeting of the Board's Panel on Structural Geology and Geoengineering, to be briefed by and to enter into discussions with the DOE and its contractors on the status of the design for the Exploratory Studies Facility (ESF). I wish to thank the speakers in advance for the time and efforts each has taken to prepare his or her material and for coming here to present it to us for review and discussion.

I remind the speakers and commentators to use the microphone, to identify themselves and their affiliations, and to speak up clearly so that we may generate an accurate transcript.

I will now introduce fellow Board member, Dr. Clarence Allen, who is Chair of the Panel on Structural Geology and Geoengineering, for some opening remarks before I enter in to the main part of my opening statement.

Clarence.

DR. ALLEN: Thank you, Don.

Let me also welcome you to this meeting of the Panel and let me introduce Dr. Edward Cording on my left, consultant to the Panel from the University of Illinois, and senior professional staff member, Russell McFarland.

Yesterday, I was at a meeting in San Luis Obispo, California involving PG&E and Nuclear Regulatory Commission and PG&E managed to put on a magnitude 5.1 earthquake not very far from the plant during the afternoon. And so we are looking forward anxiously to see what the DOE can do for us today. Perhaps, Carl, just a small eruption at Lathrop Wells.

So thank you, and Don, let me turn the meeting back over to you.

DR. DEERE: Thank you, Clarence.

The Board and this Panel particularly, have been following the ESF Studies for a year or more. In our July Panel Meeting in Arlington, Virginia, we received information on trade-off studies of the ramp or tunnel decline diameter, the grades, portal locations as well as the proposed staged construction concept. Senior professional staff member, Russ McFarland, whom you just met, our specialist in the geotechnical field and the Board consultant, Dr. E. J. Cording, a professor in Rock Engineering in the Department of Civil Engineering, University of Illinois, and a recognized authority and consultant in tunnel design and construction, attended here in Las Vegas, about one month ago, a DOE design review meeting on the ESF.

Meanwhile, I have had the opportunity of discussing some of the items with Ed Cording, Russ, and other staff members and with a number of the Board Members, including Dr. Allen. The DOE and its contractors have done extensive conceptual and preliminary design work and much has been accomplished. However, we do have some questions and points of concern. Some of these will no doubt be covered in the upcoming presentations today and tomorrow. Others we would hope to discuss with DOE at appropriate times in open session during this meeting, perhaps following the prepared briefings of today, if we finish on time or hold to schedule, and if not, perhaps tomorrow morning.

Certainly, a recent concern is the cut in the appropriations which will curtail the ongoing design work and will lead to a projected one-year delay in starting the portal construction work, from November 1992 to November 1993. In the Board's view, this budget cut could also delay the early determination of site suitability, or unsuitability, by an equal year; and, unless the appropriations for site work are increased very substantially in fiscal year 1993 and the following years, the present target dates all down the line will slip.

The main points that we would like to present for your consideration, and for the information of other interested parties, are listed in the following-- are discussed in the following five points.

Point 1. We suggest that the ramp diameter could be reduced. From the viewpoint of exploratory works, a diameter of 16, 18 or 20 feet should suffice. Benefits could result in less volume of excavated rock (35-50% less from the currently proposed 25' diameter); from savings in the TBM cost and in greater availability in the marketplace of TBMs of the 16' to 20' range; from increased wall stability and decreased support requirements because of the smaller diameter; and from higher tunnel advance rates.

Point 2. If the site is found to be suitable, then an enlargement of the ramps and tunnels could be considered to see if necessary or not for repository construction and operation. Since such a finding is many years off, and construction ever farther out in years, the present worth of such future construction is low, and could compensate for part if not all of the additional future cost of enlarging, if such were to become the case.

Point 3. The phased concept of ESF construction has 10 phases extending over many years. To us, it appears that the exploratory tunnels arrive rather late at key areas. It seems to be based more on equal construction and funding increments than on key geological issues and the early assessment of site suitability. For instance, the Ghost Dance fault in the Topopah Springs unit is not crossed until Phase 8 (out of 10 phases).

Point 4. The Board considers that early access to the Ghost Dance fault is imperative in order to get an early insight into what most likely is a permeable zone cutting across the heart of the candidate repository block. This fault zone should not only be viewed and studied at two or three places in both the Topopah Springs welded tuff an in the underlying Calico Hills unit, as is currently planned, but also in units above the level of the candidate repository. An ideal area would be where the fault crosses the contact of a fractured and permeable welded tuff unit underlying zeolitic or bedded tuff, a perfect situation for perched water to move down the contact and either be trapped by or drained by the Ghost Dance fault. We believe such exposures are critical to understanding the hydrogeologic framework of Yucca Mountain.

Point 5. One suggested method is to pinpoint three areas where the Ghost Dance fault crosses the above described upper contact, the Topopah Springs formation, and the Calico Hills unit, and to make them early targets of exploration. The north ramp could be in the form of a J inclined downward, and then turning into the north-south drift at the level of the candidate repository and following it until the Ghost Dance fault is crossed a thousand or more feet to the south. The south ramp could go directly down to the Calico Hills unit as a deeper J tunnel where it curves into the projected south-north tunnel and proceeds northward until crossing the Ghost Dance fault, or vice versa. The concept being that there is an upward tunnel that comes into one unit, a second tunnel that goes into the lower unit, both crossing Ghost Dance fault. Meanwhile, an upper drift excavated by roadheader could take off from the north ramp in a softer upper tuff unit, perhaps a bedded tuff or zeolitic tuff, until crossing the Ghost Dance fault above the candidate repository horizon.

In conclusion, we offer these comments in a constructive sense as potential enhancements to the layout and design of the ESF. We know that flexibility is being built into the system, and these potential changes will challenge that flexibility. The early emphasis on the Ghost Dance fault in no way changes the rest of the exploratory program as it is currently proposed. All other faults deserve close scrutiny as does the general fracture and matrix permeability which are important to hydrogeology. It is recognized that the engineering construction restraint may be the ventilation, however, this plan with only two tunnel boring machines of smaller size, would reduce the ventilation requirements.

Once the two J tunnels and the third upper tunnel by roadheader are constructed and have arrived at their target goals, a great deal more information will be available about the characteristics of the Ghost Dance fault about the offset along that fault which varies considerably, becoming greater as you go to the south; many other minor faults, many different beds will be crossed; so, we believe that this is an enhancement of the existing program that is brought about only by consideration of tunnel size and of the position of sequencing the operations.

Thank you very much. We will return to some of these points later. I now would like to turn the program over to Carl Gertz, who will comment on the status of the project and I am sure that his comments will perhaps shed some light on what we have here.

I would also like to hand out for your viewing, three or four photos of, one, being of a tunnel boring machine getting ready to go underground. This is a portal and I would well imagine not too far from Las Vegas. This portal in welded tuff obviously would take the better part of a week to design and probably the better part of a month to construct. Other portals here are not quite so fancy, and you will see here the comparative size, the so-called smaller TBM, and this happens to be an 18' TBM when you can compare it with the people who are standing there, it is really a rather massive machine in diameter. I will pass these along and you take a look at them at your leisure.

Carl.

MR. GERTZ: On behalf of the Department of Energy, I would like to welcome you all here today. Don, I appreciate your opening remarks. Certainly, we want to consider all of your remarks as we go on with our design of the Exploratory Studies Facility. So, many of those items you addressed will be discussed through today and I think over the next year we will have ample opportunity to interact with you on that, because that is really what this is all about is to try to see if Yucca Mountain is safe.

So, with that thought, let me tell you what I am going to talk about today. In order so you can understand where my team is going in the next year in our efforts to study Yucca Mountain, I thought I would give you a little status about the project and put things in perspective so you know where we are heading on the ESF in the next year. So, one, I'll talk about what we did accomplish this last year, what our plans and priorities are in the face of limited budgets next year. I'll talk to you about status of law-suits, status of permits and entertain any questions you might have.

We are ready to start major new site characterization activities. The only thing, essentially, that is going to be limiting us through the next year is limited funding. We are ready to get on with the job of studying Yucca Mountain to see if it is safe.

One of the pieces of equipments that we have developed is setting here and is now finished testing in Utah and will be at Yucca Mountain on mid-October to November 1st. It is our LM-300 and we will have it down to do some drilling at Yucca Mountain next year.

Here are some of our major accomplishments. We did start new work at Yucca Mountain, I talked to you about that in July at your meeting there. We are developing site suitability methodology. We want to look at the data that we have accumulated over the last four or five years since we have last made an assessment of site suitability and we are developing criteria and data. That is being reviewed by a 14 member independent peer review made up of members of academia and they are conducting that peer review right now.

We continued non-surface disturbing activities, whether it was Bruce Crowe's volcanism studies, Dr. Crowe's studies, other seismic studies in Midway Valley, John Stuckless' studies at Trench 14.

We did complete four on-going major studies. First of all test prioritization; what tests are important to do first. Secondly, you will hear much more about it today than you have in the past, our ESF alternatives. We focused at this preliminary stage, and I want to emphasize that, what you see here is a preliminary design. It is just a first shot at it; we are then going to go do a lot more design. We have a model of this preliminary design for your observation setting on the corner of the table. But, in effect we've completed that study which included the risk/benefit analysis of penetrating the Calico Hills and you've alluded to importance of that interaction. And, we have completed some alternate license applications strategy.

The subject today is: we have revised our ESF Title I design summary report. It is our next step for going on with enhancing the design.

You saw this before. I just want to invite you once again for the Board to come out to the mountain to see what has happened. You haven't maybe been there for awhile; some of you have. But, sometime in the next year if you would come out to the mountain and see what is going on, we would sure appreciate that.

Let me tell you where we are going in 1992. We are going to complete our initial site suitability evaluation activities; we will produce a report and submit that for public comment after the first of the year.

We are going to do minimal surface-based testing. Minimal is the word, because it is limited by funding.

We'll continue our ongoing characterization studies; monitoring the size of its stations. Dr. Allen, I don't think I can produce a new eruption at Lathrop Wells as you alluded to, but every fifteen minutes this evening down at the Mirage they simulate a volcanic eruption. But, we are going to continue all our ongoing activities.

We will begin limited Title II design of this concept that is in front of you, and I will show you what that is a little bit later. We will start construction of ESF pads and roads in November, 1992; once again limited by funding. We had originally planned to do this in May or June of this year, but it will be postponed to November.

While we do all of this work, we need to maintain a sound environmental program. We have to make sure that we are paying appropriate attention to the flora, fauna, archeological aspects of the program. And we can do that and provide support to field activities.

We will be conducting performance assessment to support our project priorities; numerical performance assessment to assure our test are prioritized; our activities are prioritized; and, to support our design activities.

We will implement, once again, a full project-wide quality assurance program. Over the three years we have developed a sound program subject to numerous audits, surveillances, total them all up, it is well over a couple of hundred audits and surveillances. We will continue that because we have a sound program. We will continue a fairly comprehensive cost schedule control system. We are able to point out both to the GAO and the IG, members of Congress that we know where the funds are being spent; they will be in control; we are reporting on progress.

Unfortunately, we will have to reduce, because of funding limitation, our waste package/EBS/near-field environmental activities; that will be somewhat reduced, but we will continue them.

We need to maintain an infrastructure. There is so much of fixed cost whether you do five million work in the field, ten million or thirty million work in the field, you still have a certain amount of fixed cost. That includes roads, buildings, record centers, project control systems, QA programs, environmental programs. We will maintain those activities. We will continue to conduct our institutional and outreach programs, somewhat limited by funding, but always we feel it is important to make sure the public is informed as to what we are doing on the program.

Throughout all this we will transition a major new contractor, the M&O, the TRW team into project activities. That will be working, transitioning throughout this year, and in 1993.

That is our priorities. And there are many more things besides those twelve that we are going to do.

Let me put it into perspective of a little Gant chart for you. This is our surface disturbing, essentially, activity that is going on next year, that we planned. Even as we talk our plans change. My staff is back in my office right now evaluating what we should be doing in '92 and who should be allocated the money. Things do change.

Today, one of our first activities would be very shortly to start Dr. Flint's investigation of the unsaturated zone infiltration and that would be consisting of about 36 boreholes both in infiltration and in the simulated small plot for rainfall and the large plot rainfall simulation. That is an 8-hour a day operation with that drill rig.

We would continue to be throughout the year doing other activities; Dr. Crowe's volcanic studies at Lathrop Wells; the study started at Midway Valley by the Sandia; Dr. Stuckless' activities. This would just be going on. We call them trenches and pits.

In addition to that, you saw the picture of the LM-300. We hope to have that here at the test site at Yucca Mountain in the November time frame. The first thing we are going to do is drill a deep monitoring well that is required by our agreement with the National Park Service, so that we can monitor any withdrawal that we might be taking from the RJ-13 well. Then we would go onto a prototype of unsaturated zone of about 3,000 feet deep, that would once again be a five day a week; when we get into a certain part of it, we will go sixteen hours a day. We would move that rig and do a geological or another unsaturated zone and that would be a 24 hour/5 day operation near the end of the year.

In addition to that, to provide the designers with some information, you'll hear more about that, we need to get ready and do some boreholes where the ramp location would be, so that we can understand the physical characteristics of where our proposed ramps would be on that model so we can do an optimum design.

Today, as we speak, or just shortly last week, we were working on and completed drilling some holes near our hydrologic research facility. That is where the researches can work on prototype instrumentation, so when it is time to come to the mountain they will have their instrumentation fine tuned. And, we always have ongoing things, whether it is lab analysis, unsaturated/saturated zone, monitoring, geologic mapping, seismic monitoring, etc.

That is kind of our field work in '92. That sets the stage for our plans.

Let me talk now about though, the ESF, our Exploratory Studies Facility. In '92, you see what is up here in green, our plans are to start our construction design, definitive design, we use the words in DOE Title II design, of roads and pads. In essence that is about all we are going to do on this activity. We are going to do some shallow drillholes as I pointed out in the previous chart; we will do our soil/rock surveys; we will fix the first location along about July, and we will end up at the end of that year with a construction package ready to start in the field (that is the blue area) of constructing the roads and pads for the first portal. We hope to start in the field, November of '92.

In 1993, as you alluded to, we hope we will have overcome the funding hurdles; that Congress and the OMB will have recognized progress is being made at Yucca Mountain. Some of the impediments that were originally there, be it permits or whatever, have been removed and we'll have sufficient funding to start a comprehensive design, not only of the first portal, but also surface facilities, electric power, and the remaining ESF design activities underground.

We hope at this time also to place a contract with an underground constructor for consulting services to help us through this activity, start long-leap procurement, and eventually, as you have alluded to, there will be a one year slip in the portal construction. We had hoped to start the first portal going into the side of the mountain, be it Exile Hill or at the south side of the portal, we had hoped to start that October 1, 1992. We are now going to defer that to about November of 1993. But, we hope to have the pads ready and everything before that so that when it comes time to go, we are ready to go.

This green package, on the bottom as you are aware, in order to do a pad and roads, you need portal design sufficient so we can get the blasting done; you need to know where your gradient is; you need to know locations of the temporary facilities above-ground. That is our design chart and you saw our field chart.

Let me remind you, and I think you alluded to it very well, Dr. Deere, that here is our mission at ESF. We want to provide data to evaluate the suitability of the geologic barriers. That is the only reason we are building the ESF, to understand if Yucca Mountain is suitable. In addition to that, once we get there, if it is suitable, then why not obtain information for the design of a potential repository. Our primary mission is to evaluate the suitability of geologic barriers. So, we look forward to all interactions that will lead us to that conclusion.

Let me just put things in perspective. As I said, the model setting over there, this is a view of Yucca Mountain, a planned view. North is at the top of this sketch. What you see here is the road to the top of the mountain. Those of you who have been to the top of the mountain are familiar; that is usually where tours are conducted, right up there (indicating). Here you see our north ramp and our south ramp. The main drift in green is the outline of the repository perimeter. When I talk about roads and pads for '92, what would we design? It's either a pad here or a pad here and appropriate support roads to get those pads constructed. That is the construction package we are talking about. We have not decided, you'll hear our staff talking, whether south or north should be the first one. That is part of our studies.

We have produced 200 drawings; we've produced many trade studies at this initial stage of our design. But, all of it is to be enhanced and fine-tuned before we dig dirt in these areas. That is our mission over the next year is to pick out the right spot and get construction drawings going someplace to get on with the design.

In starting this design, we have had many interactions with the NRC; the most recent was last Monday in Washington, D.C. Initially a couple of years ago they had some concern about our process, our design control process, etc. We believe we had a very successful meeting with the NRC last Monday; their management reported at the end of the meeting they saw no reason for us not to start our Title II design, and we will be interacting with them on the formal letter.

In effect, we have an adequate design control process in place, that meets the regulations that has sound QA pedigree; the participants have been audited extensively in the implementation. We are looking at the design and the geologic repository operations area design simultaneously.

Although we wouldn't be building a repository operations area as you correctly point out twenty years from now, fifteen years from now or so, the regulations require that these designs are brought along interactively; that one is considered with the other at all times. We assured them that we have a process that does that. We certainly have looked at alternatives for design features, ramps and shafts. We have excavation methods, alternatives that have been looked at. We have addressed test interference. In fact, we have increased the underground area almost four-fold to assure we have a proper area for testing; and, we will of course be collecting different site parameters throughout our excavation process and this design allows us to do that.

In summary, we believe all elements of the system recognize that we are ready to perceive with Title II design. Our next step is to take this package to the Secretary of Energy's Board, and he allows us authority to go ahead based on cost and schedule. Because it is a significant cost and schedule activity, not only do we seek approval for this activity, we seek approval for the entire surface-based program. That is about a 5 billion dollar activity. The Secretary's independent cost estimate people have reviewed that; we are within about 4 percent of an independent cost estimate of it, so we think we satisfied our prerequisites to move forward.

Now let me switch just a little bit to our accounting system for next year, so I can help you understand a little bit what we are going to do next year. It may enhance your planning of our interactions with us, but at least I want you to know as a project manager where I am placing the priorities and I'll do this from a numerical sense.

This just reminds you what the titles of our accounts are; 1.2.1, 1.2.2, site investigation, repository, regulatory, ESF, ongoing facilities, and our project management activities. I went through this in detail with you in July; I won't go through it again. Once again, that just enhancing our accounting system, so that you know the different activities that are undergoing, and actually there are about 4,000 activities when you get down to the 5th, 6th and 7th level.

But, I guess here is the crux of the issue that I as a project manager have to deal with this year. In '91, on the project, we had spent--will spend about $175 million. In '92 we are going to spend about $20 million less than that. That translate into reducing personnel; reducing activities. There is just no other way to read that.

For our present planning purposes and I have underlined that that is planning, and that simply is what it is, here is how we distributed the money. I won't go through much of the details with it, but we have emphasized some of the site work. We think it is important to get some drilling done; get some early indication of site suitability. In order to emphasize that, we have had to de-emphasize something else. In that we de-emphasized the ESF, and we have deferred that for about one year. We have also de-emphasized our work on the waste package. I as a project manager would like to spend about 350 to 400 million dollars a year. That is what I believe is necessary for a sound comprehensive program at this stage. Unfortunately, we didn't get that kind of funding allocated to us by the Congress.

Here is what we have. We have to make use of it as best we can. As I alluded to, there is certain amount of fixed costs that you have to have, no matter if you are doing a one million or a hundred million field program. Some of those fixed costs evolve around project control, QA, administration, you have to pay rent, you have to take care of roads. That is kind of our breakdown of the money allocation today.

With that, I am going to briefly go through each work breakdown structure to highlight some of the things we are doing. In 1.2.1 which is systems, performance assessment, and technical data, we need to keep a configuration management system in place. We have to have plans and procedures. We are doing performance assessment, including a total systems performance assessment just after the first of the year. We are enhancing our technical data bases; we call them the RIB and the site engineering properties data base, and our supporting requirements development program is evolving along those lines.

In waste package, we will continue some ongoing waste form testing. We believe we have multi-year tasks that we need to continue. We will hope to complete our systems approach to EBS design concepts. We don't know if we can make it or not, but we are going to sure try. We will do some near-field environment activities; put out some reports; we still want to study the near-field environment with respect to hydrology, hydrologic aspects around the waste package.

Also, in '92 for planning basis, you have seen most of the stuff in site. We'll do volcanic investigations, ongoing surface-based, do some new drilling be it at Yucca Mountain, the borehole for the Park Service, unsaturated zone boreholes and geological investigation boreholes.

ESF, in repository, we want to make sure the repository design is being brought along respective to the ESF design, and that the interfaces are addressed and we'll do some geomechanical testing, because, even if it is an ESF, we think we need to design the underground openings for the thermomechanical loads that will be involved with the repository 20 years from now.

1.2.5; we'll do the regulatory, institutional, environmental activities. Site suitability report falls in this area. We have to continue our broad-based environmental activities at the site. We conduct our institutional program including a comprehensive tour program; point of information, we have over 520 people signed up for a tour of Yucca Mountain this Saturday. So, we think it is important to keep the public informed, and that is a very successful program. These are people who took the initiative, saw an ad in the paper, called up and said we would like to tour Yucca Mountain.

As this meeting and many other meetings go, we will support NRC. We were at a comprehensive meeting last Monday with the NRC, Waste Technical Review Board, and Advisory Committee on Nuclear Waste and any other oversight activities that go on; and, there are several activities.

We will hear more about this today, so I will just go over that quickly. We want to make sure we do the Title II design and we will implement a construction management plan so that we can get on with the first area when the time comes.

We have a field operation center. We have 12 buildings. We have miles and miles of roads that we have to maintain. We do have real estate that must be taken care of.

We want to make sure that we can do work in the field expeditiously and we have a field change control process that provides for flexibility. In fact the day we started Midway Valley, we ran five changes through our change control board that the scientists thought were necessary in order for them to get on with their activities. So, the system is working and we want to assure safety of our existing facilities.

1.2.9 is our fixed costs, so to speak. We unequivocally have to maintain a sound QA program. Once again, I am really proud the way the scientists and engineers have evolved this program over the years; have worked together with the QA professionals; and there seems to be a meeting of the minds that we can get the job done from a scientific point of view and still meet all the regulatory requirements. That is very heartening as a project manager to see that progress.

We need a cost schedule control system. We need it at detailed level. I have interacted with Congressional staff; I believe the fact that we have one saved us from a $40 million further cut last year in Congressional appropriations. So, we are going to need this comprehensive system. We just need certain infrastructures, certain fixed costs that goes along with running a big project.

Let me switch now, a little bit. I've talked about the challenges of a budget, now let me talk about the challenges we have in the legal arena. As you are well aware, this project has been extensively litigated. One of the lawsuits was initiated by the State of Nevada and that has gone through a series of appeals, even to the Supreme Court. We now consider this lawsuit closed that the state's veto and the state's law AB-222 were premature and unconstitutional. So, that is one lawsuit that we have off the books.

However, there is another one that remains open and that is the suit we filed seeking the state to act in accordance with their laws to issue us permits. Part of this lawsuit has been dismissed because the state did issue two of the three permits we asked for. The state engineer though, will be holding a hearing on September 24th; its a ten day hearing. It is a hearing for the water we want to use from J-13. We are following that process. It is an extensive hearing even though it is about 1/50th of the amount of water that the nearest gold mine uses, it is still a part of our procedural compliance approach, and we will be participating in that hearing. That lawsuit is open right now until this activity is completed; at least, that is what the Judge has indicated.

We had some other major lawsuit that were in front of the 9th Circuit Court of Appeals; very recently they have been resolved. We call them the Big Picture lawsuits. They were the guidelines and in environmental assessment cases, they were originally filed in '85 and 86. They had been working their way through the judicial system, but just three weeks ago, the final decision came on the last case of the assessment. And I think it certainly sends a message at least to the Department that the judicial system recognizes that Congress ordered the Secretary to conduct the scientific studies at Yucca Mountain. It also said that that Waste Policy Act as amended sends clear, it is a clear legislative command, and it is not contingent upon much else except go study the mountain. It is a fourteen page opinion that you might be interested in reading, but in essence, we think we have a judicial mandate as well as a legislative mandate to study Yucca Mountain.

So where do we stand on permits? As you pointed out, we have two permits. Our major water permit is the subject of a ten day hearing. But, we also just recently received a permit from the state to use a well that we originally identified in 1982 for site characterization activities, but we hadn't used. It is on the west side of Yucca Mountain. It is 26 road miles from our current storage tanks, but the state issued us a temporary permit so that we could use this well as opposed to haul water from California at least while they are evaluating our major appropriations permit. This does not take away the need for our J-13 appropriation request; one, because it is only for about the next eight months; two, because it is not where we want it to be; but, it does allow us to conduct those studies that I have alluded to in my previous chart about surface-based activities next year.

So I guess I would like to just summarize where we stand right now on the project and the status of the project. One, in order to make progress, we do need help. We need litigation. And we are moving slowly but surely along that path. But, we also need legislation, because, we would like the scientific study of Yucca Mountain which is going to take ten years to be decoupled from any political maneuver. We want the science to proceed without any political interference. I think that was Congressional intent; I think that's the Court's interpretation of that, but we may need legislation and both Houses and Congress have passed at the sub-committee level bills that allow the separation of the science and the politics. They are called permitting expediting bills. They would allow us to go ahead in absence of state permits.

Secondly, though, even if we have permits through litigation or legislation, we need OMB and departmental support to obtain adequate resources. I'll just state right now, we really have a tough year; as a project manager I have a tough year. We are facing lay-offs. At the same time we are bringing on a major new contractor to take a role, the M&O contractor; those activities are going on. And while we are doing both of those things, facing lay-offs, bringing in a new contractor, we still must meet on major milestones. So, we have a challenge in front of us and lots of trade-offs were involved to come to the position that we are in now.

We need that to move forward; and then, after we propose adequate resources, we need Congressional support. Without all three of those checks, this program will become stalled. Dr. Deere, I think you alluded to that. We don't want to see it stalled, certainly, but it will become stalled unless we have adequate funding. Many of us believe that the program becomes stalled and the nuclear option becomes less viable as a part of this nation's energy strategy.

That is my overview; tries to set the stage of where I think the project is going this year. An important part of what is going on this year is getting on with the definitive design. Once again, I would like publicly to compliment the architect engineer Raytheon for the product they have produced. We went over some of it with the NRC on Monday. It is a fine product. It is just sad because of budget cuts that their work force will be reduced. I'd like to keep them on full bore and go ahead with design, but in our view other activities are more important to keep the viability of the program in front of Congress.

I'll respond to any questions you might have.

DR. ALLEN: Thank you, Carl. Questions from the Board or staff or consultants?

DR. DEERE: I forgot to say one thing, Carl, the opening remarks that I gave are being typed and there will be copies available after lunch for all of those who are interested.

MR. GERTZ: Great. Well, we are looking forward to interactions with you on those remarks, because many of those ideas were considered at different aspects of our design and will be considered in the future. We appreciate your input on those areas; collectively your report and input.

DR. ALLEN: Any comments or questions from the audience?

Okay. Let's move on the. Mr. Petrie, I guess you are on next.

MR. PETRIE: My name is Ted Petrie. I am the acting director of the Engineering and Development Division of the Department of Energy. As part of my introduction I am going to first go a little bit over our agenda and I'll try to keep the agenda on this other screen.

We've been through the first two items; now I am going to say a few things. Then, we will turn it over to to Dick Bullock of RSN and who will talk to you about the status of the ESF design reviews.

Then, we will have some discussion about ramp diameters by Bruce Stanley; some more discussion of ESF ramp gradient by Bruce; ventilation analyses by Mr. Jurani; ESF excavation plan by Bill Kennedy, will talk about underground transportation and the plan and rationale for the phased approach. That will complete our first section of this presentation.

We will then go into a discussion of the waste isolation constraints in ESF; I'll give you a short introductions on that. And then we will be talking about introduction of foreign materials; control of fluids; thermal structural effects on underground excavations. Then, we hope to have completed that by the close of the day.

Tomorrow morning we will go into our third feature which will be a discussion of the repository design features as they relate to the ESF and what we have done and have been doing over the past few years to ensure an integration between those two, namely the repository and the exploratory shaft facility. I'll introduce that; Mike Voegle will be presenting and as indicated, we would like to complete by about noontime tomorrow.

Having said that, let me just go into the introduction. The first section which will be again on the ESF design. The first thing I would like to remind you about the DOE design process. We in the Department have a lot of orders. Orders are the things that the Department prepares such that they get a consistent set of work throughout the entire Department managing. There are hundreds and thousands of pages in the orders. The order that concerns us for the most is the part where we go to design, is 4700.1. That is our document or our bible document within the Department that tells us how to do a design task. And it calls off four phases of design: conceptual design; a preliminary design which is Title 1; a final or definite design which is Title II; and the as-builts which are the inspection portions of it which we call Title III.

As you know, we are in Title 1. We are in Title 1 or just barely completing Title 1, trying to get into Title II. And just as a block diagram, conceptual, Title I, Title II, and the as-builts Title III.

The conceptual design, it encompasses those efforts to develop a project scope that will satisfy program needs, I won't read all those to you, but it is a typical conceptual type of activity. And all of that is summarized in the conceptual design report. We did our first conceptual design on this project for the ESF several years ago, probably about five years ago. Then, about a year ago or two years ago, we decided to do an Exploratory Studies Facility analysis to look at alternate characteristics or alternate types of ESF, constructual methods and so on.

In effect, that was a revision to the conceptual design. That is the way I look at it and I think it is appropriate for everyone to look at that the ESF or pertinent studies was a re-visit to the conceptual design.

The preliminary design or the Title I utilizes the conceptual design and design criteria that have been developed as a basis. It provides sufficient design to illustrate the extent of the project scope and construction features, and to develop construction cost and schedules as well as design cost and schedules for the final design.

It includes these tasks which are all important, but the major issue is to get sufficient design done so we have confidence that we understand what is to be accomplished. And sufficient confidence in development of cost and schedules so that we can convince our management, that is, the Secretary that we understand it. Then, he can say with some confidence then the organization or Department can do this task for this budget or this cost, and within this schedule provided, of course, you get funding as indicated.

That is really what we are looking for in the Title I. We are trying to get the project well scoped such that the Secretary can with confidence say, this is what we are going to do. That is all summarized in a Title I Design Summary Report. And, some of us know at any rate we prepared a Title 1 Design Summary Report about two or three years ago.

However, the DOE 4700 allows for substantial changes to be made in the Title 1 design. It is not fixed at that point. But, if you do make a substantial change to the design, then you are required to prepare a revised or a revision to the Title I Design Summary Report; that is what you see here. We have now gone through a revised conceptual design. We have completed the revised Title I design. Now, we are looking for the Secretary's approval to proceed into Title II.

Just to refresh your memories, when we lay out the plan for doing a Title I design revision, we said we were going to complete the alternative studies, as I said, because it affected the conceptual design; prepare requirements documents; perform the design activities. We did that, as you know in two ares, the north area and the south area. Last time we talked to you about the north area design reviews. We have had reviews in both of these areas, and now we are going to talk to you about the south area design review which we completed in August. We have modified our summary report and we have submitted to headquarters; the next action is for OCRWM to accept the Title I Design Summary Report; transmit it to our ESAAB which is the Executive Secretary Acquisition Approval Board.

Once they have approved it, and it is equivalent to a Change Control Board, by the way. If we make a change which is like something more than $50 million dollars, this

Board must approve it, and in fact we have done just that. So we need a Change Board approval at this point before we can proceed. In fact, once they say we can go ahead, at that point, we can change our base line.

I won't go into the configuration management, but this in fact allows us to say, this is where we are going from here. Up to this point, it was the two shaft was in the base line. And we'll resume Title II then in October.

Now Title II design has as its inputs, the approved Title I design, design inputs as revised during Title 1. The activities include the preparation of studies; completion of studies; analyses, specifications, drawings, and one of the major issues from a Nuclear Regulatory Commission viewpoint, that is where we do our verification of design.

Let me say, I can't over emphasize that really. All the studies that you have seen to-date, although they have been through independent reviews, they are not final. They are done only to the extent necessary so that we can scope the task.

With that, if there are questions, I'd be glad to answer them.

DR. ALLEN: Would one of you go ahead and introduce your following speakers.

MR. PETRIE: Next is Dick Bullock who will talk about the Title 1 design.

DR. BULLOCK: The last time I talked to you folks was in July. We covered the reviews that we had done at that time on the north end principally. Today, we will review several things.

We will review the criteria by which the design was made; a little bit of what Ted has already gone over, but talking about a few other documents that we had to follow; the purpose and criteria and schedule for the design reviews; those people that were involved which was a real big task for them the reviewers; the reviewed documents, we will take a look at those; the review results; and summarize.

You've already heard this. This is just simply a statement that the design study is preliminary, it is comparable to a Title I design. The main purpose of course is to get to a good cost estimate and a schedule and have the project scoped out properly.

As Ted has already said, this is the procedure that allows you to change your Title I and get to a new Title II.

In addition to 4700, there are other documents that we must follow. Of course the 6430 document talks about design criteria; the Exploratory Studies Facilities requirements document; the Yucca Mountain disposal system document description; REECO's requirements as a constructor and the applicable standards, national standards and state standards that any operation must follow as they develop an underground structure. And of course repository design requirements, which include all 10 CFR 60 requirements, which apply to the repository and those also apply to the ESF, because it becomes a part of the potential repository.

Those participants which helped us are listed here throughout the study LANL, USGS, US Bureau of Reclamation, SAIC, Sandia and Parsons-Brinkerhoff. Those people were involved on a daily or weekly basis as the design study proceeded.

This cartoon shows, obviously it doesn't show very well in your print, but we can look at it, remember the first time in July we covered the north portal area and some of the facilities at the north portal. We covered the north ramp to the Topopah Springs and the north ramp to the Calico Hills. That is about all we talked about in July. This time we are talking about the south ramp area and the facilities at the south ramp. The south ramp itself to the Topopah Springs, the south ramp to the Calico Hills, and we are talking about both levels; the Topopah Springs level and those drifts to the following areas and on the Calico Hills to the fault areas, as well as the main testing area where most of the testing will go on once it is developed.   So, as you might guess, there is quite a lot more mining drawings that went into the south end study than there was the north end study.

Feel free to interrupt if you would like.

DR. DEERE: While you have that picture there, perhaps you could show the two J-Tunnels that I talked about. If you want to, start with the north ramp coming and turn the corner and take it into the upper level on the north/south down to the fault.

DR. BULLOCK: Maybe you would like to help me.

DR. DEERE: That's the first J; the second J--both of them continuing to the intersect at Ghost Dance fault. Somewhere in the upper area would be in one of the bedded tuffs or the zeolite tuffs, would be the roadheader excavated ramp to see the contact between two of the beds.

DR. BULLOCK: When you mentioned J, I thought it was a rock formation that I had forgotten. I was puzzled here. I think I will have a better viewgraph later on that that can be illustrated.

I'd like to put this viewgraph over here; it is the same one that Carl had up. It shows the facilities that are covered on the surface, in particular the H-Road which I will refer to later on. In the south portion there some H-Road that has to be improved, and of course the south ramp areas here; the rock storage; and, the soil storage is here, explosives, batch plant and of course the north portal is here (indicating). So, it give you a good layout. I'll just leave that up there for awhile so you can look at some of those things and see where they are as I talk about them.

The south ramp area, some of the facilities that will be located in the south ramp, they are not as extensive as what was located in the north area because at the time we were thinking of the north area as being from the Option 30, the north area was to be the principal facilities, though that could very well change and the south area may become the more predominant facilities and those could be switched. At least for now, the south ramp there is a sub-station, building for switch gear, building for transformers, a small shop, warehouse, changing office facility as well as the transfer for muck. A conveyor system comes out of the south ramp; it is then transferred to a conveyor system which is taken to the stockpile and of course we have the closed portal facilities, because for ventilation reasons, both are flow through ventilation, it is closed and you'll hear more about that later on from Mr. Jurani, and the fans location and if we need a microwave tower it would be located there. Those are some of the facilities that are located in the south ramp in the existing study.

Elevation of the south ramp is about 3900 feet and the pad itself is about 8 acres. H-Road improvements in this package, the south package was about 4,000 feet of H-Road that had to be improved. But, in total in the north and the south there is about four miles of road that has to be improved.

There is also about 1600 feet of portal access road. A transformer line will go from--it is in the process of change. It was 6900 that would go to the station. After the Canyon Station upgrade, we are in the process of studying this now, and that will be upgraded to 138 KV instead of 69. So that is kind of in transition right now.

The booster pump station with approximately 1100 feet of pipe; potable water, about 50,000 gallon tank; fire suppression, about 200,000 gallons; waste water pond of 1.5 acres; septic tank and leach fields are included in the study. The conveyor system is a 36 inch wide belt. It goes on out to the stockpile which is about 4,000 feet long, and of course there are inspection roads that go with it of about 4,000 feet.

The ramps themselves, of course they provide access to the Topopah Springs and the Calico Hills. The ventilation system is provided, men and materials handling and going up and down the ramp. And of course, some geotechnical testing will be done in the south ramp to go not as much as planned as in the north ramp at the present time; that could change.

The south ramp, we are talking this time of 25 feet in diameter. The reasons why that is 25 feet will be discussed later by both Bruce and Romeo Jurani. The length of the ramp is 9100 feet; the grade is only 1.6% which makes it quite attractive compared to the north ramp. The turning radius is 600 feet going onto the Topopah Springs. The equipment that is in the ramp of course is the ventilation, a very large ventilation duct, conveyor system and utilities. The ventilation duct will be in there during the construction phase or the development phase. That will later be taken out.

The south ramp to the Calico Hills is 18 feet in diameter, 7,450 feet long, slope of 10 percent, and at this time has a turning radius of 300 feet. That will be re-studied, of course, in Title II, because that is an awfully sharp turning radius. We recognize that though equipment is available that could do it, it is still a very sharp turning radius. It also contains the same equipment.

On the exploration level and I am not sure whether you can see those numbers. I'll read them off here. As far as the development footage, it is a little over 11,000 feet from the length of the development from north to south. The first drift out to the Ghost Dance is 1,520 feet. The drift out to the Solitario Canyon is 2,200 feet. The drift to the Imbricate fault zone is 2,160 and the second drift of the Ghost Dance is 1,075. So it is planned to intersect the Ghost Dance actually three times in the process of developing the Calico Hills.

MR. GERTZ: Dick?

DR. BULLOCK: Yes.
MR. GERTZ: All of those are 18 foot drifts right now?
DR. BULLOCK: They are planned at this time unless something comes along and tells us something different.
DR. DEERE: Excuse me, Don Deere, again. Could you back up and put the last slide up again?
DR. BULLOCK: Yes. You bet.
DR. DEERE: You have the three crossings of the Ghost Dance. I guess the one that we mentioned as a possible target one would be the main one as you come whipping down the north-south drift when you cross the Ghost Dance.
MR. GERTZ: You come from the south and go up.
DR. BULLOCK: If you came from the south and go up then you would go off here to a distance of 1520.
DR. DEERE: No, just keep right on going.
DR. BULLOCK: Oh, keep on going here?
DR. DEERE: Yes. That point right there.
DR. BULLOCK: Oh, okay. That point.
DR. DEERE: And that is why we say whether it is the south that continues to that or whether it is the north that continues is up to your engineering analysis.
DR. BULLOCK: Okay. I'm glad you cleared that point.
DR. DEERE: Yeah.
DR. BULLOCK: Now on the Topopah Springs, the distance from north to south is about 10,600 feet. Two major

crosscuts, drifts going out the perimeter, one is 3,220 out to the east and one is 3,800 feet out to the west. The one going to the west is 2.46 percent upgrade; the one going to the east is about it looks like over 5 percent downgrade. And of course, we also developed out to the Imbricate fault on this level, primarily we are developing the main testing area, which I will have a blow-up of in just a minute.

One thing I would like to point out though while it shows the whole picture, is that there is ample space to more than double the amount of testing should it be required. In fact, this whole test area could be flipped-flopped over into this area right here, if you see what I mean. So, there is plenty of space here to repeat all these tests to the northeast.

And if you will look at the layout, it is turned a little different in your--this is the way that was oriented on the last plans, so I oriented it this way here. But, you can see all the tests--this is the way the testing area looks at this time. It has been an evolving process as tests change and as our concept of separating certain things and getting the spacial distance that you needed. In general, this area right in here is the operations area. Though there are a few tests scattered around the perimeter because they were trying to get quite a ways away from the others, the same tests run elsewhere. But, all the testing that was planned in the original testing program are still located about the same types of things that were planned here before.

The sequential drifting test here, the repository horizontal near-field hydrological testing here; these two drifts go downgrade and this drift goes upgrade, so there is a spatial relationship there, plus heater block tests, canisters tests--you can read those. But, this is the way, at least at this time the way the testing, the main test level area was planned to be developed. And this would be developed with a roadheader machine, mobile miner, I should say, developed most of this.

Just a quick note on the ventilation system because it will be talked about in detail. We do plan on once the operation is fully developed, to have flow-through ventilation. It will require about 400,000 CFM, which is quite high. The main fan motor is 700 BHP. The static pressure is seven inches, which is plenty. That 400 will be split between the Topopah Springs, 285,000 and the Calico Hills 115,000. And of course, there would be auxiliary fans on both levels pushing the air where you need it or pulling it.

Now let's talk a little bit about the review process that we've been through in the last few months. Management review has helped to develop a consensus with those people that were involved in the project, and to get a level of understanding that what they wanted incorporated was incorporated and we are indeed in compliance with the upper tier requirements.

The independent technical review was somewhat people. You bring in people who are not involved with the project in anyway before, and they are to gain an independent view of whether or not this preliminary design is meeting the design criteria and purpose of ESF. That is the main purpose of the two reviews.

The review criteria, it was stated a little bit different in the reviews themselves, but what it said basically was, consider the following list of parameters for which this design must be consistent and whether or not the parameters can be implemented into the design. And the things they would look at are the applicable NRC regulatory issues; site characterization testing, can these things be incorporated in the design; the MSHA and OSHA regulations of course had to be in there; reliability, maintainability, operating ability, can these things be incorporated in the design that you are working with; constructability; and detailed stress and thermal loading, can these things be incorporated into the Title II design; environmental compliance, is there anything that would cause you to be out of compliance with the environmental issues and socioeconomic issues. So that is what the reviewers were asked to look at when they looked at this package.

This is the overall schedule of the review system that we went through. We talked about the first two in July and covered those first two reviews. July 29th we held a management review on the south area, an independent technical review in August and submitted both the north and south packages to DOE for their internal 06-04 review, August 26th, and finally submitted the package to DOE on September 3rd. And bear in mind, between these two weeks, between these review processes, we had to take the comments, resolve the comment with the commenter, get his sign-off on the comments and then incorporate them into the drawings and get ready for the next review. So this was the process that we went through.

The reviewers, project office, Sandia, Los Alamos, USGS, U.S. Bureau of Reclamation, Reynolds Electric, Science Application, and the project office for quality assurance, as well as the project office for technical issues and the TRW, these people sat in on the management review. The technical reviewers, there is a long list; I won't review them. You can see that the discipline reviews, we brought out Raytheon, people who were not acquainted with a review and they were the ones that reviewed the technical aspect from discipline point of view; LANL from a testing performance assessment with Sandia; QA; the Project Office construction; REECO, TRW and Parsons-Brinkerhoff for the repository interface, T&MSS for maintainability and operating ability and environmental and regulatory; RSN safety man reviewed it from a safety point of view; Decision Analyst from strategic insight looked over our package; geology was T&MSS; and hydrology U.S. Bureau of Reclamation.

In addition to the reviewers, we also had observers, and those observers are listed here and there were nine different organizations listed in the observers.

MR. GERTZ: Why don't you go over those again, Dick.

DR. BULLOCK: DOE/Yucca Mountain Project of course were there for an independent observer point of view; OCRWM/Weston from headquarters; DOE/NTSO had representatives there from the test site; MSHA had people there looking over our design; U.S. Bureau of Mines also had engineers there; the State of Nevada had a representative consultant there; I believe in the first reviews the county was represented, I am not sure about the final technical, but they were there for the management, at least I believe two counties were; TRB, Russ was there and looked at the package; and the NRC representatives were also there.

Just to give you an idea of how many reviewers then reviewed the package, in the first management review there were 14; second the independent review, the first independent there were 16 for the north end; for the south end there were

18 reviewers for the management review; there were 21 reviewers for the independent review; and in addition, there were an additional 20 observers for each of these technical reviews. And then for the QMP-0604 DOE had another 5 people look at it.

What they were reviewing were drawings for one thing. Principally we are talking today about the south area, and you can see there were 112 drawings that had to be examined and critiqued. But, the people that had reviewed the north end as well, now came back to review the south end, had to go back to the north end drawings to see that their comments were incorporated in those north end drawings and then later sign off on them if indeed they were incorporated. So, they had a big job to do looking at both packages, a total of 210 drawings.

You can see the increase in mining in the south because there were 42 mining drawings in the south. Those people that did the reviewing had a lot of work to do and they deserve a lot of credit. The studies that were reviewed for the south end were a preliminary study on opening stability analysis. We were talking about methodology primarily; two studies on ramp sizing; two studies on ventilation; one on the development or preliminary ventilation and then the operations ventilation; one on water distribution system and one on waste water, compressed air, and finally a preliminary soils/rock study plan was there for review. That was done primarily by the Bureau of Reclamation, USGS and us contributing to it.

The package that went together is a design summary report and we have talked about it before and basically these five volumes provide general description of the exploratory studies facility, provide basis for decision to proceed in Title II and are comprised of five volumes.

These are the chapters that had to be revised in the main text, the narrative; 14 chapters. I'll show you a little more later on, but RSN had a lot of help from SAIC, from LANL, from Sandia, from REECO in developing many of these chapters. I think we only did about half the chapters and other participants did the other portions that were more in their area of responsibility. I won't read these, but you can see that they pretty well cover the field of what you would look at in a feasibility study.

Certainly, one of the most important chapters is the cost estimate, because that is what you are trying to come down to, a cost of schedule that DOE can go forward with, that the DOE people can feel that we have looked at all the possibilities. When they did the independent cost estimate and it came within four percent of our estimate; we felt very good.

Volume 2, simply contains what were given in the north review and the south review. So, you've seen them before and I won't repeat them again.

Volume 3, are the drawings and Volume 4 is the ESF outline specifications, which I have not mentioned before, but there was a 101 outline specifications developed for this south area review.

Volume 5 is really a collection of reference material to previous studies. An awful lot of Sandia studies in here of work that was done earlier, back when there was a two shaft concept. But the methodology of some of their things is still the same. So we included a lot of the back up material in Volume 5, the appendices, as well as the back up for the cost estimate. All the back up for the cost estimate is also in Volume 5. So, this is more the reference material and back up material that is in appendix 5.

Going back and looking at the results of the management reviews, this was of the north area, and you saw it back in July, a total of 490 comments, all resolved, all included into the documents. Sixty-four of the 490 were not applicable to make any changes.

Again, the technical review, the 346 comments, the same applies. All comments were resolved. Twenty-nine comments had no application for change.

Going onto what we are really here for is to talk about the south. In the south area management review, there were 494 comments. And to those we added the outline specs, so we were commenting in more things this time than they were commenting on the north area review. There were 214 that were applicable to Title 1. Of those, 115 were not applicable to make any changes in the design. There were 165 that were applicable to Title II design. Of all those comments that were applicable to change, they were changed and were incorporated into the documents. All comments reached resolution.

Such things, the types of comments, some minor comments, examples, there is one that is a long list of long-lead procurement items could be reduced considerably. We also had comments, one comment was, your outline specs have too much detail. Another comment was your outline specs don't have enough detail. So, you get these kinds of things that you have to work with.

Define the underground worker as MSHA would, in otherwords an authorized person. Couple of significant comments, the maximum probable flood discussions must be consistent in the reference basis cited. Of course it should. And incorporated into the Design Summary Report, a discussion or schematic showing the transition of the ESF Title I design from the shafts. That was something we had left out and needed to be in the Design Summary Report.

Number of comments in the Technical review were

452; 218 were applicable to Title I; 234 were applicable to Title II. All were resolved and 65 of those comments were not applicable to change in Title I.

Typical comments, a minor comment, provide freeze protection from ambulance parked in ambulance area; bury utility lines deep enough to prevent freezing. I am giving you these just to give you a flavor of the types of comments. They vary all over the place. Significant comments, examples, recommend method of conveyor suspension should be evaluated to assure current approach is suitable to the proposed application. That certainly was something that had to be restudied in Title II. Not only the suspension system but the location of that conveyor. It was in the tunnel periphery.

Sizing of water supply services underground should be evaluated to assure adequate support of expected tests and underground operations including fire protection. That is part of the Title II design. All these things have to be looked at, and that will be looked at in Title II, I am sure.

In summary, by letter dated March 4, the A/E was authorized to develop an engineering plan to do this study. The study consisted of 210 preliminary drawings, 20 preliminary trade studies, 101 outline specifications and revising 14 chapters. I have already said we had a lot of help on revising those chapters. There are 14 appendices sections.

We preformed four management and independent reviews where we encouraged comments from an average of 26 commentors per review. These commentors produced 1783 comments. All comments reached resolution and resolved with the commenting organization.

We revised the Title I preliminary shaft analysis report also in addition to that. And submitted all the RSN approved deliverables to the project office by September 3rd.

Just to turn for a moment to Title II, we are waiting approval to proceed. Looking at some of the details expanding a little bit on what Carl mentioned earlier that we will be entitled to. Of course, we want to finalize the location of the portals. At least as far as we can look at it at this point.

Area design sufficient for ripping, blasting and site grading of the sites. Portal design sufficient for blasting, if required. Topsoil and subsoil storage area, not much of a design problem, but needs to be looked at and designed. The waste water storage area. Potable industrial water distribution system. Electrical substation sizing; facility layouts, not detail design, just the layout of them. The building envelopes and primary sizing the buildings. An operations plan should be developed; maintenance plan; safety analysis report on that which is designed; value engineering report; and associated performance assessment related to the design.

Trying to look at those things that can be designed and ready to go for the site prep package, so that when they start to do some work, the design will be there to place the soil and the rock, or whatever it is, it will be in place.

That covers my presentation. If there are any questions, I would be glad to cover them.

DR. CORDING: Ed Cording, Dick last month there was some work being done on looking at various numbers of TBMs and various scenarios for advancing them down into both the Calico Hills and the repository level.

DR. BULLOCK: Yes, sir.

DR. CORDING: So there was some with the 4 TBM approach, 2 TBMs, 3 TBMs; various combinations. I know that was the work that was in progress or was just being developed at this time. How will that be brought into the other work that you are doing on Title I and Title II. What is the status of that and how is that--is any of that being included in Title I? Is that coming in--that is basically going to come into the Title II? What is the status on that?

DR. BULLOCK: Well, from our point of view, that part is not in our package. We have looked at some of these things, and certainly they are all feasible and affect the cost and affect the schedule. That will be looked at in great depth, I am sure in the early part of Title II. And Ted, you might want to expand on that.

MR. PETRIE: Yes. This is Ted Petrie with DOE. Dick is correct, we will be looking into the construction sequence at which phases of construction get done first, as a part of this initial effort to select the location of the first portal.

DR. DEERE: When I see there are 1783 comments, well I guess our four or five comments were not too great. However, I would hope it might have more impact than some of the comments that came here.

Certainly, they involve in many ways, management decisions as well as technical. They are connected. It is hard to separate many of these out. But, when you look down the road and you see the funding problem that suddenly came up and has caused great difficulties, then one has to make an assumption that it is all going to come back next year and we will be able to recover and maintain the schedule. But, what if it doesn't? Then, you have to look at your layouts and say, do we have one that can move forward on this year's budget, because, that may be all there is. So, I think this was one reason of looking at the two separate J tunnels to go after, as fast as possible some critical information for the scientists, particularly the geohydrology problem.

DR. BULLOCK: Right.

MR. GERTZ: Don, I absolutely agree with you. Many of those are management decisions and what will promote program viability as I have called it, what will demonstrate progress if there are limited budgets. That's decisions that we are going to need to be made. And I want to point out just to describe what you have there, what you have there is purely as we discussed, a preliminary design. There has been no final decision as to pad or portal location, as to whether there are two or four TBMs, as to whether that is the way it is going to look or not. Maybe the final design will encompass many of the suggestions that you all came up with today. That is part of our next phase is to figure out what is best to do next. And maybe, Don, it consists of alternates. What do we propose to do if you have sufficient funding, and what do you propose to do if you have limited funding? There may be two different approaches depending on it. That becomes much of the trade-off studies that I am continually doing as a project manager.

DR. DEERE: Thank you, Carl. I think that is a good way to approach it. And certainly, we had in our minds some of the contingencies that might have to be taken down along the road and which ones will still allow you to get the early site suitability assessment moving along. Some of the critical areas we think are the ones that we mentioned.

MR. GERTZ: I would like to point out to you that my personal opinion as a project manager is I believe we will have lots of questions resolved when we get underground with the big excavation. The sooner we get there, the better. So, I want you to know that is my personal opinion. Unfortunately there are other tradeoffs that I have to make, all keeping in mind how soon can I get the low ground though. That is one of my views.

And Don, I would like to just take a minute to go over your comments on one of Dick's view graphs so I make sure that I and my team understand and if you don't mind, I am going to go up there and reiterate your comments and see if I have understood them properly, but I think so.

DR. BULLOCK: Fine.

MR. GERTZ: This is the one you used. I took your comments. I think it is important that we understand what you've said so that we are talking the same thing. As I took your comments, you would say, one of your J tunnels would be something like this (indicating), to wherever the Ghost Dance would be from the North.

DR. BULLOCK: Right.

MR. GERTZ: Another one would be south one coming down over to here, wherever you intersect the Ghost Dance.

DR. BULLOCK: That's right.

MR. GERTZ: Let's call that a fault or whatever.

Another one would be--let's go up in there and go off to the upper interface of Topopah Springs or wherever the welded and non-welded tuff at the Ghost Dance fault.

DR. BULLOCK: Right. At the Ghost Dance fault and obviously it should be a little to the south so that there is a larger displacement on the fault zone.

MR. GERTZ: Right. In plan view it would be off the repository block, probably.

DR. BULLOCK: Could be.

DR. CORDING: I am not sure whether you would be able to catch it off the repository block or not, I'd have to look at that. But, the other possibility there Carl, might to be to bring that test ramp down a little closer to where you want to go in the upper level and then either loop it around or do something to bring it closer, you know.

MR. GERTZ: Which one is that, Ed?

DR. CORDING: The north ramp. If you are trying to get over in that area, perhaps the direction of that ramp could be adjusted or even looped and coming back out.

MR. GERTZ: And those are good options.

The other thing you pointed out is you thought perhaps 28, small of 16 or 18 foot diameter ramps would be more conducive to cost savings, to availability of equipment and everything. And certainly that is what we also agree in that, and that is what we looked at the Calico Hills and reduced it to that for other reasons. And you'll hear more why we have opted to look at this time anyway at the bigger ramps up here, but your thought process is essentially the same as ours if you can get by with a smaller ramp.

DR. DEERE: Well, we are also trying to get an operation started that goes a long ways without major changes where you are not stopped and start and bring in another unit and set it up and back up and those sorts of things. Because, if you are limited in funding and you are after some critical information as fast as you can get it, then you should get one operation and take it down and start the other.

MR. GERTZ: Get below ground and get a hole and get going, yeah.

DR. DEERE: That's it exactly.

MR. GERTZ: As a project manager I am very sensitive to that. And I think now is the time to think of that, because we have overcome some of the hurdles that we've had before. The permitting issue, I think is addressed pretty well, or will be either through litigation or legislation, so we can move forward. Our QA plans, our interactions with the NRC are all in place, so now it is just a matter of getting going and demonstrating progress so that we will sustain support in the future. All along the way the more progress we can demonstrate and I think that includes getting a hole in the ground, we better be there.

DR. DEERE: Right. And those two tunnels could be again vice versa.

MR. GERTZ: I understand that. You had no preference if we did this one in here first and the other one at the Calico Hills.

DR. DEERE: I don't think we do.

MR. GERTZ: That is certainly a matter of studies.

DR. BULLOCK: I might mention that if you come in with a Z tunnel like this you are also decreasing the grade. While looking at those things, you would have to go up about 9500 feet and you would probably pick that up by going within Z to bring it back to five percent. You are also raising that repository level up about 145 feet, so we have been looking at this.

DR. CORDING: Good.

I think one of the things we have been thinking of here and what Professor Deere was mentioning in his introductory remarks is that we are starting out the way the present plan is, they start out with a 25 foot machine and then you are switching to an 18 to get down below. And we certainly like the idea of the smaller diameter. But, in that process of switching there, you've got to build a starter tunnel which is drill and blast and that is several hundred feet. And, you are talking about months of work to get that all started. At the same time you are doing that you have pretty well stopped your other operation. Then you've got the ventilation requirements. We can discuss this more and I am interested in what your perspectives are on these things, but you've got the ventilation requirements to take care of all these machines finally starting up and going again. If one is instead of spending time waiting for machines to get started and to get mobilized underground, you are bringing one down and taking it all the way through, you are able to make progress with those machines; you are using less machines; your ventilation requirements start to reduce and I think there are a lot of beneficial effects of that which we assume would come out as you get into your more detailed design tradeoff studies.

DR. BULLOCK: I just have one more comment. Remember how we got here from there was they went through the alternative studies, where they had originally 34 options which they looked at and they reduced to this option. This option is what we did a design study on. There are many variations and many appropriate further studies to come up with these things. So all you are saying is right in line with what needs to be done.

MR. GERTZ: I guess what I need to do is emphasize from a management point of view. Because you see drawings, 200 drawings in a report doesn't mean it is set in concrete literally or figuratively. It is just our basis for going to the next step and the next step may look completely different than this step as we do further studies. That is I guess much like this looks different than the two shaft concept we had on the board a few years ago.

DR. DEERE: And I would like to emphasize also, that we would not have been able to make these comments that we did in a constructive sense if we weren't building on the work and the studies that you had already done.

MR. GERTZ: And I guess before we get onto the studies or one of the trade studies by Bruce, I wanted to point out one thing that Dick didn't enhance on, but the observers that we had in design reviews were more than observers. I think Ted, you had a four o'clock meeting everyday with those observers and we took into consideration any comments they had at those times. So, it wasn't merely silent observers, it was interactive observers and we appreciate that.

MR. PETRIE: Mr. Stanley.

MR. STANLEY: Thank you very much. Now that everyone has made all my excuses for me, I'll try to get into some meaty topics and the first is going to be on ramp diameters.

This morning I would like to address ramp diameters relative to both the Topopah Springs ramps north and south and the Calico Hills ramps, north and south.

First of all, I would like to start by addressing the size of the Calico Hills ramps. The Calico Hills ramp requirements were based upon the ability to perform testing in the ramps; the ability transport personnel safely and adequately on a timely basis; to accommodate equipment; to accommodate the utilities that were necessary; to provide adequate ventilation for the activities underground; and to provide an emergency escapeway. Also, to limit any effects to isolation capabilities that may be in place.

We considered some functional goals in sizing the Calico Hills ramps, those being to provide a rapid access to the Calico Hills as desired by everyone on the program for early site suitability evaluation. Second was to accommodate the required testing, both by space and configuration requirements. And the third was to provide a safe arrangement for utilities and personnel movement.

Now some of the general considerations that came into play were that the size of the ramps were to be based on a reference design being the Option 30 of the alternative studies with enhancements of the optional shaft being in the north area, and with the location of the main test area also being in the north area. We have recognized that the placement of the conveyor within the outline of the ramp influences the required diameter. This is pretty much of a construction or an engineering aspect to consider.

We also had to consider that the alcoves may be required at various locations in the access and how to excavate alcoves and in what sequence to excavate these alcoves. And, lastly, that the ventilation requirements will definitely influence the access diameter.

Next I'd like to put up the outlines of a couple of considered sizes; one being a 16 foot diameter size; the other being an 18 foot diameter.

Originally, we had considered a 16 foot diameter cross-section for the ramp. We had located the conveyor belt to be hung above the area giving us adequate road space. Due to certain comments which we received in the management and technical reviews, we were requested to move the location of the conveyor down to the spring line and locate it and attach it to the rib. As part of the other considerations we had to look into were whether to fill this round configuration or whether to cut bottom.

After we had moved the conveyor and decided on the filling concept, we recognized here that we were limited on our available space for moving equipment and people. On a second thought, we increased the size of the ramp diameter to 18 feet to see how that would affect the available space.

Now we have 10 feet 6 inches in width for available roadway, versus the other configuration which allowed us 8 feet 6 inches. Now what we want to do in meeting the requirements at whatever size that we select, and whatever size that it is, that size will reflect that neither size ramp precludes testing. We can do testing adequately in either the 16 foot or 18 foot size.

The cross-section allows the specified equipment to move and function freely; the adequate spaces is provided for the ventilation and utilities; and, according to the best available information, size has limited impact and is not considered to significantly impact the isolation capability.

I want to show how the arrangement meets the functional goals. The arrangement as we have it now provides access for personnel and equipment safely; it provides rock mass exposure adequate for testing; it provides that either size will accommodate the testing and either size will accommodate ventilation requirements; that 9.5 feet of headroom will facilitate the movement of anticipated mechanical excavators working behind a working TBM.

Taking all these factors into account, I made up a chart which basically covers the consideration areas. The first being testing, where both sizes will accommodate testing; both sizes will accommodate ventilation; both sizes will accommodate muck handling. However, the reason the 18 foot diameter size was chosen for Calico Hills is based upon the safe movement of equipment and personnel. The 16 foot diameter size fell short because we could not accommodate an 8 foot wide roadway for the equipment which we have selected preliminarily for our purposes, plus a 30 inch walkway for people. In other words, there is not enough room for a person to stand and walk while being passed by a vehicle in that walkway without having to accommodate that with a cut out.

DR. DEERE: A question.

MR. STANLEY: Yes, sir.

DR. DEERE: Don Deere, again.

How strongly did the commentors feel about that elevated position of the conveyor belt?

MR. STANLEY: The comments came from the constructors and from the construction arena. They felt fairly strongly that we are attempting to build a very safe laboratory-type environment that is not really a mining environment. In a mining environment, we may go up above and move this conveyor up above as is typically done in the soda ash, for example. And we could provide adequate shielding. But, this was a patchwork type of approach to the problem. They felt much more comfortable with moving it to the rib line or spring line. So we acquiesced to moving that down there and doing further studies on that and a Title II trade-off analysis.

So, based upon that comment and our resolution to that comment at this time, that influences the size of the roadway and therefore, what we have chosen for the size of a ramp. It can be done with a 16 foot, that I want to emphasize, but for that reason, safety reason, is why the 18 foot diameter has been chosen.

DR. DEERE: But I take it it is still a possible solution if you build in correct safety features and you have any benefits to be gained?

MR. STANLEY: Absolutely.

DR. DEERE: You would hate to see thousands and thousands of feet be perhaps constrained by that one point that might have another engineering solution.

MR. STANLEY: That is correct. Engineering solution can be made to, as I said before, in the case of the 16 foot diameter, move the conveyor belt upwards to where we have somewhat of an adequate standing area for a person or personnel. We can cut a little bit of bottom to be able to have a cut out environment. But, this crosses over to the realm of programmatic management decision on what we would like to be able to do here.

MR. PETRIE: This is Ted Petrie, DOE again. Safety is one of our most very important issues as you can probably well imagine. We do put a lot of emphasis on it within the department.

DR. DEERE: I agree.

MR. STANLEY: We cannot overlook safety, as Mr. Petrie just said. It is of our primary importance. What may be safe for a mining environment may not be well received by a laboratory environment, so we must take that into account.

In conclusion, on the Calico Hills ramp size, the ventilation, muck handling and the transportation equipment space requirements are the primary determinants. The testing program as it is currently scheduled can be accommodated in either size and that all applicable ESFDR, that is Exploratory Studies Facilities Design Requirements, affecting the ramp diameter for Calico Hills, are met by the proposed 18 foot diameter.

Now I would like to address the Topopah Springs ramp. The Topopah Springs ramp ESFDR requirements are the same as the Calico Hills requirements; testing; personnel transport; accommodate equipment; accommodate utilities; provide adequate ventilation; emergency escapeway; limit the effects of isolation capabilities; and we felt that we also had to consider the capability of future use in a potential repository environment.

The reason that we felt that were some 10 CFR 60 requirements which I will be getting into later. I thought I had a viewgraph right now, but I can mention these other requirements. Some of the functional constraints which we considered on the Topopah Springs ramp was first for transportation. For transportation purposes, we determined that a 36 inch wide conveyor was needed for muck removal throughout the entire facility, not only the ramp, but the entire facility excavation. We must accommodate rubber-tired vehicles a maximum of 8 feet in width; and there will be an occasional 9 foot wide mechanical excavator moving within the ramp cross-section. This is to traverse its way from the surface down to the Calico Hills level. I think we are primarily addressing a roadheader.

Now the two various sizes, just to give you examples of how they could compare, I want to put up a cross-section of a 23 foot diameter ramp and a cross-section of a 25 foot diameter ramp. You can go over this in the handout. The cross-sectional configuration is the same, as you can see, differences being in the available space for equipment movement and personnel movement. Here in the 23 foot diameter, we have 12 feet of roadway available. We have an ultimate 14 foot 6 inch without the conveyor. The 25 foot diameter cross-section makes available 13 feet 6 inches of available roadway space and 16 feet of available ultimate road width without the conveyor.

Now I have to also mention that under this configuration we have decided to fill for roadway at this time, rather than to cut bottom or to put in a permanent invert. We also have included, which we don't see in this configuration, minimal rock support, without putting in a concrete liner, per se. But we will include rock support everywhere where needed for safety.

Now on the 25 foot diameter, which we have chosen, the functional constraints are satisfied in that we have provided a 36 inch wide conveyor. The road width accommodates an 8 foot wide vehicle and a 30 inch walkway. A mechanical excavator may pass on an occasional basis, so being careful, we may be able to take that down and encroach upon that walkway space.

A 72 inch diameter vent duct provides enough air for about 400 square feet drift cross-section, which this represents here with all the utilities included, and the roadway also. It permits the 400,000 CFM of air movement with a maximum of a 1,000 feet per minute velocity in those areas where you may have a vehicle and the cross-section is enclosed or closed down. This will be addressed to a greater degree by Mr. Romeo Jurani in a later presentation. What we are trying to achieve here is to minimize that velocity to get it down below terminal velocity.

The conclusions for the ramp size on the Topopah Springs which we came to was based upon this chart basically. Here again we have considered ventilation, equipment movement and testing in future use consideration at this time. The ventilation for a 23 foot diameter, does not according to our calculations accommodate enough air at the required velocities or restricted velocities, let me phrase it this way, but the 25 foot does.

Equipment movement and personnel movement can be accommodated by both scenarios, however, the 23 foot diameter configuration is marginal. The reason I put in marginal here is it was a concept that if the testing community wished to use small, narrow, five foot wide vehicles, we may be able to accommodate two vehicles passing on that roadway. Anything wider than that would not be recommended; it would be one-way traffic. Testing can be accommodated in both sizes; it can be accommodated in most any size as we have looked at.

The last, under future use consideration, the 25 foot diameter configuration of the road bed as it is shown, will accommodate what is currently known for a transporter vehicle. The 23 foot diameter roadway will not accommodate that transporter vehicle size. Transporter vehicle as known to-date, being approximately 15 feet wide. So if you go back to the 23 foot diameter configuration you can see that that is not going to be useful.

I threw this in just for consideration purposes, just to demonstrate that a 23 foot diameter would certainly have to be over excavated; 25 foot diameter may have some other alternatives available to it.

The conclusion for the TS access ramps was that the 25 foot diameter cross-section fulfills the requirements and the constraints. Based on ventilation, the 25 foot is an adequate size for the Exploratory Studies Facility Design. The diameter is influenced by the need for a flat roadway in a round opening. Here again, that is pretty much of a design constraint. We have chosen to in-fill on its round opening. We recognize that we can cut bottom. But this is a topic for a future trade-off study in Title II design. I just want to emphasize that we have recognized the ability for flexibility. There again, at the bottom we have two five foot wide vehicles can pass without the need for a cutout.

That concludes the presentation on the ramp sizes and I am sure there are some questions that I may address.

MR. MCFARLAND: Bruce, I would like you if you would stress the point though, as I understand, that the presentation, the analysis assumes simultaneous operations of a machine, tunnel boring machine, as you said excavation behind it and men and equipment going in. Once you decouple these functions as an incremental, as not being able to--if you assume that I may not have my entire budget, I have to decouple, then these assumptions have to be re-examined. For example, the 400,000 cubic feet per minute, I believe assumes ventilation from both levels simultaneously, Calico Hills and Topopah Spring. If you were to operate--if you were to defer testing until after construction, if you were to defer testing at one level in lieu of testing at another level, if you were in anyway to decouple the excavation, the drifting and the testing, then your assumptions on diameter should be re-examined.

MR. STANLEY: Absolutely. And, I will re-emphasize that, as you asked. The sizes that we have chosen so far are so very much based upon the scheduling and the assumptions which we have made for coupling and decoupling the activities. It is based upon how and when we put in testing the alcoves for example. Do we put in an alcove, immediately after a TBM passes or can that be deferred until future excavation. That has an impact, for example.

One thing that I did not mention because it would be stealing a little thunder from a future presentation, is that the area 200 feet immediately behind trailing gear on a TBM is dedicated to mapping, so that has a special configuration that is necessary for that function.

And it is certainly true that if one were to continue that TBM all the way down through here, that it would be engineeringly better at anytime to stop and put in at least a few rounds for a cut out in any case. But, the program's purpose will have to drive what we want to do on this whole project. We can accommodate most anything if properly done in a proper sequence and safely and well-designed.

MR. GERTZ: Bruce, excuse me. This is Carl Gertz.

You didn't elaborate on the 10 CFR 60 requirements. You indicated that you thought you had a viewgraph right after that one, because, certainly that is one of the considerations I think that you all took into as part of the requirements precisely in this ramp. In addition, what Russ pointed out to some simultaneous operations that we assumed at this level, we also assumed if suitable, it would be close to being what we needed for the permanent repository. And when you spoke of transporter vehicles, I am sure that is what you were meaning was the transporter vehicles for eventual waste emplacement. Correct me if I am wrong.

MR. STANLEY: That is correct. It was for eventual waste emplacement. I don't have the overhead at this time. I was incorrect. It really refers to ramp gradient more than it does the ramp size. But the 10 CFR 60 requirement to which I am alluding, asks for consideration to be given to accommodate that future use and for the consolidation of effort to be able to handle anything that is being sized or built for such an important purpose.

DR. DEERE: Yes. Don Deere here. But, yet it doesn't specify the method you have to use to be able to do that. You just simply have to be able to convert, either make it big to start with or do conversion if it is found to be desirable and you have a facility that is suitable.

MR. STANLEY: That is correct. That's one of the ways of addressing that.

Ramp size can be changed. Ramp gradient is very, very difficult to change.

DR. DEERE: But we are talking on the size now.

MR. STANLEY: That is correct. And so that is one thing that I wanted to bring into the discussion.

MR. GERTZ: Certainly, I agree with you, Don. The regulations do not preclude your oversizing it later on or anything; they just want you to consider it.

DR. DEERE: Yes. You know what has worried me just a little bit, we made a fairly early decisions; perhaps it was presented last June that you looked at making it the correct size to eventually handle everything, versus making it smaller and then enlarging if it seems to be suitable. Well, I'm afraid that that early decision that was made, has guided almost everything that has gone beyond that, and that is why we say, well maybe this early decision is subject to re-looking, particularly if you are talking about spending money today which is not available, for something you are not going to need for ten to twenty years.

Now if that is my money, I've got to think very closely about doing that, particularly when I don't know if I am going to have to do the future expenditure.

DR. BULLOCK: If I could just add one thing. The other thing we have to look at is current technology. Expanding a ramp from 16 or 18 to 25 is not something that is done very commonly. I know of at least one case where tunnel boring device has done this. There are people in the room that could probably speak better to this than I could, but there is not a wealth of information on the exact type of machine that you use to ream out a tunnel to start with 18 feet and go to 25 feet. This is something--I am not saying that it can't be done, but it is certainly something that must be considered in the overall study of doing it. Talking to the vendors, can such a machine be successfully built and operated successfully on a decline.

MR. STANLEY: And the one other thing I wanted to emphasize and bring into the picture that we don't seem to be remembering is that factor of ventilation. Ventilation here requires us currently, under our current requirements and this will be addressed a little bit later by Romeo Jurani. We don't want to exceed terminal velocity of dust for example. We don't want to be kicking dust up in the ramp. Yet we have a certain size of ESF that we are designing; we have approximately 80,000 feet of opening underground here as depicted in rough terms, and to ventilate that amount of opening we require certain cubic feet per minute of ventilation, that going down a specific size of an opening. Now all intake is down that north ramp, all exhaust is up the south ramp. So we have to accommodate the entire 400,000 CFM.

If we want to ventilate that amount of area, we have to do it under the constraints currently given. If we want to be flexible a little bit, if we want to live in higher velocity winds, that is a trade-off. But, we have to be safe.

DR. CORDING: I am sure we will get into more discussion about that. But, I think isn't a lot of that ventilation requirement related to a the number of machines you have operating?

MR. STANLEY: It is related to the number of machines; the number of people we have underground--

DR. CORDING: But in terms of some of the load, a lot of it comes off the machines, operating the machines. And if one is going into another approach where you say we can reduce the number of machines, then that starts changing that 400,000 value. There is a lot of interrelated factors that obviously they are going to be looked at.

MR. STANLEY: It can change that, certainly.

DR. CORDING: And I think in terms of if one is trying to enlarge a drift like this, that certainly cutting the bottom out is probably one of the easier ways of getting that additional space, getting that corner.

The other point, I think is it may be, it seems to me that there might be a possibility of having one ramp at one diameter, coming from the surface now; one ramp say the north ramp at one diameter; the south ramp at another, so that you can accommodate your--one of the bullets you have there is the equipment that you are trying to get down in or having more access to do side drifting and things. Perhaps more emphasis is going to be placed in one ramp than the other. So, there might be some choices there as to two different ramp sizes from the surface now, following pretty much the same sort of approach that Don Deere was describing for the two J tunnels. One might be larger than the other.

MR. STANLEY: That is correct. However, we are still constrained by the smallest size we have on ventilation for air velocity.

MR. GERTZ: But their concept or Don's concept would be you never connect them, so if you never connect them you are not worried about--in the early stages you don't connect them.

DR. CORDING: You might connect them. But later on again we go back to the point of how much ventilation do you need and it goes back to the amount of equipment you assume is operating simultaneously. I think when you are starting and stopping machines underground, then you have to have them all operating the same time, that of course increases the requirement quite a bit, whereas at other times you are really not using the capacity at all.

MR. GERTZ: No doubt about it. And perhaps the ventilation, the study that is coming up next, maybe we can talk more about that.

DR. CORDING: Well I am interested in hearing from people that are experts in ventilation.

DR. DEERE: I have to mention, that just a couple of weeks ago down in Mexico in a welded tuff, the ventilation was getting a little bad as they were finishing two of the caverns. So the contractor just moved over and in about two weeks he had a brand new ventilation shaft with a raised bore. It is just nothing.

MR. GERTZ: Just nothing.

MR. PETRIE: However, the NRC might not look on that favorably.

DR. DEERE: Well it depends on which level you are coming from, I think. You know, maybe if you are talking about an upper level or a position, I understand their concern.

MR. STANLEY: You are absolutely right. This is one of the factors we all recognize that in a normal mining environment, we need more air, we need something to move it around quicker, easier; we can pull a raise; we can pull a shaft. But, we are constrained by the graphical layout; we are constrained by 10 CFR 60 requirements and 10 CFR 60.15(c), saying that we have to minimize a number of openings underground. So, this is why we are trying to work within our limitations.

Are there anymore comments or questions?

MR. MCFARLAND: I am puzzled, Ted, doesn't the SCP show four openings into the repository if a repository has built two shafts, two rims?

MR. PETRIE: Sure. Yes. But again there are specific locations for those. And whether they would be appropriate to decide in five minutes to put one here--

MR. STANLEY: No, we are not saying that.

MR. PETRIE: The message I got was, hey, let's throw in another shaft. We don't just throw in another shaft on this job.

MR. MCFARLAND: In this phase of design, if there is a constraint at this point, you would say I have two options. I can increase the size of my potential tunnel or I can examine where those two shafts will be as previous studies have shown and consider bringing in a shaft for ventilation as part of the SCP.

MR. PETRIE: That's one of the alternatives one could consider.

MR. GERTZ: In fact, as you are aware, we have one optional shaft already being designed in this concept.

MR. MCFARLAND: Not for ventilation.

MR. GERTZ; No. But it certainly could turned into that, it's big enough to.

MR. PETRIE: That alternate shaft may be used for many things. It is considered an alternate in the event of geological or testing needs. We in the engineering organization are looking at it for other potential activities as well.

DR. ALLEN: Do we have a question or comment from the audience?

MR. FRIANT: I am Jim Friant. I've got a couple of comments in the form of questions, I guess.

In a 16 foot tunnel at 400,000 SCFM, just a bald tunnel is 22.6 miles per hour; in a 20 foot tunnel 14 1/2 miles per hour; and in a 25 foot tunnel, about 9 1/4 miles an hour. Now, I haven't done ventilation studies for awhile, but there are regulations both on, as you indicated the velocity of air in a tunnel, but there is also regulations on a tunnel with a conveyor in it because the conveyor bounces, so you have to have slower velocity of air in a tunnel when there is a conveyor. So, I just don't remember those regulations anymore, it is has been too long, but both need to be looked at. As anybody knows, that's been in an 22.5 mile an hour wind in a tunnel is an impossible thing to deal with.

Second comment, once you get in about four miles, we are going to supply this tunnel boring machine by a truck, from what I see. About the most you could get to the tunnel boring machine after you are in about four miles is about one truck every half hour. And that doesn't count turn around time outside if we are one way here. That is, I would say a marginal amount of transportation to a tunnel borer. You might need extra storage or something for bolts or something.

And then there was a comment about reaming out. The Wirth Company in Germany has made two or three of these reaming machines, but, it is necessary to use glass rock bolts in order to be able to ream it back out. And taking out steel rock bolts in a reaming situation, which I have observed is extremely hazardous. So, I doubt whether you are--since the glass bolts are like four to five times what the steel bolts are, I doubt whether there would be much savings in roof support.

Another comment that my friend, Dr. Ozdemir made, was if you are going to put cut-outs every once in awhile, it is a very simple thing. On your cross-section, shove the pipes over to the other side under that conveyor and then you have one side of the tunnel at least that is free to dig and sample and observe and whatever else. It's a very simple change on that.

DR. ALLEN: Thank you.

Any other comments? Why don't we take a 15 minute break.

(Whereupon, a recess was had off the record.)

DR. DEERE: To reconvene the meeting, I would ask that an interested observer, State Senator Tom Hickey has been listing to the proceedings this morning and will continue. I have asked if he has some comments. I believe that he would.

Senator, if you could use the podium.

SENATOR HICKEY: Thank you.

Mr. Chairman, first of all I would like to introduce Assemblyman Spriggs who is a part of our committee on High Radioactive Nuclear Waste. Assemblyman Spriggs would you please stand?

We have a subcommittee that has been in existence about ten years. What we have tried to do is familiarize ourselves with the technical issues. You are chairman over all of your committee. We have sent a letter and asked if with our involvement, and we've generally through our rules we can't form subcommittees, but we have identified legislators that will work with each of your subcommittees. So, at those meetings we will have some legislator that will be involved or have an understanding of what is going on in this process as it goes through.

Our concern is a couple of concerns and as I talked to you during your coffee break, one, I think Carl Gertz articulated it very well, is the financing. We too are feeling the pinch on reduction of funds and seeing this planning. We were well aware that it meant a reduction in the overall plan. It raises concerns, that reduction both from perspective of the government and DOE and also our own is an oversight, that as goals are set, that they are not going to be met, or that oversight will not be proper in overlooking the goals that are being set. Our problem lies in the possibility of work not properly being done because of the goals set. I know it is going to be said that that can't happen. I work for a company that puts safety first. However, they put safety first within the constraints of financing. So, I leave that with you.

Second, and something that I feel is important has been a thought that decisions will be made just through this body. And I think it is indicative upon all of us to recognize as we go through the process that NRC will be the final judge. And, that involvement, it would be my intention to move at least our committee closer to an involvement with NRC. We have not taken an adverse position with DOE, this committee, and our committee will not. In fact, when this project originally was initiated, you are looking at one who initiated the cooperation between the state and DOE. That lasted not too many months, but it did initiate.

Last, but not least, your statements in dealing with the size of this hole, I leave you this political consideration. Statements made to the state up to now has been that this is going to be a scientific study. I submit to you that that is what it should be up until a final decision has been made through scientific study. The message you may send us if you start designing holes that will receive the repository size, is a message telling us those decisions have already been made. So, I leave that with you.

Thank you, Mr. Chairman.

DR. DEERE: Thank you, Senator.

We will continue then with the technical presentation.

MR. STANLEY: The next presentation will deal with Exploratory Studies Facility ramp gradient.

Ramp gradient is a topic of engineering discussion that is a little bit different from the ramp size, in that as I mentioned before ramp gradient is something that is very, very difficult to change. In fact it cannot be changed once it is in place. Another ramp may be excavated, but that same ramp's gradient cannot be changed. So, significant design consideration has to go into that thought process.

The objective and scope of this presentation is just to merely report on the progress that we have to-date in developing some of the information which can be used in the selection of the proper ramp gradient.

The scope of the presentation is to describe the existing conditions, as we see them right now which affect or are affected by ramp grade; to briefly describe the operational safety and schedule implications of some of the grade options that we have to consider; and to number three, to state preliminary conclusions which can be drawn from examination of the information that we present here.

First of all, we would like to say that the ramp of principle interest is the north access ramp because the south access ramp is currently on a grade of 1.6% and that is of little or no concern to anyone to-date. It is a railroad grade; it is a normal drainage grade and it really presents no problem at all.

The second item that we want to mention is the braking performance that is shown here is the minimum prescribed by SAE standards. These values have been field tested.

The maximum rail grade recommended for any ramp service by the American Railroad Engineering Association is 2.5%; that ramp grade has permanent ramifications, and therefore, the ESF and repository functions should both be considered. And here is where we have to address future use considerations.

I want to go over a little bit of the existing conditions and the latest general arrangements. And I think once again it would be very helpful to put this configuration back on the board and to point out that at this time we are talking about the north ramp gradient in this location right here (indicating).

Some of the applicable requirements which we have are our ESFDR requirements. This is the Exploratory Studies Facility Design Requirements that the ramp and roadway shall be designed to provide an acceptable slope which is suitable for excavations, for safe vehicle traffic and material handing equipment requirements.

Out of the repository design requirements, which we must consider at this time because this is an opening that may be used for future use, we have to consider that some of the constraints stated are that the ramp slope shall not exceed 10 percent and that the ramp entry point of the repository, the potential repository area, which I am talking about approximately right here (indicating), will consider the overall design of the potential repository lay-out to provide the optimum travel route.

In discussing some of the grade implications we have received a number of comments in our management and technical reviews. These can be consolidated in three primary areas. The first being to explore the possibility of rail haulage which requires flatter grade. The second to be, the minimization of the grade is always desirable. The third, is to examine the safety aspects of the ramp grade. And I have to emphasize again here that safety is a primary concern.

Currently our layout in the subsurface, and this is a very difficult viewgraph to see on the board, but you can refer to your handout, is that the north ramp declines at an approximate angle of 9.57 percent. The Calico Hills ramps are at 10 percent and the south ramp is at 1.6 percent grade.

When considering what grades are appropriate and inappropriate, we considered also what would be the potential grades going across the proposed or potential repository block as currently known for a repository configuration. Well, at the current geologic elevations, we can see that maximum grades in some of the emplacement drifts go up to 7.5 percent. This means that an emplacement transporter would have to negotiate 7.5 percent.

Some of our recent information at re-examing the geologic core has raised the entry elevation from 3100 feet, that entry elevation being right at this point here (indicating), to as much as 3240 feet. Now, what would that do to the grades within this area of interest?

Now instead of 7.5 percent we deal with a maximum of 4 percent on the emplacement drift, but still the long north/south main as we have known it, exists at 4.5 percent. Still this is not railroad grade.

But, what are we talking about? We are talking about future transporters, ideas, concepts. The transporter as anyone knows it to date, looks something of this nature. It is a rubber-tired vehicle. And the main area of concern when looking at that transporter is the braking system. How fast can something like this stop?

Well as it is known to-date, this transporter has three sets of brakes. First the normal set of brakes, which can stop this vehicle fully loaded traveling at 5 miles an hour down a 10 percent grade to a complete stop within a distance of 20 feet. It has a series of parking and holding brakes which is capable of holding this vehicle on a slope of 25 percent. And it has a system for emergency braking which will allow the vehicle to be stopped traveling at 10 miles an hour traveling down that same 10 percent grade within 30 feet. So it has basically three different systems of braking.

Under consideration also is traction power requirements on various grades and how they react, whether we pave the surface, whether we use a crushed material surface. And these are all engineering aspects.

As we can see here, on a paved surface, any ramp roadway, you would still require some power to the wheels up until a negative 3 percent grade. And you can see how this power requirement compares to a tuff surface for a roadway in that you would need more power to propel that vehicle. Well the same translates to how a vehicle would perform in a stopping mode.

This is a very interesting graph. This is a graph of stopping distances, designed stopping distances versus vehicle speed for a 200,000 gross vehicle weight load on a tuff roadway. This was calculated using SAE performance recommended calculations. The thing I want to point out here is let's take an example. Currently as I mentioned the north ramp is at 9.5 percent. What would be the tradeoff between taking that ramp from 9.5 percent down to a 5 percent, for example? Traveling at a speed of 10 miles an hour, the stopping distance--on a 9.5 percent ramp on tuff for 200,000 GVW load is approximately 36 or 37 feet it would take to stop. Now if you take that same vehicle on a 5 percent ramp it would require approximately 24 feet to stop. The tradeoff we have here is 13 feet. That is what we are buying in stopping performance; we are buying 13 feet of stopping distance for a great deal of distance in excavation. What is that distance?

If you go to the next graph, we can see some of the calculated distances that we are dealing with. For example, the 9.5 percent ramp requires approximately 6,000 feet in general terms, you can read that on your handout also, of excavated ramp. To take that down to 5 percent grade, we have to increase the length of that ramp to 10,000 feet or more. Now we are still not at railroad grade. If we are to take that grade to railroad grade at 2.5 percent, we start dealing in the neighborhood of 25,000 feet of distance.

Also, you can see the implications it would take on schedule, the number of days necessary to excavate; the longer the ramp, the longer the time it takes to excavate. The shape of that curve changes just because of the logistics.

Now what would some of these ramps look like if we changed the grade? Here is a picture of a typical north ramp layout. You can see how it is configured currently with this straight configuration going in to a 600 foot radius curve. This straight configuration is the 9.5 percent grade at the 3100 feet, which we have chosen currently in our system for the elevation of entry.

If we wanted to change that to a 5 percent grade, we could play some games, such as swinging this ramp out in an S curve. This is not the configuration, understand, but this is an example of what we can do with swinging ramps out. We could swing it to the south; we could come in this direction; we can accommodate various different layouts.

If the elevation of entry into the proposed repository area were to change to the 3240 foot elevation, the implications wouldn't be quite so severe. Here we have the current ramp again, and here we have another alternative ramp at 5 percent grade. So instead of taking a look at this S curve swinging out and around with a compound curve scenario, we can go relatively straight an come in with a

1000 foot radius curve to establish a straight approach into the area of interest block.

Where we are today, we have made some preliminary conclusions, those being that the existing conditions, the proposed repository grades would necessitate the use of rubber-tired vehicles for the final emplacement of waste canisters and other activities. Rail haulage could be utilized in the access ramps if we consider some other configurations.

However, a reduction in the ramp grade from an approximate 10 percent that we have now to a rail grade of 2.5 percent would result in a ramp length increase from approximately 6,000 feet to 25,000 feet. That is a significant increase. It also impacts significantly on schedule.

I should also mention that this 2.5 percent which is mentioned in the presentation, is a result of railroad engineering. Now it has been demonstrated that 3.5 percent grades have been successfully used for many, many years under very heavy rail haulage conditions in mining environments. So we do have some flexibility.

The last preliminary conclusion is that operating speed is more important for controlling vehicle stopping distances than is operating gradient, we feel. The heavy vehicle traveling at 10 miles per hour on a 5 percent down grade will require only 14 feet less stopping distance than the same vehicle traveling at 10 miles per hour on a 10 percent grade.

Now these are all design considerations; these are the things that we have to take into consideration. We have a world of flexibility, but we can also see from what we have so far the implications of attempting to go to a rail grade or attempting to go to a slightly more favorable grade and what the tradeoff is here.

Thank you. Are there any questions?

DR. CORDING: Bruce, could you describe what the consideration of flipping the waste ramp to the south end would do? Is that part of what has been discussed informally at this point?

MR. STANLEY: Yes, sir. It has been discussed informally, and it has been targeted as a definite tradeoff study for Title II. In order to establish a ramp gradient for the north, a function has to be established for that ramp, and a function for the south has to be established also.

It would seem that it would be perfectly reasonable to switch those functions for waste transport from the north ramp to the south ramp in light of the fact that we already have such a favorable grade on that south ramp. That also impacts many different things. It impacts the underground configuration, of course, but it impacts the scenario of timing. This is a subject of consideration for a repository thought, rather than ESF thought, of course at this time. But, there again, this is an area which we much consider this implication. We cannot put on blinders on this area.

DR. CORDING: You've talked about a 25 foot size for the waste ramp; is the tuff ramp size, has that been studied and what sort of ranges does one have in that?

MR. STANLEY: If we were to consider the ramp function as only for removing broken tuff material, it would seem to stand to reason that that could be different from 25 feet.

However, we do want to build in the amount of flexibility that we need. We also want to consider very importantly, here again, the ventilation aspects of what goes in has to go out under the same conditions.

In a potential repository environment, we will have other openings which can be made available for ventilation purposes and that will change the entire picture. So, what we are designing to now is the Exploratory Studies Facilities as much as possible.

DR. CORDING: Thank you.

DR. ALLEN: Other questions?

MR. MCFARLAND: I have a question out of curiosity. Your analysis show that you are assuming a 50 foot per day excavation rate. I am puzzled. At the International

Conference here in Las Vegas last summer, there were two papers presented; one by Joe Sperry and extrapolating from the River Mountain tunnel through the tuff out here over towards the Colorado River. He said his feeling was that from a construction estimating standpoint, conservatively, he would see 100 to 110 foot per day, 8 hour shift. Levent Ozdemir, I believe, in his studies indicated something in the order of 100 to 120 foot per day. I am curious how you came up with a 50 foot per day advance rate?

MR. STANLEY: The 50 foot advance rate as an input to the alternative study program. Without knowing any of the material which you just mentioned, it was anticipated that we would be better off if we were conservative. So, we would rather err on the conservative side. A study had been done to indicate some of the construction implications and limitations which we have at the test site and the conditions under which we work. So, based on that, we wanted to merely select one advance rate and then compare that advance rate with the other ramping scenarios in that alternative studies in order to come up with the one we select. In other words, we wanted to do the comparison on a very fair and equal basis, so the advance rate will probably change. Does that answer your question?

MR. MCFARLAND: Very conservative.

DR. CORDING: I think one of the other factors affecting is even after one is mobilized and the TBM tunneling has actually started, you have a period usually for a month where rates are much slower, so when you look at short tunnels, the overall rate is slower than for the longer tunnel, because you have had a chance to go through that learning curve. When you are going through four or five learning curves, you are obviously spending more time and going at slower rates.

DR. ALLEN: Other questions?

MR. GERTZ: Clarence, excuse me. I have one question, I guess collectively from my team and maybe from the experts at the table, a 10 percent ramp does not affect TBM excavation, it is an acceptable decline for TBM excavation?

DR. CORDING: A 10 percent ramp can be mined with a TBM. The rates are affected by slopes.

MR. GERTZ: But, by certainly within the state of the art excavating techniques for TBMs to do a 10 percent.

DR. CORDING: Yes.

MR. GERTZ: Based on your experience and what you've seen.

DR. ALLEN: We have a comment or a question from the audience.

MR. THOMPSON: My name is Jim Thompson. I am a consultant to the State of Nevada.

We previously discussed I think, a couple of months ago, and I entered into a pretty good discussion with you all at the time pertaining to these ramp grades, and I am pleased to see this in respect to this trade-off so to speak of the various grades versus the linear footage of drilling and associated costs that are with that. One comment is that the issue here is not purely braking distance, and that I think it is safe to say that it is a given that it is more convenient and overall from a safety standpoint to work on a flatter grade than it is a steeper grade. So, if you can get one at 5 percent versus 10 percent, that is simply preferred if it is within cost constraints and your time constraints as well.

The two configurations you had in terms of these 5 percent grades, well I agree that the 2.5 percent for rail, you would have to come up with some pretty erroneous layouts to achieve that in terms of distance. Yet, the 5 percent grade layouts that you have here seem to be pretty reasonable design schemes. Yet, in your preliminary conclusions I didn't see whether they were discussed as being considered further or whether you have abandoned that and stuck with the 10 percent, because frankly I like the 5 percent grades. They seem to be a pretty good design there in getting down there safely and the impacts overall in terms of the total linear footage. It doesn't seem to be that extreme.

MR. STANLEY: You have a very good point.

The ability to change the configuration, this is the best viewgraph to which to speak, when this elevation raises from 3100 feet to 3240 feet, the gradient of this ramp now also changes to 6.7 percent. So no longer are we dealing with a 9.5 percent ramp, we are dealing with a 6.7. So we gain some advantage there.

The difference between this configuration and that configuration to achieve a 5 percent grade is, as you say, not that visually significant. And, it can be argued that it is not that economically significant. Taking other factors into consideration, other factors, a trade-off study will have to be made to determine exactly what we settle upon.

DR. ALLEN: Other comments?

MR. MCFARLAND: One thought, not knowing what the rail would be used for, I assume we were talking hauling waste, your AREA limitations of 2.5 are locomotive pulled; not all axle driven locomotive?

MR. STANLEY: I'm sorry?

MR. MCFARLAND: Your AREA limitation of 2.5 percent maximum is a locomotive pulled vehicle, not an axle driven vehicle. Metros are all axle driven and 5 percent exists in the New York transit system, in Buffalo and in Chicago. There is a big difference between a locomotive hauled vehicle and an axle driven vehicle, again another variable in the trade.

MR. STANLEY: Absolutely. You are correct.

The 2.5 percent is a recommended maximum by the Railroad Association for rail haulage.

MR. MCFARLAND: Locomotive hauled?

MR. STANLEY: Locomotive haulage.

MR. MCFARLAND: Yes.

MR. STANLEY: And the other example to which I alluded is the Henderson Mine in Colorado which hauls up a 3.5 percent grade over 9.5 miles of gradient with twelve, 22 ton cars in one train scenario with a locomotive in the front, one in the middle, and one at the rear and has been doing it for the last 15 years.

DR. DEERE: I am wondering if maybe Jim Friant would have some comments about the tunnel boring machine at a minus 5 percent, versus 10 percent, versus 2 percent? Any comments?

MR. FRIANT: I think that it could be proven, I don't have the data sticking in my head, but certainly the steeper the grade, the slower the TBM will advance. There have been a number of TBMs going down a 17 percent slope, because, this seems to be the magic number for conveyors in various applications. I'd hesitate to put an exact number on it, but down slopes--the other thing that bothers me is most of the time you are working with something that is wet, and here it is going to be dry. Now even a small down slope of 2 percent where there is water involved does slow you down. But, here where it is dry and with a conveyor backup system, I don't think 2, 3, 4 percent in that range would slow you down much. Get beyond that, my instinct is that it would probably begin to slow you down.

The other thing that bothers me, as I mentioned in my other comments is the supply of the TBM and you are talking about this waste container, but that is a minor use of this road frankly, in this whole scheme of things. Getting people in and out and test equipment and supplying the machine, now we are talking about vehicles that are going to tool along at 15 and 20 miles an hour, and on crushed 22 percent silicone rock, some of those need to be entered into the trade study as well.

DR. DEERE: Thank you very much for those comments.

I wonder if any of the MK support team would have some comments about the driving down slope? We are trying to take advantage of all the expertise that we have available here in the hall today.

MR. ALLAN: Thank you, Dr. Deere. I am Jim Allan with Morrison-Knudsen, construction manager for the ESF.

I don't have any extensive comments other than perhaps to say I would not be really all that concerned about the support activity to the machines in that the proposed scheme has a conveyor disposal system for the rock material itself. Basically, you are just talking support which would be primarily ventilation line, your utility piping and incidentals. I don't see that to be a restraint. I am sure that we have to assume that the production rate would be effected at those percentages. But, I don't think enough information is available at this time to evaluate those. But, it has been done and I don't think that this material appears to be favorable from a drilling point of view, and I don't think it would be a prohibitive factor.

DR. DEERE: Thank you very much, Jim, for those comments.

Are there other comments from the audience on this particular topic?

DR. ALLEN: Okay. Ted, let's move ahead then.

MR. PETRIE: All right.

Our next speaker is Mr. Jurani.

MR. JURANI: I'm Romeo Jurani. I'm Senior Mining Engineer of Raytheon Services Nevada, and I will talk about the preliminary ventiliation analysis of the ESF.

First, we have objectives and requirements for the ventilation. There are several citations about ventilation requirements, but we consider these two as the highlight: "Provide a ventilation system to supply ventilation air to and exhaust ventilation from the subsurface workings to meet the needs of construction and operation of the underground site characterization and testing program."

Another requirement: "The ventilation system shall supply and exhaust adequate quantities of air to and from underground working areas such that operators' safety, health, and productivity requirements are maintained.

Reviewing the construction sequence of the ESF, as discussed previously, we have a development and characterization sequence wherein we would go in a scenario wherein we had to advance the south ramp and the north ramp, and then later on, the south ramp will be independent. The north ramp will be independent, also. So the south ramp will be advanced later on into four headings, with the TS south heading and one lateral--I will show a picture about this whole scheme later on--the south system will proceed to the south Calico Hills level with one lateral. That makes four headings.

The north ramp, which is independent, as I said, will be advanced with one lateral and continue to the Calico with another lateral. Later on, this will be connected for the flow-through ventilation to support the ESF multiple activities.

To show a picture of the early construction, we have the south ramp here, and the north ramp. What we intend to do as far as ventilation is, as we drive this ramp, we'll install a fan, exhausting from a tube that will be following the advancing phase of the tunnel boring machine. So when we run that fan, it will suck the air from the tube, forcing the air to go into the face and out in the tube.

The north ramp will be the same. We'll install that fan there, tube, exhausting mode; when that fan is running, air is forced down into the face and out.

As we continue, the south ramp goes down. It branches to the Calico Hills, and we also continue at this level. Now, the eight headings I was talking about, there are really four headings in this system here, and four headings in this system here. So we shall say now that while we are driving these around, we have the heading to connection. We can also support, in terms of ventilation, a lateral drift that could be occurring anywhere along the drift.

In the same scenario into the south ramp, we can support the heading of the ground, plus another lateral drift that could be occurring in the south ramp. So there are four here and four here, making it eight.

Now, how much air do we need to ventilate this construction activity? There are a few tricks to calculate ventilation, but the best thing to have is the experience of the industry. We run into the survey of the mining industry practices and the ventilation of the face is somewhere in the range of 100 to 150 feet per minute. We look at, also, the ventilation expert recommendation, and their face velocity recommendation is between 100 to 400 feet per minute.

Our recommendation will be somewhere in this area here, which is on the higher side, 140 to 150 feet per minute, and this velocity is above the California and MSHA Code minimum requirement. Now, going back to this number here, the high side is because--or this is for hot mines. If the mine is hot, you have to use a higher velocity. These are for normal mines where the air is, the temperature is normal, below 90°.

Now, allowing leakage factor, the recommended equivalent ESF design velocity range will be something like 165 to 176 feet per minute. This is just adding the 15 per cent into this number here, 140 to 150.

Transforming that, or calculating it for the requirement, since we have a 25 feet diameter ramp advancing at 167 feet per minute times 491 per sectional area of the 25 feet diameter does clear. There might be some obstructions here, but for purposes of conceptual design, we will have to assume that this is clear. The total volume for that advancing 25 feet diameter ramp, will need about 82,000 cubic feet per minute.

The lateral drift that will be in this ramp drive will be driven in an assumed 20 x 12 feet cross-section, and multiply that 167 by 240, it will require 40,000 CFM, so that's the TS from our main TS level.

Now, the ramps going to the Calico ramp, which is an 18 feet diameter, has a cross-sectional area of 254 square feet multiplied by 167, will give you 42,500. Now, the lateral drift that will be in the Calico Hills, be driven in the cross-sectional dimension of about 16 x 9, requiring about 24,000. If you sum this up, that main tube that will be supporting both--all these headings, will be something like about 188,500 cubic feet per minute.

Now, what we intend to do, as I mentioned earlier, we'll be installing the fan at the portal, and the tubes following the tunnel boring machine. It branches into the Calico Hills and the other goes to the Topopah Spring main level, and these are just the lateral drifts that we probably will support, you know, if we need to have.

Talking about dust control, if this is the tunnel boring machine, probably we'll have to specify the tunnel boring machine with a built-in fan so that the air that is going to the face will be forced to go to the face, take all the dust, take it out and into this dust collection system here into the main exhausting tube.

Another scenario, if we have to drill and blast a cutout, the dust control system there will be relatively the same. We have an extendable tube going to the face and the air is allowed to go to the face and out into the exhausting tube, into a dust collector, and into the main exhausting tube.

The tube that will be installed in the main ramp is about 72 inches in this particular study and we run through our computer model with this system and this is about the horsepower requirement. For the north ramp, it's about 7,000. For the south ramp, it's about 8,800, or a total of 15,870.

Now, we played with the computer and see what, if we will increase this tube to something like 84 inches, and with 60 per cent motor efficiency, this will be reduced to, for the north ramp, 3,200 horsepower; south ramp, 3,980, for a total of 7,180 brake horsepower.

Now we go into the operation phase. We assume that the face level or the Calico Hills level is connected. This is the -- now, the discussion why the size of the ramp is 25 feet.

We looked at all the activities of the ESF and broke it down by item. If we are to support all the drifts that are to be opened, or to be tested in the ESF, we have the TS imbricate, which is 20 x 12. It will require 40,000 CFM. The Topopah Spring west drift will require the same amount because it's in the same position; 40,000. The TS east drift, 40,000, and then a package for the TS main test area is 130,000. The mechanics shop is 35,000, for a total of about 285,000 CFM.

The Calico Hills level, the CH imbricate drift, which is 16 x 9, will require about 25,000 CFM. The Calico Hills west Ghost Dance will require 25,000. The Calico Hills east Ghost Dance, 25,000; Solitario drift, 25,000; and the Calico mechanics shop 15,000, for a total of 115,000, and if you add the 115,000 to the 285,000 of the Topopah Spring level, then you will have a 400,000 CFM requirement. I mean, this is basic requirement. That means we have not done any optimization or recycling or reusing the air. We are just assuming that everything is in operation and we are supporting them independently.

Now, ventilation, as you know, in the actual --, a game of recycling, recirculation, and reusing the air, we did not do that because we do not intend to start off starving ourselves with air. We just say, okay, we need it basically. This is what we need right now. This is what we will do. But later on, when we optimize, we can talk about that, you know, in another study, the sequencing of these drifts so that we can use the discharge of one drift to be used at the next drift, on to the next drift, which is acceptable, but we would not like to start it that way. So for now we'll have to have that 400,000 CFM.

The next thing that we did was to determine which one would be our return or fresh airways. We know we have only two ramps, the south and the north. One has to be in, and one has to be out. We favored the TS ramp strategic location as intake airway because the portal of the north ramp is near buildings and near support facilities. We will have more testing at the TS north ramp. Repository interface intake airway.

We favored the south ramp as the exhaust because towards the end, or towards the latter part of the construction phase, the conveyor will be running there and there will be some dust problems in that area, and so an exhaust will be more preferable for that particular ramp. So the recommendation will be to have the north ramp as intake, the south ramp as the exhaust.

Location of primary surface fan. We know that we have to install this primary surface--the fan in the surface, but shall we install it in the north portal, or shall we install it in the south portal? We look at the favorable features of a fan location in the south portal in exhausting mode, and these are the advantages: Less presence of support facilities, because we have our concentration in the north portal; less impactive fan noise and exhaust air; less traffic, less airlock disturbance--I will show later on this airlock. We have to install this in order to get the flow-through ventilation going--the exhaust fan advantage in a vertical discharge; facilitates initial repository construction. So the recommendation is for the fan to be located in the south portal in exhausting mode.

Knowing what we have so far, this is the plan view of the ESF. This is the north portal, this is the south portal. We installed the fan in the south portal. We installed this airlock here, so that when this fan is running, it will be sucking the air coming from here instead of coming from the surface, so we have an airlock there. As we run this fan, it will force the air to go in the general direction this way.

Now, also, the -- going to Calico Hills--which is this part here--force the air to go in this direction and out into the south portal. The advantage of an exhausting fan, vertical discharge, is what I was saying is when you put this fan, we can discharge this air vertically so that you can use a lot of this surface for other stuff. The discharge, if you are going to discharge that air horizontally, will affect a considerable area.

This is just a more detailed ventilation on the main test area. The 285,000 CFM is coming this way, and in order to ventilate the main test area, we put an auxiliary fan in here, forcing the air to come this way, flushing this air in this direction and out into the ramp or into the main level drift.

Okay. We ran a computer model of this flow-through ventilation, which is the 400,000 CFM. The motor that will be installed for the primary fan is about 700 brake horsepower. The fan output is 420,000 CFM. This includes about 20,000 portal leakages, which is the airlock I was talking about, and also the structural--the structures of the fan in the exhaust side. The pressure of the fan is about seven inches water gage, and there will be one identical fan installed as a backup.

The issue on air cooling. Our intention, as required, is to maintain a temperature underground of about 82° wet bulb. This is equivalent to about 260 watts per square meter of air cooling power. This is the magic number so that heat stress can be minimized if a person is working very hard underground.

Now, the mining industry experience is that mechanical cooling is needed when virgin rock temperature is greater than 105°, because it's the heat load of the rock that is increasing the temperature, to make it uncomfortable. Our ESF virgin rock temperature is between 75-78°, going all the way to the Calico Hills, and so our preliminary conclusion is that we do not need mechanical cooling, per se, as a general recommendation, but it doesn't mean that we are absolutely going to not need mechanical cooling for areas wherein tests are conducted and they are meeting a lot of heat. We have to look at that case on a case-to-case basis.

Heating of the intake air. Heating of intake air during winter has two objectives: prevents icing of the north portal and few feet inside; minimizes potential sickness of personnel going through cold air. And we look at the mining industry general practice, same ramp situation. These are ramps. This is not a shop. No heating; personnel wear winter clothing; and chip ice manually when needed. Pending study: Establish the ESF winter intake air hazards. Now, if later on we justify that we really need a heater in the north portal, then that would be about 5300 kilowatts to heat 400,000 CFM from 5° to 42°. This is just to pass the freezing point.

Then the issue of dust. The mineral content of the rocks are definitely established to have some silica and some other deleterious minerals, so that dust will become a problem if we would not control. So we have envisioned stationary and mobile dust collection units for all those problems that we will have encountered.

For mobile units, we will have a feature that will go with the mining activity for the TBM operation, drilling, bolting, after blasting, mucking, and we have looked at one unit which is mine-proven. It's commercially available. It's MSHA tested. The report number is in here. It's a five-stage dust removal without using water, and disposal. Collection efficiency, it can go 99 per cent for particles greater than three microns; 96 per cent for particles down to one micron, and particles tested to about 0.79U. The air quantity processed for this particular unit can go as much as 10,000 to 15,000 CFM.

We still have other studies to be conducted: Ventilation life safety and monitor, evacuation and emergency ventilation (various scenarios). We'd like to do some scenarios where we will have some fire in some places underground, and we would look at what type of emergency ventilation to implement. We have to document that. Then we will have monitoring of gases and particulates.

Underground environmental climate: Prediction of underground temperatures, given heat loads of equipment and testing activities. Dust control strategy and fan noise.

When studies are needed, these apply to all phases of ESF construction and operation, and they will be conducted before and concurrent with Title II activities as data becomes available.

That ends my presentation, and I am ready to entertain questions.

DR. ALLEN: Any questions?

(No audible response.)

DR. ALLEN: How about any questions or comments from the audience?

MR. MOUSSET-JONES: Yes. My name's Pierre Mousset Jones. I'm at Univ. of Nevada, Reno, McKay School of Mines.

I have some questions, Romeo. I'll go through them. I've got about six questions.

The first one is: You used a 15 per cent leakage factor for the exhaust ducts. How did you arrive at that number?

MR. JURANI: Fifteen per cent leakage?

MR. MOUSSET-JONES: Yes.

MR. JURANI: It's a common mining industry--the range in the industry, if you have to look at the textbook, is between 15 to 50 per cent for design purposes. I would assume that we would be doing a very good job and use that 15 per cent. We could be easily going into 20-25 if we do not do a decent job in controlling that leakage, so 15 per cent is the number we used.

MR. MOUSSET-JONES: Fine. As you realize, with exhaust ventilation, you're going to get dead areas at the face in terms of clearing out dust. Have you considered using diffusers to direct air flow to dead areas so that you do clear the dust away into the exhaust system?

MR. JURANI: Yeah, definitely. We will use some diffusers.

MR. MOUSSET-JONES: So these will be additional fans needed with the diffusers?

MR. JURANI: Yes. Those are auxiliary system, which we did not address in this study because we are just concentrating on the primary system and how it looks.

MR. MOUSSET-JONES: I see.

You did refer to the possibility of using recirculation. This can be used, and I think this system is open to the use of recirculation to cut back the need for 400,000 CFM in the main ramps. Do you view this as a strong possibility that could occur with this ventilation system?

MR. JURANI: Yeah. Right now we would like to stick to what we have so that we would not be, as I said, be starving later on, because going into optimization and putting recirculation as part of our design, we are actually going into something that we do not know. For all we know, there will be more testing activities to be done, and this drift that we are showing here may not be enough, there will be some more, so our flexibility to expand--usually to expand, not to reduce--are going to be considered in the system so that the 400,000 requirement is what we would like to stick for now.

MR. MOUSSET-JONES: You refer to a computer program to do some simulation of your ventilation duct systems, and I was wondering, you know, to do it properly--and I presume you did a lot of this--that you took account of all the leakage paths that occur. Was that built into the simulation system, and have you tried scenarios with different leakage factors, and how that's going to affect your total ventilation requirements?

MR. JURANI: Yeah. We--I mean, I did that, different scenarios. I tried 15 per cent, 20 per cent, 25 per cent, but in this report here I just used about 15 per cent.

MR. MOUSSET-JONES: Okay. When you go up to 25 per cent, say, leakage, what affect does that have on total flow requirements?

MR. JURANI: Well, the face velocity will be reduced to lesser than what we recommend, and we will have to do a better job of jacking it up, I think, to about 15 per cent.

MR. MOUSSET-JONES: Okay. Where the conveyor belt--you have the airlock up near the exhaust system and you have a conveyor belt going through that airlock, if I understand correctly. That's a difficult thing to seal off from leakage. You've got 20,000 CFM estimated leakage. That's the place where you have the most pressure difference. Do you feel 20,000 is adequate?

MR. JURANI: If I could show you a data of that, actually, the conveyor is enclosed in a tube going into a building, and the building is enclosed, so as far as conveyor leakage, it's very minimal. The airlock is built around the tube where the conveyor is housed inside.

MR. MOUSSET-JONES: And my final question is: You've mentioned that it doesn't look as if there's going to be need of any extra cooling. Does that apply, also, to the heat from the tunnel boring machines? In other words, when the tunnel bore is in full action, will they be generating sufficient heat to cause the environment to be above 82 Fahrenheit?

MR. JURANI: Well, for now, it appears that way. We have not gone into the details of the calculation yet, but for now, since the virgin rock temperature is 75°, that's way below the 82° wet bulb--that's wet bulb, not dry bulb. So the heat capacity of the rock with time will become better, and so that--whatever horsepower we will have in the tunnel boring machine should be dissipated and absorbed by the rock.

MR. MOUSSET-JONES: Thank you very much.

DR. ALLEN: Other comments or questions?

DR. OZDEMIR: Levant Ozdemir, Colorado School of Mines.

I'm a little surprised with this 80,000 CFM requirement at the machine. I have not seen a tunnel boring machine that has used more than about 40,000 CFM. I'm just wondering, these velocities you use, minimum requirements, are these for a gassy mine, a coal mine?

MR. JURANI: This is just a standard mine. We took this from the Survey and you can read that in "Ventilation and Air Conditioning," by Hartman, Mutmanski, and Wong. They surveyed the different mines and they are comparable with what the, say, 100,000 to 150,000. Now, I know that there are less velocities or less volume there in the actual properties, and that's what Dr. Don Deere said. You may have to work, I mean, with another shift to boost your ventilation, but we are just putting here a system wherein we are comfortable and it's generally an acceptable practice.

DR. OZDEMIR: And the other question I have, you know, quite a bit of the dust in TBM operations is generated in just the material falling at the, you know, conveyor transfer points, and the other thing you have here which worries me a little bit, all these trucks running on that tuff material which you're going to use as the road base. Did you consider that in your calculations?

MR. JURANI: There will be more studies on dust control, definitely, and that will be addressed further.

DR. OZDEMIR: Okay. Thank you.

DR. ALLEN: Well, I would like to suggest that we break for lunch. It's twelve-twenty. We're one recitation short.

Carl, did you have something?

MR. GERTZ: Let me ask one question of the Board. Ed Cording asked a little bit about some more interactions maybe on our study about multiple TBM's, and we don't have that on the presentation, but I've talked to Ted and he can probably put something together with the individual that is conducting that study and maybe we can add that tomorrow morning. Would that be sufficient? I don't know what your time--it might cause us to go a little late tomorrow afternoon, but I think it's a subject that we'd like to interact with you on; at least hear your views of our assumptions and where we're heading because I think that's an important part--

DR. DEERE: I think that could be interesting while we had all the group here.

MR. GERTZ: Sure. Okay, Ted, we'll do that tomorrow morning. Okay, we'll add that first thing in the morning before we get into the repository phases, or to whatever else we carry over from today.

DR. ALLEN: Okay. Let's try to reconvene at one-thirty sharp.

(Whereupon, a lunch recess was taken.)

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

(1:30 p.m.)

DR. ALLEN: May we reassemble and continue with the program?

Ted, let me turn this back over to you to introduce the next speaker.

MR. PETRIE: This is Ted Petrie with DOE again. Our next speaker is Bill Kennedy who is going to discuss the ESF Excavation Plan.

Bill.

MR. KENNEDY: Well as Ted indicated I am Bill Kennedy and I am going to be providing a brief description of the Preliminary ESF Excavation Plan. I realize after looking at the agenda even though I am just getting started, I am already about an hour behind, so I will do what I can to try and get us back, on schedule.

Just a few words to start about the plan that I am going to be describing. The plan essentially uses the same general approach from an excavation standpoint, or from an excavation plan standpoint, that the reference design concept that was developed during ESF Alternative Studies, I think you can think of it as kind of a base case or a reference plan. There is obviously other ways to do some of those, which have been discussed here this morning and will continue to be discussed, I think this afternoon and maybe tomorrow.

Again, the plan that I am going to be presenting is a four TBM concept. That is the approach that went along with the reference design concept, Option 30 that was developed in the ESF Alternative Study. So it can be considered kind of a base case or a reference plan.

I guess my discussion is going to focus really on three key elements of the plan that you see here on this viewgraph; the configuration and the extent of the exploratory drifting. Again, I am not going to spend too much time on these because we've got the handouts and in addition we have seen quite a bit of this this morning already. But, again it is based, generally speaking on the ESF Alternative Study reference design concept.

Secondly, the excavation methods that would be employed, and our basic approach was that we would use mechanical methods wherever they can be shown to be feasible and practical.

The third item is the excavation sequence or at least the excavation priorities, and those again are based on the testing priorities that were developed during the ESF Alternative Study.

The next two viewgraphs I think I will show at the same time up here. We have kind of alluded to this I think already this morning, but just to give everybody an idea again of the configuration of ESF and the extent of the drifting, I think everybody is pretty well aware by now that we've got the two ramps that provide access to the upper level and two internal ramps going to the lower level. We have a considerable amount of drifting on both the upper and lower level as you can see on the viewgraph to my left over here. You can read those as well as I, so I am not going to go over them, but again there is about 76,000 total feet of drifting over 14 miles of drifting included in the accesses as well as all the lateral exploratory drifts on both levels.

Again we show the optional shaft which is tentatively located up in the north or northeast quadrant of the facility, and the main test area which is not detailed here, I have another viewgraph that details that, but it is located as well up in the northeast corner of the repository.

The next viewgraph, and again I think you have seen this already this morning as well, but a few things I want to say about this particular layout. This is the main test area layout. To kind of help you get oriented a little bit, this is the main northeast-southwest trending drift on the Topopah Springs horizon. This particular drift is the drift that goes about a half a mile out to the Imbricate Fault Zone, exploratory drift.

I think as Dick Bullock mentioned this morning, you can see there is an area dedicated to underground support facilities for the shops and the offices and the warehouses.

Primarily this area is the primary testing area over here, although we do have tests that are located in other areas. We have a science storage area as well as a science shop located down in here.

One of the things I would like to point out on this particular layout is this area of the sequential drift mining test. Now this is a test that requires the use of a TBM in order to get the kind of data that is needed. We have to replicate the same mining method that would be used for doing emplacement rooms in a potential repository. Hence, you can see there is a TBM erection chamber shown on here. The concept is that when the TBM becomes available, one of the Calico Hills a smaller diameter TBM, as soon as one of those became available, finished on the Calico Hills level, that it would be brought up to this location and erected, launched through this area and the response of the rock as it is mined would be monitored through these monitoring drifts. This TBM would go ahead and proceed another half mile anomaly out to the Calico Hills drift.

In terms of excavation methods, again we really haven't done any study, haven't done any further study since the alternative study with regard to excavation methods. As you will see in the recommendations, we think some studies certainly need to be done in this regard in the Title II phase. But the general arrangements, drawings that are part of the Title I summary design report, the work that we have just completed, that is what I mean by the design basis. These were the methods that provided the basis to develop those layouts.

While I am talking about this I will go ahead and put up the other viewgraph here because I think it is worthwhile looking at them both together.

In the Topopah Springs ramps as well as the Calico Hills ramps in the main drift, the design basis which came out of the ESF Alternative Study, the preferred concept is tunnel boring machine. That is the recommendation. I don't think really that needs any further study with regard to what kind of mining method is going to be employed.

I should mention that the colored viewgraph that we see here, I don't believe you have colored handouts, but at any rate the blue all designates drifting to be done by tunnel boring machine; the green indicates mobile miner; the lavender or purple color is indicative of roadheader; and, then the optional shaft is yet to be determined. You can see at one glance that the vast majority of the drifting is planned to be done by tunnel boring machine.

Getting back to the spreadsheet over here again, the exploratory drifts, mobile miner, TBM, the TBM again is the drift that we see. The Topopah Springs/Imbricate drift we see colored in blue. A TBM was employed in that drift because it is needed for the sequential drift mining test.

With regard to the exploratory drifts in the Topopah Springs, our recommendation is that some tradeoff studies really need to be done to determine what is the preferable machinery to be used to mine those drifts. There are some alternatives. Perhaps a heavy duty roadheader might be employed.

The reason the mobile miner by the way was selected is that it employs disk cutters. The rock is quite hard, I think, as most of us know on that level and it was felt that probably a machine using disk cutters is going to be required to effectively cut that rock. But, there is a possibility perhaps that where we see the east/west drift, it is now shown with a mobile miner, well there is a possibility and were some comments in fact in our design reviews to that extent that a tunnel boring machine is another possibility to be used in there to go ahead and erect that tunnel boring machine. These are things that really need to be looked at. They haven't been studied.

Also, the main test area, the core test area, which is not well-defined on these, it is the layout that I showed previously, that is based on a mobile miner. Again, that is an area where the rock is pretty hard. You need a machine with a lot of mobility. Unfortunately, a mobile miner, contrary to the name doesn't maybe offer all the mobility you would like to have, but it is certainly more so than a tunnel boring machine. If a heavy duty roadheader, if it is feasible that a heavy duty roadheader could be used with the conical type cutting tools, that would be a preferred piece of machinery in there. Again, that would be the subject, I think of a tradeoff study. At least one tradeoff study needs to be done to look at what are the preferred excavation methods in each of these discreet areas.

Again in Calico Hills area a roadheader would work very nicely down there in the non-welded tuff; so might a ripper type or drum type miner. Either one of those machines would work quite well.

In the miscellaneous test alcoves, we show mechanical drill and blast. Even though I said up front that the basic philosophy is that we would use mechanical where it was feasible and practical; there maybe some areas where it is just really not very practical to use that, and those areas may require drill and blast. If that layout that I showed earlier, the main test aerial layout, you will notice that many of those alcoves are shown at right angles. Those obviously--that layout is based on a mobile miner and some of those alcoves couldn't be mined with a mobile miner. That is not to say that you couldn't put some alcoves in at a different angle perhaps. But, it may be with some of those that drill and blast is acceptable. That is something again that we would recommend those need to be looked at on a case-by-case basis to determine looking at all the issues and determining what is the preferred methods.

Again, finally the optional shaft, that is something that really has only been looked at thus far in terms of where is the best place to locate it. Certainly there needs to be some analysis done in Title II to determine what is the preferred excavation method considering what it is going to be used for. It is going to be used to support the testing program and so forth.

Well the next several viewgraphs, I think everybody has got a pretty good idea of what a tunnel boring machine looks like. I've talked about excavation methods and I mentioned tunnel boring machines. We have one here again. It is a full-faced type machine, employs disk type cutters; here we have the gripper assembly back here where the machine is stabilized and steered.

Less of you may be familiar with a mobile miner; I have mentioned it. This is--it is not, I don't think you could call it a well proven machine. There's really only been one machine thus far that has been built and employed in Australia mining. It looked quite different from this. This is a second generation machine that I understand is currently nearing completion in the manufacturing process. It is going to also go into an Australia mining situation; there is a third machine being designed. Basically, it can cut hard rock because it does employ the disk type cutters on the front of the machine. You've got a head that rotates about a horizontal axis and at the same time it is slewed from side to side. It's a crawler mounted machine. It is getting very large and unwieldy compared to the first generation. I say unwieldy, I am not sure how unwieldy it is; I haven't seen it. But, it is a very large machine, very long and very heavy. This machine is stabilized in an aft location here and at the front location with the crawlers and this roller on the top. And then the cutting wheel is thrust ahead as it is slewed from side to side.

When you go to back the machine up, for example, in an area like the main test area, where there would be need to make turns and to back up and you know start another drive, you don't have to try to back it. This becomes a tractor out front. These are powered crawlers and these go into free wheel and you can essentially pull the thing back out. So that aids the mobility or should aid the mobility somewhat.

And the last viewgraph of these mining machines is the roadheader. Again, this is a type of machine, it is hard to tell from this viewgraph that employs not disk cutters but conical cutting tools, pick type cutters on the head. These type of tools typically aren't effective in the hard rock that we are talking about, the 22,000 psi, unless it is really fractured rock, you are going to have one heck of a time cutting it with this type of machine. But, this type of machine will work very well down in the non-welded tuff on the Calico Hills.

The next two viewgraphs, and I'll put these up at the same time as well, deal with the excavation sequence or priorities. Again these priorities relate directly to the testing priorities that were developed as part of the ESF Alternative Studies. Again, as we are all aware the overall idea was to get to the Calico Hills, and well, first of all the idea is to obtain information related to early assessment of site suitability as soon as we can. And in that interest we wanted to get down to the Calico Hills. In doing so of course, the first thing you have to do is get from the surface, at least down to, as this indicates, take those Topopah Spring ramps as we call them from the surface, down to the Calico Hills takeoffs, including the critical test alcoves.

I've defined what I mean by critical test alcoves. Again, this is a definition that came out the alternative study. Those critical test alcoves were the ones where would provide first of all, critical tests had to provide site suitability information and it had to be information that would be lost if you didn't get it in parallel with the construction activities. So those would be activities as we see as number 1, the two ramps on the viewgraph on my left.

Next we have got the Calico Hills ramps including the critical test alcoves in those. So, the idea again with this base case reference plan was to take the large diameter, and again we are talking four tunnel boring machines; two of the larger diameter and two of the 18 foot diameter to the Calico Hills. So, those two machines would start at some appropriate lag time, a couple of months or whatever from the surface. When each of those machines passed the Calico Hills ramp takeoff at an appropriate distance, that machine would be stopped and an erection chamber would have to be excavated underground and the smaller Calico Hills TBM launched and subsequently those two TBMs would proceed on down to the Calico Hills level with driving of the laterals to proceed just as soon as an area was opened up where you could get them in there, or get a machine in there.

So, we've got the Topopah ramps, the Calico ramps and then the Calico Hills exploratory drifting, the Topopah exploratory drifting, and finally the core test area. At some point you would have to go back up in the ramps and perhaps in the other areas and pick up the deferred test alcoves; those tests that weren't critical tests but still need to be done, and then also the optional shaft if necessary.

That basically covers the three key elements I think of the plan that so far have been looked at in this preliminary phase as far as the configuration. We do have a base configuration, the construction methods, and the priorities, excavation priorities in the ESF.

The next couple of viewgraphs here, and I am not going to dwell on these. I know they are not going to show up very well, they are so small, and you have these in your handouts. Just a few words about the TBM construction sequence. Our current planning would call for initial ground support that would occur directly behind the TBM cutter head. And again, if additional support is needed, it can be done between a TBM and the trailing gear.

Geologic mapping would occur kind of in a dedicated area, and I'll show you that in a minute on a viewgraph, immediately behind the TBM trailing gear. The TBM would be stopped to allow for excavation of the high priority alcoves or stations. For example, the Calico Hills ramp takeoff intersection, we would stop the large diameter TBM until you could proceed with the intersecting drift, the excavation of that intersecting drift without interfering and then both machines would be allowed to go again.

Permanent ground support and utilities could be installed back behind the dedicated mapping area. The idea was to leave that area as uncluttered and as visible as possible for the mapping activity.

I apologize about the size of these viewgraphs. I am not going to talk about them for very long here. But, here we have the TBM up in the face. Initial ground support would occur right here maybe through the finger shields on this TBM. Additional ground support could occur in this area ahead of the trailing gear. Back behind the trailing gear in this area we have a dedicated window. Right now or in our conceptual layouts that was 250 foot long window that was desired by the mapping folks where they could get in and do their mapping.

In that area, as illustrated by section B here, the mappers wanted if possible, to have a minimum of 270 degrees of the periphery available for mapping. And, the scheme that we show here with the temporary utilities, conveyor mounted on the rib and a small temporary ventilation duct and a utilities mounted all in this same quadrant down here, there is somewhat more than 270 degrees available.

Again, the next section over here, A, is back here in more or less the permanent utilities section. It just shows that the utility and conveyor could stay in the same location; probably would stay in the same location. But the other utilities and vent duct and so on would be relocated.

And the next two viewgraphs again, they are difficult to see, you might want to look at your handouts.

But, it just shows conceptually it is one way where a ramp station or an intersecting drift, the drift that intersects the TBM drift, it is a critical drift. It has to be started as soon as possible. How you could do that with perhaps a minimum interference with the TBM. The TBM would have to be shut down. Once you recognize where the drift was going to go, an intersecting drift, you clear that area with the TBM and basically dismantle utilities and protect your power cable. There are certain utilities like your power cable that have to still continue through that area. So, you can protect those from damage. Then you can either bring in your drill and blast or alternately if mechanical methods are practical, you would bring that machinery in and go ahead and make a couple of cuts; get that intersecting drift far enough in that you could go ahead and basically reinstall your utilities we see here on the second page, and reinstall your belt and so forth and then both machines could proceed without interfering with each other.

The final viewgraph again just a summary. I have talked about the three plan elements here. The configuration with regard to the results that we have thus far, so called Title I results. We have established at least a base case, a reference configuration and extent of drifting. Title II design, some of the things we have talked about this morning, there is certainly many refinements that can be done to this. Some of them we talked about the north ramp gradient and alignment. Those are things that are currently being looked at. Ramp curve radius, that is something else that goes right along with the alignment. And the main test area layout is something that will most assuredly continue to evolve as more is known about the specific tests that are going to be run down there and some of those ideas are mature, let's say.

Excavation methods, again the Title I results. We didn't really do any further study on those. They are based on the alternative study and as I had indicated, there are quite a few tradeoff studies that are needed to establish what the preferred methods are.

With regard to the excavation sequence and schedule, this approach of whether four TBMs, I think we have talked about that and we are going to talk about it some more. It is obviously a very expensive approach and funding is a limitation; always on programs it has to be looked at. So there are other ways of doing that and again tradeoff studies I think can be done to show alternatives and ways of doing things, and in fact select the best way of doing it.

That completes what I had to say about the base case or reference excavation plan. If there are any questions, I'd be happy to try an answer those.

DR. DEERE: Yes. With respect to the layout that you have shown there, could you go through again what the 1's, 2's, 3's, 4's, 5's, 6's, because this has six, what we have been looking in the past at things that had ten. I want to make sure they are referring to the same thing or different things.

MR. KENNEDY: Right. These were meant to show the basic priorities for the various underground elements of the ESF.

Number one should tie back pretty well to the viewgraphs that I had that I think listed those, if I can find it. Unfortunately the numbering doesn't tie one-to-one. There are seven items on this list, but again it is just these basic priorities at least until we get up through item 5. The Topopah Springs ramps down through the takeoff, those would be basically, in terms of sequencing again with this base plan, those would be concurrent activities, both of those ramps.

DR. DEERE: Okay. The first five then?

MR. KENNEDY: The first five do match between this list and the items that we see here. Number one are the ramps to the Topopah. The second priority as soon as possible, we get to this takeoff, we stop these large machines long enough so that we can do the necessary work to assemble and launch the Calico Hills TBMs and then those TBMs precede on down to the Calico Hills level. So, I've called those number 2.

The third priority is item 3, and that is where perhaps it gets a little confusing. These are priorities probably. I've called them over here priorities rather than sequence in that even though this is priority item 3, I think it is easy to see that if you start a TBM right up in this area going to the Calico Hills, at the same time you restart a TBM here, that you are going to get this excavation on this level done before you get it done down here. I was just simply trying to show the priorities. And, as it works out if we saw a schedule of this, it is obvious that you would actually get this information concurrent with or before you got this information.

MR. PETRIE: Bill, again I would like to emphasize that this is all preliminary data. When he says a priority, it hasn't--that is for this particular discussion based upon what he was looking at. It has not been given the thorough analysis that we need before we can decide what in fact should be the sequence.

DR. DEERE: Right. Thank you.

And then a second question on that. Let's say that you could only drive one instead of two of those declines on down to the Calico Hills. What would you be missing if you were going to cut out the south approach, or what would you miss if you cut out the north approach?

MR. KENNEDY: You are talking about only one of these two at least on this list?

DR. DEERE: Yes. Just musing about it.

MR. KENNEDY: I'll give you a very brief answer and then I think I would like to turn it over, maybe this is a question better answered by the testers.

It is my understanding that this one thing we've learned more about during this recent Title I or general configuration development is that much of what needs to be seen with regard, or many of the important things, not the structural features, but with regard to the facies changes between the zeolitic and the vitric, occurs down on the south end. You would probably want to use the south ramp to go down and get a look at this area here. I am not sure if you concur with that.

MR. PETRIE: This is Ted Petrie, again. I am going to spend a little bit of time on that when we get to my presentation, so it might be better to hold off on that.

DR. DEERE: Right. Thank you.

DR. ALLEN: Other questions or comments?

DR. CORDING: As you mine out these alcoves, is there a layout that you have in terms of the positioning of the utilities and services where you could mine out a side alcove, at least small ones; perhaps not this big area chamber for the startup of the other TBMs down to the lower level, but certainly for upper levels or smaller side drifts, couldn't you lay it out in such a way that you wouldn't have to disrupt the utilities and services to the TBM. You know mine out on one wall where you pull your conveyor up at that location and all your pipe services are on the other wall.

MR. KENNEDY: Right. And I think somebody indicated earlier, the preferred situation is where you can, you would locate these alcoves on the side opposite for example, especially if you are going to locate your conveyor down near the invert on a spring line and your utilities over there, you would try to coordinate that so that most of your alcoves would be on the other side. So, if that was the case, you could probably do those, particularly the smaller ones with very minimal interference to the utilities. Again, particularly if it is in an area that is amenable to mechanical excavation, then you don't have the blasting concussion and stuff, then even with blasting, you can do things with your blasting mass and so forth. I think maybe the viewgraphs I showed earlier were kind of a worse case, if the alcove had to be on the same side that the utilities are on. Occasionally that will happen, but we try to minimize that type of a situation at the layouts.

MR. MCFARLAND: Yes. Perhaps a question of Ted. Other than perched water, have there been any tests identified that are defined as critical?

MR. PETRIE: This is Ted. I'd have to ask Hemi. Maybe he has a better knowledge than I. I don't know.

MR. KALIA: This is Henii Kalia with Los Alamos. As of now we have given top priority to the perched water only. We do not think there is anything else that we need to be--we will be collecting samples which we think are not interfering with construction. We are doing geologic mapping; we think is not interfering to construction.

If we see some unusual features that were not expected making some impact, but as of now, perched water is the only one that would require stopping the operations.

MR. MCFARLAND: Thank you.

MR. GERTZ: Just let me add one other thing from a big picture of project manager's point of view. I asked my team obviously to keep lots of options open, because while we have limited funding and the next year's was limited funding, I am still being held to a 2001 license application date, so I want to make sure I can get all my information by 2001. So, while we may not have enough money to get a lot of TBMs started at once, at some point in time I may need a lot of them going so I can complete everything to get the tests done in order to meet 2001. I just thought I would throw that out into the many variable and tradeoff studies that we think about. But, right now, our committed schedule is still get a license application in 2001 despite the limited funding in 1992.

DR. CORDING: There is another definition of perhaps a critical test in terms, it is not so much that the data is irretrievable, but according to the schedule you want to get some early information perhaps at upper levels. That might be a reason you want to be able to break out at an upper level. And if one can do that without slowing the TBM down significantly, then you've got a benefit there.

But again, I just go back, Carl, to looking at all four TBMs stopped waiting for those start-up chambers to be mined down at that lower level. There is a tremendous amount of time involved in trying to get those other two TBMs in operation and you shut your other two TBMs down. So you have got several months for each one of those TBMs and that adds up to something in the order of over a year of time that these machines aren't being productive. That is the other part of it.

MR. GERTZ: Absolutely.

DR. CORDING: More numbers sometimes doesn't add up to more progress.

MR. GERTZ: A thousand men can sometimes not do a thousand man hour job in one hour.

MR. KENNEDY: I agree with that. That really needs to be looked at as how much time savings if any does four TBMs really buy you.

MR. GERTZ: And we'll talk a little bit more about that in the TBM studies tomorrow morning, I think.

MR. FRIANT: I'll save you a little time unless you are emotionally tied to that intersection between the 25 foot ramp and the 18 foot takeoff. If you would just come down with the large TBM, come off at an angle, back it up 100 feet and then go on its merry way, you have done the chamber in about three days.

DR. ALLEN: Ted, did you want to say something?

MR. PETRIE: I was just going to ask Bill a question.

How many alcoves have been identified to date?

MR. KENNEDY: A lot. I can't answer the question.

MR. PETRIE: That's why I asked the question. Do you recall, Hemi? I think it is about 100, isn't it?

MR. KENNEDY: Our general engineering drawings show a good number of alcoves.

MR. KALIA: I don't recall exact number, 60 or some. But remember a significant amount of excavation that is being made and a lot of contacts are being intercepted. When you look at both north and south ramps, there are types of information that is being looked at from the geological contact and the testing that has to be conducted. There are certainly a large number of alcoves that have been identified.

The purpose of the alcoves of course is to allow the TBMs to operate. In otherwords, you get out of their way basically. And alcoves, we have not said they must be constructed when you are mining with TBM. They can be done later on as a deferred task. They are not in the list to stop the progress of construction.

DR. CORDING: Just a follow-up to what Jim Friant was mentioning. But, Jim's comment about backing the machines up would seem to me that perhaps is what you are talking about when you indicate the TBM alternative in the Topopah Springs for the east and west drifts. You back up to that and take a radius there and do the cross drift mining there without having to use a mobile miner. Is that it?

MR. KENNEDY: No, not quite. And the reason is, I mean that might be a nice way to do it; the only reason at this point, well that is a study that really needs to be looked at. One reason why we may not want to do it that way is again looking at future needs, this drift, this main north south drift in a potential repository becomes one of the main drifts in there and there are others that parallel that. You have got to be careful with what kind of a configuration may eventually come down the road there. And of course, when you back up and start radiusing that, it gets harder, let's say to integrate that into a future pillar layout in that area, a room and pillar layout. It is a little easier if you just constructed a chamber at right angles. It certainly would take a lot more time to do that.

One of the issues there is what kind of a turn radius you might have. And of course, that gets back to what type of machine and how large a machine you have. The larger the turn radius that you have to have, the more you are going to tend to cause problems with real estate that may catch up with you in the future.

But those are things that just really need to be looked at in a tradeoff study and I think it should be pretty easy to list the issues and make an assessment of it and document it and know which is the best.

DR. ALLEN: Okay. Are we ready to move on.

Bill are you also the next speaker?

MR. KENNEDY: I am.

The second topic I'll be discussing this afternoon is the tradeoff study, a preliminary tradeoff study that looked at some of the primary elements of an underground transportation methods, underground transportation systems.

Three key aspects are shown on this viewgraph for the underground transportation requirements that were looked at in this study; specifically the muck haulage including main and secondary haulage; transportation of personnel including all the operations and maintenance personnel, test personnel, visitors, ambulance service and so forth that would fall under that general heading; and, then the transportation of materials and supplies in regard to support the construction and ongoing operations activities of ESF.

So again I will be addressing these three areas of transportation requirements.

The first thing I will be talking about is the mine draw, muck haulage, as we call it. We will look at some of the requirements there. One set of requirements, with regard to haulage grades and distances, are illustrated by this schematic and we've been over this several times, so I will just go over it quickly. We were looking at grades that vary from in the mains basically, as we see with the solid line, one of the ramps we have about 9.5 percent currently, with the current configuration. The other one is 1.5 percent and this main entry that connects the bottom of the ramps is about 6 percent.

On the lower level, Calico Hills level, the ramps have grades of current configuration of up to 10 percent, and the main connecting drift in the north south direction is about a 4 percent grade. As far as distances, you can again get an idea that in some cases you are up to about four miles with your main haulage system; about a four mile haul from the point where the material comes onto the main haulage system until it gets out of the portal.

Another requirement that bears on the selection of a haulage system is the required capacity. How much material do I have to move or transport? Again, consistent with the ventilation constraints that Romeo Jurani talked about earlier and consistent with the excavation plan that I just described, the haulage system capacity for a peak situation is based on handling four different areas; four different mining faces. A TBM on the Topopah Springs level, producing perhaps an instantaneous tonnage rate of slightly over 300 tons an hour, another mechanical miner on the upper level producing 75 tons an hour and a TBM, an 18 foot diameter TBM on the Calico Hills level producing approximately 170 and a mechanical miner down there at 70 tons an hour. When you add all those up and allow 25 percent for uncertainties, you are talking in excess of 770 tons an hour instantaneous rate. This rate would apply to either the amount that would have to be hauled either out of the north portal or the south portal. Again, with the reference excavation plan concept.

This schematic basically just illustrates that point again. We have again with the solid line we have a TBM and a mechanical miner on the upper level producing at instantaneous peak rates of 471 tons an hour. When you include the uncertainty allowance, the lower level, the additive tonnage spilling onto this main haulage way or whatever is 300 tons an hour for a total of 770 tons an hour including the uncertainty allowance. So that is the basic tonnage requirements. And again, with this excavation plan doing everything at once, you could have this same amount, what we show here is the north end, but this same amount could be required to be transported out of the south end as well.

This kind of just summarizes some of the key haulage requirements with regard to main haulage; tonnage, out of either the north or the south is 770 tons per hour; the haulage distances indicated up to four miles; haulage grades that vary between almost flat, 1.5 percent on up to about 10 percent; product size of less than 12 inches much of it is going to be mechanically cut and it would be small material and that that may have to be drill and blasted could be sized if necessary in a feeder-breaker type arrangement. And again, it is based on excavation areas that are on two levels with two headings on each level.

Based on those requirements, the main haulage systems that you see listed on this viewgraph were considered. I see six of them here basically; a rail with diesel locomotives; a rail with electric locomotives; monorail and cable hoist, that could be a double track but with a cable hoist; and then either rubber-tired vehicles either electric or diesel; and finally, a conveyor.

As we heard this morning in earlier talks, the configuration as it currently exists, doesn't lend itself to the rail haulage because of the grades that we are talking about. So, that pretty well eliminates rail as a main haulage throughout the extent of the south.

Likewise a cable hoist type system on monorail or double rails is not really applicable to the configuration we have. We have many changes in direction. We have changes in grade and so forth, so that system was basically eliminated.

The rubber-tired, either diesel or electric, doesn't really seem appropriate given the quantities that we talked about; over 700 nearly 800 tons per hour. These are pretty sizeable instantaneous quantities. When you look at the number of vehicles that it would take, you realize it would be an excessive number of them, excessive traffic on the ramp. And in case of the diesels, excessive ventilation requirements. So, it really is a pretty easy decision to arrive at the conveyors as being a recommendation for the primary or main haulage system. Conveyors, of course can accommodate very high capacities. They lend themselves very well to the configuration and the capacity and the distance requirements that I have described. If they are correctly designed, installed and maintained, they have proven to have very high reliability in many different kinds of mining applications. Likewise, they are very cost effective, if properly designed and operated. And of course, they are a well-proven piece of equipment in this type of an environment.

When you talk about conveyors, there are options as I think Bruce indicated this morning. Particularly with regard to one area where there are options, where do you mount it? Do you have a wire rope supported, chain suspended type conveyor from the roof or the back of the tunnel? Or, do you locate it up against near the spring line or down near the invert against one rib? Another issue is special conveyors for the curves. I think someone indicated that the general arrangements, at least in the Calico Hills level showed 300 foot radius curves, and that is an area that I think I mentioned earlier that needs to be, that would be a refinement. It certainly needs to be looked at in that configuration.

You can either use special conveyors to get around those curves or you can increase the radius of those curves and perhaps just use standard belt conveyors, which is certainly preferable if the configuration can be laid out that way. So these are things that really need to be evaluated in the detail design phase, and will be.

Some of the considerations during the evaluation would be such things, and we talked about some of these this morning again. The clearance envelope; what kind of a roadway width do you have? By suspending the conveyor from the back, certainly we increase the potential width of a roadway in a given tunnel size, but then perhaps you raise a safety issue if you are going to have people traveling underneath that belt, the conveyor breaks--in other words, it might be a situation where you would want to look at some kind of a safety thing like guarding the conveyor. Putting some guard there in case the belt breaks.

But these things can be looked at in evaluations and tradeoffs and the best engineering solution can be developed. Maintainability, operability issues are always something that has to be accounted for in this type of a tradeoff study. And also, any potential impacts that testing is something we have to constantly be aware of in this program.

The next viewgraph again just illustrates the point of two possible locations for a conveyor. In this case in an 18 foot diameter cross-section, we have one that is mounted down here, a rigid mount on the side of the tunnel. Another alternative would be locating it, again a rope mounted, roof suspended with chains, hanging up in this location. You can see we have considerably more roadway. But, again you may find a need from a safety aspect to guard that conveyor full length.

So while we recommended conveyors, there is certainly more work that needs to be done in the detail design phase, of course, in determining the exact configuration of the conveyor that is the best for any particular area.

Secondary haulage, these would be the material that is mined, for example, in the lateral drifts or the alcoves or in the main test area that has to be loaded onto the main haulage or main conveyor system. Preliminary recommendations are that conveyors again would make sense in the longer drifts. If you have got drifts that are a couple of thousand feet long or more, which we have most of them are down there that way, a conveyor would certainly make sense, it appears in those drifts.

Some of the shorter drifts and particularly the alcoves that are not long enough to justify or warrant putting a conveyor in. Also the main test area, those areas are probably going to be better served by rubber-tired vehicles. Again this is an area that further evaluation of these things needs to be done in Title II to determine on a case by case basis, what is the best solution.

Several options, the next several viewgraphs just show several options with regard to this secondary haulage. A load-haul-dump LHD may or may not be applicable in some of these areas. A LHD as most of you know can be used for hauling muck and also it has high utility in many areas, typically in mining situations. They can haul materials and supplies on a limited basis down there for short hauls. It can be used for other things; mucking uphill and downhill, cleaning roadways, clearing out sumps and ditches. Typically their efficiency drops off as the haul distance gets longer.

And of course, there is an illustration, kind of a typical LHD with the front bucket on it. A low profile vehicle commonly used in mines. It can be diesel or electric. Diesel is certainly more flexible, but it requires additional ventilation over electric.

Another possibility are shuttle cars as far as secondary haulage, particularly in the main test area. If you are going to use a mechanical mining machine be it a heavy duty roadheader or a mobile miner, a shuttle car might work quite well in there. Again, the only thing they are used for is hauling muck. A unique aspect of the operation of shuttle cars is that they can load, tram and unload without turnaround. They are loaded from one end, they tram back to the dump point and the material is unloaded out of the opposite end. They require typically 14 feet. The typical size shuttle cars require a little bit wider roadway, they require 14 feet or wider which we apparently will have down in the main test area. They can be either electric or diesel.

This viewgraph just shows a typical shuttle car. In this case it is a rather large diesel-powered shuttle car. Again, the material would be loaded from the machine, the excavator, the primary excavator would be up at this end loading this end of the shuttle car. There is a chain conveyor in the bed of the shuttle car which moves the material forward so that you can get a full load and then the machine trams out to the dump point and without turning around it elevates this end of the conveyor and can load onto a belt very nicely or a feeder-breaker or whatever.

And finally, there may be some areas where trucks of one type or another, one size or another are needed down there. Some of this remains to be seen. It needs to be looked at. Some alcoves for example; some area where for whatever reason you might not be able to load it onto a belt that you need to take the material on out to daylight. I can't think of any situations right now where that would occur, but if it does, then something like a truck may come into play; there are several different types of trucks that may be applicable. And there of course is a truck. It happens to be a fairly large end dump truck come out of a portal some place.

Well I am not sure--I appear to be missing a viewgraph here, but I'll just kind of wing it. I am not sure whether you have it in your handout, but the next function would be the transport of personnel. Of course we are talking about the operations people, the maintenance people, all the inspectors, the visitors, injured people perhaps; all of these types of functions have to be accommodated and again our preliminary recommendation is that they would use rubber-tired, probably diesel powered vehicles. In some case electric battery powered vehicles may be worthwhile where the distances they are going to be used is not great and they don't have to traverse steep grades or anything. Perhaps down in the main core test area or something like that. But again, rubber-tired vehicles and the exact nature in terms of the types and the size and the number needs to be looked at in Title II. This is kind of a typical personnel carrier or a rather large personnel carrier. You can take quite a few people underground in something like this.

And finally, you have to transport materials and supplies underground. All the consumables, all the materials and supplies required to keep the ESF running, need to be taken underground. In some cases, things have to be taken back to the service. Again, preliminary recommendation is rubber-tired vehicles. They are highly mobile, highly flexible type of vehicles, well proven in this type of environment and this type of surface. Again additional analysis is required really to determine in Title II how many of them you need, what sizes, what types.

When we are talking about all of these, whether it be personnel transport or particularly, let's say in the area of the secondary haulage vehicles, those really need to be evaluated in concert with the mining equipment that is going to be used. That really comprises the system, the excavation equipment and the haulage equipment that is going to support that operation. And that needs to be looked at together, at least those pieces of equipment.

In summary, main haulage, recommend belt conveyors. Certainly the details of where you mount those and sizing, preliminary, something on the order of 36 inches looks like it could certainly support, perhaps even smaller could support the excavation activity that is currently envisioned. But, the details of those conveyors can be worked out in Title II.

Secondary haulage, longer drifts, again conveyors. The details of which need to be examined in Title II. Rubber-tired vehicles in other areas, particularly in the main test area and the short drifts.

Personnel transport and supplies transport, rubber-tired vehicles, again the details of how many you need, what sizes and specific configurations need to be worked out in Title II.

That basically completes the discussion I have on the transportation analysis. Are there any questions or comments regarding that?

DR. DEERE: I think that was a very clear presentation. And, I believe we will try to make up a little time and move right onto the next topic.

MR. PETRIE: My viewgraphs giving the agenda have disappeared. I kind of thought somebody might have scarfed them up with their own, so anyhow, this will be the last talk on this section and then I'll introduce the next section and we'll be off and running again.

I'm going to talk a little bit about the rationale for a phased ESF construction approach. This can be about as long or as short as we want to make it, I think. At any rate, the rationale for the phased approach is that we'd like to--well, we'd like to establish hold points for evaluation and control of ESF development; that is, points where we can ask questions of ourselves, such as:

Have we gathered the scientific information that we need in where we've gone? Has our approach to collecting scientific information been adequate? Do we need to make changes during the next phase, when we go through the next phases of the construction? Is the approach to the performance of future phases still all right? Is that where we want to go?

Again, site suitability. Is the site still considered suitable? Should we stop here, or is there specific information we know we now need that we would get by going in some other direction?

Cost impact, it allows flexibility and it maximizes the use of limited resources. As you know, we may end up with only enough money to buy, for example, one TBM next year. So we've got to make sure that we use that to our best advantage.

And the schedule impact, the design-build methodology allows construction to begin before the total design is completed, and again, that's essentially a utilization of resources to the best of your ability.

Now having said that, we have a couple of alternatives, and, plus, there's going to be some more which we mentioned earlier we'll be talking about a little bit tomorrow morning, and let me say first when I put this together I had no intention of saying that that was going to be number one, that'd be the first thing we'd do, or that would be number two. I should have used random numbers, I think, and just thrown them at the--because we haven't really decided yet what is the best way and what is the best phase to begin with to get the information that we need, and I'll talk about those things as well.

Just by having these phases, though, the thought is that you could start over in the south there if you wanted to, do this and this, and then you could make a decision here as to, zip, go over here, go down here, or you could--or you maybe will say at that point, I want to get that done. I want to get to this main test area as quickly as I can and get that going.

But the point I'm trying to make is that all this was intended to do was to break it up into sections that were feasible from a design and/or construction standpoint, and of course, my construction people look at it and say, well, that's not what I would do, so let me just show you the next one.

Another alternative is to use Roman numerals instead of Arabics. So at any rate, with that scheme we get --the first phase is--goes, let's see, down to--I'm not sure whether it goes to here or to here. The second phase is, or another phase is this one, which is the Topopah Springs level. The third phase is the one that goes down to the Topopah Springs and the Calico Hills from the north, and a fourth phase is the main test area and the optional shaft.

Again, this is again just something that we're looking at, amongst many others, to try to decide what, in fact, would be our optimum approach this year. It might change next year, but this year, where should we be going first? And, as I said, we have not decided yet. We are, during the next--over the next--I'd say by the end of October, we should have made a decision as to whether we're going to go north or south first, and that's about all I have with respect to the phasing. I have a couple of other shots I'd like to show you, which I think--

MR. GERTZ: Excuse me, this is Carl Gertz. Leave that up again.

Don, this was put together before your

recommendation, so it's just coincidence that number one looks like one of the packages you talked about, and the second one wouldn't be unlike one of your other options, Roman Numeral three.

DR. DEERE: You sure that wasn't done at the noon hour?

MR. GERTZ: Well, it looks like, by coloring, that it may have. I guess I'll ask Ted for an honest answer now.

MR. PETRIE: Honest. Honest Injun.

MR. GERTZ: No, I've seen this earlier, but--

DR. DEERE: Well, if it was, I congratulate you.

MR. PETRIE: Okay. Now, somebody asked some questions: Well, what do you see in the north that you don't see in the south, and vice versa? And we have a couple charts and I'm not going to spend a lot of time on this because I'm not your local expert, but I will just put them up there, and if you have a few questions on them, we'll try to answer them.

Let's see if you can see what this is. Well, let's see, in the north ramp, if you went through the north ramp, these are the rock types you would be cutting through when you got to the Topopah level, and then as you got down to the Calico Hills level, and this one shows what happens if you choose the south ramp. You go through all of these, including, of course, all these faulted areas, and then down to the Topopah level and into the Calico Hills.

I thought it was very interesting. At least I can get a better feel of what's going on. Let me just leave it there for a minute, and if you have any questions on it, we'll try to answer them. But again, I just wanted to give you an idea that these are the kinds of things that we're thinking about in trying to make a decision as to where we should spend our resources over this next year.

DR. DEERE: Yes, Don Deere here.

As I recall, most of these faults that you show do occur almost at right angles to the direction of the ramps. Isn't that right?

MR. PETRIE: I'm not sure that's true. I don't think that's--well, I don't know.

DR. DEERE: They're mostly north-south trending, and we're mostly--until we get into the J part and turn the corner.

MR. PETRIE: I was thinking of the Ghost Dance one. I think that's--

DR. DEERE: Yeah, Ghost Dance is not quite normal. It's the one that's a little more oblique.

MR. GERTZ: In general, your comment's correct.

DR. DEERE: Because this will make a lot of difference in the ease with which one can go through these. When you're parallelling one, it's where you usually get over-break problems and occasional fallouts and things such as that.

Are there any other comments that anyone in the audience might have about this; some of the geological fellows?

MR. WILLIAMS: Dennis Williams, DOE, part of Carl's team.

I helped put together these drawings in a kind of a cartoon or conceptual standpoint, but I think your observation about the orientation of the faults is correct in a broad sense. I think a couple of critical issues that this shows, that were important to us in laying out the testing program in the different ramps, you notice on the north ramp that the takeoff ramp down to Calico Hills does not encounter the Calico Hills in that ramp, per se, until it actually gets down into the Calico Hills level. On the south end, however, you do get down into the Calico Hills in that takeoff ramp, so that helps give us a little earlier look at those particular features down in the Calico Hills.

If you just kind of add up the projections of the faults on these two different ramps, you'll see that the south ramp has a lot more apparent intercepts than you would on the north ramp, and I think that came--possibly comes into the area of one of Dr. Deere's comments about the Ghost Dance Fault versus other faults, and if you're looking at this as a fault system and looking at the characterization of a fault system versus individual faults, you'll see more of that in the south ramp area.

Again, this geology is descriptive, but it should be taken more as a cartoon to give a general impression of what we're dealing with down there as far as the accuracy of contacts and faults.

DR. DEERE: Okay, thank you.

From these, perhaps one could pick out where would be the easiest place to go with this third excavated road header, excavated upper drift. Perhaps you could comment on that. Would it be easier to reach that in the north ramp or in the south ramp?

MR. WILLIAMS: I'm sorry I left too soon.

I don't know whether I could, at this time, make a statement on that, but I guess my tendency is to try to encounter a feature like that from one of the ramps instead of going with a whole new drift into the situation, but one of the things I'd early consider would be coming off the south ramp and going for that particular intercept. It may be a little difficult to do, but that would be the only ramp, main ramp that you would have the option to do that with. Obviously, you wouldn't hit that particular area on your north ramp.

MR. PETRIE: Well, I'm confused, okay? Where are we trying to get?

DR. DEERE: Well, we're trying to get into that--someplace in that purple layer.

MR. PETRIE: Oh, okay.

MR. WILLIAMS: Yes, you're trying to get into that purple layer into the area of the Ghost Dance or the Abandoned Wash Fault intercept, yes.

DR. DEERE: Right.

MR. PETRIE: Oh, okay. So then, therefore, you've got to do it like the man says. If you want to get into the Ghost Dance area, that's where you're going to try it.

MR. WILLIAMS: Yeah. Somewhere in the vicinity of the south ramp.

DR. DEERE: Okay. Well, thank you for those comments.

MR. PETRIE: That's about all I had for the moment. We'll talk a little more tomorrow morning when we have some of the other diagrams on some other alternatives.

DR. DEERE: Right. Any possibility of getting copies of those?

MR. PETRIE: I'll stamp them "draft," and give them to you, yes.

DR. DEERE: Yeah, that'd be fine. I'll turn it back to Clarence now.

DR. ALLEN: Where are we?

DR. DEERE: Ted is going ahead with his second topic.

MR. PETRIE: Okay. Now I'm going to talk about the approach to waste isolation and our concerns there.

DR. DEERE: Oh, wait a minute. Weren't we supposed to have the break now?

(Affirmative responses.)

DR. DEERE: Let's take a break.

DR. ALLEN: Reconvene at three o'clock.

(Whereupon, a brief recess was taken.)

DR. ALLEN: Yes. May we reconvene, please?

And, Ted, I guess you're still on.

MR. PETRIE: Thank you.

Now I'm going to introduce the waste isolation approach, but before I do that, I was going to close out a little bit on the effort to date, and we've shown you this before, but I think it bears repeating. What we have is a preliminary Title I design. A substantial amount of work is needed before finalization of the design, and construction starts, and this work will be done during Title II over the next probably three years, and let me just say that this is an opportune time for TRB and our other observers to provide us with some insight into where their concerns are so we can get them included into our Title II design and into our thinking.

DR. ALLEN: We're trying.

MR. PETRIE: Very good, very good.

So anyhow, as somebody told me one time, he said, "Petrie, you can use all the help you can get."

(Laughter.)

MR. PETRIE: Okay. Title I level of detail, again, going back into this, the preliminary stage of project design utilizes the conceptual design to go into the Title I. In this case, we consider the exploratory studies, consider the alternate studies as, in effect, a conceptual design, and we need to have performed enough design work during the Title I so we can get, really, design, construction, and cost--cost and schedules. That's what we aim to do within the DOE. That's what our major function is. But it does, as I said, give us an opportunity to get thoughts from all walks of life; everywhere.

Then I have just a few diagrams here, and I think you've seen some of these; and really, all I want to show--I'm just going to flash them up, take them down--and what I'm really saying here is it should be clear from these that what we've done is not something you can take and go build something with. That's not where we are. That's at the end of Title II, and as I say, I'll put them up, flash them up a little bit, and especially on something like this, which is a conveyor, and again, it should be obvious that this is not the kind of a document you give to a manufacturer and say, "Go build something," or a procurement man and say, "Go buy it off the shelf." No way. These drawings are not in that shape, but they are fine and good for what we want them for, which is to get cost and schedule information, and get our arms around the scope of the project.

So having said that, let's get into what the next topic is going to be, which is the consideration of waste isolation in the ESF. The programmatic guidance, requirements, and regulations are included in 10 CFR 60.15(c). The project requirements are in the ESFDR. That's our requirements document. It's about two inches thick and I think most of you, or I know Ed and Russ have seen them. The Q-list tells us which items are important to waste isolation, and what we need to remember is the ESF is expected to be an integral part of the potential repository. Therefore, we've got to give it the same kind of considerations, to the extent we can, that we would to the potential repository.

Some of the studies and considerations in progress and to be completed during Title II are the following, and they are the control of fluids and foreign materials--and we have some discussions on that this afternoon--and some additional items are those indicated here, and we also have indicated the design phase, and when I'm talking about design phases here, I'm talking about one through ten, and where we would expect to have to have this pretty much under control in order to be able to complete those designs.

So, for example, surface construction water movement, we would have to have that resolved as to how much water we're allowed to put on the surface before we can say we have completed the design for Phases 1 and 2. And another one might be, let's see, this one: Access and collar thermal stress. We would need to have that completed before we could say we had completed the design for Phases 2, 4, 5, 6, and 10. That could be the drifts. And the others are indicated here. Again, this is preliminary, but this looks like when we've got to have that work completed and for which phases.

And I don't think I'll spend too much more time on these things. We're going to talk about them. That's the Title II level of detail I've mentioned already, and the major considerations for Title II. That is the verification of design and design inputs, results which have occurred during appropriate design phases, and incorporation of waste isolation requirements into the design. All those will be carried out during the Title II design phase.

So now I'm at a little bit of a loss. I don't know who's next. Hemi, you're next.

DR. ALLEN: Let me ask, are there any questions from the Board members or any staff?

MR. STREETER: Will Streeter, Parsons-Brinkerhoff.

I just wanted to confirm, the design phases you're referring to are the one hypothetical illustration you had in your last presentation?

MR. PETRIE: That's correct. It was the first one. The one that went one through ten, I think.

DR. ALLEN: Okay, thank you.

MR. PETRIE: Okay. Then Hemi Kalia will talk to us about introduction of foreign materials.

MR. KALIA: Thank you, Ted. Good afternoon, gentlemen, Dr. Deere. As Ted said, I am Hemi Kalia. I work for Los Alamos National Lab located in Las Vegas, and I'm responsible for coordinating the ESF testing program.

The topic of my discussion is the use of, or introduction of foreign materials in the ESF, by which I mean any material which are other than native or the welded tuff. As we do the construction, several materials--such as concretes, steels, and so on and so forth--will be introduced and it has always been a concern as to what we are going to do and how we are going to manage those in this particular project.

Requirements to manage the material have been realized by the project office from the early days because of the nature of the location, which is the unsaturated hydrology in site characteristics where the fluids or materials can potentially interact with the existing rock formations and could result in getting erroneous data.

Other basis that exists for this requirement comes from the Code of Federal Regulations 60.133, which basically talks about post-closure performance and is concerned with maintaining the site integrity. How we have to do that is we need to understand what we are doing in the pre-closure phase so that the materials used would not have an impact on the waste isolation, would not affect the waste package behavior or the site behavior. This information is then put into the SCP under Issue 1.11, which talks about how do we go about--what are the concerns and how we will handle this.

60.133, as I indicated, is a post-closure design criteria which requires that the underground facility should contribute to containment and isolation, assist the geologic setting, and consider thermal and thermomechanical response to provide sufficient flexibility. The concern, of course, is the containment issue, and as Ted indicated in the last presentation, that the ESF goes into the repository. We want to assure ourselves that what is being done during the site characterization phase would not in any way impact the site's suitability in the future to be selected as the repository site to contain the waste.

Issue 1.11 requires that we show compliance with post-closure and design criteria of 60.133, and provide information that allows us to resolve that particular issue.

As I indicated, during the construction, various materials will be used, and these materials would, over a period of time, react with the environment and could cause adverse chemical effects because of their chemical reactions with the materials use, such as concrete, shotcretes, grouts, and so on and so forth. During construction, it is required in the SCP, and also it has been an area of concern to limit the use of water. It's a similar concern. Water will be used during construction, during operations, and decommissioning and the intent, of course, is to again assure ourselves that there will be no negative impact on the site, particularly the unsaturated hydrology.

This major concern exists during the site characterization phase, because a lot of the information that we are seeking would have to be with respect to unsaturated hydrology. We want to make sure that the water that we do intercept is, indeed, the water that was native, and not something that was brought in during construction phase.

DR. DEERE: Could I interrupt, please? Don Deere here.

Could you go back two slides to the one that says, "Materials"? I bring this up simply to mention that organics apparently is of some concern because of their ability to make some of the actinides soluble.

MR. KALIA: Yes.

DR. DEERE: And I wondered if this was the point that--

MR. KALIA: Yes, that is the point.

DR. DEERE: In one of our meetings Dr. North, you may recall, was quite concerned about it, and felt that there needed to be a great control during construction that somebody didn't throw waste and things like this that might eventually be a carrier.

MR. KALIA: Absolutely correct, and as I go through this I will explain what project plans to do at this time in the way of helping control mechanisms and control systems, so hopefully that will not be the case. At least the effort is to do that.

DR. DEERE: Thank you.

MR. KALIA: As I have indicated, it is somewhat repetitious, but I do want to drive the point that there is a potential impact from the materials being used. Again, the chemical changes could affect the--construction and testing could affect the data quality, which could impact the--perhaps indirectly, waste isolation and the data might be subject to some debate. We are concerned with the test-to-construction interferences because, again, the construction could have impact on the test data. We have concern with the test-to-test where one test maybe is to inject water or some other fluids, while other tests nearby could be impacted by the test activities.

As I said, I have a little more on that. I think basically, again, they could contaminate the unsaturated formations. The organics may have the impact on post-closure performance. It could alter the geochemical environment, and affect the waste isolation capability.

It was, therefore--has been a concern to the project as early as in '86, late '87. The Title I, earlier Title I process project directed Los Alamos to look into the fluids and materials that will be used during the construction of the old ESF, and a study was conducted which has been published, or the Los Alamos report for the project we can provide you if you'd like to have it. It goes through discussions and evaluation of the extensive details of tables, listing all the materials that may be used during site characterization effort, and their potential impact.

It also looks at the recovery of those materials. Some can be recovered and, therefore, have less of an impact. Some become an integral part and recovery is not possible. It could have a potential impact.

For the current effort for the Title I process, we were directed by the engineering group--again, Los Alamos was directed to develop a management plan for the management of the fluids and materials, tracers and so on and so forth, within the ESF. The scope was broadened to look into use of these materials during site characterization.

In addition to this plan, there are two administrative procedures; AP 5.32, which is the test and evaluation plans and a job package AP that requires that the scientists who are going to conduct experiments must identify actual material they'll be using, quantities, where they'll be used, and so there are two places where these controls are identified.

In addition, before a material is used, the project office says you can use this material, or says, no, you cannot use this material, based on what is being found by analysis. So there are two plans that already exist, two of the administrative procedures to guide this to some extent, and then there's a management plan that we are developing for the project.

The information that gets to the designer, in terms of use of material, comes through the planning process, which is guided by the AP 5.32, and it requires that you look into the waste isolation capability of the site, that it will not be compromised is a requirement from that AP; also, that for the general arrangement, a review of the Title I package for north and south, detailed test planning, and they identified the constraints, such as dry mining for the purpose of testing. They identified the use of tracers in water, although it did not--and also in the water, although it has not identified yet as to the potential impact of those materials on the site performance.

The plan that is being developed will support the approach for controlling the use of materials within the Title II process. It has undergone two project reviews. Comments are being resolved, and we hope to have this one out by another three or four weeks as a project document. It'll be used then for the management of the material.

The way we see it, the way it requires flow to occur at this time is to develop a controlled database, which is controlled by the project, which provides the listing of all the fluids and materials, tracers to be used, the quantities, locations, their compositions, along with the interpretation of their potential impact, their site characterization on waste isolation.

The way the information gets to this control document, it comes out of--through the investigators providing all the site characterization work. As the test planning packages are developed under their effort, they identify the quantities, types of materials they will be using in their effort. We also realize that the design team would identify materials such as steels and concretes and rock bolts and whatnot they'll be using. Their material will be identified from them, the potential interface with the repository, as to their preference perhaps.

So all this information then moves to getting analysis done, with these as being criterias: Is it a potential impact to waste isolation? Will it potentially affect the data collected in the test for the site characterization effort? And I think the answer to both would have to be negative before material makes the controlled data list, or a approach to recover those materials should it appear as a potential problem.

Under the controlled database, then, the components are an inventory of all approved materials, and this will include just about anything that will be used there: Any impact on site characterization, any impact on post-closure, all post-closure considerations; impact on waste isolation; and constraints on use of material.

You have in your handout, also, which I would like to point out just as a sample, just a compilation, a table of the material I lifted out from the earlier Los Alamos report. It talks about the type of detail that had gone in developing that document, and I just want to show it for illustration purposes and to point out that the project has been sensitive to this concern.

If you look at the list, which is a very short list, it looked at the anchors. These anchors will be used during the plate loading test with the multipoint extensometers. It has material such as spray paint that may be used to mark the walls, perhaps, for study points or some other purposes. It includes use of water for dust control. They have gone into identifying surface use of water, underground use of water and this type of information.

I sort of switched gears here just a little bit to talk about a apparatus that was also designed at the same time. It was to inject a tracer into the water, main line water which was going to go to the--for the underground use in the ESF. It's a relatively simple device to inject tracers. The target was to get a tracer concentration of about three parts per million, and really simplistically, it's strictly a 100 gallon tracer reservoir with a metering pump, some pump controllers, signal converters and flow meters and whatnot, and bring the material to a surge tank where they are then fed into the main water supply system.

The device was tested at Los Alamos and found to be adequate to maintain the concentration about 20 parts per million, and we tested that in waves, discharge waves. It is a prototype device which is currently stored at--I believe it was moved to a warehouse for safekeeping, but should we choose to use this I believe it will need to be probably scaled up for new use, to a two-shaft condition. Basically, the large chamber, the reservoir, some controls, and then the discharge end. So it's a portable device, simple, you know, nothing very fancy about it.

The work that was performed earlier on by--I guess I would like to make this very clear, really, that in the earlier effort that was done to understand the impact of fluids and materials, the basic conclusion was that they did not see anything that will impact the waste isolation capability or the data as long as we manage the water controls for testing for that basically hydrologic impact on the site.

The basic conclusions of the report, was that based on information currently available, the use of fluids and materials in the ESF will not have a significant impact on the site characterization data or on the ability of site to isolate nuclear waste from the environment. It also indicated in the vicinity of selected site characterization tests, the use of water should be controlled to minimize adverse hydrological impacts. And the conclusion they had arrived at was the use of hydrocarbons or solvents underground should be minimized.

In addition to the list that you see as a control in the controlled data, an additional list would exist from the environmental perspective, environmental safety and health concern on toxics, hazardous waste that may be used in the site.

So in summary, then, I want to indicate that the project has been sensitive to the requirements of both the 10 CFR 60.133, which are addressed to the Issue 1.11. It has diligently made efforts to develop methods and controls to allow it to control the use of introduction of foreign materials, and in the Title I effort, through the test planning process, at least for the ESF, effort has been made to identify the impact on testing through the use of waste materials, and either by allowing adequate separations of the tests, or by using tracers and controls. We have tried to address that concern.

The current plans which once the management plan is approved, should that be the case, it would result in developing a controlled database which probably would require developing a procedure into how to get the material into the controlled database, and all the material used in the site characterization effort would then go through the controlled database, which will provide information with respect to quantities, locations, types of materials, and composition that are authorized to be used. If a material is not in the list, I believe it probably would not be considered for use in the effort.

That is basically my presentation. Are there any comments or questions?

DR. ALLEN: Any questions from the Board or staff? Russ?

MR. McFARLAND: A question of clarification; perhaps Carl. Is the drift in the Calico Hills being looked at any differently than the drift at the proposed repository level?

MR. GERTZ: I'll pass it on to Ted. I see he's ready to do it.

MR. McFARLAND: It'll never be part of the operational area. It won't fit the GROA definition of NRC. I've pondered that. In listening to Kalia on this, it--

MR. PETRIE: Well, it will not be a part of the GROA. One still has to consider the impact on waste isolation, so to say it's being treated differently, I say that it could be if it was found to be, for some reason, appropriate to do that, to treat it differently from a construction viewpoint since it is not going to be a part of the GROA. From a waste isolation viewpoint, you know, that will be treated the same.

MR. McFARLAND: But in terms of QA documentation control?

MR. PETRIE: Well, the same controls, yes. QA would be the same. I don't see any difference there.

MR. McFARLAND: Thank you.

MR. PETRIE: But if there were some stresses or thermal stresses one were to try to take into account in the Topopah Springs level to try to assure ourselves the repository in a GROA would be satisfactory, those same things might not apply--I stress "might"--to the Calico Hills.

MR. McFARLAND: Thank you.

MR. KALIA: From testing perspective, Russ, we are doing the same thing. We are certainly concerned about Calico just as well in the main test level, on test-to-test interference or test-to-construction interference, and the use of tracers and other controls we'll impose just as we'll do in Topopah.

Dr. Deere?

DR. DEERE: Yes. I wondered if you've considered the possibility that there might be some exploratory drilling done from the lower drift in the Calico Hills? Do you see a restraint drilling into the saturated zone, and even a little deeper?

MR. KALIA: From Calico?

DR. DEERE: Yeah. I guess the first question, do you have any in the program at the moment?

MR. KALIA: None that I know of. We just have a couple of holes below--not within the ESF.

DR. DEERE: Yeah. Within the ESF I was thinking.

MR. KALIA: Yeah; not within the ESF.

MR. GERTZ: I know of no plans to drill from the ESF into saturated zone. We do have drill holes that will go into the saturated zone within the repository perimeter, I believe, but...

MR. KALIA: Not in the ESF.

DR. DEERE: This would be frowned upon? I mean, if there were--

MR. GERTZ: Sure. You don't want to create preferential pathways to the saturated zone.

DR. DEERE: Simply because you're getting a vertical pathway down into the saturated zone.

MR. KALIA: A lot of concerns were raised when the shaft in the ESF was going down towards Calico, and a lot of objections were raised as to, or concern as to we are creating a preferential pathway, and that's where we backed off and put a multipurpose borehole to try to get the information, so I don't believe that we'll intend to really penetrate Calico within the ESF boundary.

DR. DEERE: Yes. I anticipated that would be your answer. I just wanted to check. I just saw a potential there for--

MR. GERTZ: Yeah, well, that's one of the reasons you see some of these ramps that are going around the perimeter of the repository, rising into the Calico Hills. That's why many of our ESF alternatives that had direct pathways were looked on with less favor for capability to isolate waste, because they created pathways from Topopah Springs to Calico Hills.

DR. ALLEN: Other comments or questions?

(No audible response.)

MR. KALIA: Our next speaker is Merton Fewell from Sandia. He's going to talk about the calculations and analysis that will go with this.

Thank you.

MR. FEWELL: My name is Merton Fewell. I'm with Sandia Albuquerque, and I want to talk about the control of fluids: the role of performance assessment, and this is meant to complement the talk that Hemi just gave in that there will have to be some evaluations done to determine what the impacts of tracers, fluids and materials are on a repository performance, potential repository performance, on a test-to-test interference, et cetera.

The way we think of this is the control process that Hemi just described is sitting in this box. The user community, the A/E's, the designers, testers and repository considerations, et cetera, will make a request to the tracers, fluids, and materials control group to use a quantity of materials or fluids, and the question will have to be asked, "What quantity can be used, and what's the location?" The first question that will be asked is, "Has PA evaluation been done?" If the answer is no, then there will have to be a PA evaluation, and if the answer is yes, then there should have been controls that had been put in place from the PA recommendations, but before these controls can be done, the PA evaluation will have to be done to quantify.

Now, the identification of controls is not just the PA effort alone. It's an integration between the ESF, the design, construction, and testing; the repository design, construction, operation; surface-based testing; and PA analyses, and these interactions or integrations can occur in several different ways. One is PA analysis will need to know something about the design, construction, and testing before we can do analysis. Once we've done analyses and have results, we have to put those in terms that the users can use.

At a higher level, there must be a budgeting of materials or fluids such that the total use by all the users that would use the material or fluids is such that a limit is not violated, so there has to be some integration in that sense, and there has to be forward-looking such that, for example, a design consideration or construction, when your road watering doesn't use up the entire budget and there's not any budget left for water use for, say, surface-based testing.

Now, the way you might look at this is that there's a cycle or a site characterization engine in which there's project resources fit into, and the knowledge of the site, or knowledge of the site is needed to design and construct and test the ESF, is also needed for surface-based testing. That information is also needed to do a PA evaluation. The PA evaluations are needed in order to design and construct and test the ESF and for surface-based testing. From that will become a greater knowledge of the site, and this will continually--to iterate our cycle until we reduce the uncertainties.

This didn't come out too well. What this is meant to be is the uncertainties of our ability to understand the site is composed in two different components. One is the data, parameters and values, and the other is conceptual processes and events. As the preparation of the ESFDR started, the uncertainty is level, or we have not reduced the uncertainty. When this site characterization engine continues to iterate such that PA impacts design, design impacts PA and testing until--and we continue to revise the ESFDR, lowering the uncertainty until we do surface-based testing, which further lowers the uncertainty. The construction of the ESF will, and finally, testing, until it hits some acceptable level, and that's the role that I see of performance assessment in this process.

Now, on the top, I'd like to break it down into three parts. One is we have devised a plan for support of the ESF Title II design. I'm going to talk about analysis that are required to support the control of fluids that are the result of this plan, and I want to discuss a few--two, in fact--specific analyses that recommend--and recommendations that support control of fluids.

The motivation or the purpose for coming up with a PA plan for Title II design support was twofold. One was to address NRC Objection No. 1 for design control, and another was to implement and aid in long-range planning and utilization of resources.

Many of these PA evaluations or analyses are such that current technology does not allow us to do them. We need to get as far in advance and project as far in the future so that we--when the time comes to support the controls for the materials and fluids, that we have a PA evaluation, or the capability to do that.

This design control, the objections will be broken down in three parts. It must consider 10 CFR 60 requirements. It must recognize the need for integration between participants responsible for design, construction, performance assessment, and operation, and the DOE should demonstrate the ESF design control process has provided for systematic review and consideration of 10 CFR 60 requirements in the development of the ESF design, and for verification that these requirements have been, in fact, incorporated into the design. That's the motivation for coming up with a plan.

The elements of the plan that resulted for Title II is identification of the 10 CFR 60 requirements that are applicable for the design operation and construction of the ESF; the linkage between these requirements and the ESFDR, the ESFDR being the working document that we will use to show compliance, and which the designers, operators, and constructors will use as guidance for implementing the 10 CFR 60 requirement; a linkage between the 10 CFR 60 requirements and analyses that are required to support the controls of fluids and other--and all of compliance with 10 CFR 60, and I might note that analysis is used in this to be a very broad term. It might be evaluations, it might be experiments, it might be expert opinion, or it might be complex numerical calculations.

Another feature of this plan is to integrate it with the design schedule such that the design schedule is not held up by the performance evaluations, and then to identify some products and methods of evaluation. The primary product of this plan will be periodic SAND reports, and update of the performance assessment appendix to the ESFDR, which will present results and recommendations for addressing concerns in the ESFDR requirements.

And also, identification of resources. By identifying the types of analyses that will be needed, it can be used to plan what organizations should be doing the analyses, et cetera. And then to apply the results of the analyses to the final compliance review to show that, in fact, we have complied with 10 CFR 60 requirements with evaluation.

And last is a implementation/integration of PA, and this has been done primarily through the TIG, the Technical Integration Group
for the ESF on an informal basis. There is also a sub-group of the TIG that is for control of materials and fluids. The primary emphasis in that group early on is to identify the fluids and materials that may be accurate such that we can get an early idea of how to do the analysis.

If you look at this schematically, your plan is broken down like this. There's the 10 CFR 60 requirements that apply to the operation, construction, and design ESF. These relate to constraints and performance criteria in the ESFDR. From those performance criteria and constraints, we can define analyses that will address the concerns, and these analyses can be grouped such that there's a linkage between the 10 CFR 60 requirements, the requirements in the ESFDR, and analyses. So by doing the analysis, the results of the analysis relating back to 10 CFR 60, it also relates back to the ESFDR, and it also relates back to 10 CFR 60 requirements.

In doing that type procedure and the way that was done is the 10 CFR 60 requirements and the language associated with those 10 CFR 60 requirements that apply to the ESF were compared to the language in the ESFDR, and the linkage was made with the ESFDR between the 10 CFR 60 and the ESFDR.

Going from the other direction, the ESFDR requirements were examined and reviewed to determine what analysis would be required to address the concerns. But in so doing, the 10 CFR 60 requirements and the accompanying ESFDR requirements were grouped in three groups: Those in which there's no PA analysis required; those in which required PA analysis; and those which would be satisfied or roll-ups of satisfying lower level requirements.

From that, analysis categories were defined as fluid flow, geochemistry and materials, thermal/structural, and total systems. The analysis categories that apply to the control of fluids are the first two, although thermal/structural and total systems could be, in a coupled sense, could apply, because thermal/structural or thermal effects, structural effects might cause preferential pathways to be opened up. Then you'd have a fluid flow problem and then a total systems problem. But it's primarily the first two.

Now, some examples of--or sample ESF requirements related to the control of fluids are given in the next overhead, and this is a view out of the database that exists that takes all 337 of these requirements and links them with 10 CFR 60 requirements, links them with analyses, types; links them also with the results of analyses that have been completed to date, and these are such that 10 CFR 60 requirement 60.15(c)(1), and the accompanying ESFDR requirement from the revision, 7/29/91, says: "Review materials for substance effects on EBS & waste isolation." There is one that says: "Assess impacts of materials and support components on waste isolation; control all substances and tracers added to water and compressed air; use of hydrocarbons and solvents comply with criteria determined by

PA; limit use of water; seals shall not compromise ability of site to meet performance goals."

Now, I'm going to show some examples of calculations we did that relate to this requirement later on in the talk, in the third part of the talk. The next overhead complements this one and it shows the analyses that have been identified that will address the requirements that I just showed. This LBL or label on the left-hand side is the correspondence between the two overheads.

This category is fluid flow, geochemistry and material, thermal/structural, and total systems. I will describe what this nomenclature means. It means that Label 171 has a couple of fluid flow-type analyses that will be required to address those concerns. These--and I will describe that in a moment--these geochemistry and materials, which is Category 2, it says there's sub-category (i) and (ii) will need to be addressed, these concerns, and four, to address these concerns in the requirement. Label 301, there's also thermal/structural requirements or analyses that will be required, and total systems calculations may be required for those.

Now, what I'd like to do is start the second part of the talk, which will describe in a little bit more detail what these analyses are that are required to--but first, I'd like to summarize the PA plan.

It's a flow-down from 10 CFR 60 requirements to ESFDR requirements to analyses that will support and address the concerns. It provides PA integration with test planning and work authorization process. It's dynamic--maybe a better word for that is adaptive, such that as the designs change, as more site data becomes available, and as I understand it, conceptual models change, we should be refining the analyses such that it reflects that, and that's also a statement that's encompassed in this last bullet that talks about the PA analyses are ongoing and iterative, and that they should continually be refined as information becomes more available.

Now, to talk about the--in a little more detail about the types of PA evaluations that were needed in support of control of fluids, I'll talk about that in this section.

This is a list of the types. In the fluid flow category, it's broken into isothermal subsurface flow, non-isothermal subsurface flow, and floods and runoff on surface. Isothermal subsurface flow is ESF-related alteration of surface infiltration. The second one is localized--it is similar to this, although it's localized. Alteration of near surface hydrologic properties by ESF activities. I'm not going to go through all of these.

I want to get down to the geochemistry and materials one, in which primarily require reactive contaminant flow and transport. These may contain some of these analyses up here, but none of these analysis types up here will contain contaminant transport. In other words, these are not as complicated analyses as the ones that's below. So the reactive--the geochemistry and materials analysis, canister corrosion is one in which the introduction of foreign materials or fluids may corrode the canister and break down the engineered barrier system in a period of time, and that has to be studied. That would primarily be probably a Lawrence Livermore function.

The next is chemical reactions with the source, which from a PA calculation point of view will alter the source term which would be used in the PA calculation. That, again, is probably Lawrence Livermore.

The third one is a fairly encompassing one in which you're looking at far-field type analysis in which the isothermal fluid flow which incorporates infiltration of surface would be part of--you introduce a fluid at the surface, or material, and you see how far it migrates, and if it alters the repository, the performance of the repository. Also encompassed in this are exploratory shafts that might penetrate to certain depths, and what are the effects of those on the repository performance. Boreholes are another instance of this. Shafts, or ramps that access at an angle are also a sub-category of this, or are included.

And the last one is the zones of influence or test interference, ones in which the introduction of a material or a fluid in a region, and you want to know how far and what extent does this modify the surroundings, and the components of the zone of influence might be combustion products, construction drilling excavation effects, neighboring test dust control additives, wall cleaning, water, et cetera.

Now, those analyses--I should point out that there may be many, many analyses associated with those types, but those types of analyses encompass what we feel are needed to address the concerns in complying with 10 CFR 60 for control of fluids.

Now, the third part I'd like to talk about, a discussion of specific analyses and recommendations that support control of fluids. There are certain attributes of these analyses. One can question their validity because we don't know all the physical processes and mechanisms that are active at Yucca Mountain. Our conceptual models are no better than our understanding. They're the ones that reflect--that are implemented, and these are the ones that reflect the widely used understanding of the physical processes and mechanisms, and we have very limited site characterization data at this time.

These analyses were done under quality assurance, as implemented by Sandia's QA plan, and they should be ongoing to incorporate configuration change, additional data, integral part of the design process--which has been discussed before--and also for testing. So we don't view these as being necessarily the final answer. They should be continually improved.

Now, I think there needs to be some understanding of what has to happen if you're going to do a quality level analysis, and perhaps some of the time constraints that are involved. What this flow chart shows is starting from the ESFDR requirement, how you flow through and finally get conclusions, provide criteria, or you have to iterate back and then start the analysis over. The shaded boxes are intended to indicate where there should be a lot of collaboration with the designers and testers, et cetera, in defining the analysis and in providing criteria to make sure that you're providing criteria that can be used by a designer or a constructor.

For example, if a hydrologist draws a conclusion that the saturation increase surrounding a test is only 5 per cent, that doesn't do a designer much good, because they can't measure saturation very well. What they'd like to know is, how much water can I use before I cause test-to-test interference or I violate the ability of the site to safely store waste?

So this process starts, and you define an analysis. A decision is made. If the analysis is complex enough you need software, you have to determine, is the software I'm going to use, is it QA? If it's not QA, I have to go through a QA procedure to QA the software. I have to define the problem, which encompasses a problem definition memo in Sandia's implementation of it. This problem definition memo describes the analysis, the input, the products of the analysis, the method, the computer codes that would be used, and a schedule.

There has to be a technical review both of the problem definition memo and of the calculations and analysis that come from the results of the analysis, and also, the conclusions. If, anywhere in this process, there has to be a change in the analysis of input or you run into any numerical problems, et cetera, you have to go back up through this loop and come back through and rewrite the problem definition memo, et cetera.

Once your conclusions are drawn, the question has to be: Does this provide adequate criteria for the customers? If it does, it's incorporated in the ESFDR. If it's not, you extend the analysis and go back another loop. If you can't extend the analysis, you may have to define further analysis, which include other participants.

I'd like to close with a couple of examples. Analysis No. 1 relates back to--this is one in which we're putting water on the surface and want to know what the impacts of that. That relates back to Ted's talk when he talked about the--I think that was Concern No. 1 or List No. 1 about water use on the surface. The 10 CFR 60.133(d) is the requirement, NRC requirement. That's control of water and gas. The design of the underground facility shall provide for control of water or gas intrusion. The ESFDR 729.91 version of it is 1.2.6.1 Constraint, F.i. It says: "The amount of water used in site preparation and operations should be limited to that required for sanitation, dust control, compaction of engineered fill material, et cetera."

Now, from that, a analysis was defined, and it's purpose was to provide numerical criteria for limiting the amount of water that can be placed on the surface above the repository and for determining the lateral extent of this water.

Now, that doesn't say anything about how much you use for dust control on roads, how much you use for surface-based testing, how much you use for repository construction, et cetera. It said, "Limit the amount of water that will be used." We posed a problem in terms of how much water can you put into the surface before you cause degradation of repository performance.

The model that was used, this depicts a one-dimensional model. We actually did a one-dimensional and two-dimensional and compared the results, and there was collaboration between one and two-dimensional results. This is intended to indicate the hydrogeologic model that was used. There was a Tivah Canyon unit, Paintbrush Tuff. There were two welded and non-welded Topopah Springs and the Calico Hills. The composite porosity model was assumed; equilibrium between fractures and the matrix were assumed; and characteristic curves were used.

The problem was posed, is to place upon the known depth on top of the mountain and see what the effects of that known amount of water is once it's infiltrated into the mountain. The intent was, is to measure the performance, and the criteria for measuring the performance was, is the groundwater travel time less than a thousand years, or is there limitation of radionuclides that can reach the accessible environment in 10,000 years? Those related to the 10 CFR requirements, 10 CFR 60 requirements for repository performance.

The next overhead shows the results, which if you plot the change in the repository horizon saturation during 10,000 years resulting from surface water addition as a function of the water added, you can see that there's a dramatic change in repository performance from in situ values at about 16 cubic meters per square meter, or 16 meters of water. It's equivalent to a pond sitting on top.

If you look at the results, the groundwater travel time dropped below a thousand years only when it was somewhere in this region here. At that point, the entire repository had been saturated for years and years and years, so we felt that that was not a conservative enough constraint to apply on the effect on repository performance.

We further made the assumption, rather than going into complicating this analysis with source term calculations, we would be conservative and see if this posed a limitation on the operation or design of the ESF. So we said--we made the assumption that before it could have an affect on the repository performance, you had to increase the saturation at the repository horizon. So with that assumption, we limited the amount of water that could infiltrate the mountain to 16 meters.

So our conclusion is 16 cubic meters of water per square meter of disturbed area can infiltrate the mountain without increasing the saturation at the repository horizon within 10,000 years. Our recommendation is to limit the placement of water on the top surface of Yucca Mountain above the repository block to two gallons per square yard per day continuously applied over a five-year period, and it turns out that that's 16 cubic meters per square meter.

Now, after presenting this to the ESF designers, this statement of this turns out to be a problem, because, really, results of analyses says it's how much water that gets into the mountain over a relatively short period of time--five to ten years--in comparison to 10,000 years is a short amount of time.

This statement's interpreted to mean that I cannot violate two gallons per square yard per day, and so by interacting with the A&E's, we restated this recommendation and said a goal that if you average two gallons per square yard per day over a five-year period, you will not exceed the 16 cubic meters per square meter.

DR. DEERE: Question. Do you feel pretty strongly about that?

MR. FEWELL: Yeah. I feel pretty strongly because of this next view graph.

DR. DEERE: Okay.

MR. FEWELL: There's a lot of conservatism put into that, and first of all, I should qualify, with our present understanding of what--or accepted understanding of what the conceptual models are, yes, but we took no--we said limit the amount of water that's applied to what we said, infiltrated amount, so that's a very conservative interpretation of that. It doesn't take into account any evapotranspiration, any runoff, any down-dip, any climatic change, which could be conservative or non-conservative.

It also does not take into account, just because water gets to the repository horizon doesn't mean that there's a negative effect, a positive effect, or an effect on the repository performance. We assumed there was. So these two statements add a lot of conservatism to the results. And we also collaborated, as I mentioned before, with two-dimensional analyses.

Okay. I'd like to talk about one more example calculation. This has to do with surface ponds, and this has to do with 10 CFR 60.133(d), additional design criteria for the underground facility, control of water and gas shall provide for control of water or gas intrusion. And the ESFDR sections that relate to this, it says: "Fluid recovered during construction or testing operations shall be disposed of in such a way as to avoid potential for performance impacts," and it also says that the location of waste disposal system away from the perimeter block must be determined by a performance assessment.

So an analysis was defined that looks at sewage and settling ponds, and wants to estimate the potential for water leakage from settling ponds and muck storage area, and discharged from the sewage pond system to interfere with experiments conducted in the ESF.

A two-dimensional analysis was done, using a finite element code, NORIA, which incorporated the same conceptual model as I described before in Analysis No. 1, in which a surface pond was placed on top of the mountain at the Title I design location, the Title I design area, and the Title I design depth of pond. That pond was allowed to stay there for five years, and at the end of five years, the boundary condition relaxed back to in situ infiltration at the surface.

The calculation was continued for 10,000 years to trace the movement of this pond--the water that came from this pond, and the area outlined in red is inclusive of all the water that was--that had infiltrated the surface and had dispersed throughout the formation in 10,000 years. As you can see, this area here is the perimeter block boundary. This is the repository horizon, and the--in 10,000 years, the water had just penetrated Upper Topopah Springs unit.

So the conclusion from that analysis is that water leakage from ponds on the Title I muck storage area and discharged from the sewage pond system have no effect on the saturation at the repository horizon and will not interfere with experiments conducted on the ESF. The recommendation is: "Locate muck and sewage ponds off the repository block."

In summary, I'd like to reiterate we feel that the role of PA in fluid control in the ESF is ongoing, integral, iterative, and will result, if we do it, in a continuously refining and will result in refined PA capabilities for performing PA calculations in support of the repository license application.

A plan for implementing PA support of the control of fluids in the ESF was discussed. This plan is the mechanism for showing compliance with 10 CFR Part 60 of the Title II design. And I described some analyses that are necessary to show this compliance and discussed some examples of these analyses.

I'd like to make one recommendation that I think is pretty necessary here, and that is to build on the test and evaluation plan to develop a budget and allocation process for fluids and materials to include all usage during site characterization and to the extent necessary for potential repository construction and operation.

By the word "budget," I mean by PA calculations, we determine how much can be used or applied as a function of space and time, perhaps. That has to be apportioned between all the uses that are going to apply to a given material or fluid. If we don't do that, we'll get ourselves in a situation where something that precedes in the design or construction or testing process could use all of the budget up for material, and give us no ability to operate that budget.

That concludes it. Any questions?

DR. ALLEN: Thank you.

Are there questions from the Board; staff; consultants?

DR. CORDING: Ed Cording.

These are--these models are, again, a matrix flow? Are they assuming that the flow is matrix flow?

MR. FEWELL: No. They assume that--the composite porosity model, which means the fractures only become active as you approach saturation of the matrix. So they're not strictly--it depends on where you are in the saturation. If you're at low saturation, it assumes that equilibrium is at saturation of--well, it doesn't assume that. I mean, that's the results of...

DR. CORDING: There was a model that was described to us a few meetings ago where we were looking at the combination of joint and matrix flow. Is that the sort of model that's being included in this type of assessment? I'm trying to recall the gentleman that did that.

MR. FEWELL: Was that Tom Buschek?

DR. CORDING: Yes.

MR. FEWELL: That's a different model. It showed different results.

DR. CORDING: Would that be the sort of model that you'd be putting into this type of a--

MR. FEWELL: Well, I think there should be sensitivities to determine which regime each model is applicable in and from site characterization, where we are. The results of that model, you can show that with a continuous pond at the surface, you can get very rapid flow through fractures all the way, but we don't know which model is applicable at the present time.

DR. CORDING: I think the model was certainly a simplification, because it didn't involve a lot of different layers, but just in terms of the integration of joint and matrix flow, it was--

MR. FEWELL: Yeah, that's a different model.

DR. CORDING: Yeah. Thank you.

DR. ALLEN: Any questions, comments from the audience?

(No audible response.)

DR. ALLEN: Okay. Let's move ahead, Ted.

MR. PETRIE: All right. The next speaker will be Steve Bauer. He's going to talk to us about thermal structural effects on underground excavations.

MR. BAUER: I'm Steve Bauer from Sandia Labs, and I'll be talking about thermal and structural effects on underground excavations.

I'll begin today with a general description of our work, and try to tell why that work is important to the ESF, followed by a description of the extent of the work thus far completed for--or completed for Title I. The results, I'll talk a little bit about the results and their sufficiency in regard to Title I, and then the planned work for Title II, and end with a schedule to complete that work.

The type of work that we're involved with is the development and application of methods for thermal and structural analyses of underground excavations, and the types of analyses that we seek to do in the immediate future to support the ESF effort are 2-D analyses of underground opening cross sections, 3-D analyses of underground intersections, and 3-D repository scale conditions analyses, and I'll talk more about them in a minute.

This work is important to the ESF because ESF excavations and--certain ESF excavations and regions are to become part of the potential repository, and because of that, we need to show compliance in Title II with the requirements of 10 CFR Part 60.

Thus far, the work we've completed for Title I is detailed in the ESFDR, Appendix (i) that Mert talked a little bit about, and these three sets of analyses are, at a minimum, summarized in that report; the far-field thermal effects for the repository vicinity have been predicted. Shaft and collar thermal stresses have been predicted, and the potential for creep has been assessed. Now, keep in mind, of course, that these analyses were done in the context of the design that's in the SCP/CDR.

Next, I'd like to move on and talk about some of the results and their sufficiency in regard to the Title I, and as I said in the beginning, you know, part of the results that we're obtaining is the development of analysis methods, along with preliminary analysis results using those methods.

In the area of thermal and structural analyses, we're pursuing the following analysis methods: 3-D thermoelastic, finite element, distinct element, and one which I left off, boundary element methods, and I'm going to briefly talk about two of these methods and some of the applications that we have obtained to date with them just to show the types of results we can obtain.

For the 3-D thermoelastic, for that we are limited to a single homogeneous isotropic material with a constant set of thermal and structural properties. By constant, I mean it's not allowed to vary with temperature, time, et cetera. And another attribute of that method is that we're allowed exponentially decaying heat sources.

Other inputs that are required for this analysis method is that we need a layout of the ESF and repository facility. We need to know where the locations are of drifts, intersections, et cetera, that are to become part of the repository. We need to know the time sequence waste emplacement scheme for the repository. That's how we generate the thermal loads in the analysis.

And, of course, what we're allowed to calculate with this method are the stresses, strains, and temperatures as a function of time and position, and what we'll do, what we do at the onset is we tell the code where we want to obtain results, where and when we want to obtain results; either a line in space or a plane in space.

As an example of the type of results we obtain, these are temperatures plotted as a function of horizontal distance from what's called here a midpanel access drift. It's a drift for the CDR design for which we would access emplacement panels, and what's plotted are temperatures at four different times perpendicular to that access drift. And one of the things that was important in doing that analysis was what are the temperatures as a function of time? Another thing that's important is what are the stresses in the vicinity of that drift as a function of time? And, of course, both of these would be important in determining what type of ground support system we may put in.

And here, just to show an example of utilizing temperatures to drive a structural model, here we calculate stresses at two different times; here at excavation, and at 100 years after heating began. You can look in detail to see how the stresses change at these two different times.

On a much larger scale, other information that we can obtain from this type of analysis--again, this would be looking at a region that would, of course, become part of the repository with time--is what and how does the state of stress on many of the structural features here, the Ghost

Dance Fault, how does the stress stay changed as a function of time as the repository is heated? And what's plotted here is a factor of safety per slip at three different times: prior to waste emplacement, at 100 years, and at 10,000 years, and the zone in here, we see high values for the factor of safety or slip. Of course, where the heated area of the repository is, very high horizontal stresses are generated locally, so the chance per slip is, of course, decreased in this region because the normal stresses on these faults has increased.

And moving on to a second and final analysis method that I'll talk about today, is the finite element analysis that we're doing. Most of the work we've done this far is in two dimensions, and we're very close to being able to do 3-D analyses routinely. Within the next six to twelve months, we'll be able to do non-linear finite element analyses in 3-D fairly routinely.

And what the finite element analyses allow us to do is--as I was alluding to--is that they allow us to look at non-linear thermal and structural behavior, and the reason, of course, we're pursuing this type of behavior is lab and field tests tell us that certain of the material properties for the rock at Yucca Mountain behaves non-linearly.

In the area of thermal analyses, the conduction is the heat transfer mechanism that we're considering. The reason for that is that experiments and analysis comparisons to date show that--well, within the uncertainty of both of those, that both experiment and analyses, that conduction can account for the heat transfer that's observed, and within this analysis regime, we allow for the conductivity and the heat capacity to vary as a function of temperature.

An example of the type of analysis results that we have obtained from these thermal analyses, what you're looking at is an emplacement drift with--these are on 2-D analyses--with a heat source in the floor, and we're looking at temperatures calculated after--well, two times; 25 years after emplacement, and 100 years after emplacement, just to show the magnitude of the temperatures. And to put that work in perspective with the longer time periods, plotted on this graph is temperature versus time. Here, this is a log plot time, and you can see that even though the temperatures peak at about 100 years, the floor and roof of the room--in other words, the immediate vicinity of the room--remains quite hot for an extended period of time.

In the area of structural analyses, again, on the finite element end of it, we're doing elastic analyses, and we look at what we call a jointed rock mass response, which allows us to look at both the non-linear response of--well, the non-linear response of joints in terms of their non-linear shear and normal stiffness. Another feature that we're allowed to look at here is that the coefficient of thermal expansion is allowed to vary as a function of temperature, and typically, what's done in the finite element analyses is that we'll run the thermal analysis separate from--well, run the thermal analysis initially, and then use that as a driver input to a structural code, and calculate stresses and strains as a result of that thermal load.

DR. DEERE: A question?

MR. BAUER: Yes, sir.

DR. DEERE: Don Deere.

What do you put in for your in situ stress state? Do you let it generate? Are you starting just with an elastic model in Poisson's Ratio, or are you starting with some K_o value, let's say?

MR. BAUER: Okay. It depends on the scale of the analysis. If we're modeling the behavior of the entire mountain, we can--if we want to, we could assume, let's say, that the mountain's being gravity-loaded, okay? So we can put in the densities, et cetera, and allow for the mountain to load itself and generate its own in situ stress. Okay, that's one tack we can take.

For an analysis like--well, let's say a room and pillar-type analysis, where we're just looking at that scale, maybe, oh, 15 meters wide by 100 meters high, we can then take that larger scale analysis and look at the--and just input a fixed horizontal stress of--at Yucca Mountain, low end is probably on the order of three megapascals horizontal stress, initial stress, and at the repository horizon, vertical stress is on the order of seven to ten megapascals, depending on where you are under the mountain. So it depends.

DR. DEERE: Yes. The reason for my question is I see that in the test plan there is only, I think, one location for an in situ state of stress determination, and I just wondered, is this sufficient, or do you have enough background data to show that it is--that you can determine it at only one site?

MR. KALIA: This is Hemi Kalia.

The in situ stress will be determined at several locations in the entire facility; all the ramps, so the analysis is conducted at multiple points.

DR. DEERE: Very good. I'm very glad to hear that. I was sure it was. I just saw it there in one spot. Some of us--quite a number--all of the Board, actually, and our staff--visited the Canadian facilities and their underground rock lab, and they got quite a surprise when they went in and started measuring their stresses. You may know something about that, to the point that, you know, very, very high class granite is failing under its own stress at depths of only 400 meters.

MR. BAUER: Yeah, a very different situation.

DR. DEERE: Well, what I wondered, do we have enough information to know that?

MR. BAUER: Well, I would say no. I would say we need more measurements.

DR. DEERE: Yeah, I agree.

MR. BAUER: When we're looking to do a structural analysis, we go through a thought process--as diagramed here --as to what type of structural model we may want to use. For almost any problem that we look to solve, the first thing we do immediately is an elastic analysis to kind of scope out the problem, find out--try and get an idea of what's going on.

Then, depending on the rock structure--be it good rock, poor rock, very poor rock, excellent rock, et cetera--we would choose a model that would be consistent with the type of rock, okay? And listed below are types of models, and, you know, for example, if the rock is blocky, you would choose a model that, you know, a discontinuum-type model where we'd model the rock as basically a stack of bricks with some compliance in between those bricks, et cetera.

What I'm trying to say is we don't use the same model all the time, regardless of what kind of rock we're dealing with. And at this stage, because we don't know exactly what kind of rock we're going to have down there, what we're doing is sensitivity analyses and, let's say, and looking at what are the effects of using different types of models?

And by changing some of the parameters from one model to the next, you can get one model to--the results from one model to look like the results of another by, let's say, varying the joint space and varying block size.

Just to show you the type of results we get doing these structural analyses, these are the same times that you looked at for the thermal analyses. This is for an elastic, linear elastic analysis, the horizontal stresses that are generated in an emplacement room 25 years after waste emplacement, and 100 years after waste emplacement, just to give you an idea of what kind of stresses that can be expected.

To summarize at this point, we've seen that the stresses, strains, and temperature in and around underground excavations are found to vary as a function of time and position, and at this time we feel that quantification of these changes is possible with the analysis methods that either we have in hand or we're working on developing. And finally, this change in stress, strain, and temperature state with time shall be incorporated into the design process through the mechanism that Mert was talking about, the performance assessment plan.

Conclusions relative to my talk: Although I didn't go into the details of this to show you ironclad proof, if you read, let's say, the ESFDR, you'll see that the Title I design is not inconsistent with the analysis results obtained to date. Next, the development and application of analysis methods is continuing, probably will continue for at least a little while, and the methods that we're developing shall be used in analyses to support Title II design compliance with 10 CFR Part 60.

In terms of the planned work for Title II in the area of thermal and structural analyses, the next two or three view graphs show the analysis types similar to what Mert Fewell talked about in the performance assessment plan, and if you'd like to know more detail of it, other than is provided here, I invite you to read that document when it comes out. These just show basically the analysis categories on the next three view graphs, but I don't think you need to be hit over the head with those.

In terms of completing this work, as you're aware, we began this work to support Title I. The analyses that are to be done first would be the far-field analysis that I described initially, and based on Ted's view graph, you saw that the results of that type of analysis are needed for Phase 2 of the phased design plan, and pretty much immediately after that analysis, or those analyses are completed, the cross section and intersection analyses would be initiated, and they would have to be completed to support individual Title II design phases.

Thank you. Any questions?

DR. CORDING: Ed Cording. I had a couple of questions here.

In the conclusions, the Title I design is not inconsistent with the analysis results to date, are you saying that--I'm not sure what the meaning of that is. Are you basically saying that given the configuration that's presently there, you don't expect much damage from heat?

MR. BAUER: All right, I'm not sure I understand what you mean.

DR. CORDING: Well, I guess my question, my statement is, I don't understand what: "Title I design is not inconsistent with the results to date." I'm not sure what that means.

MR. BAUER: Ted, you have a good explanation.

MR. PETRIE: Well, all that really means is that to the extent the design has been performed to date, we can't find that there would be a thermal problem or that you could, in fact, not make the design in detail such that it was consistent with the thermal stress that he's talking about. Did I make myself clear? No, I did not.

DR. DEERE: I understood you.

DR. CORDING: It helped a little bit.

MR. PETRIE: All we're really saying here is, I mean, look at the design now, which is rock bolts or whatever. You can't find that it could not be made compatible with what he believes is going to come out of his analysis. That's as far as you can say. Clearly, his analysis is not done yet, is not completed yet. The design is not completed yet, but there's nothing in there that would lead us to believe that we can't design it to be consistent with what one would expect.

MR. BAUER: And the analyses have shown that there's no major problems to be encountered.

DR. CORDING: I guess one question is, in any of these analyses, particularly when we get into our finite element analysis, boundary element, some of these others, they describe some of the changes in stress that can occur in displacements, but in terms of--you still have to couple that with a failure mechanism or behavior mechanism. What is really causing this rock to break up, to fall apart? You get some clues from some of these analyses, but they certainly don't tell you about failure mechanisms directly, most of them.

In fact, you have to make some interpretation of those, and I guess that part of the link as to whether it is or is not a problem, a certain stress condition is or is not a problem, has to do with--one needs to tie into those failure mechanisms and look at the behavior that actually occurs.

MR. BAUER: All right. Well, you're 100 per cent correct, and what we've done in that area, where we'd use, let's say, an elastic model where we've reduced the modulus to account to joints, okay, typically what we would do is calculate stresses and strains through time and compare that with, for example, a Houke & Brown failure criteria, okay.

We would then go in and identify regions, based on that comparison, where the rock would have failed, okay? The kind of thing that I'm describing is talked about in a document called "Drift Design Methodology," which was just recently approved by DOE, and, you know, basically what we've done is that we've done numerical analyses for all different types of rock--by different types of rock I mean, you know, different joint spaces, things like that--and compared them with different types of failure criteria.

We've compared them to plasticity analysis, or plasticity failure criteria with Houke & Brown-type criteria, with just failure in extension, okay? And then--and looked at those results as where has the rock failed in the roof of a drift, and said, well, what kind of ground support would we recommend to hold up--we don't know what to do with failed rock. So we've taken a conservative approach in that methodology and said, well, we're going to hold it all up, hold up the dead weight of all that rock with the ground support systems, and then what we've done is compared that recommendation with a recommendation that would come from, oh, like a, you know, block mass rating-type analysis, and whichever--and this methodology we've done is actually just chosen whichever is the most conservative of the two to recommend a ground support system. So we're trying to use these analyses in practice.

DR. CORDING: So basically, given the stress conditions you see around the openings, one could say that you've been able to find a support system that would hold what you're describing as the failed rock?

MR. BAUER: Yeah.

DR. CORDING: That that would be a more or less conventional-type construction loads, designed for the structural support system?

MR. BAUER: Yeah. And these were included, you know, I've only talked about here today the thermal loads, but we also would include in there seismic loads.

DR. CORDING: I think one other point is that one of the things we see, for example, if we reached some criteria--like the Houke-Brown criteria and Mohr-Colomb criteria--and in terms of the stresses that we see distributed around the opening, that may mean that the material has reached some limit and it doesn't necessarily, and very often does not mean that there's going to be a failure in terms of rupture, or failure of the tunnel itself.

MR. BAUER: That's right.

DR. CORDING: A lot of rock has to perform at its limit in high stress environments, and so just looking straight at the analysis and saying, well, we've reached a limit here, or, for example, even looking along a fault surface, if we have gotten a factor of safety of one on, one point on that fault doesn't mean that the fault's going to displace.

MR. BAUER: That's right.

DR. CORDING: Because you have to have the kinematics to make the whole thing work, and so it's the same situation we have around the openings, or this linking of analysis with what we expect in terms of performance and the rupture and failure that can occur around an opening in terms of loss of stability, those steps in there are not automatic and simple steps to take.

MR. BAUER: That's right.

MR. McFARLAND: Have you made any effort to validate your models?

MR. BAUER: Yes, by comparing them to whatever field and laboratory experimental results are available, and the--we haven't, in terms of validating, right now we're at a stage where we've compared them in terms of stress/strain behavior.

We have not validated any of what we think is failure, any of our models for what we think is failure, but we have, you know, we'll grab anything that we--any type of experimental work that's in the literature or work that was done at G-tunnel, work that's been done--well...

MR. McFARLAND: Do you have access to the other Rainier Mesa tests? Sandia has been involved--portions of Sandia have been involved for I know of at least 20 years in trying to model survivability of underground structures subject to nuclear weapons effects, and I could look up in my diary the people at Sandia that supported both the ballistic missile and defense nuclear over the last, at least I know of at least the last decade in this work of trying to define survivability, and then, as there will be a test tomorrow or the next day at Rainier Mesa, as an add-on to the underground nuclear weapons tests to predict performance and see how the predictions compare, and as I said, this is a portion--this was being--was supported by Sandia. I left that six years ago, but I'm sure there are people at Sandia that could provide you reams of experimental data.

MR. BAUER: That's right, but are you saying that because you think that those types of loaded conditions are important for us to work with?

MR. McFARLAND: I'm talking validation of a model.

MR. BAUER: Well, except, you know, the types of seismic loads that we're looking at are relatively minor compared to those. You know, I've walked in those drifts and looked at them and, you know, I don't think we're going to come to those types of loadings, and so, you see, what we're--in this drift design methodology, we're actually treating as--the seismic loads as a static dead load and it's not--we're not that worried about it in terms of a dynamic event.

MR. McFARLAND: Again, as a validation of a model, that they have a considerable amount of experimental data and they've been trying to do it for some time.

MR. BAUER: Well, I'm sure I can get into that data, data set somehow.

DR. CORDING: In regard to the thermal condition, I don't believe we do have a lot of data in the tuffs; pretty much all I know of were the start of those experiments in G-tunnel in the tuff.

MR. BAUER: Yeah, we're lacking for experimental data.

MR. GERTZ: And once again, only by heater tests will we get some data, and what we are looking at in the ESF will be ten or twenty years of drifts without any heat loading, and only once we determine Yucca Mountain is suitable would the heat loading come into effect, and then we want to make sure it's retrievable so our tunnels are structurally sound so we can get back in and retrieve them, or the decision will be made, backfill them 70 or 80 years from now. So I think that perspective has to be kept in mind.

DR. DEERE: Don Deere

I think that the beauty of a lot of these analyses are that if, even if one is wrong on assumptions along the way, rockbolts can cover an awful lot of sins, and so I feel pretty good about your analyses.

DR. ALLEN: Other encouraging comments from anyone?

(Laughter.)

DR. ALLEN: This is the first time in the history of this Board that we seem to be approaching the end of the day ahead of time.

We're adjourned until tomorrow morning.

(Whereupon, the meeting was adjourned, to reconvene on September 19, 1991.)