UNITED STATES
NUCLEAR WASTE TECHNICAL REVIEW BOARD

PANEL ON STRUCTURAL GEOLOGY & GEOENGINEERING
WORKSHOP ON EXPLORATORY STUDIES FACILITY (ESF)
DESIGN AND CONSTRUCTION STRATEGY

November 4, 1992

Plaza Suite Hotel
4255 South Paradise
Las Vegas, Nevada 89109
(702) 369-4400

BOARD MEMBERS PRESENT

Dr. John Cantlon - Chairman
Nuclear Waste Technical Review Board

Dr. Clarence Allen - Chairman, SG&G Panel Moderator
Nuclear Waste Technical Review Board

Dr. Edward J. Cording - Moderator
Nuclear Waste Technical Review Board

Dr. Patrick Domenico - Member
Nuclear Waste Technical Review Board

Dr. John J. McKetta - Member
Nuclear Waste Technical Review Board

Dr. D. Warner North - Member
Nuclear Waste Technical Review Board

Dr. Donald Langmuir - Member
Nuclear Waste Technical Review Board

ALSO PRESENT

Mr. Russell K. McFarland, Sr. Professional Staff

Dr. Carl DiBella, Sr. Professional Staff

APPEARANCES

KEY PARTICIPANTS:

Carl Gertz, Yucca Mountain Project Office

Neil Dahmen, The Robbins Company

Lok Home, Boretec, Inc.

James Friant, Colorado School of Mines

Joseph Sperry, NWTRB Consultant

Hugh Cronin, NWTRB Consultant

S. H. Bartholomew, NWTRB Consultant

William Simecka, DOE

Russell Dyer, DOE

Uel Clanton, DOE

Lawrence Hayes, U.S. Geological Survey

Thomas Statton, Woodward/Clyde (M&O)

Scott Sinnock, TRW (M&O)

Ned Elkins, Los Alamos National Laboratory

Dale Wilder, Lawrence Livermore National Laboratory

Thomas Blejwas, Sandia National Laboratories

I N D E X

P R O C E E D I N G S

(8:00 a.m.)

DR. ALLEN: Good morning. Good morning to all of you.

I am Clarence Allen, Chairman of the Panel on Structural Geology & Geoengineering of the Nuclear Waste Technical Review Board. Let me welcome you to this workshop on the Exploratory Studies Facility Design and Construction Strategy.

Before turning over the podium to Ed Cording, let me simply introduce the other Board members who are present here today.

We have the Chairman of the Board, John Cantlon; we have Warner North. We seem to have our members distributed throughout the audience today, maybe to disseminate their efforts. Pat Domenico, is over here; John Cantlon, back there; Ed Cording at the head table; and, Don Langmuir and Garry Brewer, both members of the Board, will be joining us later today. Staff members of the Board present with us today are Russ McFarland and Carl DiBella, back over here.

As you can see, the format is somewhat different than we have had in previous Panel meetings; hopefully, because of the workshop nature and hopefully to promote informal discussion among all of us here. On the other hand, please, when you go the microphone, again identify yourselves so that others will know who you are, as well as for the minutes of the meeting.

John Cantlon, you are next on the program, but as I understand it, you have no particular words of welcome here this morning. So, I think without further ado, I will turn the chairmanship over to Ed Cording.

DR. CORDING: Thank you, Clarence.

We are very pleased as a Board and as Structural Geology & Geoengineering Panel to welcome you to this meeting which, as you see, is a somewhat different format than our usual meetings. And, having the Board in the audience, I am not sure whether that is a good idea or not. They seem to be a little more, I wouldn't say rowdy would be the word, but I think we are looking forward to the opportunity for all of us to interact with you as we conduct this session.

We are pleased to discuss with DOE their plans and approaches to constructing, exploring, and testing in the Exploratory Studies Facility. I think the meeting is unique because we have organized it as a workshop, and we are trying to make more time available within the sessions for discussion and interaction among the participants. And the participants include everyone in this room, not just those at the head table.

I think the format is particularly appropriate at this time because of the rapidity of the events and the significant developments that have occurred in DOE's program for the ESF over the past even three months. The current '93 budget includes the start of underground construction at the north portal and the schedule moving ahead with the ESF and what had been planned in previous years. So, you will hear some of this in presentations from Bill Simecka, Ed Petrie, and Carl Gertz.

I think the progress that has been made provides us with the opportunity to discuss in greater depth various aspects of construction and testing for the ESFs. We hope that the ideas brought forward and discussed by DOE and its contractors, by the Board and its consultants, and by the representatives here in the room including those from industry as well as other portions of the DOE program, will be a benefit to the DOE in efficiently developing the ESF and integrating exploration and testing priorities with construction capabilities.

In each of the four sessions, participants have been named and will lead in the discussions following initial presentations. As I have said, I think, however, that we are looking forward to full participation by other attendees at this meeting.

The first session will focus on underground construction issues and that's this morning. We will begin with presentations on the planned construction sequence, cost, and schedule for the ESF. It will be followed by discussion of strategies and methods for the ESF, and those that show promise for accomplishing what has been termed the baseline configuration and perhaps alternatives. But, I think that you will find that most of the methods that are being discussed are ways in which we will accomplish what I consider to be the baseline concept. In other words, being able to look at the two ramp approach, tunneling across the length of the repository, and then intersepting major faults at the Topopah Springs level, the repository level, and at the Calico Hills level.

The second session this afternoon will be directed towards exploration and testing in the ESF. This discussion will center on the early and high priority testing needs. We're looking forward to the presence of the discussion by the various labs and other portions of the DOE program, as well as the Board. It is hoped that the participants in this session will be able to respond to some of the concerns and capabilities that are being described in the construction session in the first session. How can the testing take advantage of construction capabilities and the ESF layout? And, what are the requirements for the ESF construction that will facilitate achievement of high priority test objectives?

The third session tomorrow morning is directed towards a review of management and contracting methods. We will learn about the current status of the ESF design and management and we will discuss means of obtaining early delivery of construction at minimum cost.

The fourth session would be a wrap-up session tomorrow afternoon. And we hope in that session that the engineers/the constructors will be able to respond to some of the requirements and concerns brought forward by the people involved in the testing, the science portion of the program. We really look forward to all participants discussing together the integration of testing, management, and construction.

I just wanted to review briefly a few items that we have been thinking about as a Board and discussing with DOE over the past several years; just a little background.

One of the first recommendations of the Board after it was formed was that exploration by tunneling across the site was needed to characterize the site, to intersect the anticipated fault zones, to obtain a representative picture of geologic conditions across the repository block and, particularly, the high angle features that are considered to be a potential pathway for flow of fluids and gas.

TBMs are recognized as a most efficient means of excavating long tunnels. The ESF Alternative Study by DOE in late 1990, as I recall, resulted in their selection of an ESF layout that provided access from two ramps, allowed exploration across the repository and to the anticipated fault zones at both repository level and then the lower level down into the Calico Hills.

With budgets less than requested by DOE in the past few years, it has been apparent that initiation and development of underground exploration in the ESF could only occur if a single TBM were mobilized with surface preparation and portal development kept to a minimum required for exploratory construction. The Board recognizes that other parts of the project, such as surface exploration, must also continue so that funds cannot be used solely for the underground program. And, we recognize that economy must be practiced in other parts of the program. Our meeting today is, however, focused on the Exploratory Studies Facility, the ESF.

While overall cost of the ESF is important, one of the major concerns of the Board has been in regard to the schedule for underground exploration, particularly the initiation and the initial portions of construction. So much of the site characterization program depends on underground progress: the access to observe the condition of the unsaturated zone and its faults; access for the testing groups; data provided to the analysts and to the modelers. Thus, delays in developing the underground has an impact on the progress in other parts of the program. With or without progress in getting underground, the overhead and infrastructure for the Yucca Mountain Project continues.

With this perspective, the focus then goes to the items required to initiate the project. If a limited budget must be used to develop extensive surface facilities for the ESF, then tunneling may have to wait for lack of funds or even, perhaps, will have to wait because the surface facilities are on the critical path and tunneling cannot start until after that work is accomplished.

I think, further, there is a significant benefit from initiating one tunnel a year early, as compared to starting several a year later. Access for observation and testing to portions of the ESF, at least to some portions, is a year early. The interference and inefficiencies associated with an accelerated schedule in which several TBMs are operated at once are avoided. We should see some discussion of this and examples in the presentations in our first session.

Many decisions as to how the ESF will be constructed remain to be made. Future decision points responding to conditions encountered in the initial phases of exploration may be appropriate. We see that much remains to be done in integrating and sequencing the testing and construction. We appreciate the opportunity for this timely interaction with DOE, as they develop their plans. We also recognize that the ESF program needs to proceed and changes that would delay the development of the ESF should be avoided, if possible.

Our objective for this meeting is to provide a forum to allow ideas for testing and construction to be presented. To me, one of the most interesting and challenging parts of this program is this interaction between engineering and construction, and then on the other side, the science and the site exploration and testing that needs to be done. Integration of the two is essential. There is much to be learned from one group listening to the other and that's really the reason that we have organized the sessions in this manner, so that we can have the groups listening to each other, and then the final sessions discussing together some of the possibilities.

Perhaps, as we listen to these possibilities, there will be a growing consensus on cost and schedule; efficient means for achieving the exploration and testing objectives. The ideas generated here are for DOE to consider as it develops its program and for the Board to consider as it reviews the program and prepares its own recommendations that it must make. We anticipate that some of these recommenda-tions and some of our discussion of the ESF program will be prepared and issued in a separate topical report by the Board.

Before we start with the presentations, I just wanted to introduce some of the participants in the first session who are at the head table.

We have four individuals who are consultants to the Board. S. H. Bartholomew, to my left, is a consultant. In the past fifteen years, he has been on the faculty in construction engineering at California State Universtiy at Chico. He's been active as a member of disputes review boards and arbitration panels, construction schedulings, construction management issues. He's been very active in underground construction working on tunnel boring machine projects. Formerly, he managed an underground construction division of a major U.S. contractor.

We have Hugh Cronin to my left, the President of UCI in California. He provides underground construction services; construction planning and estimating. He's been involved in managing and supervising tunnel boring projects, as well.

I would like to also introduce to you Bob Matyas. Bob is going to be sitting up front in a later session. He managed and procured construction services for many years on high energy physics projects. He was at Cornell University managing much of their facility there. He established the Underground Technical Advisory Panel for the SSC project and directed the tunnel group there. And so, he's been very much interested in and involved with the underground construction related to development of the high energy physics program in the United States.

Others that we have with us today with the DOE: Carl Gertz, at the head table, Yucca Mountain Project Office; we have Bill Simecka; Ed Petrie is right here on my left; Tom Statton with Woodward/Clyde Consultants with the M&O; James Scott, Raytheon Services; Tom Blejwas, Sandia National Labs, and Tom may not be here at this point, but we expect him later; Jim Friant, Colorado School of Mines; and, also Levent Ozdemir, both in Colorado School Mines involved in tunnel boring machine research and design.

We also have Lok Home and others from industry and I just briefly wanted to indicate some of the representatives from industry. Some are in the audience, as well, but Lok Home is with Boretec in Solon, Ohio with development of tunneling equipment and rebuilders of tunnel boring machines. We also have Neil Dahmen on my left and Ed Kennedy with the Robbins Company, manufacturers of TBMs for worldwide market.

I would also like to introduce to you one other person that's been a consultant to the Board that I failed to insert here and that is Joe Sperry. Joe Sperry is a local resident here. He has been active as a construction consultant on underground projects, disputes, review boards. Much of his work has been on tunneling boring machines. He's managed tunnel boring machines projects in the past.

Have I left out anyone?

(No response.)

DR. CORDING: Thank you very much. We look forward to continuing the session with the presentations.

DR. ALLEN: The first presentation will be by Carl Gertz.

MR. GERTZ: I would like to just set the stage and perhaps go over some of the ground rules as I saw them, Ed, when we developed the meeting.

Certainly, I look forward to a dialogue. That's what, I think, we meant to have here is a dialogue. As a result, nothing, per se, said by the Department or our contractors will be deemed policy. It's all part of a discussion that's going on.

Some of my presentation that I will give you about our current program, of course, is stuff that I have provided to you, with the ACNW and, in effect, is our current program and policy. But, throughout the other discussions when we talk details or people speak their piece, I've encouraged my team to speak up, talk about what they think without fear of getting in the way of policy. So, that's what I wanted to let you know, that this is truly a discussion and a dialogue to exchange ideas. We hope to learn from you all and we hope in some ways you might learn how we've established our program.

DR. CORDING: We very much appreciate that approach, Carl.

MR. GERTZ: Okay. So, that's our ground rules.

Secondly, we thought in the morning, early-on, we'll start with a short presentation by Ted Petrie of the history of the program for those people who are not aware of what's gone on in past years. And then, after Ted provides that, I'll provide you with our current approach. Our current approach--in fact, you stole some of my lines--is very similar to some of the things that you've been pointing out. After those two short presentations, we'll let the dialogue begin.

With that, Ted, I guess you are going to provide the background. Being a good project manager, I like to keep projects and presentations on schedules. So, if Ted gets going too long, I'll hook him off or something. I would like to point out that I have asked Ted to shorten the presentation considerably and there is lots of backup and lots of other information both in the books that we'll hand out and he has some viewgraphs for the dialogue section. But, his overall presentation is fairly short.

MR. PETRIE: My name is Ted Petrie. I am with the Department of Energy. I am the branch chief responsible for the Exploratory Studies Facility design and construction. And, as Carl mentioned, I am going to discuss where we have been in the past and what our present--I feel like I don't like to say baseline, but where we were, let's say, six months ago or a year ago; six months to a year ago. Don't let this stack of paper frighten you. There is only about so much in the presentation for the moment for this part.

Let's start out with the purpose. What we are there for is to determine the suitability of Yucca Mountain as a potential repository site. In doing that, we need to provide access to the potential repository horizon for inspection and testing and provide access to the Calico Hills for testing and inspection and develop the data for the potential repository site and construction. So, we're there not to build an ESF, per se; we're there to provide access so the scientists can make a determination as to whether or not the site is suitable. In doing that, of course, we want to do that in the most efficient and cost effective matter.

And now, we will talk about the evolution. And, the next one is the ESF layout as it appeared in 1988. That's about the time we first started talking through the Technical Review Board. At that time, we were talking about two exploratory shafts which would get us to a main test level, and there was some drifting planned off that test level to do some examination of the site.

There were some concerns with that that resulted in concerns especially by the TRB and also by the Nuclear Regulatory Commission. We re-evaluated our ESF. It was enlarged to allow data collection over the entire potential repository block. The primary excavation method became mechanical, as opposed to drill and blast. Ramps became the primary access mode.

In order to resolve some of our concerns with the Nuclear Regulatory Commission, specifically that we had evaluated all the major features and come up with--so that we would have an understanding of how the major features could affect site suitability--we did an Exploratory Studies Facility Alternative Study where we carefully evaluated all of the alternatives--well, I won't say all, but a substantial number of alternatives, and based upon that, came up with a preferred configuration which formed the basis for our completed Title I design and our continuation on into Title II. And, that is from an artist's conception and is represented by the drawing we have here where there two ramps coming into the main drift area. One here and one over here. And then, another ramp coming off the primary ramp going down into Calico Hills, as indicated here.

So, this is essentially where we are today from an overall viewpoint. There is an optional shaft which would be constructed if the scientists determined that there was not sufficient data obtained in this transfer through the various levels of rock between the repository level and the surface. So, if this is constructed, it will be for scientific purposes.

This is just a summary of the ESF drifting. I won't go into each one of these things. Just let me say that the total is like 76,000 feet, close to 1.7 million tonnage of muck removal. And, this is the kind of machine we were thinking about for each one of these areas. This again is the Title I ESF drifting. So, this is as of like October of '91 when we were making this position. And, it gives some indication of the sizes of each one of these openings. You may want to refer back to this, if you need to, during the discussions.

Well, the summer before last, we completed our Title I design and we got permission from the Department of Energy to proceed into Title II design, which we did. However, we had a substantial reduction in budget or in funding, I should say. A substantial reduction in funding and, therefore, the design activities were limited to the surface facilities at the north portal.

Since that time, a couple of things have happened. We have changed AEs, a transition from Raytheon to the M&O. This was based upon our M&O contractor coming on board around about a year ago. And, so this transition was performed. It's effective the 1st of October and should be completed in a couple of months.

Raytheon performed the design of the north portal site, the TBM launch chamber, and mixed rock/top soil storage area during FY92. And, although not stated here, it also included the specification for the tunnel boring machine for the first access.

In '93, we'll include a portion of the north ramp portal surface facilities and the north ramp from the surface to the Topopah Springs level.

This is again an isometric of the present con- figuration. And, the significant point on here, you should notice, is that we are using a phased approach for design and construction. And, these numbers 1, 2 through 10 are the various design and construction sections which we will do the design and construction effort. So, in effect, we do this section first; this section next. Well, I shouldn't say that. This section is next, but the numbers 2, 3, 4, 5, 6, 7, 8, 9, and 10 are only unique identifiers. They are not necessarily the order in which it will be designed and constructed. What happens is that 1 and 2 are in the right order, but beyond that, we will be reevaluating this essentially as the design and construction progress, so we take advantage of whatever situations develop. And, as indicated here, this is the titles of those various sections.

We were asked to give you a little information about our cost and the summary of our ESF cost estimates. You are probably not too familiar with the DOE processes, but we had to come up with an Option 30 cost. This came out of the evaluation of all the studies we did. And, that was to compare the Option 30 with all other options. It is not necessarily a formal cost of that activity; it is used more for comparison purposes between the various options. The absolute number here may not be correct, but it is good for comparing between the other options that we're evaluating. And, in the Title I, we also are required to make a cost estimate by the DOE requirements. And, this one came up actually quite similar to the one we had in the Option 30.

Now, in every year, we have to validate our costs to headquarters and that's a fairly extensive review of the details of our cost estimates. And so, when I say '93 validation and '94 validation, that's the validation for the fiscal year '93. It's done in '92. The '94 validation was done in fiscal year '93. These are all one year back, but for DOE's purposes, they call them one year ahead, '94. So, in '93, we validate for a couple years ahead.

Now, you can see that these validation numbers have, in fact, changed by some amount. This one stayed essentially the same. And then, in addition to that, the DOE requires that we have independent cost estimates performed by an external organization selected by headquarters.

In this case, headquarters selected Gilbert-Commonwealth to do the independent cost estimate. They have done this activity and you can see that there's a substantial difference in the bottom line. However, most of that is made up out of contingency which they did not include, but which we are required to include by the Department. I suspect that the reason for that is that, over experience, many tasks have been performed by various organizations with not only DOE, but the Department of Defense. It has been found that, generally, or let's say too often, there has been more funding required to complete the job that was originally estimated. And so, based on those needs, we are required to put in a contingency allowance. Now, we don't spend this; we don't allocate it within that. It is all under the control of the managers, but nevertheless from a reporting stand-point, that has to be included in that estimated cost.

One thing we thought would be of interest to this group would be the TBM unit costs in the Topopah Springs level formation and, specifically, the construction cost per foot on Option 30; again, this number here. This is in dollars. So, it's $7,000 a foot. And, in the '94 evaluation, it was $4,803, where the ICE Committee came up with $4,457. That's total construction cost. The TBM itself was $1,510 within that. With capital, it went up to $2,654. Remembering that this is based upon using four TBMs and more recent evaluations have indicated we're are doing that with two, so I think that we will probably have a decrease in this if we have a look at this again.

And, just for your information, in doing our cost estimating, we prepare this kind of a chart for each one of the elements within the cost to come up with a total cost for that element. There will probably be several hundred of these items for our total cost.

The major milestones, again as of last October '91, Carl will talk more up-to-date up to this. But, we indicated site prep start the 30th of November; launch chamber construction starting 4 October '93; start TBM operations 30 October '94. That was the time we were thinking of two TBMs. And then, the other dates that follow. So, that was as of October '91.

MR. GERTZ: I want you to keep in mind those milestones Ted put up were October '91 milestones. Now, we're going to tell you what our current milestones are, and they have changed.

Like many things in this world, the best laid plans become subject to change, be it due to funding constraints or whatever. Particularly in this program, it has been some funding constraints. So, what you see now is our plans for '93 and our modified plans for the out-years; where we are going with the project.

Ted gave you a background in an ideal case where we might liked to have gone. We've changed that. We have to play with the cards that were dealt. We have some realities with the situation. Once we determined what our '93 funds were, we went to work to change our program. There was some question on whether we had sufficient '93 funds to do anything. We were able to secure an additional 100 million in the appropriation process that allowed us now to move forward with some firm planning. So, I am going to tell you what our program is as of today.

In '93, you have seen this before, it's still preliminary. We're still sorting out some of the numbers, but this is the entire project cost in accordance with our work breakdown structure and we are focusing on two areas, the ESF and surface-base testing. Of course, today's and tomorrow's meetings are essentially going to focus on ESF. So, that's what we are going to talk about.

Once we found out what that funding was, I asked the project team to get together and the M&O team lead by M-K, Fluor-Daniel, Woodward/Clyde, Duke Engineering, and here was my goal to them, provide progress toward initiating underground site characterization work by doing pad portal by July of '93 at the lowest possible cost. That is what I asked them if we could do, knowing what they had. Well, they weren't able to quite fulfill all of that, but they came up with some plan that's pretty close. First of all, we will be starting site prep near the end of this month, November 30th to be exact. We have continued our ESF design. And, we will be doing Package I(b) and II this year. In '93, the Package II meaning the ramp down to the Topopah Springs.

In mid-November we will issue the RFP for the TBM. From January through April, we'll receive proposals and hope to award the contract for the TBM in April. In January of '93, we will start our temporary power supply upgrade. March '93, we will award a subcontract for underground construction. Now, I have some more milestones that I will talk about later. But, let me put some of the main ones on a chart for those of you who like these kind of charts. We also have detailed networks, detailed charts; everything is pretty well laid out.

But, this is the TBM procurements with one milestone for start site prep. This is our construction simplified sequence where we will prepare our topsoil pad road and drainage; construct the north portal pad and slot; construct rock storage pad and road; construct our first 50 feet of starter tunnel; cut and cover; and extend the starter tunnel to 200 feet. So, by September, not July as I had hoped, but by September, we intend to be about 250 feet into Exile Hill. That's our current plan.

This would be drill and blast. And, then we would hope then to have a TBM and that's a somewhat aggressive schedule and we hope to negotiate that and talk to the manufacturers when the time comes. If it's a new one it may take a little longer than a refurbished one. A TBM on site may be November, a year from now, so to speak.

So, that's our overall schedule. I'll talk more about our approach. You saw this before and, in essence, what we are going to be doing is starting up here at the north pad doing the north ramp, going across 10,000 feet at the repository level, and coming up the south portal with one TBM. That's our current plan.

When we get down here, we will have decided whether it's time or still appropriate to go to the Calico Hills. Right now, that is in our base plan and we would be ordering a second TBM and do the Calico Hills loop, a smaller diameter. While we conducted this excavation, we'll be doing some other excavations to drifts in our main test level as we go past those areas.

Ted showed you this and I'll show it to you again. As he pointed out, our original schedule was 1, 2, 3, and 4. But, we are not going to do it that way. It is going to be 1, 2 and then we will do across here and up. And, that's our current plan. Somewhat still undefined is exactly what we are going to do at the Calico Hills, but we just don't have the funds to go into that in detail this year, but we will be doing this ramp.

The cross-section of the ramp is going to be 6,000 feet. You have seen that before. I don't need to dwell on that. As I said, I will show you a schematic here in a second, too.

Part of the charge in order to get underground soon was a simplified portal and a simplified pad. And, this is in a year what this may look like with the building being an electrical sub-station. Certainly, we are going to have to have some change shacks and other office buildings, so to speak, but they will be modular, trailer type buildings at this stage. And then, this will be our portal into the mountain, our start-up tunnel. I'll show you some sketches of that. You have all seen the TBM. I don't need to talk about that much any more.

There's our schematic with the existing drill pad and that will be cut away in some way, shape, or form and a launch chamber be in place, and the pad be constructed. We'll be heading towards the Bow Ridge Fault.

In plan view, being a civil engineer, I would like to show these kind of views, too. This is the pad. Right here is the slot and the starter tunnel. It will go off this way. This is our topsoil storage and rock storage pile. UZ-16 is right up around the corner. That's the road into Midway Valley. We will be building this road and improving some other roads. The focus, though, will be do what's necessary to start underground activities.

Preliminary engineering drawings indicate we would have a concrete portal face. We would have a multi-plate steel arch at approximately 120 feet and then we have 200 feet or so of drill and blast. There is still some debate among the scientists. Is this the proper time to start the TBM? Perhaps, the rock characteristics might be more suitable for a TBM another 200 feet down. We probably are going to have to drill some test holes to figure that out. But, that's one of the reasons we have some slack in the schedule. In addition, we just can't get a TBM here that soon. But, that's the cross-section view of the design. It's not quite the final design yet, but I just wanted to point that out.

In plan view, once again, this would be the multi-plate steel arch. This would be the starter tunnel. And, we do have one test alcove in that part of the excavation.

Let me just review. I am going to take one step back again as Ted did. When we were doing the ideal planning, we were looking at four TBMs and we were going to have them operating, and get everything done as soon as we can. That included north/south ramps starting at about the same time in October. When they got to where the Calico Hills ramps off-take was, we would then erect the Calico Hills TBMs and do that excavation, it would begin at the main test level once its location had been reached by the north

TBM, and breakthrough of the Topopah Springs would be achieved well before completion of the main test level.

That was our thought. The fact is, we don't have money in '93 to plan on four TBMs. It doesn't look like we will get that kind of money in '94. So, we've scrapped this approach essentially. That is kind of out the window right now and we have gone to this approach.

Procure one large diameter to begin, procurement to begin in mid-November; operation, whatever it takes, a year to fourteen months, sixteen months from then. That will determine the actual start-up date. A receipt could occur as early as '93. Operation could begin as early as '94. One large diameter 7.6 to 9.1 meters. In your book, you may have to fill that in or we will provide you an updated page because we are moving really quick here. We will start at the north portal. The narrative would be excavate the north ramp to the Topopah Springs, then do the Topopah Springs, what I call main drift, north/south drift, and then up the south ramp to the surface. That's approximately five miles of heading, 26,000 feet. So, that's a lot of one tunnel heading. But, we think it's right now an appropriate approach.

A second smaller TBM will be employed to drive the north Calico Hills ramp to the Calico Hills level and the south Calico Hills ramp from the Calico Hills to a connection with the south ramp.

Not much activity is going to happen on that in '93. That is going to be a '94 or '95; '94 design; '95 activity, probably.

Let me put this in a little different schematic. You haven't seen this before. So, you will have to bear with me. But, what I am trying to say is if you are looking in plan view--and, we'll have a model here shortly. We have a model of this operation. And, you start up here in the north ramp and we start 3/15 or whenever in '94 with the TBM. We would bring the TBM along the north ramp. Our best guess is in July we could be down to the Topopah Springs. We would then start across the north/south main drift. We would construct some cross-drifts in this time frame. We would also construct our core test area and perhaps even out to the Imbricate Fault. We would complete the main drift in '95 and breakthrough early '96 on the south ramp. Certainly, it depends upon penetration rates and how well the TBM works. But, this is our best guess.

Our approach is going to be this one loop approach; our best guess to the dates. Perhaps, there's ways we can improve the dates or whatever, and we hope to get any of your ideas you may have along that right now. But that is today's approach to doing business.

With that, I will give you some more milestones because, as a project manager, you have to have goals and milestones for teams to achieve.

We had hoped to have the design done of the north ramp 9/30/92. We had some good comments in our design review. We've decided to lower the height of the high wall; use the metal Arco starter tunnel, so to speak. It provides less rock cut, less environmental impact. So, we will have that design and be ready to go with what we need to on 11/23/92. That is our estimate. These two activities have indeed started. I am probably a little lax by not having that as started. We have started the Title II design on north ramp. The M&O team has started that design. The Raytheon team is finishing this package; the M&O team is starting this design and selected surface facilities, what's going to go on the pad other than the initial electrical activity.

The TBM request for proposal should be 11/16/92. That's a goal. We might miss that. We're working hard to get it out, but that's what we've laid on ourselves right now as a target.

Just going through the dates then, start site prep, 11/30/92. That's Monday after Thanksgiving. We have every reason to believe we are going to start that date. Start TBM launch chamber, 4/2/93. That becomes a matter of semantics what exactly is that, but that is getting into Exile Hill with the rock blasting. Complete the TBM launch chamber, 9/15/93. That is the 200 feet or so of drill and blast. Complete the design in north ramp at the end of the year and complete selected surface facilities at the end of the year. So, we will have a complete design to go on from the launch chamber, which is no surprise to those of us who do that kind of work.

But, start Title II design of the main access in '93. We will be designing the main access about a year from now. Remaining north access facilities, core area; a lot of design, as you can see, has been deferred for a year. We are only doing limited design next year. We hope to have the TBM on site in November or December, depending on what dates we look at. We hope to negotiate with the suppliers, maybe even for an accelerated delivery schedule. Start TBM operations 3/15/94, 2/15/94, 1/15/94; it depends.

North ramp, these are kind of dates that are close to what's on the other chart. And, I have just laid them out in a tabular form for you so you can have it either way; on the chart or in a tabular form.

I just need to tell you a little bit and go back one step. I have talked about different organizations and for those of you who are not familiar with the structure of the project, I thought I would perhaps give you a score card so you would know who the players are.

I have a project office. Ted Petrie, Bill Simecka, and many people here work for me, about 70 Federal people. I report to John Bartlett who reports to the Secretary of Energy. We have the M&O team on site now, about 250 strong going to 300 strong, that provides technical direction to the participants. And, they also are a participant role. They're doing design activities and other things. Dale Faust leads that team and that, of course, includes the M-K, the Fluor-Daniels, the Duke Engineering, those types of entities, in addition to TRW. I think they have 8 teammates. Doing the scientific work is the USGS, Sandia, Lawrence Livermore, and Los Alamos. Raytheon originally did the design of the ESF. They will continue to design support facilities for us and surface-base testing pads and trenches. REECO is our constructor. They are the constructor of the test site. In the third session, we will talk more about the REECO organization and how they are organized. Dale Frasier, a general manager for REECO, will talk. And, SAIC provides various support services including running the sample manage- ment facility, the outreach program.

So, that's kind of the team. Bill is going to talk a little bit more when it comes to construction management, how he carries out his effort with this team for the ESF alone. But, we have MOUs or direct contracts with everybody. I am satisfied with the management structure and the charter

I have.

I think that is all I was going to give in an overview and we are ready to answer any questions or expand on anything. I hope this met your needs for at least initiating the discussion.

I don't know that I need to stay up here, Ed.

DR. CORDING: We would like to have some discussion, particularly on items you presented and any comments that people would wish to make and then some of our discussions will proceed from there and more general topics related to the ESF development.

If I might, one question in regard to the overall schedule. There is a schedule developed for Mission 2001. With respect to that, you have basically started tunneling approximately one year ahead of what the Mission 2001 had anticipated. And, you have shown the time taken to get through the repository. Is the time of the entire under-ground construction moving forward from Mission 2001? I believe it was somewhere in 1997 that most of the tunneling work would have been completed on that Mission 2001 plan. Do you have a feeling for that at present?

MR. GERTZ: My feeling is and maybe someone can help me, Dale or some of the schedulers, that it has moved. That part of Mission 2001 has moved forward a little bit. However, other things in Mission 2001 have been deferred because we have concentrated on this activity, like next year we'll still only have one LM-300 working.

I have to now just share an incident with you. You know, two weeks ago you all were out here and I was talking about getting underground and certainly in your opening statements then and now was an aggressive approach to getting underground. Last week, I had the ACNW here, the Advisory Committee to the Nuclear Regulatory Commission. They were aggressively indicating to me we should be doing more surface-base testing, and why weren't we understanding about the hydrologic head, and why were we so aggressively pursuing underground? Well, sometimes, I can't win in some of these activities.

But, to answer your question for 2001, we have completed some underground work a little earlier, I believe. I don't know. Dale, do you want to add or Bill maybe has something to it.

DR. SIMECKA: According to the plan, I can give you an indication of the first loop, that is the Topopah Springs loop. And, we're about six months early over what our baseline plan was. So, that gives you an indication by starting a year early, we gained a few months, three to six months. And then, the rest of it depends, of course, on when we start the Calico Hills. But, if we only have two TBMs, it will take a little longer totally, but by starting early, we've gained some time.

DR. CORDING: In regard to the cost breakdown on the total somewhere in the $800 million range and looking at the ESFAS--in other words, the ESF Alternative Study which was about 1990 when you're looking at all the various alternatives and comparing, my understanding is that the cost of the--you know, taking the actual construction costs of building the tunnel and not including the cost of supporting the testing and the other operations related to the support of the test program, the actual construction costs of developing the portal and then going underground and doing the tunneling, the numbers looked like something in the range of $450 million out of a total of what was at that time something like $765 million, if you didn't include some of the costs related to repository design. So, the other part of it, as I understand, is largely related to operating the facility and some other support activities and some of the communications that are required for the testing itself. Is that a fair assessment of the numbers?

DR. SIMECKA: I think that is about right after you take out the operations, and of course, part of that was the integrated data system that was in there and so on. So, if you have taken that out, that's about right, I believe, as I recall.

DR. CORDING: Yes. And, the construction costs are--I know you are in the process of looking at updating those. Is that 450 million the same number? I know that you have been looking at different rates for tunnel boring machines and I'm wondering if that is resulting in changes in that $450 million number. This is the $450 million for about 78,000, or something like that, feet of tunneling.

DR. SIMECKA: I think the construction costs are staying about the same. The difference is, the major difference is in capital equipment. If we go with two TBMs, then we do not buy, of course, the other two, plus an extra power line. So, we're saving on capital equipment costs as a result of the new approach. So, I think that would reduce the construction costs that includes the capital equipment. Does that answer your question?

DR. CORDING: Yes, I think so. I am thinking there may be more savings in some of the tunneling that may be even in addition to that because of higher advance rates being able to be assumed or being assumed at present compared to the previous estimate I have done.

DR. SIMECKA: I think the Title I assumed, correct me if I am wrong, Jim, I think it was 35 feet per day, I believe, is what you used in the estimate. On the average, about 35. And, I think now we believe--I mean, our plans are about an average of 50. Of course, it depends on the machine, obvi- ously, which we haven't gotten yet. But that is what we are using is about a 50 average.

DR. CORDING: We would like to open the discussion for others in regard to the presentations that have been made, in particular. Are there any other comments and questions that you would like to bring? People at the table, members of the Board, or anyone in the audience?

MR. BALLARD: I have one question, Ron Ballard, NRC. I wonder, Carl, if you could comment on the relationship of any of your GROA design plans to the ESF design?

MR. GERTZ: Okay. Ron, as you point out, we're well aware we have to integrate the GROA design, the geologic repository operations area with any ESF designs as part of 10 CFR 60. And in our ESF alternatives, we had repository designs that were well described in our Title I ESF design. We had a suite of repository drawings. And as we moved forward, part of the tasks in '93 that I didn't show on here was repository advance conceptual design by the M&O team. So, they will continue bringing up to date our interface drawings with the geologic repository area. And, part of that, of course, will come into play when we do Package II which is the ramp which now intersects the repository horizon. So, we'll also have a suite of drawings. Not detailed repository drawings, but certainly much like we have had in the past to integrate the ESF with any potential repository to assure we have looked at alternatives, to assure we are not impacting ability to isolate waste. So, that is part of our plan and we are committed to do that.

For those of you who may not be aware, when we originally put the SCP out, we had two objections issued by the NRC; one on the quality assurance program, and one on our design control. The quality assurance program objection was lifted a year and a half ago or so, and just yesterday, I got a fax that the objection on design control from the NRC was lifted. With that, though, we have lots of commitments as to what we needed to do during design which includes paying attention to the GROA as we move forward.

DR. CORDING: Some clarification for me on the plan for excavating once you get down to the Topopah Springs level. There is the testing area in the northeast corner of the facility and then there's some cross drifts. And, at least in this estimate, the means of excavating that and accomplishing that would be of interest to me.

MR. GERTZ: Let me have my team help out. I think when I talked to them they were talking about mechanical activities. I think what you are talking about is that, you know, we are going to put a TBM down here and then we are going to move forward along here and up, and the question is what are we going to use--what's our plan today for excavation here and for excavation along here.

I guess we have put some dates here. We have indicated we are going to do it as we pass it. Now, the next question is what was our basis for estimate for mechanical mining?

DR. SIMECKA: Well, of course, it's budget sensitive. If we get the adequate funds to purchase in '94 a 16 to 18 foot second TBM, we can use that to do the Imbricate Fault excursion, as well as the cross-drifts that go to the Solitario Canyon and then east to the Ghost Dance. And, the actual MTL area, we planned to do that with drill and blast because of the nature of the heater test which is an urgent thing. We haven't defined exactly how that is going to be, but it may be such that a TBM mechanical miner can't do that as well as the drill and blast because it has tunnels above each other and all that sort of thing. So, that hasn't been worked out.

But, if we had a 16 to 18 foot machine that could work in the Topopah Springs, in other words a pretty powerful machine, we could take off from the MTL area and head for the Imbricate Fault and then do drilling and blasting off of that for the MTL.

DR. CORDING: I'd like to have more discussion on some of these methods as we continue with the session. But, in doing that, at least with this plan, are you anticipating that the main TBM that is going through on the green line, when that occurs--when you do, for example, the Imbricate

Fault, perhaps with an 18 foot machine, does the main TBM have to stop or how long does it stop and when can it resume? Does it have to wait until completion, or does it resume progress before the completion of, say, the 18 foot tunnel to the Imbricate Fault?

DR. SIMECKA: Well, you would have to cut the utilities, you know, remove the utilities and the conveyor while you get started with that cross-drift because, depending on how you can do that, whether you do it--and, I understand you have some ideas or somebody has ideas on how to do the--using the TBM to make that turn into the cross drift. But, in any event you are going to have to stop it during that time that it takes to do that. And then, once the cross-drift TBM is operating and you can get the conveyors back there and the utilities back, you should be able to continue on with the big machine. And, the same way if you do drilling and blasting. Until you get it started and get it far enough back in there, you know, you'd have to stop the TBM and, of course, while you are doing any blasting at all which you would do during the shift changes or maintenance stops on the large TBM, you would have to stop it during those intervals.

MR. GERTZ: Our goal though is to keep the TBM down a minimum amount of time so that we can get up and out the south ramp. We have not figured out the details yet, that's for sure.

DR. CORDING: We have been thinking about various possibilities here and I know you have, and I think later we can have further discussion on this. And then, when we get to the testing part of this, I would be interested in hearing the concerns that management, as well as the testers have and the science groups have and the labs, on whether or not it would be an advantage to just go through the entire facility and not even start those cross-drifts. And, you know, we can talk about in this session about how much time it would take to do that and then come back and do these things in contrast to doing it this way and I think both are options that need to be looked at, at least I would like to see them discussed in this session. I am looking for the input that others of you will have on that topic.

DR. SIMECKA: There is an issue on how soon you can get the heater test started. So, that is kind of a long pole in the tent issue. So, we would like to get the heater test started as soon as possible because that is going to affect our license application.

DR. CORDING: Those are essentially five year tests, as I understood.

DR. SIMECKA: Five to six, yes.

DR. CORDING: And, that's located right in the blue area?

DR. SIMECKA: Yes, as far as the in situ testing. As you know, we had planned and looked at the Busted Butte which we will talk about tomorrow to get those heater tests started early, but we do not have the funding for it this year to do that. So, we feel that we ought to start those in situ heater tests as soon as possible. So, that would be one reason why we would want to get into that MTL area.

MR. GERTZ: But, Ed, let me just make sure I can summarize. Your approach or your thoughts might be would it be better? An approach would be to go all the way down and do nothing in these areas and then come back and do whatever is necessary.

DR. CORDING: It's an approach. I am not advocating it. I'd like to discuss it.

MR. GERTZ: No, I understand that. It's an approach that you described. And, I know we did think of some of that. Our goal is not to be down too long because we need to breakout at the south portal before we can get in the MTL and do testing. We need to have the breakout before we can start the actual testing. We can do mining on one heading, but we can't do much other work, as we understand the regulations right now.

DR. CORDING: Any other direct questions?

Yes, Hugh? Hugh Cronin?

MR. CRONIN: Bill, can you tell me how much drill and shoot tunnel are you planning in the test area at present?

How many feet of drill and shoot tunnel are you planning?
DR. SIMECKA: Well, I have heard all kinds of estimates. We are working on that now to combine the effort. I have got some people here that might make an estimate.
MR. McKENZIE: In Title I, the total footage in the main test area is about 9,400 feet.
MR. GERTZ: Is it our current plan to drill and blast all that now or to use mobile miners for part of it?
MR. McKENZIE: Title I was mobile miner and, as he said, right now we're evaluating doing that as drill and blast because of the flexibility of the method.
MR. GERTZ: And, that did include the drift off the Imbricate Fault?
MR. McKENZIE: Well, the Imbricate Fault zone was planned to be a TBM.
MR. GERTZ: Okay. Does the 9,600 feet include that?
MR. McKENZIE: No.
MR. GERTZ: No.
MR. CRONIN: Maybe you could clarify this, then. I don't understand. If it's 9,400 feet, if I'm reading this chart right, we have 21 months to build that. Is that correct?
MR. McKENZIE: It looks like it. It's a drill and blast relatively slow operation. I'm not sure what our penetration rates were assumed, but they are not record breaking by any

means.

MR. GERTZ: If you get a chance to go to our information office, we have a model of the main test level that was modeled after a two shaft approach. It has to be changed somewhat, but it included tunnels and multi-level tunnels for conducting a scientific test. That is one layout of what it may have looked like.

DR. SIMECKA: As a followup there, we are looking at all of the tests from a design--you know, those tests that were to be used to get design data for the repository. And, we're looking towards consolidating some of them, maybe reducing the size of them, et cetera, et cetera. So, the total excavation in the MTL is yet to be determined.

MR. GERTZ: And, certainly, I don't think we've ruled out, is it partially mobile miner? Is it a roadheader? Is it partially drill and blast? Is it a combination of the two? Correct me if I am wrong, but from the discussions I understand is we're still looking at that. We don't know what it is.

DR. CORDING: And, I would think that perhaps in the afternoon session, some of the testing groups might be interested in describing what they would like to have in terms of geometries for that situation.

MR. GERTZ: To just put it in even more detail, here is the main test level and the different ramps, tunnels that we are now considering that came off of the Title I. As Bill points out, as we optimize the design, work with the testers, we're not sure all this is necessary. Or, do we need to do something different? We're not sure. But, that's the design. As you can see, this was round the corner so it must have been some kind of mobile miner type approach. Mobile miner approach.

DR. BARTHOLOMEW: I've got a couple of questions just as points of clarification.

Talking about this $450 million cost estimate and the scheduled dates that appear on these handouts, my question is, are the cost estimates based on the same penetration rates, roughly, that are reflected in these scheduled dates?

Secondly, are both the cost estimates and the scheduled dates predicated on some kind of a standard underground work day and work week? I don't think any of that information was mentioned. And, just as a point of clarification, I think that might be of interest.

Looking at the footages involved and the time involved, it would appear that about 75 feet a day would have to be the penetration rate if you're talking about a five-day week on the north ramp. Conversely, the main drift across the formation would appear to be about 40 feet a day, again assuming a five-day work week, and there undoubtedly is some thinking there, an explanation of those discrepancies, and I think that might be a point of interest.

MR. GERTZ: Are some of our cost estimators here, people that put the schedule together? Great.

MR. SCOTT: This is Jim Scott. I don't know if I should qualify a little bit here that the new approach that's being discussed isn't 100 per cent of what's in the estimates. The cost figures that Ted showed, the '94 validation is really the current budget figures. And when I redid that, the TBM advance rates for instantaneous work effort is based on 100 feet a day. Now, that doesn't represent tear down and set up of TBMs. That's extra time in the cost estimate.

All of the underground construction has been estimated on a seven-day week. That mainly impacts the type of REECo wage rates that are used in the cost estimate. How the M&O is reflecting that and the dates you see here, I can't really comment on. They'll have to go with that.

While I'm here, the test area initially was estimated with mobile miner excavation, but, in reality, you can see there in some of the tests--the heater tests, for instance--you're not going to get a mobile miner in the test excavations in the little slashes off the main drifts. So, really, the main test area where you see the rounded corners was principally the mobile miner area and the cost estimate reflects the use of a mobile miner.

I agree with some of the comments about going to drill and blast, where we were using between 20 and 35 feet advance for a mobile miner. With a multiple heading drill and blast, you can achieve that rate as well.

While I'm here, take me apart if you want.

MR. GERTZ: No, I think you bring up a good point, is that the dates we've put up are probably put together by the construction team that's working on it, the construction management team, and they may not have fully integrated with the cost estimate. The cost estimate is still the main facility. So I think it's kind of their best guess from their construction expertise as to what it would take to do this, and we have not fully integrated those two. Is that a fair comment? Dale, is that fair?

DR. BARTHOLOMEW: You're still talking about a seven-day week?

MR. GERTZ: We are still talking about a seven-day week, yeah. I think it's around-the-clock operation, essentially, isn't it?

MR. SCOTT: The surface construction is on a five-day week.

MR. GERTZ: Dale, who put the numbers on our little chart for us as part of your team?

MR. FOUST: Which chart are you talking about?

MR. GERTZ: This one.

MR. FOUST: These kind of dates are the milestones that we've been using in our planning purposes, ESFAS, and everything else. They were developed by our design group, and then given over to the graphics people for integration into your briefing, so the technical part of it was done by our design people.

MR. GERTZ: Did that take into consideration a seven-day week when you were thinking of it, too?

MR. FOUST: It was seven days a week, yes.

MR. GERTZ: Okay. Great.

MR. FOUST: There has been considerable discussion as to what advance rate we should use, so probably that's where the bigger variability is.

DR. CORDING: Jim, in some of your estimates, have you seen the impact of changing advance rates on the costs? Have you seen some changes from what I thought was about $450 million estimate in the ESFAS, whereabouts, you know, for the full development of the drifts.

MR. SCOTT: The ramp construction is generally of such a short duration, I haven't seen any significant impact between going from like 50 feet a day to 100 feet a day. You're talking about a several-month time period. Well, that's about all I can say.

DR. CORDING: Other questions? Joe? Joe Sperry.

MR. SPERRY: What other constraints are there in this main test area, main test level? I hear you have, in the heater tests you have, you go up over drifts, one on top of the other, and I heard something about some narrow drifts from Jim. Can we either now have a description of these difficult to excavate things, things that have to be drill and shoot, or maybe somebody could prepare something for later this afternoon or something? See, that plan view doesn't really indicate what the requirements are.

MR. GERTZ: Yeah, right we have some cross-sections of some of the more difficult to excavate areas in MTL, don't we, in Title I?

MR. McKENZIE: There are some Title I sections, particularly in the heater test area where the drifts are not on the main elevations. You can actually see that on that slide in the lower left corner.

MR. GERTZ: These three here, yeah, there you go.

DR. SIMECKA: But I would say that we're not ready to tell you exactly, because we're re-evaluating those. So I'm not ready to say that's going to be the way we're going to do it.

MR. GERTZ: What we can do, though, is bring in our Title I design that may expand a little bit on this drawing as to what the main test area excavations look like. We'll bring in some of those after the break. We'll get them.

MR. SCOTT: It would also be interesting to hear how flexible the design of these various test facilities is. I see you have one a little bit above the other. That's the first time I've seen that drawing, but I can't see the size. But, you know, the corners and just the whole layout of the main test area, could this be optimized for machine tunneling or is drill and shoot absolutely necessary? I've been under the impression that we really didn't want to introduce any water into the formation. So I'm surprised that there's so much drill and shoot here.

MR. GERTZ: Our drill and shoot will not be introducing much water though, either, much like our current core drilling doesn't introduce any water into it.

MR. SCOTT: Yeah, but there's a big difference between your current core drilling. That introduces no water and that was my understanding of what you wanted. Drill and shoot's going to introduce water into the formation.

MR. GERTZ: When we were looking at drill and blast, were we talking about much water? Who can comment on that?

MR. BULLOCK: It didn't bother the scientists as we talked about the amount of water.

MR. GERTZ: It was within our impact analysis for affecting test-to-test variation or waste isolation?

MR. BULLOCK: Right. But there's nothing definite. It was back in the Title I period and it was not really finalized. And then we went on to these other things rather than drill and blast, so we pursued it no longer.

MR. GERTZ: I will assure you what we need to do, whenever we do anything like that, is do an impact analysis: Does introduction of any, whether it's fluids or other materials, impact the test-to-test operations, and impact the ability to isolate wastes, and what's the third analysis we do, Max? Test-to-test, isolate waste.

MR. BLANCHARD: Foreign materials.

MR. SPERRY: In the back of my head, the modern hydraulic drill uses 7 to 10 gallons per minute of water. And I'm not sure if that's correct or not, maybe Dick knows, but it's something like that. And that's, you know, 7 to 10 GPM is a lot of water by some criteria. And I just didn't know, and I guess maybe the question is what's your criteria.

MR. GERTZ: We went over in G-Tunnel--maybe that's what Dale's going to talk about--and we had done some drilling, dry horizontal drilling, as a matter of fact, underground in prototype testing in G-Tunnel. I don't know if we could apply it to production operations.

MR. WILDER: Dale Wilder. I just want to make the comment that when we were originally looking at the ESF construction, we recognized that there would need to be some water if you went drill and blast. The project was looking at ways of minimizing the water because it does, for some tests, create problems, especially if you're looking at infiltration and some of the hydrologic tests. Some of the other tests were less sensitive.

And at G-Tunnel, we did use water in our drilling and we saw some results of having drilled with water. For our particular tests at Livermore, we were able to look at what the saturations were and go from that as a starting point. Some of the other tests were more critical, and so I think the approach that had been discussed in the past was that we would try to limit the use of water to whatever was required for safety aspects, even if it was drill and blast, to try to keep that to a minimum.

DR. SIMECKA: Let me say that we will consider mechanical excavations. In fact, we would like to maximize the use of mechanical excavation just for the reasons you say. And until we get the actual tests laid out, we won't know if we can do mechanical excavation. And with mechanical excavation in mind, we may be able to adapt it to that, but that's yet to be determined, because you have to detail out the test pretty carefully because that's the main purpose of it. So we're not against mechanical excavation; in fact, we'd love to have it wherever we could because it tends to go faster, but for short types of excavations, and so forth, it may be more cost effective to do drill and blast, and that's kind of the position we're taking.

DR. CORDING: I think that's most of the questions we have in regard to the presentations, and thank you very much, Carl.

I thought we could just outline briefly some of the items that we are interested in discussing in this session. And you see some of the questions or bullets in the agenda that are items that we are planning to cover. I've reorganized it slightly in terms of perhaps an order for discussion, and I'd like to just briefly read that to you as some suggested approach for us to discuss various items related to construction.

For the first item, I would like to continue to discuss some of the constraints on construction, and these are in the areas such as the type of materials--and we started this discussion already, but the type of materials that can be introduced into the potential repository site in terms of things such as organics, water, cement, other construction materials. Some comments from people that are concerned with that, perhaps the NRC, also, will be of interest.

Then some discussion within this general discussion of criteria and constraints, things such as the MSHA and OSHA standards, what really applies to this site, what are required in terms of support for the TBM and the testing at utilities, the use of alcoves and refuges. Those are all under areas I would categorize as sort of criteria and constraints.

And then, going on to these other topics would be development of the north portal, and we've already seen a much simplified north portal, development of the north or south portals, what is required there, and with certain of the construction schemes, what might be the required or what could be even reduced.

The third item, after constraints and development of the north portal, would be considerations regarding tunneling at the repository level, and this is where we get in, then, to the tunneling straight through the repository with a TBM, or stopping to bring in mobile miners and doing side drifts in the test area, multiple operations of more than one machine at once, what's its impact on the operation. That would be, then, what I've described as the third item.

Then the fourth would be the approach to excavating alcove side drifts, test areas, a main test level with the various machines, and this kind of follows straight on from what was in the third item. But we would like to have more discussion by people within the industry on capabilities of various approaches and the various types of equipment: mobil miners, roadheaders, tunnel-boring machines, drill and blast.

Then we go on to a fifth item, which would be TBM size and the requirements for TBM size, particularly for going through the main test level, the influence on progress on risk, ventilation requirements, other requirements that may be related to repository development, and the discussion, perhaps, of abandonment or backfilling of portions of the ESF if they do not fit what ultimately might be chosen for a repository alignment.

And finally, in this session I thought we could talk further about the approach to the Calico Hills, the baseline approaches that have been discussed, and then the timing of some of that, and perhaps even a decoupling of the Calico Hills from the excavation of the upper main test level at the Topopah Spring level; in other words, decoupling might be a completely separate operation with a separate portal.

Those are the items that I would like us to consider as we continue, and that first item, then, that I go back to now, then, would be criteria and constraints on the construction, and continuing, I think, with some of the discussion we've just started.

I am interested in some of the background regarding what really are the requirements for the ESF in terms of things such as the materials that are introduced, and I know there are people here that could help us with that.

DR. ELKINS: This is Ned Elkins from Los Alamos.

The project has just approved a plan in the last few weeks that has been in development for over a year. The central focus of that plan is the control of materials, fluids, and tracers that are used in construction or testing activities within the controlled area. The basic premise of the plan is that: design, construction and test organizations each have points of contact; and working with the design, construction and test planning, provide to a coordinating source all requested materials that are a part of that design, construction or test planning, with backup information on location, amount, and basic characteristics, chemical information and data.

That input is then provided, by formal request, to series of analyses that will be all coordinated and performed by the M&O contractor for: potential impact of waste isolation; for test-to-test, test-to- construction interferences; and, also, a coordinative check with the classification analysis program that goes hand-in-hand with design.

Those analyses will either recommend use with limited constraint, constrained use, or the fact that some materials requested could not be used for their intended purpose. Those will then be capsulized, summarized, presented to the project office for approval, and once approved, will become part of an inventory and data base that again will be developed and maintained by the coordinating organization.

We have initiated that process already for a surface-based testing program, and that is the process we are using to control materials that are used as part of that program. We are in the process of compiling the requested inputs for analysis for the north portal pad construction process beginning in December, and then we'll continue into the starter tunnel and north ramp as we proceed.

That's a pretty good summary of, I think, where we're at.

MR. GERTZ: For instance, let me just point out, organics are going to have to be controlled, hydraulic fluids. They would tend possibly to accelerate radionuclide transport if we had a lot of them in there. So we're going to have to control them unlike you might have to in other mining operations. We're not going to let organics be on the floor of the drift, so to speak, because that would affect the ability of the mountain to isolate waste.

DR. CORDING: Could that lead to restriction, for example, on the use of diesel equipment underground, or will that be--

DR. SIMECKA: That will have to be looked at, you bet.

MR. GERTZ: It might not prohibit all diesel equipment, but it would probably cause us to limit that type of equipment.

DR. CORDING: So you would be going as strongly as you could for electric equipment?

DR. SIMECKA: Depending on what the results of the impact analysis would show, but if, indeed, we have to limit that, it may be far better to go electric.

MR. GERTZ: You know, I think I told you the other day, my biggest excavation right now on the site is not a trench or not getting ready for ESF, but it's cleaning up an old oil spill. And I was at a conference in Denver the other day where an oil driller, doing just normal oil drilling, says it's costing him $10,000 to clean up a 15-gallon spill in accordance with RCRA. So we're certainly taking a different look at how we do business, based on today's environmental laws; and, secondly, based upon the ability of the mountain to isolate waste, and we know organics is not a good thing to have in the mountain.

DR. CORDING: In the other restricted items, what about, for example, the introduction of cements, shotcrete, concrete; is that a problem? Rock bolts, the drilling of rock bolts throughout the facility, that has to be done even if you're not using drill and blast. You'll probably be doing some drilling. Will water be able to be used there? Can it be restricted? Are there ways of approaching the insulation of rock bolts? Cement that's put in for the rock bolts, can it be cement? You don't want organic resins, I assume. Those are questions that I think are certainly of interest to people who are thinking of the construction.

MR. GERTZ: Let's see if we can have someone--Dale, I guess, is going to take a shot at it. Great.

MR. WILDER: I wanted to point out that we do have a study which has been proposed on manmade materials to look at the impacts of many of these materials. In the SCP, if you read the SCP, you'll see that there are limits placed on changing of the pH of the water chemistry because of its impact on the waste container. And also, cements are mentioned there because of the problem with leaching the waste form.

Now, I'm sure you're aware that the project has been rethinking some of the approaches, and we certainly have not revised the approach to isolating waste, but there are some things that may modify our original conclusions in terms of whether we could use cements, and let me give you as an example, the reason for limiting cement is because right now the approach is that there is about a thousand years period of time in which we rely on the waste container. There is an additional 9,000 years in which we rely on the leach rates of the waste form.

The waste form is what's driving the limitation on cements. If we can convince ourselves and others that the container can last for the 10,000 years, then using of cements may actually be advantageous, and so that's really undergoing a lot of review at this point. We are working currently with the M&O in trying to define the best we can from literature what the impacts of man-made materials are. Unfortunately, we have not had the funding to do the studies of the impacts of man-made materials. We're hoping to start that up this year.

DR. CORDING: Dale, do you think there'll be a problem with using cement-grouted, for example, rock bolts, or placing shotcrete as a protection on the rock arch?

MR. WILDER: It depends on which approach you're going to take. If the approach is that you're going to rely on the dissolution rates of the waste form, then there is a potential problem with the use of cementaceous materials. However, there are some cement formulations which minimize the impact on the water chemistry, and so I think you can work around it.

Of much more concern to us would be the use of organic resins, and so forth, because the organics really do complex the radionuclides; and, secondly, they serve as a basis for biological activity which can really get into the biological corrosion rates of the container. So I guess I'm waffling a little bit because it really depends on the approach that the project term is to take.

Certainly, if you go with drift emplacement, very thick containers, and you're trying to get with a 10,000-year kind of waste package container lifetime, then I would say there's probably not a problem with cements.

MR. GERTZ: But, Dale, you did point out there are some cements that have less of an impact than others?

MR. WILDER: That's correct.

DR. CORDING: Thank you, Dale.

MR. SPERRY: A point of clarification on the use of diesel underground. I assume that you're concerned about spilling diesel, rather than the odors, the noxious fumes of diesel exhaust?

MR. WILDER: Once again, Dale Wilder; Livermore. Our big concern with diesel fumes is that it does put organics underground. So it's a waste isolation issue for us.

MR. SPERRY: It's the fume, then, not a diesel spill?

MR. WILDER: Well, it's both. It's the organics, the presence of organics, and, of course, that would include a lot of compounds. We're picking on diesel because it's the most obvious one. but to put diesel fumes underground and have those in the environment could very well introduce those organics to impact both our corrosion rates of the container materials, as well as the complexing with the radionuclides.

MR. SPERRY: With mechanical excavation equipment, you're going to have a lot of high-pressure hydraulics there. I've been on a couple of jobs on a day-by-day basis that you spill a heck of a lot of hydraulic oil. What right measures need to be taken under the tunnel-boring machine and in the heading to minimize the impact of that?

MR. WILDER: We've discussed methods to prevent the spilling, be it shields, double--well, it looks like Ted was going to comment, but there are precautions that would be necessary to be taken in order to keep these spills from becoming a problem to the waste isolation.

MR. FRIANT: I think I can comment on a couple of things. In the specification that's being prepared for the tunnel-boring machine, there are a number of, let's say, extraordinary measures to be taken to attempt to prevent even minute spills out of the machine.

Some of the things, for example, are better instrumentation. One of the dumbest things I see pretty commonly is a pump fails somewhere and maybe the main bearing cavity fills up with oil, and then somebody notices that the sump is low and so they stuff another 50 gallons into the sump, and about that time someone else comes along, fixes the pump, and then you have 50 gallons on the floor when that stuff goes back to the sump. So, with instrumentation, a lot of that can be prevented.

Then the second thing is just extra little things; a cylinder goes out and needs replacing. First of all, we can catch drips with drip pans under the spots where they leak. Secondly, we can do clever little things like you have an extra valve on the hose so that the mechanic just doesn't take off a hose, throw it on the ground, and let it drip. You have to actually turn the handle to shut the valve off before you can get at the fittings to pull the hoses off. So there's a number of things that will be a bit of an extra cost on the machinery, but there are many things that can be done to reduce the spill possibilities.

DR. PETRIE: This is Ted Petrie with DOE. As far as the specific solutions are concerned, what Jim has suggested is certainly some of the things that can be looked at. From our viewpoint, we are placing requirements on the TBM vendor to provide for the mitigating features which will assure that excessive leakage does not occur. And that will be part of the things we'll be evaluating when we get their proposals. We've notified to them, that we expect the TBM vendor to use his ingenuity to come up with cost effective techniques for meeting our requirements.

DR. STATTON: One thing I'd like to kind of get back into focus here is, as we look at constraints, as we look at constraints on cement, exhaust, et cetera, we have put back into context why we're down there in the first place. And what I see is Phase 1 of this new ESF, this upper loop we're talking about, as being, in essence, our opportunity for a sanity check.

What we're saying is that we have a model in mind of what the mountain is all about, and there are some things we kind of need to check, have a little reality check. And if that means walking through the mountain with our cup, looking to collect a water drip to find out that we have old water, we clearly want to control anything that can compromise that single drip that can be one of the most enlightening things we learn as we check out this plumbing system. So that, in fact, the constraints may be phased through time.

I mean, there may be places where the constraints early on are that we don't know what we're going to encounter. Once we have gone through and identified where alcoves ought to be, what tests ought to be run, which fault appears to be one that we're interested in either examining for its water conduit capacity or, frankly, for a gaseous conduit capacity, then we could probably come back and become more lax in what we do elsewhere.

DR. CORDING: Your first approach to it, then, the way you're describing it, would tend to--you'd want to be conservative.

DR. STATTON: Probably extraordinarily conservative.

DR. CORDING: For example, can we install rock bolts dry? That's a question, well, it has to do with safety and dust and technology.

DR. STATTON: And how close behind the TBM do we have to be putting the rock bolts in?

DR. CORDING: Yes.

MR. GERTZ: Certainly, some of our original concepts for drill and blast included essentially dry drilling, with mist to control the dust for safety and health reasons, and do the drilling dry. Certainly, I'm aware of rock bolts that you don't need to cement, that are just the cinch-type anchors, as we all are.

DR. CORDING: But you still drill a hole.

MR. GERTZ: You still need to drill a hole, absolutely.

MR. HOME: I just would like to make a comment, just an observation comment. It seems that we're awfully close to D-Day here and there's a lot of things open. I mean, if we don't know we're going to put rock bolts in, or whether we're going to support by ring beams, you're going to order a machine in two months, it seems a little unrealistic to me. You should have your decision whether you're going to use rock bolts or not. It's going to be a major criteria when you go to order this machines.

MR. GERTZ: Dick, do you want to comment on the Title I design? It includes rock bolts and everything.

MR. STANLEY: Bruce Stanley, RSN. Title I design includes rock bolts and mesh in most of the facility. It does not include shotcrete, but it does include shotcrete only in the areas of gravelly ground or particularly bad ground. Everywhere else, the rock will try to be controlled with the use of rock bolts and/or wire mesh.

We really didn't have any controls on the type of material to be used. We were cognizant of the potential impacts of using resin. We are designing the starter tunnel with the use of resin bolts. That is a significant distance away from the repository block. We have gotten a reading on that from our performance assessment people, and a performance assessment evaluation. But there are other methods for installing rock bolts. Yes, holes can be drilled dry. You can use split sets. You can use point anchor rock bolts, et cetera.

A final decision on exactly what is to be used has to be yet made. We don't have a reading on the type of ground in every particular area, either. So we have to have fall-back positions.

MR. CRONIN: Excuse me, Bruce, am I understanding you correctly, you're talking about Title I design criteria?

MR. STANLEY: Title I design criteria and Title II design criteria both.

MR. CRONIN: Oh, both. Okay. Thank you.

MR. STANLEY: I was referring to what the Title I design shows because there is no Title II design for the underground portion as of yet.

MR. CRONIN: Well, I think that's the point that Mr. Home was making. I think it's a very valid point. If we don't have design criteria, we don't know what we're going to do to support the ground, or what the restraints may be, then how can we be buying a machine at this point?

MR. GERTZ: I think we have a pretty good idea, but keep in mind that the machine, as best I know, will have to provide whatever is an appropriate ground restraint after the machine moves through the rock.

DR. PETRIE: This is Ted Petrie, DOE, again. Bruce talked about two issues or two areas; the Title I design, which is the underground portion of it, where we have only that Title I design information. And by underground, we mean well into the ramp and down into the bowels of the mountain.

In the Title II design, which we are essentially finalized on that, we are talking about the first couple hundred feet of--he talked about the first couple hundred feet of drift to prepare the launch chamber for the TBM. And there he stated the kind of support he's planning to have in that area. So you're going to need to separate the--remember, we said we were going to design in phases and construct in phases. And the Title II design is for the first phase, and Title II design for the next phases is still in process.

Now, we will not, in fact, be ordering the TBM for about six months, and although I'd let one of our underground engineers speak to this, but I believe that there is ample time to come up with decisions on what will be necessary for support of the ground during that period, and if there's any TBM effect.

MR. FRIANT: We are making some assumptions at this point in time that the, first of all, you know, the tunnel-boring machine that we feel is needed is a basic open-type machine, nothing really very special. And these types of machines are capable of installing all sorts of bolts and ring beams, mesh, and behind the machine at the bridge conveyor area, some shotcrete where it's necessary.

We spec'd the machine out to the degree that it is spec'd out today, assuming that you're going to be putting rock bolt of a type where you drill dry, use up a lot of bits perhaps, but it's quite possible. We use either Swellex or split sets as the bolt. And you need this platform on the machine to do so. You can put ring beams up and any type through the fault areas that may be raveling, you can even then include some areas with ring beams, mesh covered with shotcrete just a little bit behind the machine. So from that standpoint we can specify the machine. Now, the type of drills on it and things like that would still remain to be settled.

DR. CORDING: Let's move on to one other question regarding constraints that I'd like to have the participants discuss, and that has to do with the MSHA and OSHA standards and requirements for things such as alcoves and number of accesses, and I would like to have some discussion of that.

Joe Sperry, do you have some questions in that area? I know you've been looking into some of that information.

MR. SPERRY: It appears to me, as I review the literature that I have had the opportunity to review, that you are complying to MSHA standards.

DR. PETRIE: And I don't understand the requirement for that.

MR. STANLEY: When we turn on the test that would be similar to our production phase, if you will, prior to that time we would be in development. So to try and draw a parallel and to try to put things in perspective, that is the best we could come up with at this time.

MR. SPERRY: What I understand from Carl is that you are going to have two accesses before you start testing.

MR. STANLEY: That was one of our requirements.

MR. SPERRY: This does get into the critical path and it is required for your testing program.

MR. STANLEY: That was one of our requirements all the way through Title I, and it is currently required. I understand that no long term testing would occur or start before a second means of egress was established.

MR. GERTZ: Maybe you can help me on super-conducting, super-collider, do they use MSHA rules, too?

MR. SPERRY: The answer is no. This is during construction. Now, of course, there are accesses all around the ring during operation and experimentation.

We are currently building--there is a Robbins tunnel boring machine starting out under Boston Harbor and I think that is an eight-mile tunnel.

DR. CORDING: It is nine and a half.

MR. SPERRY: Obviously, there is no second egress.

MR. GERTZ: I think that is appropriate. We hope to go five miles without a second egress.

DR. CORDING: We need to have an egress here.

Let's take a 15-minute break and come back and continue.

(Whereupon, a brief recess was taken.)

DR. ALLEN: Would you please be seated?

DR. CORDING: We have an announcement.

DR. ALLEN: Could I make an announcement about the speaker system, please? There are so many microphones in the room that we're just having too much feedback trouble. So what we're going to do is to leave the microphones on around the table here, but all of the floor microphones are going to be turned off until someone wishes to use one. So when you stand up and go to a microphone, would you please raise your hand so the staff over here will know to turn that particular microphone on; a little bit further delay.

Ed, carry on.

DR. CORDING: We had just one comment on what our plans are for the lunch period.

MR. McFARLAND: The hotel has a buffet luncheon they serve in the dining room. I believe it's $6.00, $6.50, something on that order if you're interested. They have suggested that we break for lunch at a quarter to twelve. That will give us entre into the dining room before there is anyone else in there. We have scheduled from a quarter to twelve to a quarter to one for lunch. For anyone that would like to take advantage of the buffet, or whatever other conveniences you feel--but they can handle us. The buffet is good. The hazard is eating too much, which kind of slows down the afternoon, which is not good. But we wanted to bring that to your attention. Thank you.

DR. CORDING: I'd like to continue with our discussion. I know we may be pressed for time to cover all the topics. I want to get to the important ones to emphasize that and get to those.

I'd like to go now to the discussion of the considerations regarding the tunneling through the repository. We're talking about the idea of going straight through the repository with a TBM and in comparison to stopping to do some work in the side drifts and test area.

Joe Sperry has looked at some possibilities regarding going straight through the repository, and I'd like him to make some comments in regard to that.

MR. SPERRY: This isn't quite as easy as having a canned presentation because we're sort of responding at the same time to what we've learned in the past couple of hours, and I've learned an awful lot in the past couple of hours.

We had some ideas that Ed would like me to present. I'll try to get them organized a bit here. I have some view graphs, or overheads, I guess you'd call them.

This is an 18-foot tunnel boring machine, a fairly typical Robbins machine. It's an 18-foot diameter machine. I base this discussion on 18-foot diameter machines because they're quite available. There are used machines available now. I think there are maybe four to six used 18-foot machines available, and an 18-foot machine, of course, it's going to cut the rock faster. My estimate on this would be and without delays, Russ uses the term commercial practice, but I think in the rock of the Topopah Springs, you could expect to advance about 120 feet a day with an 18-foot machine. I notice Levent looking at me and making notes. My estimate on a 25-foot machine would be about 95 foot a day in the Topopah Springs. So it goes a bit faster and it's easier to erect, faster to move around, and so forth.

In this study I have also figured to do everything with tunnel-boring machines, and this has taken some thinking of developing some different type of equipment, but I'll just run through that in this whole presentation, I think.

A tunnel-boring machine is by far the best equipment to excavate both the Topopah Springs and the Calico Hills. It does have two drawbacks. It creates a circular invert which is hard to travel on, as you know, and it also must be supported on the invert and on both sides. It's going to roll over if you don't support it on one of the sides.

A roadheader, I'll comment on the other methods a little bit, a roadheader won't cut the Topopah Springs. It is very slow cutting sideways. Even in the Calico Hills, I watched a roadheader, Russ and I watched a roadheader collar a drift at the MX missle egress demonstration going sideways and I was amazed at how slow it was, even in an unwelded tuff.

The mobile miner will definitely cut either of your rock formations. It's almost as large and expensive as a tunnel-boring machine, and none of them have been used in the United States. And I thank Neil Dahmen for getting lots of literature to me and bringing me up to date on the state of the art of mobile miners, but I think I'd rather put my money with a tunnel-boring machine here if we can make it work throughout.

Now, both the roadheader and the mobile miner require a flat invert to get started from. It's ideal to tram them down to the excavation level on their own tracks. You need a flat invert to do that, and certainly, to collar off at a right angle or whatever side or kind of turnout, you require a flat invert.

Now, there is one big disadvantage of the flat invert. It precludes backing the tunnel-boring machine out. If you take your tunnel-boring machine through and exit out the other portal, that solves that problem, certainly.

We all agree that a conveyor is the only way to remove muck from this excavation, especially considering the slope of the excavation, but also, how fast you're going to cut the rock. So we agree on that, but the conveyor brings a problem that I see, combined with a flat invert. This is your lifeline. All your muck comes out on that conveyor, and if you travel on the flat invert with a free vehicle, this is an outline of a Gettman, I believe it's a nine-man personnel transit vehicle, you're putting your lifeline in jeopardy, especially on the grades and curves that we have here. It's a dangerous situation. The conveyor is running at 500 to 600 feet a minute and you're traveling down there. If you get out of control, some day you're going to hit the conveyor and you're going to shut things down.

So I would conclude to use tunnel-boring machines for all the excavation, if possible, use conveyors for all the muck removal, and do not fill the invert.

Now, to do this, we need some new equipment. We need some equipment to deflect the tunnel-boring machine into turnouts. I have a conceptual sketch of this. This sort of gives the start of it. The tunnel-boring machine has progressed and the deflector, I'm calling this the deflector, TBM shield deflector, is in front of the tunnel-boring machine. We'll discuss that later, but the tunnel-boring machine attaches to the deflector and tows it, tows it backwards. And this shows the deflector anchored in the tunnel--I have another cartoon that shows a bit more about that--and the tunnel-boring machine grips on the deflector and deflects over into, on a 100-foot radius, into a turnout.

You get the concept a little bit better here. There's rock bolts that hold the deflector in the tunnel and this turns out.

Now, if there are some modifications that need to be made to the tunnel-boring machine, this is a short main-beam tunnel-boring machine and the operator's station and the controls are put on the trailing equipment back here. This is a guide shoe that's added. There are some other minor things that would be added to the tunnel-boring machine, a fast way to put a dolly under the cutter head to move it back on the rail. Another feature, you probably want a fast method to remove the dust shield so that you can jack it up a little bit for moving back on the rail, but understand, it wouldn't be jacked up but a few inches.

Now, the other thing that's needed for this due to our grades coming down here is a different way to get the men and materials underground and I think a cog rail locomotive system could be considered for this. It was used on the English Channel Tunnel. This system was developed, I believe, in England, namely for the coal mines. I believe they used these at the Selby Mine. They were used operating on a 15 percent downgrade into the English side of the English Channel Tunnel. It's a proven technology.

Now, we have to consider the radius that the tunnel boring machine is going to turn on and the radius is determined by the conveyor. The conveyor manufacturer--and, I'm talking to the Long Airdocks people who have supplied all, but I believe two of the conveyors to the construction industry--they recommend a minimum of 1,500 feet radius; 1,000 feet is okay; and, recent developments may allow a smaller radius. I talked to them recently and they think the 750 feet radius, you compromise the life of the belt a bit, but you can turn a 750 foot radius.

Now, the deflections that we talk about with the tunnel boring machine would not have the continuous conveyor going around, but we would have a different conveying system, a cascading conveyor, a flexible conveyor, then followed by cascading conveyors, and then the drive and storage unit of another continuous conveyor would have to be erected after the turnout is made. So, the turnouts and/or alcoves, whatever is required, the geometry would be circular and the same diameter of the tunnel boring machine.

The excavation sequence, just to go through a quick one here. As I visualize it, this is just a fair outline of your facility. You go down here and it excavates the entire thing, just as you planned to do, but you wouldn't stop and do anything. And then, on the retreat, if you want alcoves along here you'd come down and you would pick up your deflector here at the south portal, pull it in behind you, and deflect to your alcoves, whatever, your drifts across here into your main test level.

Are there any questions, so far? Next, I will go into an example of what this might--a layout might be. But, I think maybe there are some questions.

MR. KENNEDY: Joe, how do you get the deflector out in front of the machine? How do you get that deflector in front of the machine?

MR. SPERRY: Of course, there's two ways to do it. You can hole through as coming out through the portal or you can bustle it around in front of the machine, just as we take the main bearing in front of the machine, something like that. I haven't figured to do that at any time.

MR. KENNEDY: Okay. I just wanted to make comments. We have faced the same problem in designing other machines. And, we've got solutions that are very simple and straight forward and I can present that whenever it's convenient.

MR. SPERRY: That you can get it in front of the machine or that you can turn out?

MR. KENNEDY: No. We designed the machine. It is actually part of the machine. The machine has a small auxiliary gripper that's at the face that will react to side forces, so that you can steer without having a wall. And then, also, most people think of grippers always being horizontal. We do have machines or machine concepts where we can take grippers and go vertically so we can walk past or go past shafts. The super-collider machine we are building right now can also do that kind of thing very easily. But, there are other solutions. I just wanted to mention them.

MR. SPERRY: What we were trying to do was create a solution that would not be very elegant where we could incorporate into a used machine and, of course, the viability of this if you have, say, one or two deflections you want to make, each deflection is going to cost you a lot of money and time. If you have 30 deflections you want to make, you're going to get pretty good at it and, of course, you would probably put in a fancier deflector; then, you can do it much more efficiently.

MR. OZDEMIR: Joe, this machine that will make this 100 foot radius turn with alcoves, is that right?

MR. SPERRY: What's that?

MR. OZDEMIR: This 18 foot machine which can make 100 foot radius turn?

MR. SPERRY: Yes.

MR. OZDEMIR: Is it a specially designed machine with a short beam and so forth?

MR. SPERRY: As I understand it, it is a short main beam, that is all. The main beam is short and the operator's platform, the controls are on the trailing gear.

MR. OZDEMIR: Right. But then, will that compromise the high performance capability of that machine?

MR. SPERRY: Not that I am aware of.

MR. OZDEMIR: The other thing you mentioned, the rates on the 18 and 25 foot machines, 18 for going faster; is that based on the same power intensity to the rock or different power limits on the machine?

MR. SPERRY: Oh, no, the 25 foot has much more horse-power. I don't recall what I figured. I think the 25 foot had 2400 horsepower and the other had 1600 or something like that or 1800; I'm not certain.

MR. ALLAN: Joe, why do you feel that the 18 foot machine advance rate would be greater than the 25? Is that what you said?

MR. SPERRY: Yes.

DR. PETRIE: Ted Petrie, DOE. When you say it has much greater horsepower, is this at the cutter head or the total? At the cutter head, is it essentially identical or is it less or what?

MR. SPERRY: The horsepower on the cutter head would be less on the 18 foot.

DR. PETRIE: And, it would penetrate faster?

MR. SPERRY: Oh, yeah, it puts a lot more--it's got plenty of horsepower. Is somebody telling me that bigger machines cut faster?

DR. PETRIE: No. We were wondering if your horsepower at the cutter head, isn't that the significant item, rather than the total horsepower of the machine?

MR. SPERRY: Yes. Yes. As far as the rotation torque.

MR. FRIANT: I was going to be a nice guy and wait until Joe was finished to butt in, but everybody else did, and so I will jump, too.

It's power density. It's the power per square foot that dictates how fast the machine will go, among other things. But, if all other things equal, I would say the force on the cutters and the cutter spacing and everything else being equal, it would be the horsepower per square foot of face. So, you know, if he's got on that machine 1750 horsepower, it means on a 25 footer you need about roughly

3300 Hp; on a 27, 4000 Hp; and on a 29, somewhat higher than that. Today's technology allows for those kind of powers to be put on a new machine for sure and, quite possibly, some used machines.

The second thing that I want to mention is that the deflector and/or other means of doing a cut out are part of the specifications being prepared for a TBM currently. And, the third thing I already mentioned was the shorter main beam does compromise the speed of your machine if you are putting rock bolts up at the time. We have made long beam and short beam machines with the idea of having a larger station for putting the rock bolts in on front to allow you to operate faster. So, it is a compromise. A short TBM is a compromise on speed if you are drilling rock bolts.

MR. GERTZ: Jim, let me ask you to clarify something. Are you saying that properly powered, a larger machine would advance at the same rate as a smaller machine if properly powered?

MR. FRIANT: Virtually, yes.

MR. HOME: I'd like to respond to that. What Jim says is correct as far as cutting the rock is concerned. But, the real restriction on radius bends is dictated by muck pickup and muck removal. Once you get past about 600 feet per minute, the muck stays in suspension and you can't get it from the buckets into the conveyor hopper. It creeps up a little on the larger machine. But, the restriction is not the power of the machine. Certainly, we can keep putting more power on it as we go up in diameters. Restriction in rate of advance is dictated by muck removal.

It is an obvious thing. I can show you on someone's viewgraph. After watching what stays in suspension, just doesn't drop out, and there is that problem. After a while if you keep rotating this head and getting this speed faster and faster as you go up in diameter, this muck doesn't have time to drop out into the hopper and that's the main restriction. Certainly, that's why you don't see 35 foot machines rotating at the same speed that you see for 12 foot machines. The muck just stays in suspension.

MR. SPERRY: What I had based my calculations on was I went down the Robbins list of tunnel boring machines and tried to pick out a typical horsepower that was on 25 foot machines. This wasn't the latest, you know; this wasn't the highest powered machines and typical on a 16 to 18 foot machine.

MR. KENNEDY: I would like to make some comments about this peripheral velocity thing. I have a couple of charts and graphs that will show that.

Basically, this is a listing of historical velocities of several different manufacturers of machines. You will notice that the current rate about 623 feet per minute of a 13 foot machine is our current experience. And, the smaller the machine is, the more difficult it is to get the muck out of the buckets. But, as you go up in larger diameters, usually it's 300 to 600 feet per minute.

In this graph what we are illustrating is this is typical of 600 feet per minute, this chart, this line. And, there is a 32 foot machine in Chicago, the 254 machine. It is just around--this is the rpm's over here. So, it's right up in that area. Actually, it is about 550; I didn't put it on the chart very well. And, there's other machines. Most of the machines that we are building are below this level. That's because we've always thought 600 feet per minute was a big issue. But, if you go through and do the calculations when we were building this one machine where we started getting up to 624 feet per minute, we began to look and do some calculations on a drop time and friction inside the buckets. And, these two lines here, this is where you are going to begin to have it miss the muck shoot and stay in the bucket. And, this lands in about the middle of the conveyor belt. So, if we get up in between these two areas here, we're in good shape. So, the larger the machine, the higher the peripheral velocities can be. And, it's a fact when you look at the angular acceleration of the Omega squared, as you are in smaller machines, the rotational speed has to be much higher in order to reach 600 feet per minute.

So, I just wanted to point out for example, a 32 foot machine according to this chart, still being very conservative, could have about 10 to 11rpm.

MR. HOME: That clarifies my point. You've got a curve on it; so, therefore, a smaller machine connects a bit faster. Your own chart clarifies that.

MR. KENNEDY: That's correct. If I take the 18 footer, I could come up to about 12.5rpm. My 32 footer or 25 footer, is that what we want to--you can come up to about 12.5rpm. So, virtually, if you put the amount of horsepower on it, from a muck handling standpoint in the calculations and also the videotapes that we have made in our tests on this higher velocity machines and slower thing, everything has been calculated and this is still rather conservative and it will work.

We can go to higher velocities. The question is will the cutters handle it? But, it is not the muck handling. The cutters, we do have cutters running at 600/ 700 feet per minute at this time. I just wanted to make that comment.

DR. CORDING: Thank you. Just one clarification. The cutter head rpm for a given penetration per rotation of the head, the cutter rpm is directly proportional to penetration rates. So, that is where this and how this curve comes in. So, if you follow the curve down, you could be putting for a given penetration per rpm, you could then be putting on that side penetration rate.

DR. ALLAN: Ed, when you add all those factors together, such as Ed Cording suggests, the penetration per revolution and so on, as to your experience it's shown a tremendous difference in advance rates based on those factors? I'm talking advance rates per day. There are a lot of things that happen to you in the course of a day's time. And, as Jim said, he felt that the overall advance would be virtually the same. We were talking 18 versus 25. My question is has that proven to be a restraint to production to your knowledge?

MR. KENNEDY: Let me make certain I understand your question. If you get a machine that is too small, then everybody is tripping over each over and you can't pass cars and so on. As the machines get bigger and bigger, you get more room, but you've got more muck, more ring beams, and so on.

If you take a look at the production right now in Chicago of a 32 foot machine, they are getting about 130 to 150 foot a day average. They're in that area. It is virtually double what they did years ago where they were getting about 90 foot a day. A lot of that has to do with the muck handling and the organization of the job site itself.

The machines, themselves, we can build 32 footers that are getting 12 to 18 feet an hour. What I wanted to do is point out that if you get a contractor that's set up for high production, I think that they can keep up the same rate as what a small machine is as long as everything is not getting in the way. Like if you've got conveyors and trains and if they're too small, you're trying to put too much in a small tunnel, then it gets more difficult.

DR. ALLAN: That answers it. Thank you.

MR. CRONIN: Ed, before you leave, there has been a lot of theoretical discussion here about a large machine can go as fast as a small machine. In your experience, have you ever actually seen that happen, and if you have, is it one out of 30 or is it some significant number?

MR. KENNEDY: I think the best way to answer that is when you start building bigger machines, we have always been very conscious about--because there's not as much experience with big machines as small machines, and we have always been extremely cautious about pushing the limits from what our current experience is. Like our current experience is 620 some feet per minute. Back ten years ago when we were building those first 32 footers and 35 footers in Chicago, my God, we wouldn't go over 350 feet per minute on a cutter head because we just didn't know what would happen.

So, to answer your question, we know a lot more now. We feel more comfortable. We've got a lot more bigger machines out there that are working and we also have experience with higher velocities. We've found out that the old wives tale versus what our scientific data shows now with a lot better design methods, we are able to build machines that can push and push it knowledgeably to where-- and this is an illustration of people thinking 600 feet per minute on muck handling is the limit; well, it's not. And, that is what the equations show and that's also what our test show.

So, to answer your question, do we have a lot of experience with big machines going as fast as small machines? You take a look in the Chicago TARP printout, I guess I can go get that, you'll find that the third fastest production in a single month is held by a 32 footer. And, the fastest was a 14 footer. I think it was 4,000 feet in a month. And, I think there was a little 8'6" machine that takes second place. So, you've got first, second, and third.

MR. CRONIN: But, I think my point is you can't look at three particular applications and say that they have any validity if you are looking at something that you're making projections on here in the future.

There's a basic problem. There's many things that go into how fast you're going to build a tunnel. And, I'm not going to attempt to do a little seminar here on it, but let me just say this. There's one thing you can never get away from and that's the ground. And, as you get larger in diameter, you're going to have more trouble controlling the ground. And, if for no other reason than that, you're going to go slower in a larger machine than you will in a smaller machine.

DR. CORDING: This goes to that question of utilization and not just how fast the machine penetrates, but how much of the time can you keep it penetrating at its maximum rate?

MR. SMITH: My name is Tony Ivan Smith and I was involved in the ESF in the Task I. Now, I'm with a corporation in Chicago. I have two tunnel boring machines there. The 32 footer which is now currently going through rebuild and a 10 foot machine. We've taken a very aggressive approach as far as this tunnel is concerned. The large machine will have over 5,000 horsepower. We've designed a system to handle 1200 tons an hour as a maximum peak. So, we are making expectations of daily production as an average over 150 feet a day. This machine in its prior work at Healey, an earlier section of the TARP, with trains and without a conveyor belt system, achieved days in excess of 224 feet a day. Now, if you consider the average utilization of a tunnel machine is in the 40 to 50 percent range, that machine was achieving penetrations above 18 feet per hour.

As Mr. Friant mentioned earlier, we'd forgotten in his power density, the cutter spacing. The cutter spacing is very important because the power density of the tunnel machine is related to the number of cutters on the head and the torque. Because, we have two words here: we have penetration which is really penetration per revolution; and we have rate of penetration which really is the rate the machine is moving. They are two very separate things.

So, in my experience in the last ten years, I kind of initiated raising the horsepower with a tunnel machine manufactured by Atlas-Copco. That machine was in the Rochester limestones, and was running below 10rpm, about 8.89rpm. We took it out to California and raised the rpm to 14rpm. And, that machine was able to achieve in 40,000 to 50,000psi rock penetrations in excess of a quarter of an inch per revolution. And, the Sandbar Project is well known for that activity.

So, relating that back to my current job, we have 48,000 feet of tunnel; 1.4 million cubic tons of material under 6,000 feet of tunneling and it will all be completed in just 18 months, starting this spring.

So, I feel that the issues concerning penetrations relate back to cutter spacing and horsepower and also peripheral velocities which I still do not feel that we have maximized yet.

DR. CORDING: Neil Dahmen wanted to comment. Do you want to come back to some other items that Joe was getting to? Neil, please?

MR. DAHMEN: Well, I guess that's really what occurred to me when we were talking about 100 feet a day, 200 feet a day, 250 feet a day. Joe had presented an 18 foot machine to do turnouts, to do these alcoves. And, I think anybody with any experience in construction can see that as an extremely time consuming, difficult, complicated operation that is going to break up the systematic TBM operation when it's running on a long run. And, that is going to have a terrible effect, I think, on the overall production. And, all these 100 foot, 200 foot a day rates are going to go out the window because you are going to spend all your time trying to do these turnouts.

I think it would be better to look at some options to do turnouts with a second piece of equipment, or if you can afford it, after the main tunnel is finished. And, I have an idea on how to do that.

DR. CORDING: Okay. We want to come back to you on that, Neil.

Joe, I think in some of this description of turnouts, he's describing backing down after you've gone through the facility and backing down and recognizing that that's not the same rates. But, we'll come back to some other ideas there, too. Neil, thank you.

MR. SPERRY: Neil's point is very well taken. And, understand, as I prefaced my remarks earlier, I've learned a whole lot more in the last two hours than I knew about this project previous to this. And, so some of these ideas are pretty half-baked, especially this one that I am putting up there now with Neil.

But, Neil, yes, I figured an 18 day delay to get up to speed for essentially a 400 foot turnout. Just in that area, 18 days. But, the other thing, you do have your tunnel completed. So, let's just talk through this, what we had here. This was something we sort of cooked up over the weekend and, as I said, it's sort of half-baked in light of what we've learned, so far.

But, this is the north portal and the thought is to put an 18 foot machine in here and come down. This is a 1500 foot radius curve. Come across here, another 1500 foot radius curve, and up here. That's the first thing you do. You hook onto the deflector here, and you come down. We didn't know what alcoves were required or what your spacing was, so we don't show anything there.

The next slide I am going to put up is the possible schedule for this operation, but we are aware that you want cross strips here and a test area here. And, we were aware that you wanted the test area as soon as possible. So, the thought was to back up, pulling the deflector all the way down to here, and come in here.

Now, somebody asked how do you get the deflector ahead of the--I guess that was Ed--the tunnel boring machine. So, it's ahead here; we deflect in here and we've got to get it back ahead again, so we make a loop here. This is a 750 foot radius and this would be another conveyor, another continuous conveyor here. We would expect high belt wear due to ply separation on the inside of the curve. But, it can be done.

So, we loop around here and we hole through into ourselves and then we get the deflector down and we pull it down and this was my idea of possibly a heater experiment. I had no idea what your criteria was. But, we deflect here. I think there is a total of 15 deflections in this whole thing, but you can see they all go ahead deflections. So then, we come around here and we come back down, and we deflect. I assume you want to see the Ghost Dance first. So, you deflect here, go back down here, and go over to the Solitario Fault.

And, this next viewgraph or overhead, I apologize for this one because I screwed up the computer a little bit last night as I was watching the election returns, putting this together. I got fairly upset about something. So, this is critical path operations coming down. It shows the total of about 40 months duration here. My bust here is that this starts adding again, so these aren't cumulative figures. So, this is 19 and 14 or about 33 months here and then this is 20 added to the 19, 39, which checks this. But, anyhow, I assume you take nine months to get the equipment and erect it at the portal, another ten months to do the entire initial loop excavation, 13 months. You back up and here's all the details attached to the deflector and so forth. Excavate the loops and this total of 11 drifts that you deflect into. That's about 14 months. Then, you go back down and do your cross-drifts in five months. You park the machine at the end of the Solitario Canyon Fault and, potentially, it's there available to go down to the Calico Hills if you want to. A total of about 40 months for that.

So, Neil, you can see these. A 250 foot deflection is 12 days; a 600 foot deflection, and so forth. So, it is intensive. It is a lot of delay. But, you've got the thing done and the idea is to get the main test area excavated as soon as possible which comes up to this total. So, it is this 13 plus 19, 34 months, a little bit less than three years to do that.

Any further discussion?

MR. FRIANT: I've got a couple of questions. I'll try and be quick about it. I like Joe's approach. I think it is great. But, I would question whether you want to do both situations with one machine. Personally, I would like to just get a machine that hauls ass through that first loop and then a short radius type of a machine that goes and does all those little deals. Because I think you would end up with a compromise that would do neither in the best way, whereas a separate designed machine would go.

MR. SPERRY: Jim, I would like to just say that I think that is probably right. I saw that layout of the test area for the first time this morning. I assumed that you were aware of that and that's probably quite true.

DR. CORDING: That layout, of course, there are possibilities and we may hear more this afternoon about how that can be adjusted to fit more of a mechanical system.

MR. FRIANT: That area is being really attacked in this second stage of design, too, I might add. We are looking--Neil hinted about a device and I can see a device especially built to start alcoves which wouldn't even interfere with the main TBM if somebody wanted to do it that way. That is within the scope and the technology. And, he also mentioned this short radius TBM. But, that study is still--is not final.

I want to make one comment, backing up a little bit, when we're talking about the speed of TBMs and our relationship to what I call muck stuffing. We had a couple of nice big Air Force contracts where a number of millions of dollars were spent to just see how fast would machines go;

when did machines get stuck with the buckets? And, interestingly we found that almost, regardless of size of the machine, this occurred around 20 feet an hour to be practical.

Now, what we're talking about with this 23,000psi rock is not approaching that. Even with the smallest machine I studied, we're talking about something that is doing 10 feet an hour. I don't believe that bucket stuffing was an issue in this particular condition, regardless of size.

MR. MCFARLAND: Jim, I seem to remember that we were talking vertical machines.

MR. FRIANT: Yes. But, it still had the slots and--

MR. MCFARLAND: Yes. And, the problem with getting the muck--yeah, how do you ingest it through the machine vertically.

MR. FRIANT: Right. We also did that--remember, we did that 18 footer. We got that sucker going up to about 39 feet an hour with six inch spacing on it. We couldn't hold that. That one also stopped at about 20 feet an hour.

MR. MCFARLAND: Yeah. What Jim is mentioning, we were throwing words around. Spacing of cutters, as Lok mentioned, normally two to three inches. We were spacing cutters at six inches. And then, there was a possibility of even going larger. The constraint was even with that very efficient cutting, it couldn't ingest the muck into the head. The limitation was muck handling, not rock breaking.

MR. FRIANT: But, as I say, that occurred at around 20 feet an hour. So, we're not up to that point where we're talking stuffing on any of these, regardless of size.

MR. SPERRY: This is on the Topopah Springs. You are not talking about the Calico Hills.

MR. FRIANT: That is correct.

MR. SPERRY: You have got a big bucket stuffing problem there.

MR. FRIANT: That's the whole problem in Calico Hills.

MR. SPERRY: I would like to make a comment. You know, in Ted Petrie's opening remarks this morning, he said the purpose of the ESF was to access the Topopah Springs and the Calico Hills. And then, he also said I really like this and I think I hear this happening. The second purpose was to develop data for the repository design and construction. It seems to me that this repository can be certainly built totally with mechanical excavation. But, to do that, you've got to develop machines that deflect the turnout, whatever you want to call it. And, I think that is going on and that's wonderful. That's something the industry has never done. There's been no requirement for it like this.

MR. FRIANT: As I pointed out, Joe, it is in the specifications for the machines right now.

MR. SPERRY: I glanced at your specification. It is about a quarter of an inch thick and I probably missed that.

DR. CORDING: Thank you. Neil, you have some comments on other approaches?

MR. DAHMEN: Yeah, I've got one very rough sketch I'd like to put up and maybe we can get some questions on it.

We'd been in touch with some people working on this project with the idea that perhaps going to a smaller diameter tunnel certainly immediately we were struck with difficulty in maneuvering the mobile miner within this tunnel without disturbing the permanent conveyor and the vent line. So, we got to looking at one of the machines that we have built before to see if there was possibly a way to utilize it during the tunnel boring operation even at a smaller diameter tunnel.

The concept, of course, depends on being able to grip this machine because we do have fairly hard rock in the upper section. We have to have a gripper machine. How do we grip an 18 foot diameter tunnel or, certainly, how do we grip a 25 foot diameter tunnel? And, we thought about all different ways of putting sky jacks on, but the best solution and one that seems to make some sense and I offer it for discussion is this system which would essentially require the installation of an invert; either could be poured concrete or it could be prefabricated steel segments that are just brought in and placed on the invert.

The machine would actually then be bolted to this invert section and drive the curve using the floor for reaction. And, we think with this machine, this has been modified slightly for this work, we would put the power packs independent of the machine at the side of the tunnel and we think we can get--this shows a 16 foot radius turnout.

Now, there are some advantages to this. It's a minimum amount of excavation. You are not doing a big 100 foot radius or 75 foot radius curve which means a lot of extra excavation. We think the machine could be set up. I think it's going to be pretty tight in the 18 foot tunnel. Admitted, we've probably still got some work to do. But, I think this machine could conceivably be set up, brought down while the tunneling is going on, and drive this at it. And, I am not sure of the spacing of these little compartments, but at one time I heard they would be maybe one every 700 feet, which would make it quite crucial consideration. When the adit is finished, just leave the machine in the adit, just park it there. You carry on with the tunneling and when the new point or the new adit comes up, you simply back the machine out, drive it down to the new position where you have already located maybe a half a dozen of these invert segments, and do another turnout. We think a concept like this and this one certainly isn't well developed should have some merit.

DR. CORDING: Neil, do you think that you can turn out and do that and maintain? What is the effect on the conveyor belt and the other services that are going through the section at that point?

MR. DAHMEN: Again, we don't know exactly what that is going to look like. Our assumption is that if the conveyor is mounted on, say, an upper corner and the ventilation line right at the top, we think there is a good chance with a very small invert fill of getting the machine down with those in place and that would be the ideal thing. If the turnouts can all be made in the same direction, opposite side of the conveyor, I think there is some potential for accomplishing this.

DR. CORDING: What sort of time is associated with this? What sort of rates can you obtain with the rate of advance or time to take--when you're doing a short turnout, I know that the rate of advance isn't as important as setup, but what sort of rates can you achieve? There will be some longer tunnels in sections.

MR. DAHMEN: In a straight boring, we have estimated with this machine about four feet an hour. It's not really a high rate. I think in these turnouts the rate would be somewhat slower, but--say, two feet an hour. So, your 30 foot drive would take 15 hours in real time, maybe double that or triple that.

DR. CORDING: Would you be thinking of using these types of machines to drive several thousand feet of side drift?

MR. DAHMEN: This machine is set up particularly for just doing these turnouts. What we had in mind for the longer drives for continuous operations would be a second trailer that would trail the power equipment rather than putting it kind of out of the way and to the side. So, it would be a self-contained unit; a regular mobile miner type approach.

DR. CORDING: Other comments?

MR. BULLOCK: Do you have a size limit? I don't see dimensions on here. Have you proposed certain sizes of this machine?

MR. DAHMEN: This sketch is taken from an actual machine that has been built and actually used. So, the tunnel is 18 feet. That machine is a 12 foot height and has the capability of going out to around 20 feet. I think we are showing it at 18.

DR. CORDING: That rate of four feet an hour, do you multiply that out as a daily rate? You're talking about 90 some feet a day. Is that what you are describing?

MR. DAHMEN: I think you would apply for a long-term operation, not for the alcove, because certainly there is a lot more fooling around. But, a 50 percent utilization could be applied to that.

DR. CORDING: Fifty percent on that 90, so that your--

MR. DAHMEN: If you've got 24 hours to operate, I assume you can bore 12 hours at the estimated rate.

DR. CORDING: Okay. So, 12 hours would be about 50 foot?

MR. DAHMEN: About 50 feet a day.

DR. CORDING: Fifty feet per day once it's making progress. Once it's up to production.

MR. DAHMEN: A production setup with backup equipment and conveyors and everything behind it.

DR. CORDING: All right. Any other questions on that?

DR. STATTON: Before we get too far off here, we keep-- and maybe I am sitting in the wrong group, but we are off talking an awful lot about whether it makes a difference whether the estimate is 100 feet a day or 120 feet a day of tunnel advance. And, the goal here isn't a quick tunnel. The goal here is an opportunity to look underground and it is that opportunity that is going to get in the way of that rate of advance anyway. I mean there are some fundamental things that we need to and I think later we will talk about when we stop and why we stop at this progress rate going underground to collect what kind of data. What irretrievable things are going to say it doesn't matter whether I am capable of doing 120 feet a day; I've stopped for a week and here is what it is I am doing for that week and it's related to my purpose in getting underground.

You know, we're not trying to set tunnel records. We're trying to make some real observations. I wasn't sure whether when we started off on tunnel diameter, are we challenging tunnel diameter because of a speed phenomena because we think we can tunnel faster at 18 than at 25 and that's part where practice might tell us one thing and technology might tell us something else. But, does that make any difference?

You know, in our time estimates this morning, one of the reasons you couldn't come up with a constant rate of advance is we put into the system some estimates of down time because there are some fundamental things we are going to do when we cross faults. So, there are some estimates that say we are going to stop here and we are going to perform this test.

There are some estimates of the number of times we're going to stop specifically for a water sample or for a fracture filling gel sample. That's the reason when you look at that--again, back to your calculations this morning--it is non-uniform. And, they're seat-of-the-pants estimates; yeah, they are. We made a bunch of seat-of-the-pants estimates saying where and what do I need to stop and do.

DR. CORDING: I think we do want to discuss that in much more detail and I think your bringing it up here very appropriate.

One point though in looking at that, I got the impression in going through the repository that the operation was about a two year--I can't recall the exact time that it took to get through, but it was a fairly efficient operation. There wasn't a lot of time put into stopping and looking at things.

MR. GERTZ: Our overall philosophy that I am trying to implement is let's move through that loop as fast as we can; stop only where necessary. I think we've developed some ideas with the mappers where we don't have to stop to map. We can continuous mine while the mapping is going on. There still may be some other scientific tests that they're going to want us to stop for, and Tom brings up a good point.

The only reason we are building an ESF is to gather scientific data. No other reason. Get underground to let the scientists see if the mountain is suitable. That's our driving requirement is what will appeal to the scientists and meet their needs?

Secondly, though, as the project manager, I want to do things efficiently because I have many, many oversight boards not only looking at technical oversight, but cost and everything else, and I won't have a project if it costs too much.

DR. CORDING: Sure. And, I think the whole point is we have to keep in mind our vision on what the point is. I think it is extremely important. And, what I would like us to be continuing to discuss here is how we can best accomplish the things that will allow the testing to be done. At the exploration, testing sometimes has the vision of somebody having to go in and taking an instrument in, but sometimes it's just looking at what's there, as well. But, how can we best accomplish that?

The one area I think I would like to bring up and ask in this session--perhaps, we can discuss it further later in the management session--has to do with risk. And, we are estimating rates, in some cases well-proven rates, in other cases, they're not. Because we are changing the system to some extent, we are coming up with different approaches, we're taking machines beyond what they've done in production basis, some of them have been demonstration type projects. What is the risk when we go with a certain approach that we're going to be able to accomplish that? That's as important as instantaneous rates. Any comments that you may have on that in terms of how do we take that into account--if we have a certain machine that isn't going to perform up to standard, once you put a machine in the ground, you're committed. And, there are things that you can make do to change it, but as many of you in this industry know, if you've made some estimates of things and the machine isn't working the way you expected, you can have a project that really doesn't even come close to achieving the rates and the progress that you expected. And it's not just that you didn't go 100 feet compared to 120 feet, but you sat there for two months or three, or whatever it was, trying to figure out how to get going again. And, that can set the program back in terms of accomplishing testing objectives.

So, one of the questions I have for some of you and maybe some general comments, how are we accounting for risk and what sort of risks do you see as people within this industry to some of the approaches that are described? I throw that open.

DR. BARTHOLOMEW: I just had a comment, Tom, with relation to what you said. My point wasn't so much that I was arguing for or against a particular rate of advance for planning purposes, but simply to understand what the thinking was on the rates that were down on these schedules. And then, your point really brings up another point that if, in fact, there are allowances that are prudent to build into this thing for purposes that you've outlined, it seems to me that it would be helpful if they could be identified as to what they are so that you can see them, even though as you say, they may be just seat-of-the-pants estimates at this time. But, at least that you contemplate that it is going to be necessary to do that and you think that it might be necessary to happen so many times and so much loss of time per occurrence. I think that would make it easier for some of the rest of us that are not very close to this thing to get a little bit better handle on what some of the problems might be from a construction standpoint.

MR. GERTZ: It would make it easier for some of us that are very close to it, too, to understand. So, I appreciate that. That's a great comment, Bart.

DR. CORDING: I guess one question in regards to some of these approaches, if we have machines that haven't been developed or are new, what sort of risks are we taking with that? What sort of factors do we put into it? And, the other point I think also has to do with the interaction of the ground with the machine and conditions that cause certain systems to perhaps not perform as we had anticipated.

MR. HOME: I'll take a shot at answering risk on new machines. I think one answer is how long does it take Robbins to develop the mobile miner to a commercialized machine; what is the answer? Because I left Robbins 12 years ago and we were working on it then. It's not to pick on Robbins. Robbins has done a great job because our industry doesn't get any money except from these types of projects to develop new equipment. And I think, Robbins has done a great job and is persistent and spent a lot of money in R&D where they have got absolutely no government support for doing it.

My point is, all development takes a long time and we are fooling ourselves if we think we are going to do it in a very short period of time. If the machine doesn't exist today, it won't perform two years from now. It just won't.

MR. FRIANT: We did two Air Force egress contracts where we made a vertical tunnel boring machine, completely different design, and we finished in one year two machines. When you've got the money, you can do it. I began that mobile miner program, you're right, it was like nine or ten years ago. But, the funding was peanuts. We just piddled away at that with no firm commitment. That was during the depression, the TBM depression.

MR. GERTZ: I really appreciate your thoughts about some focus on risk. And, maybe I would like to break it down into two areas. We've had, I think, some great discussion about if we do the main U-shaped drift, then how do we get off to do the testing alcoves of the test areas. And, that's certainly an area we need to think about and I really appreciate the discussion that's gone on. But, I would like your thoughts about the risk for our main loop, 25,000 feet, 27 foot diameter nominal or so, 25,000psi rock, various stratas. Do you all think that's a high risk approach or is that more state-of-the-art or whatever because to me that's my major concern. Is that a fair question?

MR. FRIANT: I want to put a viewgraph up and address it.

DR. CORDING: Will that address that? Okay.

MR. FRIANT: This is a bottom half of a computer output that we did in establishing the schedule. There are all kinds of different sizes of machines with different powers on them and spacings and what have you. And, I have got a stack of these things about a half an inch thick. Now, this particular one is a 29.5 foot machine.

What we did, first of all, understand that we are not guessing a lot on these penetrations. We ran with actual cutters on the actual rock, both Tiva Canyon and the regular welded tuff. So, we divided up into the slope coming down the north slope, the 1.6 percent upslope for the south, the two curves at the bottom which are 1,000 foot radius. Here we have the Tiva Canyon, the short section coming down the slope, again going up the south slope. We have interface zones from a number of faults. We assumed that 7.69 percent of the tunnel was interface zones and faults were 1.38 percent of the tunnel. The tunnel is 26,061 feet long. We did it as detailed as possible.

In these formations, you were dictated by the thrust available to put on a cutter. We assumed both cutters of 55,000 and 65,000 pound capability. This happens to be a 55,000 capability cutter. Then, if you take the one that's the biggie, for example, and look at the utilization, this first thone is what percent of confidence do we have that the operating crew will meet the penetration rate that we say it can go.

Now, when you are up against the power limit of a machine, if you are running at the power limit of the machine, there is a tendency to back off just because of the way the guys read needles, so I put a .9 in there. Here is a utilization coming down the north slope. It is quite conservative, 35 percent. I think that we can do better. I frankly don't feel that with the conveyor backup system we should be able to achieve these kinds of utilizations. But, nonetheless, the data that is available says you go slower on a down slope.

Through the curves, I don't care how much power your machine has, historically you don't go through a curve more than about four feet an hour because you are continually changing directions on the machine. Through the Tiva Canyon, you go a little faster than through the welded tuff. These are small portions of it. But, anyhow, when you go through the different utilizations, here someone was mentioning, well, shouldn't we go slower in case--you know, in a fault you want to take extra time for both roof support and for testing. Well, there is 25 percent utilization. So then, you come over 15 shifts a week of actual planning to bore, the number of days scheduled, and then just convert it into months. So, the schedule that was put up to begin with had --this is basically what was used plus a couple of screw-around months. So, it was looked at in quite a bit of detail.

And, this as far as I know is available to anybody that wants it. If you want to put a different horsepower into my computer or a different machine, I can quickly do it.

MR. HOME: I would just make one comment. Why are you using such a low rate of penetration if you believe that you can maintain a high penetration of larger diameters? I mean these are actually ridiculous penetration rates.

MR. FRIANT: No, it's not ridiculous at all. We ran a 17 inch cutter on the rock and at certain penetrations we got certain forces. This particular machine happens to be a specific machine. It has enough thrust to put on 53,000 pounds per cutter. That's what you get with a 3.5 inch spacing.

MR. HOME: What rpm are you turning here?

MR. FRIANT: Rpm is 6rpm for an existing used machine. I can tell you it is 29.5 diameter; 3900 horsepower; 6rpm; 55 cutters at 3.5 inch spacing. So, if you want to throw any other machine into this computer program, I can do it in ten minutes. No problem.

DR. CORDING: If you were then putting in a smaller machine, you would be coming up with, in this case, higher penetration rates, isn't that correct? You would be rotating it more than 6rpms?

MR. FRIANT: Sure. Okay. If I was constrained to the horsepower density that this machine has, then the answer is yes. In other words, I can't answer that question unless you tell me what the horsepower relationship and spacing and so on are.

DR. CORDING: Well, there's different ways of looking at it as you point out. But, the situation here would be that you would find many machines existing at the 18 foot diameter that would make substantially more progress than this. Now, you may have other possibilities for an enhanced machine at this diameter that would do better than this.

MR. FRIANT: Oh, yeah. I didn't intend to say that this was the only--I was just simply showing the methodology that we went through. But, I can tell you that the power and size when you use these very conservative utilizations don't make as much impact. I ran everywhere from 25 to 29.5 feet in diameter. My range of months varied from about 21 to 28, way down to a 2,000 horsepower, 25 footer. I didn't look at 18s.

DR. CORDING: Would you adjust your utilization based on tunnel size, for example?

MR. FRIANT: I don't have much data to indicate that utilization is a lot different regardless of size. The Norwegians have done some spectacular small ones and, as somebody pointed out, the people in Chicago with those big machines have hit 63 percent utilization. That's about as good as you can get.

DR. CORDING: Okay. We're running to the last few minutes here. What we wanted to do was leave at quarter to 12:00. We have five more minutes and we can have a few comments. There may be a few extra comments that we can make as we start the second session this afternoon on a few points that we are trying to complete. But, I think we will organize the afternoon session for the testing and the people involved in the testing part of it will be here in front.

DR. SIMECKA: I would like to bring up the issue of maybe some new technology that might make a difference. Levent Ozdemir is doing some work on a smaller cutter. I'd like him to make a few comments just for your information on what that might make a difference in application to roadheader type of equipment.

DR. CORDING: Perhaps, we should--

DR. SIMECKA: Or do you want to do that later?

DR. CORDING: --defer that until right after lunch.

DR. SIMECKA: That's fine.

DR. CORDING: Why don't we do that because we're running short.

MR. SPERRY: I have one very quick comment in answer to Carl's question about risk on that loop. I was the project engineer on this River Mountains Tunnel that was built southeast of Las Vegas in 1968 and 1969. We had a tunnel boring machine there. I can't tell the difference from what we call rhyodacite down there to what you call the Topopah Springs. And, we had, I think it was, 23 of these interface zones and faults and everything. And, we were above the water table except in one place. Now, my comment to you as on your risk, if you are truly above the water table there is very little ground support or rock support that's going to be required.

Now, I don't want to talk about a 25 or 29 foot machine, but down in the common size of machine maybe up to 20 foot, I would think you'd require very little rock support here.

Now, if you get into wet material, and especially down in the Calico Hills, you have the problem that they had on the test site on the alternate end tunnel where the machine almost stopped and the one place we had water at River Mountains was in the soft material that almost stopped. But, as far as rock support goes, I think you'll require very little.

MR. GERTZ: That's the same conclusion our team has been drawing. And, we are well above the water table unless we run into some perched water, which we have not been able to find in any drillholes or anything yet, but there is always that possibility.

MR. SPERRY: The water lubricates the joints. If you are in dry rock, it stands pretty well. But, if you are in wet rock, it's a mess.

MR. SMITH: I think there are other factors that predicate the diameter of the tunnel boring machine. And, I think one of them that faces our project is the main bearing and the longevity of the main bearing. So, there is a predicating factor, I believe, in the design of the machine because the larger the machine, the larger the conveyor. So, I mean, in essence, there is risk there. So, there is a more optimum design because let's go for an 18 foot tunnel. It is like all of these here and they go to 30 feet. The space above is just totally unusable, but we have to excavate it so there is more materials being born out. We have a high risk factor as we go larger in diameter.

Going back to the performance of the machine, the main bearing and the structural aspects of the machine are very, very critical to its ultimate longevity and perfor- mance. We feel that we will lose a main bearing in Chicago. It will cost us $1 to $2 million. We do not feel the main bearing in the tunnel machine will go the whole length of the tunnel because no machine has gone this diameter 48,000 feet without a main bearing failure.

So, it might not happen, but we are taking the chance that it will happen. We are taking that risk. That is a risk we have to assume. If we had a smaller diameter machine which we couldn't use, of course, the relationship to power and the size of the main bearing, the Calavaras machine which I think is a little over 20 foot in California, completed its 45,000 feet, main bearing intact. So, I feel there is a real optimum diameter that has other factors than just the testing which is very important.

DR. CORDING: Thank you. We wanted to conclude with some discussion of the tunnel size and then we'd also had some comments we wanted to make on the decoupled alternative and perhaps we can continue with it for a short period of time after the break on some of these issues.

The lunch, as we said, is being served buffet style for you in the other room. Thank you.

We will reconvene at 12:45. We only have an hour.

(Whereupon, a luncheon recess was taken.)

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

(12:45 p.m.)

DR. CORDING: We're ready to begin the afternoon session. This afternoon, we'll continue with some of the discussion we have had on constructability, construction, and we've backed into the item of tunnel size a little bit and talked a bit about it in regard to some other issues we were discussing. But, we wanted to bring it out and have a discussion of that. Carl Gertz is going to describe the approach they've used in determining tunnel size for the first tunnel.

MR. GERTZ: Thanks a lot, Ed.

I thought I would do just a couple of things. First, I wanted to summarize for your information to make sure you understand where we are in the project right now insofar as design goes. And, in effect, we've about completed the package up here for the north portal and that will be out in a month. And then, next year, we are going to design some more facilities for the topside and the ramp. That's what we are going to design. The rest of this design is still in initial Title I design that will be optimized as time goes on. And, this morning's discussions about how we excavate and what size that these cross drifts will be certainly was very enlightening for us and will help us as we do our future planning. But, that's what we have designed for construction; this, we'll design for construction next year.

Bruce Stanley has presented to me and is ready to present the details of this to you, but I thought I would give just an overview of it and let Bruce handle some of the details. But, this is the results of our ESF ramp sizing analysis. Certainly, as we move forward and as we construct what we talked about this ramp, which will begin at the north, go all the way through and out to the south, we need to determine what diameter that ramp should be. These other drift diameters did not need to be determined at this time. But, we need to determine that 25,000 heading, so to speak.

The basis for the ramp size study including looking at the things you would look at, ventilation, conveyor utility layout, traffic patterns, alternatives for excavation, room for ground support, and considerations for the testing. So, these went into the ramp sizing study. And, I'll just briefly touch on each of these, and then whatever details you want to talk on, the team can talk about.

But, for ventilation we've based it on a two TBM scenario. One, as we've talked about all morning, going through the Topopah Springs, and then an additional one that would start in the Calico Hills at some point in time. So, that's what we have looked at.

We talked about rubber tire equipment. It's the scenario that was used. Minimum air drift velocity, maximum drift, and those kind of calculations, accommodates 200 horsepower TBM and diesel in each exploratory lateral, accommodates 30 people in each heading, and accommodates 40 percent leakage during TBM. That's some of the ventilation assumptions. I'll give you all the assumptions and then the answers.

Conveyor utility layout. We looked at both overhead or side, ease of access, maintainability and safety. Our ramps in Topopah Springs are based upon 36 inches; Calico Hills on a 30 inch conveyor.

Traffic patterns. We debated single lane or double lane, the flexibility to accommodate men and material under-ground, safety in vehicle, or vehicle personnel movement. Single lane, Topopah Springs; single lane, Calico Hills would be based on that. A double lane would be based on 20 foot nominal.

We looked at the excavation alternatives, whether you bore a big hole and then backfill the invert to provide a flat roadway or whether you bore a smaller hole and then excavate the invert by mobile miners or something to get a flat roadway. And, we looked at cost and schedule implica-tions of those.

Ground support. We wanted to make sure there was sufficient area to accommodate 80 inch steel sets and shotcrete, if necessary. Testing considerations was not a major factor in determining ramp or main drift sizing. There was no particular bent from the testing community as to which size would be more appropriate.

Our results for the Topopah Springs, and let me just once again point out what we are looking at is this loop, and as we study site suitability, that loop would be in place for approximately ten years unless we find a dis-qualifier as we go through it. And if we go to licensing, we'd have men and materials probably doing confirmation testing in there for another five years, and certainly if it's a suitable site, before we even construct a repository there would be almost 18 years of operation in that loop as we go through the process.

So, for Topopah Springs for ventilation, we believed we needed at least a 25 foot diameter; preferred traffic patterns was a 26 foot; a utility layout brought it to 27.5, either overhead or side excavation determines where the bore and backfill ground support was accommodated. Testing was non-discriminatory. Our final ESF size was 27.5 feet. That's our recommendation that the architect/engineers provided to us. It satisfies ventilation requirements; preferred roadway equipment envelope; accommodates ground support; satisfies conveyor location; satisfies testing. It is based on a engineering considerations only. It does not include any programmatic considerations. The fact is, what's it going to take to operate for about 20 years if we maintain the process in this particular loop of our excavation?

To put it in a diagram, this happens to be our ventilation ducts above it. This happens to be the conveyor. Somebody talked about running into conveyor. Well, we have already kind of planned for that with a protective barrier, but there always can still be other accidents that will maybe cause you to go over the barrier or something, but we have at least tried to think about that. And, this is one without steel sets and this is with steel sets in it.

So, that's our approach we're undertaking right now. These are 86 inch or 88 inch diameter ventilation ducts; utilities along the side; water discharge; water compressed air; power cable; and operation roadway. Being that we are going to be in there for about five miles by the time we break out, we are going to have lots of people in and out; men working. Eventually there will be testing community in and out of the facility, so we believe this is an appropriate approach for the ESF.

And, I guess, with that, I am done starting any dialogue you might want to on this. And, I will turn all the hard questions over to Bruce.

DR. CORDING: All right. Do we have comments and questions? Some of you, I know, are back in the audience now from the first session, but you are to be part of this discussion, as well.

MR. HASLAM: Yes, Carl, my name is John Haslam. I am a business representative for the International Union of Operating Engineers Local 12. We also represent the operating engineers that have run the TBM machines out at the Nevada Test Site at present. They have run the machines in E-Tunnel as well as N-Tunnel out there for those that are familiar with the tunnels.

We definitely believe that the larger tunnel diameter is the right concept. We worked with DOE, as well as some of DOE's contractors out there, in coming up with some new devices in the drilling industry, like the pipe handling device for the LM-300. Safety first is kept in mind in that particular project. If you have been out to the site, seen the LM-300, you can't believe the safety that's been built into that. That's why we think the larger diameter tunnel would be good in the long run for safety reasons. Keep in mind this is a 20 year project plus, so let's do it right the first time; let's do a large diameter tunnel and let's get this thing going. Thank you.

DR. CORDING: Thank you. Other comments?

MR. SPERRY: Well, I'll speak historically. I can't speak to the additional cost of the larger machine when the larger machine cuts as fast as the smaller machine. But, historically, a 27 foot machine is going to cost you about 50 percent more. A tunnel excavated with a 27 foot machine is going to cost you about 50 percent more than a tunnel excavated with an 18 foot machine.

The other thing, of course, as Hugh Cronin pointed out his morning, you're going to have a lot more rock support.

MR. CRONIN: My question is, looking at those diagrams and listening to your presentation, it sounds like the size is governed, one of the major factors is the roadway and the dual carriage way/roadway. Is that correct?

MR. GERTZ: Let me have Bruce discuss it with you because he went through the details of it and I would rather he do it than I paraphrase for him.

MR. STANLEY: Yes. One of the major factors was the size of the roadway and whether we have single lane or double lane traffic. That issue was brought up earlier in a Title I discussion. Of course, we can go through and use single lane traffic; it is possible. But, for safety aspect, we believe that a two-way traffic pattern is preferable. Not that we are going to have vehicles running at full speed past each other, but it is more easily accommodated to have vehicles pass each other. And then, we don't have to create cutouts, et cetera. And, we don't have to people trying to walk up on the side and perhaps slip on a curved surface and it just is a safer environment.

Does that answer your question?

MR. GERTZ: Maybe a follow on question, as we've discussed, how much did ventilation and conveyor--what kind of diameter would you end up with if you were just looking at that kind of an approach?

MR. STANLEY: We did the study in really two phases. We began looking at Calico Hills ramp size from the standpoint that any size that we have determined for Calico Hills would have to accommodate in the Topopah Springs. It would have to be at least that size to get a TBM easily to that location to go to Calico Hills.

So, we structured the study in those two phases, one for Calico Hills and one for Topopah Springs. But, the way we did the study was the same for each. I think that if I go through a series of viewgraphs you could see the logic that we followed.

First of all, I know that these are a little bit difficult to see, but we considered the differences between the various envelopes, and we had two concepts here. One was to bore and to backfill and the other option that we had was to bore and cut bottom to make a flat bottom.

Here, we show the option where the conveyor is high and we have a double lane traffic pattern on a bored and backfilled operation. Here, we have the same option with the double lane traffic and we have instead of the conveyor high, we have the conveyor on the side. There are some safety advantages to this for maintenance of the conveyors, rock spills, et cetera. Now, there was mentioned a problem with this or perceived problem that vehicles do, on occasion, through the life of a project get away from people. So, this is why we put this jersey barrier structure over here to help alleviate that problem.

Nevertheless, we have this total bored and backfilled and two lane accommodated. And, that comes out to the nominal 27.5 diameter. We also accommodated a 6 inch ring beam structure in here for support, if necessary. And, that would only be located in areas of bad ground. Other-wise, we wouldn't put in a support.

This is a case where we looked at the bore and then cut bottom option where we still would accommodate a double lane traffic. We would have to have the conveyor up above and we would also accommodate the steel arch structure for bad ground.

Basically, we can see the differences that we went through as we considered the ventilation. How much air do we really need down here for our total development pattern? We considered the location of the conveyor, high or low. We considered the bore and backfill option or the bore and cut bottom option. We considered the single lane traffic and we considered the double lane traffic. And, it was based strictly on engineering principles. It did not get into, other than consideration in our own minds, cost and schedule implications.

MR. BULLOCK: Bruce, this is Dick Bullock. Carl touched lightly on some of the assumptions on the ventilation. Some of the assumptions are requirements. And, that drive, if you're going to have more than just a U-shape, you've got to cut laterals. As I recall, that drive is a 25 foot for the ventilation requirement.

DR. CORDING: That drive is what size again?

MR. BULLOCK: The ventilation was driven to 25 foot by the requirements that Carl gave, plus the cutting of laterals, having more than just the usual.

DR. CORDING: So, basically, it's because you have four machines, TBM sized machines operating?

MR. STANLEY: No, it is not. Basically, it has a great deal to do with how many active headings you have at any one given time. For example, right here. If we have two tunnel boring machines, one that came down here and now is entering into this area and another taking off down to the Calico Hills, you will have at least two headings here and then we counted on another here and another here; so, that's four active headings at any one given time.

DR. CORDING: I think that was what I was referring to.

MR. STANLEY: Four headings, but not four TBMs. Not four TBMs, but four active headings.

DR. CORDING: Four active headings but with TBM sized equipment; things that have that sort of horsepower. In other words, you're talking about mobile miners and road-headers, perhaps. Roadheader may not be quite as demanding.

MR. STANLEY: Yes. Or, miscellaneous equipment, number of people in each heading, et cetera.

DR. CORDING: Then, in that respect, it is assuming that you don't have flow through ventilation at this point.

MR. STANLEY: At that point, no, you don't have flow through ventilation.

DR. CORDING: But, the present plan that's being shown, I believe, is indicating that you are going to be going through the main test level before you go down into the Calico Hills. Isn't that correct?

MR. STANLEY: The main purpose of the alternative--

DR. CORDING: Excuse me, I didn't mean main test level, but go through from north to south ramps before you go down into Calico Hills.

MR. STANLEY: That is a schedule question that I would defer to the M&O since they are currently doing that.

DR. CORDING: That is what we were looking at this morning though, isn't that correct?

MR. GERTZ: The exact schedules are over here on the wall for you to look at. Some of them are still in rough form. I think, we provided the flexibility that this could start when you're still up in here some time depending on the--well, Ned is shaking his head, is that right? Yeah, we wanted the flexibility. If we could get money and a second TBM and the Calico Hills was still in our plan, we would want to start that as soon as we could get it.

MR. McKENZIE: Dan McKenzie with the M&O, M-K. I think the total worst case, for want of a better term, volume in this case as 210,000 CFM and that's after breakthrough because you could have two laterals going on in each level plus you have to supply air to keep the velocity up in the rest of the facility. You end up with about 209,000 and change. That's without leakage.

MR. CRONIN: Dan, you said after breakthrough?

MR. McKENZIE: Right. That was the assumption in this ramp size and study. That ended up being the highest total quantity case.

MR. CRONIN: That doesn't have anything to do with the two 88 inch diameter vent lines.

MR. McKENZIE: I guess I don't understand the question.

MR. CRONIN: Well, after breakthrough you don't need those 88 inch diameter vent lines.

MR. McKENZIE: Sure you do. You need them because you're still running four laterals that are making a lot of dust and you want to ventilate them on a separate split. So, they're going to have a vent line going all the way out either to the north or the south. Take your pick. You're going to have four mining operations on separate splits in the tubing and then you are going to have a flow through ventilation split so your intake at the north--at the north portal where your intake is, is the highest velocity condition.

MR. CRONIN: So, you're taking the whole 210,000 through the vent lines?

MR. McKENZIE: Not quite. All 210,000 comes into the intake in the tunnel and that is where the velocity constraint comes into play. We can talk about that in a minute.

The highest velocity we would allow in the north ramp is 600 feet a minute. That's a fairly conservative assumption. We have a conveyor going against the flow of the air. So, we want to keep the velocity down to 600 to keep from picking up dust. We have two conditions combined to drive us to that low of velocity. One is the dust. It has a fairly high silica content. So, our respirable dust level is going to be pretty low. The other one is we are restricted on the amount of water we can use to allay dust. So, those two sort of feed on each other. So, we have to be very conservative in the maximum velocities that we assume.

But, getting back to the question, the main intake down in north ramp is all in the tunnel, and then if you assume your exhaust goes out the south, about three-quarters of that air goes out in the tubing out the south. It would be a lot easier if we had some cartoons here. But, you have very little flow actually in the south ramp going out in the tunnel because most of the air is in the tubing by that time. It's being used in the mining operations and been pulled off by the vent duct that goes out the south.

There's a million ways you could sequence this thing and every one of them would change the total vent requirement. This is a fairly conservative case and it allows you a lot of flexibility and that's what we like about it. If you want to run four headings, you can do it. If you only allow enough air for one heading, that's all you get. Flexibility is the key part of it.

DR. ALLEN: Could I ask sort of a philosophical question here? I can understand many of the reasons why the large diameter tunnel looks very nice. I can also think of many engineering reasons why I should own a Lexus and not a Ford Escort; good engineering reasons. The fact is most of us don't own Lexus' for very good reasons having to do with cost effectiveness and what not. To what degree could we get by with cheaper systems, smaller systems here that would still meet our objectives, or are we just choosing the most elegant one just because it satisfies all of our wishes?

MR. GERTZ: Let me just comment very briefly on the most elegant one. I have on the record a letter report relative to what would be a repository desired diameter for transporting waste. That's about 32 or 33 feet or something like that. So, I don't think we're choosing the most elegant one. It's going to be there for 20 years and I think we are looking at operational feasibility.

DR. ALLEN: But will it be cost effective? As a taxpayer, I am interested in this.

MR. GERTZ: I think, as a project manager, if it saves one or two accidents, it is cost effective. And, I can't put any figures on that if it will save any accidents or not. But, intuitively, the amount of traffic that's going to be going in and out of there, I just feel there is some intuitive savings. One accident will be very costly for the program whether it is a vehicle accident, a mining accident, or whatever. And, if this helps that and the analysis indicates that, that two-way traffic certainly will make it less likely to have a serious accident.

DR. ALLEN: Well, likewise, four lanes would make it even less likely.

MR. GERTZ: That's true.

DR. SIMECKA: One other comment, I believe that we ought to have adequate ventilation in case we have to have more than one heading active at any one time. And, if we are able to have the flexibility to make those extra headings that are necessary for whatever the scientists say they have to have, that could save months on the program by not having to wait until one activity finishes until another one can start. And, if we will be spending in the order of $30 to $40 million a month on this program and if we can shorten the total time of the program, I would venture to say we will be able to save some money.

So, I believe that it is just wise for us to have adequate ventilation and adequate safety just to make sure we don't have to hold up for some reason because we don't have adequate ventilation.

MR. GERTZ: Clarence, let me add one other thing. I think it may have gotten lost in the dialogue, but it appears that ventilation alone, if you want that flexibility, drives it to a 25 foot diameter. If ventilation drives it to a 25 foot diameter and then if we want a little operation--

DR. ALLEN: If that is really the case, I would like the facts to get on record.

MR. GERTZ: Do you have the facts of the 25 foot?

MR. STANLEY: I believe the real issue here is are we talking about the differences between a 26 foot, 27 foot type of a size versus an 18 foot size, and this is a big difference. We're really not discussing the real differences between 27, 26 or 28, or something in there.

DR. ALLEN: But, for example, does ventilation just rule out in your opinion an 18 foot tunnel?

MR. STANLEY: For what we want to do in a safe environment, yes.

MR. PETERS: I am John Peters. I am with the M&O, Subsurface Design. I did a kind of quick look at the scenario we are now talking with the main drift tunnel, driving around the loop to breakthrough, and the possibility of having other activities going in the Topopah Springs concurrently with that and the Calico Hills development coming in afterward.

I examined the various cases involved in that and this is kind of the ventilation requirements that developed. As you can see, the worst case or the maximum requirement case would be this. Now, this makes the assumption of a large TBM, a smaller TBM, and a drill and blast heading working simultaneously. This gives us about the maximum flexibility we could expect without going into a real excess here.

A little schematic of that condition right here. That assumes that quantities of air required at each of the working places with this one being a multiple face drill and blast, sort of a mini-room and pillar section, is what you would have in this area.

Now, if we talk mobile miners or something else, if we had multiple ones, we would still need extra ventilation. Depending on the advance rate, if we were going to maintain the schedule, it would take more than probably one mobile miner to keep going. Again, we have three places going. If we need to stop something for testing, we are not stopping the entire advance of the project. The other places can continue to work.

It also gives us the flexibility to have, if necessary for ventilation later on, to separate this so we can have pretty well unlimited testing going on in this area while the Calico Hills is being developed. We could split the air, take exhaust from both sides and intake the air, put an airlock in. We've got dual access. We can go through, in and out either way. Again, a large safety feature. That's a potential.

DR. CORDING: The amount used in the MTL area with that room and pillar configuration is the largest there, 114,000 CFM. Does that assume that you're supplying air to the entire headings or are you using bradices or other things to direct air?

MR. PETERS: Bradices, auxiliary fans with tubing, blowing fans in, keeping circulation. At any point that you're doing mining and raising dust, you are going to pick the air up right at that point and discharge it to the tubing. I'll have to go back to that other diagram to show that. In that concept, those are individual splits of air. The air is not re-used after being used in any place where actual mining activity is being done.

DR. CORDING: One question I have here is that if you look at the rate of getting a TBM through and out the south portal, with utilization and advance the smaller machine is going to be out earlier. The two year period or whatever period it is, somewhere between one and two years to get through the main test level and out to the south portal, even as you start developing that drill and blast area, that will not be completed or anywhere near full size before you are out the south portal. So, at the point that you have opened up this main test level to its full extent, you will have already have been out of the south portal by probably a year if you go on through with a fairly efficient TBM operation.

I am wondering if, in consideration of that flow through and the fact that the TBM isn't even there for the 44,000 CFM for the main test level or for the main TBM going through the system, it would cut down the air requirements. It seems to me that with the approach that already you're into here with the FY93 approach, there is a very high probability that the number of headings and the simultaneous operations would be less than what is assumed in some of the conservative estimates.

MR. PETERS: One of the major reasons for starting the main test level as early as possible is to provide the heater test area. That would open up the heater test area probably sooner than going all the way through.

Depending on the final design of the main test level and how many feet of actual drifting there is because, as it was said this morning, that's still an open design phase, the timing will change based on that, certainly. But, it would allow opening up of the heater test and, quite possibly, finishing a large amount of the main test level area prior to the breakthrough; not necessarily all of it.

DR. CORDING: A lot of that air requirement in that main test level is because you have so much opened up though, isn't that correct?

MR. PETERS: It's primarily because you have three major working places. Yeah, three major active mining places.

DR. CORDING: I guess my point is, even if you started --and you might look at the schedules on this--but even if you started into the main test level as soon as you could get to it as you came down and stopped the TBM long enough to start whatever operation in the main test level you are going to do coming from the north portal down, if you let that TBM go and get out, it will be out of the project before you have got the bulk of that main test level completed. And so, I would think assuming that you have to take the entire main test level, assume it is all there, and when the machine is not through is perhaps a situation that won't develop.

MR. McKENZIE: The reason for the big volume requirement in the main test area is because with a conventional unit you have a large diesel fleet. There must be 400 or 500 horse-power in diesel horsepower. I don't remember what it is, but John can tell you. That is why that volume is high. So, that volume starts out high and remains high throughout the excavation phase in the MTL. It is not driven by the fact that you have got a lot of ground opened up. It is driven by the number of diesel units that are running in there.

DR. CORDING: The diesel--which units?

MR. McKENZIE: Well, it would be the drill--you would have diesel powered drill and your mucker, you'd probably have a 5 yard LHD, 150 horsepower may be nominal. With a conventional unit, that's the kind of stuff you are looking at, and that's why that volume is large is because of the diesel horsepower.

MR. GERTZ: What you're saying is you require that kind of volume as soon as you start it.

MR. McKENZIE: As soon as you make that a separate split and you park all those diesel engines in there, you've got to have that kind of air in there.

MR. PETERS: This is an estimate mining with the method that is shown there of the diesel equipment which would be required, assuming we used diesel for all the support equipment in this operation. And, the total diesel horse-power in that comes out to be about 1,370 horsepower that we have to ventilate for.

Now, that is considering the idea of having trans-portation for the other activities, as well as the diesel mining. You may ask why would we consider a diesel bolter and a diesel powered drill jumbo and that is to give it the flexibility to move pretty well anywhere if it needs to go someplace, to cut a short alcove or something. That unit would be very mobile, very efficient in doing that.

DR. CORDING: Do you have the possibility of using other equipment?

MR. PETERS: Other than diesel powered equipment?

DR. CORDING: Yes.

MR. PETERS: Yeah, I believe that other equipment could be used in this type of mining, but I think you're talking about some fairly drastic reductions in the efficiency of this stuff. The diesel powered equipment, I think, is going to add a tremendous amount to the efficiency to that type of a mining operation. It's possible you could use electric equipment--

DR. CORDING: Any other comments in regard to that from some of the construction people?

MR. CRONIN: I'd like to see how you go from your 264,000 down to your D rate at 114,000.

MR. PETERS: The 114,000 was in the actual working place. Okay, that is with the diesel equipment running in that place. That considers that there is some support, supply equipment, some personnel transportation moving in the ESF facility in addition to what is working in that one working place. We considered that there could be diesel supply equipment and stuff hauling up here, also. That was in the stuff that Bruce presented. The same considerations were used here as in what he presented, that there'd maybe 250 diesel horsepower--or 200--operating in these TBM headings, in addition to the diesel equipment which would be operating in this area here.

MR. CRONIN: I think I follow what you're saying. I'm still a little bit at a loss. On the previous chart, you had some 300,000 CFM required, and that was for the test area, and now here you're showing 114,000. I don't follow the correlation.

MR. PETERS: The 114,000 is available delivered across the working places in here. At the same time, you're delivering an estimated approximately 31,000 into this working area, which is also an active mining area, and 40-some-odd-thousand into this area.

MR. GERTZ: I think the question goes to the previous chart, though. That's not only for this main test level testing area. I think that chart was for an entire ESF operation.

MR. PETERS: That is for the entire thing. That is with all the three active faces, plus some equipment working in the outlying area hauling supplies, et cetera. The various people, the 264,000 goes from this 198,000, which comes from this 189,000, plus some additional equipment working back behind these working faces. You come to 198,000, and then we allowed for losses due to leakage in the system, 25 per cent throughout the various tubing and across the bradices and stuff like that to come to 264,000 total needed.

MR. CRONIN: Okay, I understand. I think I understand now. Now, can you tell me how you go from the 264,000, then, to the 210,000? Is that where we are?

MR. McKENZIE: Those are two totally different scenarios. I knew that was going to come up.

MR. CRONIN: Okay. I just like to follow through the logic, that's all.

MR. MCKENZIE: The scenario that RSN used was the one that I described, and that's the one that came out with 210,000 CFM. Their scenario assumed that you had four working faces and that the worst case was after breakthrough, and you had to have those four working faces still, plus you had to maintain 100 feet a minute in the out-by--kind of hard to explain without a picture, but you had to maintain 100 foot a minute in each the Calico and Topopah Springs drifts for a total of six splits that totaled up to 210,000 CFM.

Now, this one here is a pretty different scenario. This is a little different direction that we were told, okay, now we're going to look at doing the Topopah first, and then the Calico. So we looked at the worst case with the Topopah. Then we also got into this conventional mining scenario because you can see from the volumes, when you get into the big diesel horsepowers, it drives the air volumes right up. So they're really not terribly comparable except that we used the same basic velocity assumptions and the same 125 CFM rate of horsepower diesel, and that sort of thing. So they're comparable, but they're not based on the same mix that we used in the first one.

MR. PETERS: The scenario in the first one was what was given when RSN started the ramp-sizing study. The current schedule was presented this morning. This is the scenario for the ventilation under that schedule, with going all the way straight through in that tunnel, doing nothing on the Calico Hills until the Topopah Springs development is complete.

DR. CORDING: Do we have a comment here?

MR. SMITH: Yes, Tony Ivan Smith again. In our situation, in our tunnel we were running at about 125,000 CFM to accommodate what we feel is the minimum heat requirement, you know, the heat output of the machine itself. So we're actually a little bit higher than what you're dealing with. So if you're looking at two headings, or concurrent headings just with TBMs alone, your 200,000, or over 200,000 CFM would be in the ball park.

MR. GERTZ: That's in Chicago?

MR. SMITH: Yes. But I wish to comment a little bit on your outline earlier, where you had the conveyor in place, but you had the Jersey barriers. Going back to this optimum to size is the fact, is that the maintenance of the belt and the cleanup of the belt, spillages from the belt are real happenings. So to accommodate, as you say, safety in one respect, you're actually making it more difficult in the other. And we are not putting anything in the invert. We are using regular pickup trucks and vehicles. And we will have passage--passing ways about every 500 feet where two vehicles can go around, and on the towing machines are turntables to turn the trucks around. So that's how we have accommodated the same situation you're doing here.

DR. CORDING: Do we have a question here?

MR. CALIZAYA: My name is Felipe Calizaya. I am a Research Associate at the University of Nevada-Reno. I have two points to address, especially related to ventilation. One is leakage, and the other one is recirculation, two key important things that need to be considered in the mine ventilation. I have two overheads to explain. May I do that?

DR. CORDING: All right, yes.

MR. CALIZAYA: This diagram shows the mine ventilation system when four workings are active at the same time. Here on this one, you can see this part is developed using a tunnel-boring machine. This is also developed using a tunnel-boring machine.

Through surveys through different companies, we figured out that the volume requirement at each point is in the order of from 30,000 to 50,000 CFM. That's what's needed at each point. On the other hand, if we have to have these other workings active, we need about 30,000. If we add up these numbers, we figure out that the total quantity is in the order of 150,000. That's what we need to supply to each working face.

But, in order to supply that, we have to provide this, not by curtains. We need to provide through rigid, metal, ducting system, and that ducting system, within that ducting system we need to keep velocity levels such that we can transport dust through it; we don't have any settlement. So we need to have minimum velocities inside of that.

In addition, we have to consider that we have leakage through the system. In order to provide the quantity that we need to have here, about 50,000 CFM, we need to have at least twice as much at this working place. So if we have to do the same thing for each one of these workings, so we figured out that the total quantity requirement is in the order of 263,000 CFM. That's the minimum that we need to have, minimum quantity that we need to have to satisfy this.

Now, if we don't have that, what we will have is recirculation. This overhead shows how the auxiliary ventilation system would be for this mine or for this opening. So this is the surface, and everything--the air, this is the working face, and what we are doing is providing the air through the main tunnel, clearing the dust at this end, and all exhausts are being returned through this auxiliary ventilation system.

Now, between this point and that point, we have almost five miles--I mean for the whole system, for the worst case conditions--we have almost five miles of length. That means we will have leakage. At every joint we have leakage, and that leakage is from the airway to the duct. And we want to avoid the other way, which is from the duct to the airway, which would be recirculation. And when we have recirculation, then we are not ventilating the mine. We have problems. So from that point of view, if we want to have four workings active, we need at least this 250,000 CFM.

Thank you.

DR. CORDING: Yes, and if you were developing the upper level and not the Calico Hills, then your numbers come out to

about half of that. Is that what you were indicating?
MR. CALIZAYA: If we are just working this area, that's the Topopah Springs level. So we will need 50,000 here, and we will need about 30,000 here. So all together, it makes up about, let's say about 100,000 CFM. But to provide that, still we need to have almost twice as much at this point due to leakage.
DR. CORDING: So the total required there at the north portal would be approximately--
MR. CALIZAYA: At the north portal, it might be on the order of 150,000 to 200,000.
DR. CORDING: Okay.
MR. CALIZAYA: That one--the other thing that I wanted to point out is this: Here we need to have a maximum velocity of 600 feet per minute. I think that's what other speakers mentioned. If it's more than 600 feet per minute, then we have dust problems. It will start picking up dust from the conveyor belt. Since we are working under dry conditions, then that becomes a major problem.
DR. CORDING: Thank you.
Any questions?
MR. SPERRY: Yes, I had a question. Joe Sperry.
What's the minimum velocity that you want in the fan line to pick up the dust?
MR. CALIZAYA: I mentioned 600.

MR. SPERRY: No, no. I say in the fan line so the dust won't settle out. You mentioned that you had one very early.

MR. CALIZAYA: For the duct line, I'm using 3,000 feet per minute, and I have an upper limit of about 6,000 feet per minute. When it's above that, we have another problem, noise problem.

MR. SPERRY: Well, now, so you design your duct for 3,000 feet per minute--

MR. CALIZAYA: Yes.

MR. SPERRY: --but you have leakage that--

MR. CALIZAYA: That's correct.

MR. SPERRY: So you're going to pull in an additional quantity, so by the time you get out to the portal your velocity in the duct is up to 6,000 feet per minute?

MR. CALIZAYA: It's going to increase. That means what we will have to do is change the duct size. At the very beginning, we have duct diameter of about five feet. Right here it's about five feet, and then it starts increasing to six feet and eight feet in diameter, so that we can have this maximum velocity under control.

MR. SPERRY: Okay. I normally design for 3500 feet per minute in the duct so the dust doesn't settle out, so that's okay. But I've never heard of doubling the amount of ventilation due to leakage in the fan line. Normally, in civil work, we maintain the fan line. We put on couplings that have very minimal leakage. Is that not possible here?

MR. CALIZAYA: Okay. Well, what I did is survey through existing auxiliary ventilation system. At Homestake Mine they have a long tunnel they are just developing, and we measured it at different spots. And we figured out what the pressure loss, or what the leakage is for 1,000 feet and figured out that number. We need to have diameter and we need to have pressure inside the duct almost at the same conditions. And in these conditions, I figured out my resistance for the leakage path and I used that in the simulation to figure out those numbers. It's not 50 per cent. It might be way above that number. This is one of the minimum values that I have.

MR. SPERRY: Wait a minute. You said it's not 50 per cent, it may be higher, but what's the 50 per cent?

MR. CALIZAYA: It might be higher than that. This is the result of simulation.

MR. SPERRY: You're saying the leakage is loss, the 50 per cent leakage in; is that what you're saying?

MR. CALIZAYA: That's 50 per cent of--if we look at this diagram, the air will be something like this. I have my exhaust system right here. The leakage is, depending on what the fan size is, the leakage will be just straight from the airway to the duct. If this pressure is high, I may have 50 per cent leakage just in this area. But what I'm doing is size and dust fans such that the pressure inside the duct is not more than 10-inch water gauge. Under those conditions, yes, I may have leakage of about 50 per cent for the whole system.

MR. GERTZ: Maybe it would help just a little bit if I put all these ventilation calculations in perspective. When RSN--and help me out, Dick, if I get this wrong; we are moving fast. RSN did the original ventilation calculations based upon the reference plan. The M&O team, then, has done some check calculations based upon the approach we're doing. We then also asked Mackey School of Mines, UNLV, to do another broad-based check. So, really, we have three independent people who have done checks with different assumptions, different ideas, different approaches. All have come to the same general conclusion about what might be necessary, so that's the check and balances, and that's why you have three different people and some inconsistencies.

MR. SPERRY: UNR, is that--I have some more. May I go ahead?

DR. CORDING: Please go ahead.

MR. SPERRY: It's on the same subject.

DR. CORDING: Sure. Please go ahead.

MR. SPERRY: UNR.

MR. GERTZ: UNR. Did I say UNLV? I'm sorry; excuse me.

MR. SPERRY: Well, we all do down here, Carl.

(Laughter.)

MR. SPERRY: I'm quite concerned with this. What I hear, and what I heard this morning was all--it wasn't--that was okay. It was not too controversial, but what I hear this afternoon is that the ventilation is driving the tunnel diameter choice and that, of course, I think our one controversy from this morning is whether you can drive a 25-foot tunnel as fast as an 18-foot, and I think we heard people say that, well, yes, it can be done and it's never been done yet, which I would agree with. But I know that it costs more to drive a bigger tunnel than a smaller tunnel.

So our ventilation is driving the size that you're making these tunnels, but the largest source, you had two large sources of ventilation requirement, and one was the main test level excavation, which you've determined is going to be diesel, which is an okay assumption, but you're not going to design that now because you don't have the money, and so you're making this and you're designing the whole tunnel size; whereas, if you looked at that and got your scientists in there in the act to see if that could be done with mechanical miners, and to eliminate the diesel or most of the diesel there, then your whole ventilation requirement would be much less.

Now, of course, this thing about doubling the requirement for leakage is not--I mean, I don't know what

Homestake was doing up there, but I know we don't do that on construction and we meet all the mandated safety requirements, so something's funny there.

Now, your other big source of requirement for ventilation is the vehicles that are down in the mine. Well, you eliminate that very quickly if you--and we haven't discussed the number of man-trips into the mine for various reasons, but I don't know, you had something like six vehicles down there; two supply vehicles and three man-trips and things, and at the bottom of that list on Table II, John, was a very significant contribution to your vent requirement.

Let's just get rid of that, put rail down there and have a man-trip that goes down every hour, or every 30 minutes, or whatever you want and get rid of a lot of that supply truck, supply truck personnel.

MR. PETERS: The supply trucks, certain trucks are for maintenance and handling supplies and other stuff. These personnel transports, the assumption is that they'd be making passes through this thing the same as you would be talking on rail.

MR. SPERRY: Well, this is my point. If we had a rail haulage system with this all coupled together, and one diesel engine of 150 horsepower, most of this thing goes away. But let me finish, please. I have some more here. I didn't mean to suggest that you...

The other thing that could be done here to minimize your ventilation requirement, it assumes the worst case. And, of course, the worst case makes your tunnel much bigger than it needs to be. Assume a case where you minimize the work. Assume that you work in two headings at a time, say, so that you take your tunnel-boring machine through and you start the test level. And then when your first tunnel-boring machine is finished, you-re in the test level--hopefully, with the mechanical excavation equipment that people are working on, which minimizes the ventilation requirement--and then start another machine up. And then go down below and, you know, limit it to two machines and get back down to an economical size of decline.

MR. GERTZ: Joe, yeah, I think I need to interject just a second here, because now we're talking major philosophies, and there's people saying, get down as fast as you can every place you can. There's U.S. Senators who are saying, get underground. There's the Board report that says, get underground as soon as you can. I have scientists who need to do tests. We're not sure what that test level is going to look like. We're not sure what's going to be necessary.

So, yeah, we can delay getting underground and study for another year or two, and maybe come up with an optimum design; or we can move forward now with flexibility. And as a project manager, I think it's necessary to move forward now and move forward with flexibility.

I don't want someone coming to me in two or three years and saying, gee whiz, we want to do this and that and why didn't you have enough ventilation for us to do it? That was poor foresight in the beginning. So I've asked the people to look at all the opportunities, make sure we have a credible approach, make sure safety is our utmost concern, and truly, on this project we live in a fishbowl, and so does the whole test site, and I want to do everything I can to maximize worker safety/worker activities down there, and to accommodate the scientists, and to move forward as soon as possible.

So we have had all kinds of options we've looked at, and this happens to be the one that we want to get out with an RFP for a TBM and start our excavation, and I appreciate the dialogue because we've gone through a lot of this internally over the last two or three years with much of the same discussions.

DR. CORDING: Thank you.

I'd like to make an additional comment. Of course, we have been discussing this in various sessions over the past year or two, and listening to the people on ventilation and some of these other things, other approaches to this, and the size has gone somewhat above the 25 to the 27.5 foot diameter, or 29 or 30 as a possibility at this point.

MR. GERTZ: Yeah, well, right now we're--27.5, as I've pointed out, is our RFP that will be going on the street, and we did start at 25 in our ESF alternative, so it has increased 2.5 feet in two years.

DR. CORDING: I think one other aspect of this, of rail, is the possibility of being able, then, to have a controlled operation of access into the underground; that you are working with a system that allows control of transportation; and perhaps the experts here on transportation underground may be able to say what the safety situation is there, but I would think that the rail would provide you more safety and it would allow you to go with a smaller diameter.

So the two situations of ventilation, and then the double lane for rubber-tired vehicles are the things that are driving this, and the idea of minimizing diesel and trying to use systems that will minimize the introduction of those sorts of materials might also sort of fall in this range of--in this direction of saying we probably won't have as much diesel underground and perhaps we can handle the transportation even more safely, or perhaps even better by using rail. So those are a couple of the items that we've been thinking about and we're interested in discussing.

MR. GERTZ: I guess, Ed, my only response to the rail, et cetera, is I'm also looking at perhaps, as I said, ten to twenty years of operation of this, with scientists going in and out, with everything happening. And even after we get finished running our mining head, there's going to be lots of activity.

DR. CORDING: Yeah. Well, and then the example that we have at the NTS is 30 or 40 years of operation in tunnels in which rail is the transportation method for a scientific program with a lot of people, scientists and others, going in and out of the tunnel. So that's the--

MR. GERTZ: Except I would say we probably get, right now, 50 times more interest than the NTS does in their tunnels.

DR. CORDING: Well, at this point, but there's been a tremendous amount of activity over the years there at NTS.

The other point is saying that if we get in a situation where you say you have to slow down because you haven't been conservative enough in estimating some of these things, it seems to me that by going with an operation that gets you through with less risk and more efficiently, that you minimize the possibility of having to go in and develop more headings because you can get through more rapidly with the smaller tunnels which are, you know, always, in comparison to a larger one, are traditionally faster and less risky. And so, I think that's the other side of it, the way we've been looking at this, Carl, and that's why we've been interested in having this present dialogue.

Further, if you are in a situation where you're going to--you find that you have an air-handling requirement, there is the potential, and I know it takes some time, but certainly, raised boring is a possibility. You have to consider other things, but it would be, you know, at the location of your third access and that's an additional cost at that point. But it's a backup in case one really did need it.

Then the other point that I think we can make here, that I'd like to have discussed briefly by some others, is this situation with decoupling the Calico Hills. And there has been some informal discussions of that, or comments regarding that possibility, and people in the testing community and some of us looking at that. And I was interested in this. That would, of course, reduce the impact, the interaction between the repository and the Calico Hills and I was interested in having a few comments on that topic at this point, unless we have some other things that you want to bring up on this, or others, in regard to this situation.

MR. GERTZ: I guess, Ed, only to summarize, we are looking for flexibility. Who knows what the new testing requirements will be? Even with one Topopah Spring run through, there are certainly your early Board reports and saying that it's important to intersect the faults and go to other places, so even if you have one TBM, you may have people anxious to get some other information, other than just the once through. So I think there's many scientists who believe that the once through is nice, but there's other information they want, and it's not anywhere near as much as they'd like, and we have to look at all that.

DR. CORDING: Yes. Well, that will serve as a good introduction to some of the testing that we'll get into in just a few minutes here. We're running behind on that, but I think this discussion has been worthwhile and helpful.

MR. GERTZ: We appreciate it, yes.

DR. CORDING: Going back to the issue of the decoupling, I would like to have a brief discussion of that, at least in terms of how it might look, and we may further discuss it in the testing session.

Tom, I know you had some information on that, and I think Joe Sperry had also been looking at that. Could you, Tom, first give us just a brief view of it?

MR. BLEJWAS: Well, what I have prepared--and I didn't prepare much--I brought a few view graphs, but really, what I wanted to talk about may not be the decoupling that you had in mind. So if I'm off the beam, feel free to interrupt me.

DR. CORDING: Okay, if you have just a few comments on decoupling, I'd like to save others for later, too. I'll let you decide that.

MR. BLEJWAS: Okay. Actually, what I was looking at is what are alternative concepts for the exploratory study facility, alternative strategies, rather. And in looking at that, I thought that if you're going to consider alternative strategies, you really have to look at the program as a whole because right now, the program is on a course where using those alternative strategies would interrupt the present course and would be unacceptable in the present climate.

So what I did, in looking at this, is throughout the constraints that we've been operating under, and there are two constraints that I think have pushed us to where we are that I found to be very significant, and one is that we have to have a license application in the year 2001, and the other is that we are going to have to have very large amounts of funding in the near future so that we can construct a very large and significant exploratory study facility and still maintain a significant program.

So when I looked at this, I thought, well, I'm not convinced personally that we are going to get large amounts of funding in the near future so that we can really continue on with an elaborate facility, as well as a sound, scientific program. And so, then I said, well, if that's the case, if we really aren't going to get large amounts of funding, what kind of an exploratory study program would I want? What kind of study program would I want for the system?

And so, the first thing I'd like to talk about a little bit is what kind of program should we have, or could we have if we weren't going to get large amounts of funding?

And number one in my look at that is that we need to have a phased program if we can't proceed on this path to 2001 with a high degree of confidence. We need to have a program where we gain confidence as we go, where we maintain a strong scientific content, where people have confidence that our science is sound; and hence, if we have a phased program where we're going to make decisions at key points, we're more likely to convince the technical community and the public that, indeed, we have a good program.

And the kind of situation that we're in that worries me--let me back up, or talk a little bit now about the ESF. This is what I see as a logical sequence, if somebody were going to concern themselves with an exploratory studies facility. I actually put this view graph together for a talk I gave about a year and a half ago at the International High-Level Waste Conference, and there it was really aimed at the Nuclear Regulatory Commission, because if you are going to try to get confidence in your exploratory study facility, what you do is you would design the ESF--I'm sorry, let me back up.

If you're going to have confidence in your repository system, you'd design the ESF, you would construct the ESF, you would obtain site data, you would validate your models, and you would design your repository.

But in order to design the repository with confidence to meet all the requirements you have, you're going to have to do performance assessment, and the performance assessment is going to need site data and validated models. So if you follow in this progression, you have all of that in order to do your performance assessment and to design a repository.

The way the program is going, going full bore towards 2001, what we've done is we've put ourselves into what I view as a Catch-22. Maybe it really isn't a Catch-22, but we should at least be aware that some of these pitfalls exist, because in the path we're following, we're saying, I'm going to design the ESF right now, and it's also going to become a part of the repository, or at least some components of the exploratory study facility are going to become parts of the repository.

That says, if I'm going to do my performance assessment and meet the performance objectives of the program, I logically should have good site data, and I logically should have validated models. But I can't have site data and validated models from the ESF until I've constructed the ESF. So I'm in somewhat of a Catch-22.

And, hence, when I looked at this, I said, well, if

I were not concerned about following the program the way it's presently laid out, I'd develop a very different phased program, and this is what I call an alternative strategy, and I apologize for the size of the print for those of you in the back.

And in looking at this I said, well, what can I do so I don't get in this Catch-22? Well, one thing I can do is I can phase the exploratory study facility. And by phasing it, I mean that I first construct an exploratory study facility that is not going to become a part of the repository. So I have what I've called, first, a site suitability phase, and I don't know how long that would take. My best estimate was that that would take about five years.

And during that five years, I would construct a non-repository ESF, what I called ESF I. I'd do characterization and testing for site suitability. I'd do model development and validation and performance assessment. And here is a big one, I'd do research on long lead time activities, because under the present program, we're spending so much money on an ESF for the repository, and so much money on surface-based drilling, that many of our long lead time activities are being cut out of the program.

I also, then, would come to this point and say, okay, given all this, if the site's good, I'll probably have a high confidence that the site's good and I can make an assessment of site suitability with high confidence. If, indeed, I can do that assessment and have high confidence, then I go on to what I call a design phase.

Now I've got data, I've got models that are, if not completely validated for the license application, at least we have some confidence in the models because we've checked them out in some of our experiments underground. And during the design phase, then I design an ESF II in the repository block because now I have the things I need to design it. I do the characterization and testing for design issues, repository design, waste package design, performance assessment, and I do the final assessment of site suitability. And finally, I go on into the license application preparation phase.

And I recognize that this is a very radical idea and it doesn't sit well with the present program, but if we're really not going to get large amounts of funding--and that's a question, if we're not--then I think we would have to consider an alternative for the program.

And when I say an ESF off the repository block, some people presume that I'm talking about a Busted Butte facility like the one that Russ Dyer will talk about under the testing part of the program. And Busted Butte is down here on this view graph. Here we have Yucca Mountain. The black outline is the outline of what we presently plan for the repository block, and here is Busted Butte down here.

Well, if we were going to construct an ESF off the repository block, there are many other opportunities to do construction other than just down at Busted Butte, although that may be an ideal one.

I know in discussions with Larry Hayes, he's been critical of my concept that I'm presenting here because he says, well, I wouldn't have high confidence that the site's good if I didn't go underground right here. Well, what if you went underground right here, and what if you went underground right here? And what if you had adits around Yucca Mountain? I think there are approaches to an early ESF that could be constructed quickly, cleanly, that would provide confidence, and so that we could proceed, then, in a design phase with more confidence.

I want to finish with one additional comment, that since I no longer work on the Yucca Mountain Project, these were comments from Tom Blejwas and not comments from Sandia National Laboratories, and also, that I recognize--I'll repeat myself--that this is very different from the present program, and I hesitated to bring up something so different and radical, except that I was asked to, and these are ideas I've had for some time.

Thank you.

DR. CORDING: Thank you very much, Tom.

I think we're going to come back to that as we get into the next session, and I think perhaps one other comment about a decoupled access to the Calico Hills might be of interest. Is Joe Sperry here with that?

(No audible response.)

DR. CORDING: That makes the task easier. I think perhaps we ought to take a break for a short refreshment. Why don't we take 15 minutes, and then we will come back and start our next session. Perhaps we can hear about decoupling later.

(Whereupon, a brief recess was taken.)

DR. ALLEN: We're going to continue with the next topic, which is exploration and testing. There are going to be two presentations and I think we'll do both of those in order, and then turn to other people for comments.

So leading off the discussion will be Russ Dyer, on Integrated Testing Evaluation.

DR. DYER: I'm going to come at this a little differently. I'm going to start off the testing session, the Session II this afternoon, and we're going to look at things, I hope, a little differently. The perspective I want to bring to this is not how many boreholes do we need to drill, how many feet of underground workings do we need to make, but what questions do we need to answer during the history of this project to determine, A, whether or not this is an appropriate place for a high-level waste repository; and B, if it is an appropriate place, what information do we need to acquire to support a license application?

We had an effort that has concluded, well, the first phase of it concluded relatively recently, and this was an effort within the project to try to determine what priority ought to be given to what tests; in other words, what information, what are our most important information needs at this point in time?

This is called the integrated test evaluation. At the request of Dr. Cording, what we're going to go through in this particular session is just a brief overview. We're not going to go through the formalism of how the expert panels were polled or how the judgments were aggregated. But aside from just a little bit of introductory information, we're going to spend some time on what the results were.

The objectives of this were to provide some near term assistance to myself and to Carl to try to do some wise allocation of resources in the fiscal year '93 time frame for budget allocation and for planning decisions for the testing program. The charter that was given to this group was to produce a prioritized list of tests for fiscal year '93, evaluated at the study plan or activity or, in some places, at the test package level, and to look at several criteria. The answer you come out with; that is, the importance of a particular test depends on what the criteria is that you're using to evaluate it against. And some of the criteria we looked at were site suitability, what tests provide us the most bang for the buck for determination of site suitability, early site suitability or unsuitability, what tests provide us the most information for regulatory compliance--we'll talk about another category, scientific confidence building--how does cost factor into it, and schedule criteria.

Now, part of what you're going to see in here is schedule constrained, because I asked them only to look at those tests that could be fielded in fiscal year '93, not necessarily an out-year test. Our concept here is to have an iterative process, an iterative mechanism in place, if you will, that we can go back and revisit, update the information basis in it, and essentially go through re-prioritized tests based on our increase in knowledge at some time in the future.

We built it on some of the previous studies we've done along this same vein, the ESSE report, the test prioritization task force report, Calico Hills risk benefit, the ESF alternative study, and the most recent, total system performance assessment. Another objective was to build a systematic and pragmatic approach that can be applied iteratively and that can set on the computer on my desk.

One of the first things we had to struggle with is that there are many multiple reasons for testing, and to get down to the point where you can build an objective data base, a relatively objective data base to evaluate value of information, you have to define what this information is going to try to satisfy.

Six that we defined were to detect unsuitable site conditions; demonstrate regulatory compliance; build scientific confidence essentially amongst the peer community of other scientists; build constituent confidence with such oversight bodies as the NWTRB, ACNW, National Academy, the public itself, all of these constitute some of the constituents that we were looking at; provide design information; and, of course, to support other tests. There are some tests that are fielded not for their intrinsic value itself, but rather, because it provides information for another test that is, in itself, critical.

We were able to look at three different categories in this first round: detect unsuitable site conditions; demonstrate regulatory compliance; and build scientific confidence. That left us with a pretty glaring gap that we have had to get around; that is, namely, one of the things that we are faced with in the very near future is fielding tests that provide information to support design input for an ESF. That was not one of the criteria that was evaluated explicitly by the ITE group, but it's something that we did off-line, and plugged into our resource allocation for this year.

The basic concept here is to go through with a panel of experts, if you will, determine a value of information for each test study against a specific criteria. And here are the five criteria that were included. At the beginning of the year, we didn't do anything on constituent confidence, but the model you're going to see looks at these criteria, these four criteria; unsuitability, regulatory compliance, scientific confidence, and cost is put in there. Obviously, it's considerably easier to field 20 relatively cheap tests than one test that costs $100 million.

One can go through and weight the results of each of these, roll it up, aggregate it into an overall test benefit, which we will show you in a moment.

The primary unit of testing that we examined is at the study plan level, and there are currently 104 different active study plans. We started out with 106 studies within the SCP. There have been some new studies identified, some studies that have been aggregated into a single study. Currently, we're working with 104 studies. We quantitatively evaluated 56 of these studies. These are the primary data gathering studies. We did not look at modeling studies, some of the evaluation studies. The implicit assumption is that if you put resources to a data gathering activity, you would also put some resources toward the evaluation and interpretation modeling-type activity that goes along with it. And, as I said, we looked at all the evaluation criteria except constituent confidence.

We used ten technical experts from six of our participant organizations. There is a list that is available of who participated in this. I thought I would defer that until we give a more in-depth briefing to the Board at a later time. This group produced a recommendation to us, an initial evaluation, some insights, and a set of recommendations.

Just a little word about how things were aggregated here. They went down pretty low in the system. For instance, one of the things, let me look at regulatory confidence. You can go through the regulations, pull out performance objectives--they could be total systems, sub-systems, performance objectives--and rank a particular test as to how it might increase your confidence that you are meeting this objective, and that's what we're looking for, is the value of information. How much will doing this test increase our confidence or decrease the uncertainty, if you will. And then you can roll everything up into an aggregate ranking.

Let's look at it another way. If one were to take unsuitability by itself, rank all of the sub-criteria, and use essentially an equal weighting throughout here, you can rank all of our 56 tests that we looked at based solely on their ability to resolve the unsuitability question. You can do the same thing looking at this same suite of tests and get a rank ordering of our studies based on their ability to resolve regulatory compliance; same with scientific confidence. And that's what you will see on the next diagram which has, for each of these three major categories--unsuitability, regulatory compliance, scientific confidence--this is the rank ordering of studies, study plans that, in the judgment of our expert panel, would contribute the most toward decreasing uncertainty for the question of unsuitability.

Now, I put some color-coding on here just to highlight what part of the testing program is limited to the ESF, and what part of the testing program takes place both as part of the surface-based program and the ESF program?

The only test you see on here that occurs solely in the ESF is this one highlighted in yellow, ESF UZ percolation, which shows up as number two all the way across the board here for unsuitability, regulatory compliance and scientific confidence. In all three categories, that particular test shows up near the top of the list.

The other tests on here, highlighted in green--and I think in your handouts, one is bold type and one is italic. I believe that the ESF test is in italic. But these tests highlighted in green are tests that either occur or use samples that are acquired from both the underground program in the ESF, and also through the surface-based program. So you can see that of the tests we have here, the bulk of them show up in the surface-based program. I think we can use this as a lead-in to one of the questions that we have on the docket for discussion a little later here.

And I think if you look at this, you'll see that the rank ordering of some things moves around a little bit, depending on which question, which criteria you're evaluating against, but you get pretty much the same set of tests for almost any of these objective criteria.

DR. ALLEN: But Russ, what are the ones that are not colored at all?

DR. DYER: Oh, I'm sorry. These are either solely surface-based testing tests, or they are surface-based testing laboratory-type tests, but they don't take place within the ESF.

Now, these are all different objectives. Well, what's the objective of this program at this point in time? Is it to demonstrate regulatory compliance for support of a license application? Is it to develop scientific confidence amongst our peer community; the NWTRB, say? Is it to develop a basis for making a suitability/unsuitability determination? Depending on which one of these you wish to aggressively pursue, you may wish to put your resources in one or all of these columns. And you can do this by putting weights on these different columns by aggregating up if--sir?

DR. ALLEN: Russ, I presume that this was all done before the new Energy Act came in?

DR. DYER: That's correct, and that's something that's going to demand that we go back and look at this. In fact, we're going to need to go back and look at much of the basis for our program. If the performance standards change, then the questions, the fundamental questions that our program is designed to ask and answer are going to change in some way. Maybe it'll be a minor change. It may be a relatively major change.

This is just an example of how the roll-up was done, and here is a series of tests going across. This is the value of information that was attributed to each of these tests; a computed value based on some elicitations at a lower level, but are rolled together to give a value of information for this particular criteria. These were assigned a weight, and this weight is something that can be--since this is a spreadsheet model now, we can do sensitivity analyses with this--we haven't done any yet--to try to determine if there's something about the elicitation process itself that we can refine, if there are some things that bubble to the top all the time and, in fact, we think we see that.

There is a cost and schedule. Each of these things, each of these numbers counts as a positive attribute. And the way we set up the spreadsheet, we used the price or the cost essentially as a penalty, but we gave it a relatively low weight. That's so that the order of magnitude of each of these values comes out relatively close. Otherwise, we're going to have some things that are relatively expensive that would have an extreme penalty on them, and they would just never show up very high on the list.

Now, I should note that we haven't quite completed this part of it yet, putting and building in the cost and schedule. We have allocated out parts of the drilling program; that is, the cost of actually drilling a hole and a portion of that against the particular test that takes place in that hole. We have not done a similar thing for apportioning out costs of the ESF. In my very parochial view, I think of the ESF as being a very large incline borehole that allows us to put tests underground. If we apportion out the costs of the ESF against these tests, then we may change the rank ordering somewhat.

I should point out that the weights that were provided are within the recommendation that was provided by the ITE team. Those, of course, since it is a spreadsheet model, those are subject to change.

Now, if we take all of the tests, all of these 56 primary data-gathering studies that come from the SCP and look at them, again, what you see on this is the composite ranking, and this is a weighted average that is prioritized based on weights. I believe the weights are the same that were provided in the previous sheet, but maybe whenever I get through, either Jean Younker or Steve Madsen can correct me on that. But whenever we take the columns, the individual columns, weight them, sum everything, then you come up with a rank ordering of tests, and we're also keeping track of how much each of these tests would cost us in fiscal year '93.

The objective here is that if Carl tells me I have X number of dollars to spend in a given year, one thing I could do is just go down here and say, okay, with $40 million, we can do everything from here up, to the extent that it needs to be done in this year.

Now, we couldn't implement this idea totally this year because, as I said, we didn't have the whole program built into this spreadsheet. We don't have ESF design input into the testing program, and that turns out to be a particular activity which is right down here at the very bottom, soil and rock properties. So based on these criteria, I would have no incentive to funding this particular activity this year, yet, of course, I have to fund it to provide information to support an ESF program.

DR. ALLEN: I still don't quite understand. Volcanic features is without color.

DR. DYER: That's right. Bruce's program is--

DR. ALLEN: This indicates it's solely surface-based.

DR. DYER: It's solely surface-based.

DR. ALLEN: Okay, okay. I'm with you; thanks.

DR. DYER: It's either surface-based or laboratory, or some mix of surface-based and laboratory. Only the ones that are colored take place in the ESF; yellow ones take place solely within the ESF; the green ones have some component based on a surface-based program, some component based on an underground program. Let me give you an example of that.

Surface-based UZ percolation. They will use samples acquired from both drillholes and from the ESF, essentially do laboratory tests on those samples. So they're taking advantages of samples acquired from wherever in the program you can get it.

DR. DOMENICO: Russ, can you point out on the ESF tests those that are required to take place in the Topopah and those that are required to take place elsewhere?

DR. DYER: There is one test for the Calico Hills. Here we go. Demonstrate applicability; is that right, Everett?

(Affirmative response.)

DR. DYER: This would be the Calico Hills test right here.

DR. DOMENICO: How about in the Topopah versus higher units?

DR. DYER: In the Topopah alone, I'm pretty sure Tom may be able to help me with these. The mechanical, in situ mechanical/thermomechanical are mostly design input. These are primarily in the Topopah. In fact, I think they're entirely in the Topopah. Diffusion tests, in situ verification, can somebody help me on these? Are these solely in the--

MR. BLEJWAS: In situ verification is done wherever you are actually doing excavations. You're verifying the excavation process.

DR. DYER: So this could be either level. The ambient stress, I think, is just in the Topopah--no, both levels, Ned? Okay.

DR. LANGMUIR: Russ? Langmuir, Board. The draft ITE report suggests that you had--I'd like to commend you, first of all, on the report. It's pretty nice reading and very interesting reading. One issue that came up that was acknowledged by the writers, the authors of the report, was that you did not, had not addressed test dependencies; that you could not, at this stage of the game, look at the cost of one when you had both tests running. For example, as you point out, you've got recurrence of ESF UZ percolation tests and surface-based UZ percolation at the top of the list as high priorities in every category here.

DR. DYER: Right.

DR. LANGMUIR: And yet, you haven't had a chance to look and see which tests could be done in one of those efforts versus the other, where there might be some duplication that you could avoid and save some money. I'm just wondering where you're going to go next? I'm hoping you're going to go towards looking into the details of how these tests depend upon each other, and where you can save some money where they depend.

DR. DYER: That's right. And I think that's something we're going to get to a little bit later in the program, is, obviously, the ESF--most of these tests, whether they're ESF-based or surface-based, at least the hydrologic tests--are trying to acquire the same properties. And the consideration is where do you need these properties from? What kind of spatial density do you need? Do you need a full vertical column or a concentration in some particular area? And I've got some handouts that I hope will lead us into that discussion.

But you're right, right now, we can't answer that question, or we can't resolve it. Right now, we're very loath to take anything off of the list because we haven't had any new data coming in from the site that would allow us to go back and revisit this. The whole concept of this is to give us an iterative machine that we can go back and revisit at some periodic interval whenever we do advance our state of knowledge in some of these things.

DR. LANGMUIR: Russ, just one more thing. Maybe I'm also setting you up for later comments on this one, too. You pointed out--you've got several categories of concern, and one is that the public is not part of this process. You don't have an evaluation of how they're going to react to what's going on here. You have the scientific credibility of the program which you are addressing with this committee.

I have to assume that it's the public information aspect of the program that is what's going to look at persuading the public that earthquakes and volcanoes, for example, are not an issue. They don't make your cutting list of the top five priorities for study; those items don't. And yet, the public's view is that those are the critical things in the site. Frequently, that's going to be how they look at it. And I'm wondering where you're going with respect to looking at the public's perceptions, what your next step is going to be to bring them into process and evaluate how they will react, because they can kill the program.

DR. DYER: Okay. Well, that brings us back to the category we did not address, which is--I forget what it's called, but essentially, public confidence, constituent confidence.

We consider the public being the primary part of our constituency. We're struggling with that right now as to exactly how to bring them into the process. It becomes a little dicey. I mean, this was originally intended primarily as a management tool, and there's a fine line you need to draw between trying to mix the management and the public outreach parts of the program. That's something we're struggling with every day.

Well, the bottom line here, there's a decision framework. Now, what does that list mean? Well, it may not mean anything. It depends. The user can go back through and weight the different columns, depending on the directives I get from Carl, from the director of OCRWM, from the Secretary of Energy, from Congress. The objectives of the program may change with time. This has to do very definitely with Clarence's question, how is our program going to change in a changing regulatory environment?

If we go back and change some components of this, put different weighting on different parts of the different columns in the testing categories, then the rank ordering is going to change, also.

But anyway, what we looked at and what you have in front of you is the current guess as to what tests provide us the most information based on our current state of knowledge to detect unsuitability conditions, and I should point out something here that--it may seem subtle to some people, but we're looking at two different aspects of unsuitability; one of which is the disqualifiers out of 10 CFR 960, and the other are qualifying conditions which you must demonstrate and which we think will take a considerable amount of effort to get the information, the models together to be able to demonstrate that you understand that particular prospect, process, or aspect of the regulation, so that you can close that issue and make what's called a higher level suitability finding. So both of those things roll up into the unsuitability category.

Demonstration of regulatory compliance, this is demonstrating what we think it would take to demonstrate to both DOE and NRC that the regulatory parts of both 10 CFR 960 and 10 CFR 60, and 40 CFR 191, as we currently know it, have been met.

Building scientific confidence, if you look at the weights in the tables, I think you'll find that the highest weights, the largest value of information has been assigned to those tests under the category of building scientific confidence.

And finally, minimizing costs. It's nice to say that cost is not an objective or not a concern, but it is very true that we must consider the cost of this program.

We've developed a model. I should say that Jean and Bruce and Steve have developed a model that we can use iteratively to do a number of things, and it's designed so that it's not a one-shot thing, so that we can use it time and again, which we intend to do. And we also need to expand its usefulness, explicitly built into the spreadsheet.

Okay, that's the conclusion of this phase of the talk. I don't know if you want to take questions now or what?

MR. HAYES: Russ, I'd like to have a little interplay with you here on this process because, as you know, you and I have had considerable discussion on it and I perhaps don't support this process as strongly as you do in using it to prioritize our work.

Carl, you've said, be candid, express your concerns, and so I'm going to take you up on that, all right?

MR. GERTZ: All the time, Larry.

MR. HAYES: Would you go back to your slide, Russ, where you show the top 20?

DR. DYER: Okay. Top 20 for--

MR. HAYES: Yeah, here are the top 20 studies.

DR. DYER: Well, which top 20? The aggregated top 20, or this top 20?

MR. HAYES: I'm sorry, that one right there, okay? That'll give me what I need to talk from.

I guess, first, I'm not in total agreement on some of the studies that you have identified as not being supported from the ESF. Stratigraphic units, for example, we're going to get a tremendous amount of information from the ESF to help us better define stratigraphic units. That's a minor point. Some of those things I would say I probably would have colored it in one way or the other, okay?

I think my real concern is, does this give you a baseline to work from? I totally accept that, but it's only a start. I don't believe it can be applied rigorously. Some of the things Don mentioned, Don Langmuir, are my concerns. This doesn't look at the study dependency, and it's even more than that. It's how we do business. There may not be a technical need for dependency, per se, but perhaps there is a need for the way we do business that people will work on one or two or three different studies and it's more cost-effective to have those people working on different studies rather than saying, you're only going to do this one study, because these studies often overlap and what they learn in one they can apply to another, and we can maximize the use of our people.

We can't always do what we plan to do when we plan to do it because of permitting requirements, whatever, so if these people have an opportunity to move back and forth, they're not sitting on their thumbs. That's one problem.

You look at that list. The tectonics program is not there. So again, I go back to what Don said, we simply can't ignore that the public has a great concern about earthquakes and their potential to make the repository unacceptable. Carl and I have had discussions on that, Russ and I have, and I think we're coming to agreement on that the tectonics program can't be dropped simply because this process didn't identify tectonics study plans on the top 20 list. So again I say, you can't use it rigorously. There are other factors that this process did not take into consideration, such as earthquakes occurring and that sort of thing.

And those political forces that drive you, Carl. It's like you said earlier, you can't win. Whatever you do, something else is going to happen or somebody else is going to want something else. So flexibility--and I see you as the manager starting with this, and Russ technically can defend it to you, but then you've got to make other kinds of decisions that were not included in that process.

This process also represents a limited part of the scientific community. It was a work group that had a lot of talented people. The Survey had a representative on that group, Bill Dudley. But Bill Dudley is adamantly opposed to using this process to identify priority work. He does not believe that's what the process was designed for.

So, in summary, I guess, I can see it as a base to start from, Russ, and it does give you something to hang your hat on, so to speak, but, in my view, it's only a start.

DR. ALLEN: Incidently, I made the statement earlier we were going to take both talks before we got into discussion. We're already into the discussion, so let's continue it, but I want to, at some later time, cut this off and make sure that Bill Simecka can get up here to give his presentation.

DR. NORTH: I'd like to say a few words on this; first, to endorse the philosophy. I think it's a wonderful idea to go through this kind of exercise to try to get a sense of the importance of the tests and have a system that one can use for explaining changes in the strategy of how to conduct the testing. But I must say, I share the reservations that Larry Hayes has just expressed because when I get into the numbers, I don't feel that I understand it yet, and it seems rather limited.

I am particularly concerned about the lack of a sense of timing. What is the criticality of the information at different points of time? You haven't included on your list of criteria support for repository design. This morning we talked about organics. A little later in the day, we saw a profusion of diesel equipment in the planning. Well, it strikes me that what comes out of that as an insight is that it's very important for us to understand whether minimizing organics underground is a major issue in the performance assessment that might compromise waste isolation. Before we commit to a strategy to the ESF that will use a lot of diesel, we'd better have an answer to that. And I don't see that coming out of this exercise, and it seems to me it ought to be a top priority in terms of identifying what kind of testing and analysis is needed in the near term. When do you need to know the information, and what are its impacts?

The issue of public acceptability seems to go into scientific confidence. If I can look at your numbers here, I notice that faulting near facilities, natural resources, and volcanic features all have zeroes in the detect unsuitability conditions, and zero or very small in the regulatory compliance, and maximum scores under scientific confidence. Maybe that's an interesting insight, and maybe it suggests that those issues should be dealt with in a somewhat different way. But I think I would agree with Larry's point that this is only a start. You have to take it deeper and have a strategy for how one is going to deal with those issues, perhaps something along the lines of for that kind of an issue, you want to emphasize workshops and interaction with the public, as opposed to being in a data gathering mode.

DR. DYER: That could be a very legitimate way to approach that.

DR. NORTH: It seems to me that the most valuable aspect of this exercise, given the budget constraints that the program is facing, is what can we defer or drop without major damage to the future of the program? And it may be there are some obvious candidates that come out of this exercise, such that we can, in fact, make a major change in the thinking from the site characterization plan that we aren't going to do all the same things in the same order as when that plan was originally developed several years back when we were thinking of shafts instead of ramps, and various other current thinking in the program simply wasn't there.

So I hope what we are going to get on this reasonably soon is a digestion of the numerology, what the insights and impacts are out of it along the lines of where do we want to go further. I would really be concerned about taking the numbers as they exist on these tables and pretending they're a basis for a decision. But it seems to me if the people who participated in the decision could produce a good summary of what did we learn from this and what are its impacts for the program, that might be extraordinarily valuable.

DR. DYER: Let me address a couple of your comments.

There is, at least implicitly, a timeliness consideration in here, because we asked the Panel to look at what things were most important to be done in the next several years, if we needed to acquire data in a near-term one or two-year time frame.

There are, admittedly, quite a few shortcomings with any kind of stringent system like this. As Larry points out, we've experienced quite a few of them already so far this year in trying to apply this. There are some things that we know needed to be done that just didn't bubble to the top.

One other, I guess I'll call it a reservation I have, is that, so far, this has been internal to the project, and I think a very valid criticism is that we have the same people producing--pretty much looking at our program again internally and we're getting answers that are not a surprise to us. So we need a sanity check on this, and we're looking at a couple of different avenues to get a sanity check on the results that have come out sometime this year.

DR. ALLEN: Other comments or questions, particularly those of you at the front table here, who presumably are here because of thoughts on some of these problems. Yeah, Scott?

MR. SINNOCK: I may make one comment and I can put something up. I think I can talk pretty loud. I just want to make some general observations. I don't want to spend much time, but I think we've now, internally, as Tom puts it, we've asked the same 15 people five times now what they think the value of information is, and just some observations.

I think, to me, what's interesting is we're consistently coming up with the same answer. That answer is a little bit surprising and somewhat hard to buy, maybe, but it seems there are two basic reasons for testing. One I'll call a requirements flow down, call this site unsuitability, site suitability, licensing. You have a requirement, you allocate your objectives or your performance to various system elements, and you evaluate how information can help you achieve that objective.

I think what's surprising, if you'll notice the numbers on the site suitabilities, they are very, very low. We're consistently coming up with the answer that our current models, our current understanding tells us that the site is suitable and that the uncertainty that we have remaining is not very amenable to reduction by testing in terms of strict compliance with the regulations or the requirements. That's consistently come out of about four or five studies now.

This, though, comes to an answer; do we have enough? It's sort of a yes, which is totally in opposition to the intuitive answer that comes out of what I'll call the outreach, the sociopolitical, and I'll put scientific confidence in that as well. It's the feelings of people that we understand things well enough, we can proceed. Scientific confidence, public perception, one of the studies did something on program viability. I think this is consistently coming up with the answer, we did not understand it well enough.

These two are contradictory, I think, answers to the problem. And I think we have to very clear not to try to ask this column to address the concerns that are coming out of this column. And I'd just like to put that up maybe for discussion, without giving my necessarily personal biases as to how this resolves.

MR. HAYES: If I could just reply to something Scott said. This consistency bothers me, Scott. I'm not surprised we have consistency. We're essentially just reworking the same set of data, all right? So it should be consistent. We can be consistently wrong if we don't obtain new data.

I think we're in a little bit of a circular-type reasoning when we keep saying these work groups show that we know that the site is suitable and additional data will show us very little. I simply can't buy into that, because I don't think we have sufficient new data that might or might not impact those kind of analyses.

DR. NORTH: I think Scott's--Warner North. I think Scott's dichotomy there is a very interesting one, and I think it would be very useful to explore it further in terms of specifically, what are the implications of being on each side of it? It may be, on the left hand, the systems engineering side, what we would like to know, the uncertainties or the unknown structures that we might find out either by surface-based testing or by underground exploration can be characterized fairly simply. We don't need the details of 104 study plans. We need the answers to some questions that perhaps are hard to phrase exactly, but essentially go to the insights of people who have worried about underground structures and the safety of mining or hydroelectric projects. They have insights as to what can possibly go wrong down there, and my understanding of my colleagues on the Nuclear Waste Technical Review Board is that there is a lot of value intuitively from getting down there and looking around. The answers are what you see; they are not so much in the details of sophisticated instrumentation on the 104 study plans.

Well, that tends to take you in the direction of you want to go down there as quickly as possible and look around, which is what I think our Board has tried to say in several of its previous reports. Given that you're down there and looking around, it would also be good to do the studies that you can do quickly and easily with instruments once you're there.

But then there is another level of going into extremely costly and time-consuming detailed studies there which may take a number of years and special equipment, and I think it's a valid question to ask, "Is that critical?" and do we need to describe the program in able to be able to do it and to be able to do it on some time line? If it turns out that coupled process heater experiments are really critical, then maybe you need to get down there and start those first. And if you can't do it fast enough, maybe you need to go to Busted Butte.

What frustrates me a little bit is I see us talking around these kinds of questions and not laying out a analytical structure that will help us to come to an answer: "Yes, we ought to start that early or go somewhere else"; or, "No, we think the potential value of that information in showing that the site may not be suitable simply doesn't justify the cost of that experiment." It would be much better to spend the money to get underground and look around.

But it seems to me that what is most important is to sort out, as quickly as you can, even if it's a crude sort, what information do you need for what purposes? And I like Scott's slide from the point of view of sorting the information into, we think there may be a technical problem and we need data or an opportunity to examine to characterize that, versus situations where we think the scientific community and the public doesn't understand it very well and what we ought to be doing is engaging them in dialogue to find out whether it's their lack of understanding, or maybe our lack of understanding about what they're concerned about, and get on with having that dialogue, as opposed to spending our money drilling holes or making drifts which will not address those concerns and may defer the time at which those concerns really will be dealt with.

DR. ALLEN: I was intrigued, Scott, at the fact that building scientific confidence and building constituent confidence were both on the right-hand side of the table; both under sociopolitical kinds of things, and that sort of intrigues me because, in my own experience, talking to many of my scientific colleagues who are not involved in this project and are not engineeringly oriented, they often say, you know, how can you idiots be planning this thing there without understanding everything there is to know about southern Nevada, and so forth. I retort by saying, well, what difference does it make? And they say, well, it's just --they "don't know, but it's my gut feeling". And to some degree, the scientific community and the public share this sort of feeling that they'd like to have a better understanding, even though they can't quite defend why that is really so.

It's not quite clear to me, for example, why having a tectonic model of that site is going to make any difference at all in the actual hazard that we have to design for, or that we'll ever agree on a tectonic model, anyway. But, nevertheless, certainly there is a strong feeling in the scientific community that somehow they should be sharing in these billions of dollars that are being spent and that we should be understanding more about southern Nevada. So it is intriguing to me that both of those are on the right-hand side of your diagram.

DR. YOUNKER: Jean Younker. I just wanted to make a couple of comments.

I think from the standpoint of stepping back and looking at the results, like Warner suggested we might do, one of the things that I suspect is that the relative values that you see in the unsuitability column, the regulatory compliance column, and the scientific confidence column are kind of telling you just kind of a theme that's been going around the room, which is probability assessed by these experts and, as Larry said, you know, we're working with the same data base so that I would kind of say to Larry, you know, we've asked these people to bring in any information they have from other sites that are similar and stretch the information as far as you can in terms of what you might finally find out about the site. We keep getting the same answer, it's true, the probability of the site being unsuitable, given that set of unsuitability conditions we have assessed, always turns out pretty low.

Probability, or the value of information to demonstrate regulatory compliance in the way that we assessed it in this study--and in a couple of others--comes out to be low relative to that scientific confidence criterion. I think what that's telling you is that, the same thing Warner was getting at, getting down underground and seeing that the site's about like we think it is, that the conditions and the processes are just about what we think they are, I suspect, is what's driving those high values in the third column. So, as an insight I'll offer, being on that team, I think that's really what probably drove that outcome.

MR. DANKO: George Danko, Mackey School of Mines. I would like to ask a question to Russ about this design information criteria, which didn't include any other complete evaluation. That became a hidden agenda I hear. You will need design information in order to design a conceptual repository for the licensing purpose. So you will need it, and that goes back to Larry's comment that there can be many tests integrated, so it can be done during the evaluation of the other three agendas. So why did you leave it out?

DR. DYER: Absolutely no argument. We had a limited time. When we put this program together, we didn't think we were going to be on an accelerated ESF schedule. I gave a charter to this group based on what I thought we would be doing about a year from whenever we started this, and the program has changed considerably since we started on this effort. That's why we have to go back and revisit this effort to bring some other parts of the model into the overall model.

MR. ROBERTSON: Let's get back a bit to your comments, Warner, and those of Scott, because basically, there seems to me to be several key questions that evolve in that chart.

The left-hand side is a typical Aristotelian-type problem, which us scientists and engineers think we know how to solve, and we therefore put numerics to them with a great degree of precision, if not accuracy.

The right-hand side of the column, however, even if you put the scientific consensus in that column, is a true non-Aristotelian, non-modelable general problem because it involves human beings and their perceptions.

It seems to me that we could really use help, somehow or another, in formulating an algorithm or a model of some kind against which to test that. I had, about nine months ago, about 12 of my senior staff together for a full day off-site, the purpose of which was to see if we could develop a public acceptability model. Now, the public was everybody from you people here, as the TRB, to the NRC, to John and Josie Six-Pack, all the way through that level of sophistication because it is non-homogeneous. We despaired at that.

There was such a diversity of opinions in an attempt to try to capture that in some kind of a fashion in order to use that as a criteria that was reasonable, other than the individual biases of the collective group of people that you ultimately dealt with.

Our conclusion, ultimately, was that the single surrogate for all those entities that we're dealing with is the NRC. Ultimately, if the NRC licenses this, that is the surrogate for public acceptability of this process. It's the legal surrogacy of that. But I still despair as to how to utilize what you're talking about in a structured manner to give us a framework against which to look at that, because those are clearly dominating the left-hand side.

And you're absolutely right. What you're talking about is the way you feel right here about what you may see. You're not talking about running the numbers out to eight decimal places, and we have difficulty closing on that. And I believe a workshop of some kind, with the right structure of people--certainly, you and other people, perhaps with the National Academy of Sciences--would, focused on this, be very valuable.

DR. NORTH: Let me respond to those intriguing suggestions.

First of all, I think you may have it backwards with respect to the NRC being the surrogate. My sense is that if the general public has serious concerns and the scientific community has serious concerns, I really doubt that the NRC is going to license the facility even if the technical story looked at up close seems excellent. I just am too much of a skeptic about the intrusion of politics into science to believe that it's going to be as simple as all you have to do is convince a small group of people in the NRC that you're right.

MR. ROBERTSON: No, I agree with you entirely. As a matter of fact, that was my exact point. I'm supporting your thesis, which is that we are not going to convince the NRC that this repository is safe by demonstrating that every one of those little radionuclides are captured by some little creature that's sitting down there in those clays. Why? Because John Q. Public cannot fathom that. He understands concrete and steel and things that he can deal with. And I believe that, ultimately, the NRC, as a surrogate for the public, recognizing that they're reflecting, in general, the public's, how they feel is, in fact, what you're going to have to be dealing with. I'm still trying to get that analog of how to calibrate that.

DR. ALLEN: Let's not leave the NRC out of this discussion. Ron?

MR. BALLARD: I would like to add a caution or two on your security in talking about the NRC licensing process. I remind you of Shoreham, which is technically a beautiful facility that is gone. And it takes more than just satisfying the NRC technical staff. And I could give you another example; Calvert Cliffs. If you ever go through the Calvert Cliffs Plant, east coast plant, it's built to Diablo Canyon standards. It's got an enormous superstructure in there, things that the technical community never would have put in, but it was a decision they had to make based on public perception. And I believe we had support in the concern of scientists, even, involved about tectonic problems and all; in other words, the soft sciences. I think you really do need to get those issues up front on your priority scheme, or find some variable that'll recognize those kinds of concerns, because they are very real and the nation's covered with examples of how important they can be.

MR. HAYES: Robby, I think you really put your finger on what I feel is the gut issue, and that's the ability of the scientists, and the public community to interact and to feel confident. And Carl, I think your outreach program is giving us the avenue to do that.

But it goes back to what you said, too, Clarence. These other scientists, they're talking to our scientists. And it's not--may be easy to quantify, but until they can talk to each other and say, yeah, we agree, you know what you're doing, we see where you're at, I don't think we're going to have that confidence, Carl, that you feel we have to have, and I agree with you, to sell it to the public.

MR. GERTZ: Well, I think the NRC process provides an opportunity with the public here and some public inputs, but that alone is not enough, a la Shoreham and those kind of things, because they passed all the NRC hoops and it was just a public policy question not to operate that particular power plant.

We certainly are going to have the same challenges, and the challenge I have in setting priorities is how much do we divert away from ESF, away from surface-based testing to working with the public? We're very successful when we have an opportunity to talk to the public face-to-face. We have had 5,000 take the tour; 4,000 people filled out questionnaires, having talked to the scientists, having seeing the mountain. Eighty-nine per cent of those people support the studies of Yucca Mountain, but can I get all one million population in Nevada out to the site? Probably not. Is that a sampling survey? No, it's self-selected. They call up and ask to go on the tour. But that's an attempt and we're trying to, of course, meet the public's needs, we're trying to meet the scientific community's needs, and we're to get underground and meet Congress's needs. There's lots of challenges and it will be awhile before we can get them all addressed.

DR. NORTH: To come back and respond to Carl and Robby again, there is a community within the Society of Risk

Analysis--and I'll call it associated interests in the social sciences--that are very hard at work investigating how does the public perceive risk? What models are in the public mind when they think about issues like radon in their basement, should they go have the tests run to find out how much they have?

Now, most of the technical people think that that's a fairly serious category of risk, and yet most people pay little attention to it. At the same time, they may be very concerned about cancer risk from a small amount of radioactivity or some synthetic chemical that's present at barely detectible levels in their food.

Well, why does this happen? What are these people concerned about? How do they think? There is now a good deal of research going on at Carnegie-Mellon University and other places where they are out in focus groups interviewing people, trying to understand how do they think about these issues, and therefore, if you want to inform them and educate them, where do you start? What images communicate to them? What are the basic conceptual tools that they bring to these problems? They are not, in many cases, people with a substantial amount of technical training, but they're used to forming opinions, and yesterday a lot of them voted, and you'd like to understand why.

So it would seem to be a very useful thing to do to find some roots into that literature and understand the methods of these people and explore what might be done, maybe not under the auspices of the program directly, but through research that might be carried on by other parties, or perhaps, just in terms of reframing some of the outreach and communications that you already have to make it more effective.

MR. GERTZ: Certainly, I'll get with you to get some names, because I think that's a very fertile field.

DR. ALLEN: I wonder if this might be an appropriate time to go on to Bill Simecka here. We can come back to any of these discussions, but I want to make sure you get your chance here on why an alternative testing facility.

DR. SIMECKA: Okay. There's two aspects I would like to present today, and, of course, the reason for this Busted Butte facility starting an early heater test, as well as do some Calico Hills investigation. And so the testing aspects of why Busted Butte, Russ Dyer will talk about that.

Bruce Stanley has--I think you noted that you wanted to lay out scheduled costs. He has information on what we had done when we looked at that Busted Butte facility, but Russ will do the testing first.

DR. DYER: I'm back again. My name hasn't changed.

What we're going to look at in this particular segment of the presentation is a prototype facility, what are, essentially, the benefits and the downside of a prototype testing facility, and we've subtitled this, "Or, Why Busted Butte?" Busted Butte is not the only locality we looked at. We, oh, I guess about six months ago, looked at Busted Butte in some degree of detail because it looked like it might provide us an avenue for making some significant progress on the program.

There are a multitude of reasons, some of which Tom Blejwas brought up earlier, which suggest a benefit to an off-block testing facility or a prototype facility.

We talked about the potential for such a facility in the SCP, and identified that it's desirable for some kind of testing to be conducted off the block. It may be testing that you wish to take to extremes, essentially run a test until you break the rock, if you will; something that you can take, a test that you can undertake without having to worry about potential impacts on waste isolation capabilities within the footprint of a potential repository; something that you could scale up a test or scale down a test, as you wished, without having to worry about interference of other surrounding tests.

Schedule concerns. Recently, whenever we were looking at an ESF that was some years down the road, whenever we looked at the schedule, the information feeds for some of the test results where it was talking about some of the long-term testing, we realized that we needed to, if we were not able to get an underground facility in place on a certain schedule, that some of our information needs were not going to match up, mostly with some of the long-term coupled process-type tests, the thermal testing and some of the waste package environment-type tests. And this led to a reconsideration of an alternative testing facility.

The rationale is that it would give us a longer time to develop models, and we would develop a longer history of actually observations through a testing program.

There are three main categories of benefits that accrue to an off-block test prototype facility; modeling, developmental or prototyping benefits, and schedule benefits, and I'm going to go through each of those in a little bit of detail. There's a handout, I think, in the back of the room for this particular talk. We ran out of them a little earlier, didn't realize it was going to be quite so popular, and I believe there are more that have been put in the back of the room.

Modeling benefits. Well, this would give you essentially two separate facilities, one of which you could develop the model in and do some of the model validation testing independent of the actual test locality within the block.

There is a perceived need for perhaps some aggressive in situ testing. Put a lot of water in the Calico Hills; see what happens. Put a lot of water in fractures; sees what happens. Heat things up. Look and see what happens whenever you start boiling water off. How do the minerals change? Some of this things may be large scale, long-term tests.

Some of the development testing could well take place off block. And this would provide us a separate facility from some of the confirmation and validation testing in the ESF.

Benefits from the perspective of developmental or prototyping. I think every experimentalist I have ever met in my life would like to have the luxury of fielding their tests somewhere, getting all the bugs out of the equipment, the procedures, before they go in and do the tests for real. And that's certainly one, I won't say it is non-quantifiable, but it's something hard to put a value on. That's a very valid reason for putting in place some kind of a prototyping facility.

For some of our tests that are relatively unique, cutting edge, state of the art-type tests, this becomes particularly important. It provides, as I said, some time to try out the test instrumentation, make sure that you're not getting interference in the leads to the oscilloscope from the overhead lighting system, or whatever. As you know, Murphy lives in experimental facilities.

It provides us a way to try to optimize some of the testing schemes and equipment, and try out the instrumentation. And one other potential benefit is that it's a facility where you can try out different construction/ excavation techniques, again, in an area where you're not as concerned about making fatal flaws, doing something that will essentially bring about the termination or induce a fatal flaw in a potential future repository.

DR. ALLEN: But it would still be under intense QA monitoring?

DR. DYER: Yeah. You could do it in different degrees. The Busted Butte facility that we had thought about, we were just going to do the construction, basic construction, but run all of the tests under the QA program. But we would not provide all of the aspects of design control to the development of a design in the actual construction.

There are some very real schedule benefits that could accrue to such an off-block facility. You could get an early start to some of the more complex processes or tests. Right now, the coupled process test, the heater test, long-term, slow response tests that we need to try to get underway as soon as we can. If we could get a two, three, four-year head start on fielding this test in an off-block facility, certainly, this would be something positive that would accrue to such a facility.

We looked at several places, X-Tunnel, some of the N-Tunnel, going back to G-Tunnel, looked at Fran Ridge facility. We looked at Busted Butte. Busted Butte was intriguing because it would give us a facility relatively close to the Yucca Mountain area where we had rocks very similar to what occurs at Yucca Mountain, not exactly the same, but very similar, and it can provide early access to the Calico Hills. We could essentially put a test in place in at least a stratigraphic variant of the Calico Hills, probably years before we could get something in place down within the Calico Hills as part of the ESF. This would give us considerably more data that we could compare with a longer testing history, that we could compare with both the surface-based information that we acquire, and also, the ESF test that we will eventually put in place.

One thing that I mentioned just a moment ago is that if you don't have to concern yourself with going through a very stringent design control process for developing how you're going to make this hole in the mountain, you can cut an enormous amount of time off of the development of this facility. You can minimize some of the potential testing delays that you may get in the ESF by figuring out how to work things smarter in such a prototype facility again. That's one of the big driving reasons for having a prototype facility, and flexibility would be another positive attribute of such a facility.

What's the status? Well, it's a good idea. I think everybody would agree it's conceptually appealing. However, if we were to pursue such an option, it's going to cut into the very limited resources that we have and would probably delay the start-up of an ESF. Right now, the programmatic direction is to go forward with an ESF.

Part of the rationale, or part of the reason that made a prototype facility attractive about eight-ten months ago was our understanding that ESF would be some years off. The acceleration of the ESF program decreases some of the schedule-driven benefits that such an alternative testing facility would give us; not all of them, but some of them.

So right now, our current, I guess I could say our programmatic stance is that a prototype facility is not in the plan for '93, but we have the idea. It's on the shelf, and it's a option that we could modify or break out in the future.

And at that point, I think we're ready to go--are there any questions about my presentation? This is just essentially the testing basis for such a prototype facility. I think somebody's going to talk about--

DR. LANGMUIR: Russ; Langmuir. Just a question. You closed off a number of tunnels in the past like G-Tunnel. Is it possible to get back in a place like that and do at least a few of these things, like the heater tests, without the kind of costs we're talking about in opening up a totally new facility?

MR. GERTZ: Russ, I can answer that.

DR. DYER: Okay.

MR. GERTZ: What it comes back to is a lot of programmatic decisions on costs. We shared G-Tunnel with the test program. They're no longer doing tests, so I'd have to pick up $5 million worth of the entire housekeeping costs or the hotel costs. In addition to that, the ventilation system was marginal at best and was probably having to be shut down, so we'd have to upgrade a ventilation system for two or three million dollars, and as a result, I asked the team, let's not go 40 miles away into G-Tunnel. If we're going to spend that kind of money, let's look for something a little closer that will be directly applicable and we could use.

MR. HAYES: Clarence, do you want to take comments on Russ's presentation now, or do we have a time problem?

DR. ALLEN: No, no. We have no time problems. Go ahead.

MR. HAYES: I've got a few comments, then, and I'm speaking for the Survey and its tests and how maybe we feel about a Busted Butte or some other alternative facility, and we don't have total agreement within the Survey. Some of the scientists say they really believe an alternative prototype facility would help, and others say no, they don't need it. I know there are other parts of the program, the heater tests, that may be really needing it.

Carl, maybe I have heard you too often say perception is everything, and I'm concerned about the perception of a big prototype facility. We've been doing prototype testing for a number of years. I'm concerned a lot of people will say, it's time to really do your real work. So I think there is a concern, spending limited money on a prototype facility and why aren't you really doing real work?

MR. GERTZ: Certainly, I think you're all aware, this is not in our '93 plan right now. It may or may not be in the '94 plan, or whatever, but it's not part of our '93 plan. And Larry brings up a point, and it was an element of discussion in the last meeting with you all when we were talking about UZ-16. There were some scientists who said we should not work at UZ-16, we should do one more prototype hole with that equipment somewhere on Yucca Mountain before we go do a real site hole. Well, we're at 960 feet, and we're not moving quite as fast as we'd like to, but I think we've gathered a lot of valuable data at UZ-16, so you have to weigh the checks and balances of prototypes versus getting on with real work.

MR. HAYES: That's right, and that leads into my second point, getting data where we want data from. And I am not looking forward to having to defend that what we do at a Busted Butte-type facility, particularly in the Calico Hills, is exactly what we'd find in the Calico Hills underneath a potential repository.

DR. DOMENICO: Domenico, Board. I was going to ask--and NRC is here, of course, they won't comment on this, but you're talking about the transfer of information, quantitative information, design information from Busted Butte, if this goes through, to Yucca Mountain. And that transfer may not be acceptable to some people, even though--I'm following exactly what Larry says--even though, presumably, they're the same kind of rocks.

MR. HAYES: And I think there is some difference of opinion exactly how different the rocks may be and what that significance is, I don't know. But you're right, I agree with that concern.

DR. ALLEN: Tom?

MR. BLEJWAS: I have, perhaps, a slightly different view. When I look at Canadians, they have an underground research lab. I look at the Swedes, they're constructing a new underground research facility. This is their second one. I look at the Swiss, they've got their Grimsel facility. The Germans are underground in a salt mine, and so on, and the program in the world that has probably the, well, certainly the largest budget, can't afford an underground research facility. I find that kind of ironic.

We did do some work in G-Tunnel. When G-Tunnel was shut, we had some experiments that were very close to being ready to turn on the switches, to start up the heaters, and those tests, we were hoping to find out whether or not those tests would work. We're not going to have a chance to do that. Instead, we're going to do them underground in Yucca Mountain. So we're in a situation where what we're doing in Yucca Mountain, then, is we are conducting a test for the first time. We have job packages, test planning packages, a QA system that will cost hundreds of thousands of dollars just to field one of these tests, because we have to follow all this quality assurance program. Well, and it's not the quality assurance program, it's everything we put into the program. Quality assurance, in itself, isn't bad.

But I would suggest what we're doing here is we're assuring bad quality. It may be quality assurance, but we're assuring that we're going to fail, at least in some of our tests underground, because we're trying tests for the first time. And I think that as long as we can stand that risk, then going along without doing that is all right. But if we're aiming for a 2001 license application at all costs, without any chance for failure, then I think that we're being naive at best.

DR. CANTLON: John Cantlon. Yes, since it's not in the '93 budget, how many years can you defer it before it's a non-contributing element in the process?

DR. ALLEN: But Tom, couldn't you argue that these other countries are the ones that are making the mistake, not us? They're putting all these labs in that are not in the site of their repository, and when they try to license their repositories, they're going to be doing the same thing all over again underneath the repository. And maybe we're making the right decision by trying to get underground and doing it there.

MR. GERTZ: Let's make the other thing clear, that none of them are looking to dispose of waste in 2010; they're 2020, 2040, 2050. So they have a different program based on different goals. And that's appropriate, but I think it's unfair to compare their program against ours, where our mandate from the Congress is to find an answer to the disposal problem and find it soon. Don't do research forever. Congress didn't tell us to do that. They said, solve the problem and solve it soon.

MR. HAYES: In fact, Carl, I think some of those groups are ignoring some of the really hard political questions or fallout that you're now facing.

MR. GERTZ: They have not put an X on the map. When France tried it, it was very unsuccessful for them, even as popular as nuclear power is in their country.

DR. CANTLON: I'd like somebody to take a crack at answering my question. How many years can you delay getting underground in a prototype or test facility before it's a non-contributor?

MR. GERTZ: Russ, do you want to take a shot, and then I'll take a shot, from a scientific point of view, or--

DR. DYER: Gosh...

MR. GERTZ: I guess I'll go first while Russ is thinking, and then he can correct me or whatever.

But to me, there may be some value of it even if it's two or three or four years down the road. If we can be as successful as we hope to be about getting to the Topopah Springs and starting a heater test, that driver kind of is removed. However, there still may be some value for being off the block and doing experiments that actually damage rock or over-driving it, and I'd have to weigh that. But certainly, after three years or so, it becomes a little less desirable.

The other aspect, though, there may be a very real desire for public acceptance, to bring people into a facility. We're not going to be able to run 5,000, or 400 people on a Saturday into the ESF. That's just not going to happen. So do we need a similar facility where we could show them, this is what it's like over the hill and will that increase public acceptance? I don't know. That may be worth it, in itself, whenever we could get that started. So those are answers that I don't have right now, but as we put it off, it becomes less and less viable for some reasons. It still may have other viable reasons.

DR. STATTON: I think I'd like to sort of also get back to answering a question that got asked earlier, which is what do you do with the data?

The value of an off-block facility is twofold. Number one, we're describing natural processes, induced or otherwise, numerically. And what we're trying to do is develop a model that describes a behavior in nature. Now, we can't develop the model and validate the model with the same test. So, clearly, those need to be independent.

In developing a model that describes a process, I think that doesn't have to be done, for example, precisely where one wants to apply that process. Clearly, that's not true in erosional processes; it's not true in groundwater flow processes. Deriving a process, describing a process can be done elsewhere, transferred to the locale we're interested in, and validated through testing at the site.

That's where I think Carl's right. Within the next two or three years, there is still room for us to do some rather aggressive testing. In the process of developing models, we might want to consider some limit analyses, you know, whether it's driving rock to failure in terms of its thermal load, whether it's inducing conditions that are limiting conditions, like flooding thermally-loaded rock or inducing some other type of change like that. Those are things we probably won't have the luxury of doing in the mountain itself, and yet, we're still defining the limits of some model and then validating it through testing in the mountain under a more conventional scheme.

DR. ALLEN: Dale, you wanted to say something.

MR. WILDER: Yeah, I wanted to respond a little bit, in perhaps a different view than what Larry has, as to the usefulness of an off-site facility, and I think Tom has touched on that.

One of the things that we have to be prepared to answer is the physics or our understanding correct when we go to licensing. And one of the real issues that we deal with is the scale of the tests that we're performing. Now, it is a decision, it's almost a management decision as to how much risk we're willing to live with at the time we go to licensing, and we may very well decide that it is a risk that we can accept; that if we get underground at ESF and we find out things are at the wrong scale, that we redo those tests and there's a slip in the process.

But I don't think that you have to have the identical location in order to look at those issues of scale.

And so, I don't think we have to defend the data from an off-site location as being representative necessarily of ESF. I see the ESF facility as where we really do the validation and the site characterization of the facility itself, not necessarily the physical models, and so I think that there's a little difference there.

The other issue which we have, and it came up this morning, if you look at the schedule which is proposed for ESF construction, it shows that we start thermal testing in '96. The only way that we can get data in time for license application under that kind of schedule is to go with a very abbreviated test, and even there, laying out my test schedule, we will not have had time to analyze the geochemical changes from post-test coring. We've got to have the ability somewhere to justify the use of those abbreviated tests in order to go to a license.

Now, we are currently looking at some other work-arounds, and one of the work-arounds is to go to an Alcove 8 and ESF, or to try to do some other things. But I think that it's very critical that we recognize that there are some necessary planning and some necessary justification of the approach that will be used in the ESF before you go to that license application.

DR. ALLEN: Tom, you've been waiting very patiently.

DR. BUSCHECK: Tom Buscheck, Lawrence Livermore. I think everyone here would agree that over the past several years there's been quite an evolution in kind of understanding what will be driving the hydrological system. Several years ago, it was assumed that it would be the ambient--essentially, a pre-emplacement isothermal system was of predominant concern, and I think most of the planning for site characterization was based on those assumptions. And I think people now recognize a very potentially dominant role of heat in how the hydrology is driven.

And we've even been finding recently that in the saturated zone, ten kilometers from the center of the repository, 50,000 years after emplacement, flow in the unsaturated zone is dominated by heat.

So I think that, you know, these are conceptual models that are being developed, based on our existing models, but I think it's critical that we have the opportunity to get underground as soon as possible, so that we can begin validating those models physically. Because if what we've been finding is relevant, we may very well find that it would be critical to maybe restructure some of our ongoing site characterization efforts in light of the importance of heat in driving fluid flow. If we wait for that to occur until after a lot of the data acquisition has occurred, we may find that we have lost the opportunity to gather very critical information and understand how the thermally-driven hydrothermal system responds.

We've been finding that it may take several hundred thousand years for the system to restore itself back to being dominated by the ambient hydrologic system. That was certainly not at all recognized when the original characterization planning was in place, so I agree with Tom Statton. We need to be validating our basic models, not after the fact, finding that we needed some information in the real site itself. So I think it's critical that we validate that the processes we think may be very important are, indeed, relevant to how we characterize and analyze the site.

DR. CORDING: Dale, one question. What date did you say that you anticipated with this current schedule of being able to start a heater test in the ESF?

MR. WILDER: Well, the figure that was shown this morning shows start thermal testing, 4/1/96, and we have a duration--I don't want to get into a lot of details here, but basically, that allows us to have finished the thermal cycle on our test, and to have completed the coring prior to the year 2000, which is the current date for freezing all data for the performance assessment that goes in license application.

MR. GERTZ: Ed, as you see in that chart, that's just one month after we use the breakout, and it gives us two accesses and that's what is driving it. If we can figure out another way to get around the MSHA, OSHA double access requirements, we could even start thermal tests maybe a year or a year and a half before that. So it's part of our access requirements that's delaying that in our current schedule. And these are some of the things we're looking at on this loop approach. Are there other ways? We want to get the loop down, as people have talked about. Let's see what's there, see how it looks, but we also want to start tests as soon as we can, and we're trying to figure out some of those ways.

DR. DOMENICO: Carl, isn't it reasonable to assume there's going to be a schedule slippage? I know you don't plan on that, but I mean, we talked about the need for three more big rigs out there to keep the surface-based program going, and with the history of funding the way it's been, there possibly is going to be slippage, and then we have to ask whether or not this facility is necessary, except for the points that you brought out, if those are necessary.

And the points that Tom brought out, as one more point, Penewa, the Canadian program, they have a facility only for one reason; to demonstrate that they could characterize the rock. They weren't interested in getting results and transferring them. They didn't know if they could characterize granitic rock, and that's why they put that facility in, and they're trying to characterize it as a repository. The technology will be transferred, not the data; the technology, basically. Three questions there.

MR. GERTZ: I'll respond to the schedule slippage. Certainly, on the schedule slip, if we don't get significant funds--and you all saw the funding profile I needed, last time with the TRB, is in the neighborhood of $600 million in '94--if we don't get that kind of funding, there will be a schedule slip. That's unequivocal to do the program that's laid out. We could have a different program, different standards as part of the national energy strategy may require a different program, but the current program, unless we receive some extensive '94 funding, we will be slipping.

DR. DOMENICO: But the point is that you are almost guaranteed funds to finish the ESF if you start in '93. That won't slip, if you stay with it. Everything else could slip.

MR. GERTZ: If we stay on the course, I would see funding appropriate to keep a balanced surface-based program, which is not an extensive one, but a balanced one, and finishing the ESF. I would not see anybody trying to stop it if we could stay on the course that we're on now.

DR. CORDING: Just before we go to other questions, could I ask just one more on this schedule? What is the schedule if you did develop a Busted Butte facility, how long would it take for you to have the start of a test? Say you can't start it this fiscal year, so assume that next fiscal year you made the decision to "go".

MR. GERTZ: Bruce has those schedules.

DR. CORDING: Oh, he's going to give that presentation? Max was also waiting for a response before we go to that.

DR. ALLEN: Why don't we let Max talk, and then we'll go to Bruce.

MR. BLANCHARD: Max Blanchard with the Department of Energy.

This is not a new debate. The idea of the prototype test facility has been around for four or five years, ever since we realized, as Carl mentioned, it was going to get real, real costly to continue to do tests in G-Tunnel.

At that time, we were also confronted with what I think was the lack of management tools to make informed decisions on where to spend our money: whether we have a budget that's going up and we try to prioritize it on the right things first, to put in what Warner was mentioning; put a factor of timing in here as well as importance; or whether we end up in a situation programmatically where, heaven help us, "When will we get the job done if the budget goes down?"

What is it we want to do in order to first decide whether or not that site is suitable? Because our first requirement, I think, to ourselves is to decide whether or not we've got a suitable site. And if we don't, we want to, as managers, engineers, and scientists, we want to be the ones that disqualify it, rather than end up having the licensing process and intervenors disqualify it using data that we've acquired right in front of us, but with models that we haven't yet developed.

So that's the very reason why we asked Russ to develop the ITE, and the ITE wasn't the first attempt to develop some sort of management trade-off tools to help make better informed decisions. We first tried, as you recall a few years ago, which we reported, the TPT, which was a test prioritization, but it didn't get as far in a meaningful way as Russ explained. He now has a spreadsheet with flexibility and he can set in a series of parameters, and if you don't like, you know, if one person, like either Carl or I or Russ, don't like the weighting factor on cost, we can go back through that spreadsheet, get the experts together and do it again, whether we use program experts, whether we use a third party group which is university staff or experienced engineers, or whether we use a group of people that come from the state. We could reassess that and look at the different views that are affecting this program.

But nevertheless, the previous briefing that Russ gave, which was the ITE, I think that is an attempt that we conceived two years ago or so to try to get this tool out on the table so we can use it. And to be sure, some people are a little frustrated, like maybe Larry and Warner would like to see more on that tool than we currently have, but it took two years to get it systematically developed in the way we did it and get the subject matter experts functioning, and to get a product out of it.

But now that it's working, deltas can be made to that in terms of criteria or entries. But that is the very essence of the tool, I think, that can be applied to trade-off, whether or not you want to spend quite a bit of money to start a test that's several miles from the site, that's in perhaps the same rocks, versus wait a little bit longer and start that same test in the right spot, where you already have three-dimensional knowledge and all subject matters in earth sciences focusing on the characteristics of that site.

Clearly, at least in my view, the synergism of folding the hydrology, geology, and seismology together at Yucca Mountain is far better, producing more useful interpretive results, than some sporadic tests set somewhere else where you have the transference of the data as a dilemma in the licensing process, combined with the absence of the synergistic effect from all the other disciplines working at the same spot at the same time.

DR. ALLEN: I want to get to Bruce here. Bruce, why don't you do your thing.

MR. STANLEY: Okay. This is just going to be a short presentation of what has transpired on one of the sites, the Busted Butte site, for one of these alternative areas.

Here we see an overall view of Yucca Mountain. You can see the boundary line of the proposed repository. Here is the north ramp, and here is the south ramp. Just to put things in perspective, I wanted to point out that Busted Butte was down over in this corner, over in here. It's just a little bit off of this view graph, and it's approximately three miles away from the south portal in that direction.

Now, to put this other in perspective again, the ESF, Yucca Mountain is in the direction down over in here.

DR. ALLEN: Which way is north, now?

MR. STANLEY: North is in the direction that I am pointing, basically. And before, that little corner of the road came around about in here.

The Busted Butte area was designed to go in fast, simple, with two accesses. One is from the north, and the other is from the east. There would be two ramps. One would be from the north at 2200 feet, at approximately a negative 3 per cent grade. The one from the east would come in 2350 feet, relatively flat, half a per cent grade. And then a test area would be constructed down at the end.

You have the opportunity in this test area to do an engineered barrier test. Also, while you are going through this ramp from the east, you'll have an opportunity to construct a radionuclide migration test. This is occurring in the welded tuffs. This is occurring in the Calico Hills formation.

Let me put up a cross-section, Cross-section A, which will take you down the north ramp; very simple cross-section. There isn't much, really, to see here other than that you're in the same formation all the way down to the bottom. And we gain significant cover here, also. Another thing of interest was that we were interested in seeing how much cover we could gain to simulate tests.

The real interest here comes in the east approach, and that is that Busted Butte is, in fact, busted, and has caused formations to displace. Here we would be conducting heater tests in the welded tuff, and here is an opportunity to conduct other tests in the Calico Hills-type formation a relatively small distance away in a flat orientation. So having passed over that faulted area, you have the opportunity of testing in both types of material.

By the way, we looked at the development of this area with both tunnel-boring machines and drill and blast. We decided to do a scenario on drill and blast. We also have the other scenarios available.

Very quickly, within the concept of the total budget, what this is just doing is breaking out engineering costs versus the total project cost. It's a little bit easier to see in a pie chart form than on this view graph. I think what you'd interested in here is the bottom line, which is the top line, $28 million, and then it breaks it down between surface facilities, north access, east access, subsurface excavations, and both design and construction costs.

MR. HAYES: And that doesn't include the cost of doing the testing once you have your facility; is that correct?

MR. STANLEY: That is correct.

We have capital equipment costs, construction, contingencies, and total. And as you can see, there is no category there for actually conducting the tests.

To approach, or to offer some more information on your question earlier, we did a schedule. The schedule showed that if we started engineering design at the first of this fiscal year, we could start testing at the first of March, 1995. Now, the schedule that was put up this morning said that testing would begin in the ESF, June of 1996.

MR. GERTZ: It's April, I think, is what it says.

MR. STANLEY: April? Okay. So this is the time frame advantage, if you will, of doing a prototype test facility over the ESF.

MR. GERTZ: When we originally did that study, of course--excuse me, Dale--we weren't looking at an accelerated

ESF, so we were looking to gain two years, maybe, on the test.

MR. WILDER: Just a point of clarification. There is a period of time for test installation on your schedule. It's not clear to me on the April, '96, if that is after the test has been installed, or if that's when we'd begin the installation.

MR. STANLEY: Oh, the April of '96, the original one.

MR. WILDER: Right. I presume that means that's when we have access to the main test level.

MR. STANLEY: The excavation of the main test area ended five months prior to the beginning of that test.

MR. WILDER: Okay, so we are comparing apples and apples.

MR. STANLEY: We are comparing apples and apples. I just looked that up before I stood up here so I could say that.

Since there are two tests in the Busted Butte area, the first test to be installed would be the first one that would be turned on and that's why there is this lag here.

But as was mentioned earlier, also, the purpose, some of the purpose of having such a facility is to conduct the long-term tests and the other tests in a similar type material to a Calico Hills-type material. The other advantages you would have with a separate facility such as this is to be able to repeat tests throughout this area, and to gain more confidence in your ability to do the testing; that if you did any destructive testing, you would not be destroying the mountain itself. You could prototype some construction techniques, if necessary, and public perception would be accounted for in developing this area, this portal area, being able to say to a bus load of people or visitors or interested individuals, to take a look over in that direction, three miles over you can see Yucca Mountain. That's where we're going in. Now, let's go underground in our test lab, and turn around and go underground.

DR. ALLEN: Do I understand that the Calico Hills that you would penetrate here, there is more uncertainty in its similarity to the Calico Hills at the site than there is in the Topopah Springs?

MR. STANLEY: I'm sorry, I didn't understand your question.

DR. ALLEN: Well, let's put it this way. The Topopah Springs here and the actual repository site are very similar. There is more uncertainty as to how similar the Calico Hills rocks are on the two sites. Is that right?

MR. STANLEY: That's correct. As a matter of fact, there is a great deal of uncertainty right now that we have in the type of Calico Hills rock from the north of the repository block to the south of the repository block.

MR. SPRINGER: Everett Springer from Los Alamos.

Mineralogically and geochemically, we've looked at rocks from Busted Butte over the past two years and they are very similar to the vitric Calico Hills from underneath the repository. We see fundamentally no difference from that particular unit.

Yes, there is a difference in the north end of the block and the south end of the block. In the north end of the block, you have zeolitic Calico Hills. As you move south, the vitric unit thickens up. So, yeah, there are some fundamental differences up there. But from our standpoint, in terms of doing transport testing in the Calico Hills of Busted Butte, we feel that it more than adequately will meet our needs.

DR. CORDING: The Calico Hills here is relatively shallow compared to the situation in the ESF, I would assume, yes. That's on the left. What's that scale there? So we're down at about 200 feet at most, 150 feet. Is that a situation where your fracture frequencies, as we often have near the surface, could be quite different at depth? So that the Calico Hills there is at least, in terms of fracturing, could be somewhat different.

MR. SPRINGER: You surely can get that difference in fracture, but you may get that difference in fracture throughout the repository and that repository itself.

I think the key is, can we go in and characterize this block of tuff and then predict something about its behavior, and that's really what we're looking to do.

DR. CANTLON: Since this one is going to be above the water table, how comparable are the two datas going to be?

MR. SPRINGER: Well, the Calico Hills under the repository is above the water table, also. It's in the unsaturated zone, too.

DR. STATTON: But it's important to point out that the one-year benefit that we started off with here, starting in '94, is not there. I mean, clearly, the schedule driver that brought us to this little discussion went away when Busted Butte went away from fiscal '93.

DR. CORDING: The schedule here could not be met because it used fiscal '93 funds?

DR. STATTON: Right.

DR. CORDING: All right, so you're a year back, and so that puts you about on time to the heater tests underground and the ESF.

DR. STATTON: Yes. Right.

DR. CORDING: I guess another question I would have is, if you did heater tests here, what thermal types of testing would you do, or how much could you eliminate in the ESF itself? Would you still have to do heater tests in the ESF if you did the Busted Butte?

MR. WILDER: We would not be able to eliminate the thermal testing at the ESF by going to Busted Butte. The intention was to--originally, and, of course, the schedules have changed, as has been pointed out--originally, the intention was to not only look at do we have the physics right, but also to look at the design basis for an abbreviated test at the ESF. What we are now going to have to do, essentially, is to proceed at some risk. We're going to have to go with an accelerated test at the ESF, with the observation that if we do go to Alcove-8 in an early ESF, we may actually get tests started at the Alcove-8 to justify the abbreviated test approach in ESF. But we've always said that we would have to go to ESF, because that's where we have to characterize the block, that's where we have to do our testing.

DR. CORDING: My feeling has been in the last few years is that as much as possible, I'm agreeing with some things that I've heard here, is that we wanted to use the ESF for exploration, and to understand the phenomena, and to test out our systems, we would like to use something else. And that's why, of course, the loss of G-Tunnel was of concern. And so, I had the feeling after visiting G-Tunnel that there were a lot of things that were in the development process that needed to be done.

I also felt that the tie-in with the hydrology was not as great as it should have been, or let's just put it another way, it was not as great as it has become now. That there was more of an emphasis at that point, partly because of Sandia's responsibilities in that area and the mechanical aspects of it. It's become much more important that we get into the flow situation. So I've seen that we're kind of getting--we've gotten backed into a corner to some extent in this whole area. But I certainly can recognize the situation here, where you are, at a time where you could be in the ESF and doing the testing.

I guess another question would be, is it possible once you get into the ESF, is it possible for you to go in there and over-drive the system? And the other question was, where is Alcove-8? Where is that? Is that in the block or outside?

MR. WILDER: Let me try to handle a couple of those questions, and you may have to remind me if I've missed some of them.

DR. CORDING: I've forgotten already.

DR. STATTON: I believe Alcove 8 is just about mid-way down this north ramp, pretty close to mid-way, and it was a significant amount of excavation over in this direction to prototype that heater test. That was the purpose of it.

If a Busted Butte was constructed, the concept was that the prototype, the need to prototype that would no longer exist and then access to that would be accelerated.

MR. WILDER: That's correct. Now, Alcove-8 is high in the Topopah Springs unit. And so there is some concern if we are going to have a problem with lithophysae, and so forth, but at least it is in Topopah Springs. It's not within the perimeter of the block itself, but it's certainly within the same unit.

DR. CORDING: So you could do some things there in driving it that would, since you're outside the block, you would have more freedom; is that right?

MR. WILDER: That's correct. Now, in our particular tests, we have not scheduled any over-driving to the extent we expect collapse and that sort of thing. Those are more into the geomechanical area in terms of the hydrologic heater test.

The one thing that Alcove-8 does do for us, however, is allows us to heat up that interface between the Topopah Springs and the overlying units, which if we tried to do somewhere else, we would truly have to over-drive, probably to failure, in order to see that kind of response, or else go with a very long time frame.

DR. BUSCHECK: There's another point that I think probably isn't in anyone's minds, but the fact is, is that we're finding extremely substantial effects in the Calico Hills in all of our calculations, even under low thermal loading conditions. The hydrological system in the Calico Hills will be substantially perturbed. In fact, the water table could be 95°C if we utilize an extended dry concept.

We saw today how we're not going to be getting into the Calico Hills in the initial pass with the down-scaled TBM program. We will be getting into the Calico Hills, if ever, sometime in the future. I think at Busted Butte, the Calico Hills is readily accessible. We could be heating some of the Calico Hills and seeing if there are any problems associated with having, you know, thermally-driven flow.

The fact is, it will occur, and are we going to defer to past the year 2000 to find out how the Calico Hills hydrological system responds to heat?

The Busted Butte affords us an early on opportunity to see how the Calico Hills responds to heat in terms of the hydrothermal and geochemical system. So I think that's a very important point. I think it's critical to understand how the Calico Hills hydrological system, geochemical system pertains to real conditions, thermal conditions, and that won't be for some time down the road. I thought I saw the plans for getting to Calico Hills were going to be deferred. Busted Butte would be an early on, inexpensive way of getting down to that level.

DR. CORDING: Is the Calico Hills plan presently to have heater tests in it in the ESF?

DR. BUSCHECK: No. But at Busted Butte, that could be readily part of our plan.

DR. CORDING: But I mean, but the delay, you're concerned with the delay in going into Calico Hills. At this present time, you don't have any thermal testing in it.

MR. WILDER: I think a point of clarification needs to be made here, and I have to be very up front and point out that Livermore has been going through some rather rapid evolution in thinking, especially around this extended dry concept. You've heard the extended dry concept presented, but this is not a concept which is developed within what I would call the baseline strategy of the program. It certainly is not the extended dry concept, although keeping things warm is defined in the SCP. But the extended dry concept, the source of processes that Tom just mentioned, where we may be looking at elevating the temperatures within the saturated zone and maybe for some distance, was not developed as part of the baseline program strategy.

So what we're seeing is that there are some new things that are coming out in terms of thinking which have not been validated, and I guess that's one of the things that I feel rather nervous about, that we are proceeding at risk. And as we look at what is happening, even at the low thermal loadings, we're starting to feel that some of the things we've been looking at in the past may be not that germane, and some of the things that we are proceeding on, strictly on Tom's models, really need to be validated.

DR. BUSCHECK: A point to follow up on that. You'll recall my presentation last October. In that model, I assumed that the water table was at a fixed temperature, 31°C. I assumed the saturated zone effectively was convecting and maintained a constant temperature. Since August of this year I've been modeling hydrothermal flow in the saturated zone down to a very considerable depth and find that it's a very important part of the process.

And rather than the temperature staying at 31°C at the water table, it's going up to about 95°C, and even under the low thermal loading conditions it goes up to quite high levels, and as a result of that, we don't have a heat sink down in the water table on our model anymore as we had inappropriately done in the past. So we find that the Calico Hills is much hotter than those early presentations that I showed you last October, and so there are going to be substantial thermal effects that have not been readily seen in the project and that's what Dale says, and we're concerned about that. We feel those effects need to be explored, and Busted Butte gives us an opportunity to do that.

MR. HAYES: As Dale says though, these are unvalidated model results, are they not, Tom?

DR. BUSCHECK: They will be as long as we can't test.

MR. HAYES: Okay. But also, you're basing your model on some pretty preliminary data, I believe; is that correct?

DR. BUSCHECK: All the data we can lay our hands on. If we continue to just wish it away, I think we're going to be caught flat-footed.

MR. BLANCHARD: Because there's a number of consultants that you all have brought, I would like to make sure that there isn't an error in communication. Bruce, would you mind putting that view graph back up? It may be misleading to some of the people that aren't real familiar with the ESF design concept. It shows a perimeter drift. There isn't a perimeter drift in our design, and so that should have been another color and another label. It's a conceptual boundary that we're reserving, but we don't have plans for a perimeter drift.

DR. NORTH: I'd like to return to Busted Butte. I've found this discussion over the last hour or so absolutely fascinating, because I think it represents a definite shift away from thinking that the testing is to implement the site characterization plan. We're hearing about a lot of new results from the coupled process modeling and concerns about the validity of that model that probably only can be resolved through some large scale testing.

Now, I sit here and think about, gee, this program isn't going to end with license application if that receives even some qualified endorsement; that is, other than a flat no from NRC, or a determination that the site is not acceptable. And these kinds of questions aren't going to go away, and it may be that one of the ways the situation will resolve is there will be some consensus that further testing past 2001 is needed. And it might be good to give some thought to that, and consider contingency plans that might be developed essentially to go ahead in parallel and think about tests that could be done over a much longer period, perhaps up to the time scale at which one might contemplate closing the repository, and consider what might be done in Busted Butte that would allow testing to destruction of the rock, or flooding, or other things you wouldn't want to do in the repository as a way of getting a baseline over a 50, as opposed to a five-year period, that might help you in making a decision whether at some future time everything should be taken out of Yucca Mountain because we've decided that the repository is not long-term acceptable, even though we thought it was pretty good, versus the kind of information that we're going to get in a five-year test, which strikes me that it's going to be very difficult to get the kind of time and spatial scale resolution.

And I would urge us to think about that, five versus 50 years, as opposed to can we do a test we thought we were going to get five years to do in three or four years?

MR. WILDER: What you are suggesting is absolutely what we're talking about right now in our work around planning. We have pointed out that we are going to establish tests at the ESF which will be started at the same time as the abbreviated test, but the intention is to go beyond the year 2000 so that we can look at some of those longer time scales.

Now, we're going back to the thought of maybe a six-year heating, couple of years cool down, so it's about a ten-year test. But ultimately, and we've always said we're going to have to have some sort of performance confirmation testing. Ultimately, we've got to test things at the kinds of skills that are really representative of the repository. So we have always said that that 50-year, 80-year, whatever it is, retrieval time in the repository will have to be monitored with the same scale, actually monitor what's going on as you emplace the waste, for probably a 50-year test. And so, I agree. We are going to have a series of tests of different time durations.

What we're focusing on is what's necessary to get to that license application stage, but there are tests that will be ongoing beyond that.

MR. GERTZ: We have always had in our plans extensive confirmatory testing.

DR. NORTH: Well, it might be interesting to engage the NRC, and perhaps others, in dialogue as to what could you learn from tests at Busted Butte over this longer time period, considering the potential for introducing large quantities of water and heat to the extent of over-driving the rock, so that you could explore failure modes that you would never want to come near in the ESF or the repository as it might be developed in its early years.

MR. BLANCHARD: For the benefit of those here that aren't familiar with the NRC's regulations, Warner's referring to the provision, 10 CFR 60.137, which is the performance confirmation test program.

At the time we wrote the SCP, we had a few pages of conceptual performance confirmation tests, but we felt that in order to develop a real meaningful performance confirmation test program, we really needed more of the kind of things that were going on here, a lot more information in terms of design needs, as well as some performance assessment calculations on radionuclide releases before we could get to what we thought were meaningful, long-term tests.

As you can see, over the several years between the time we wrote the SCP and now, some of those things are actually evolving to a point where maybe we do have a meaningful basis for a long, a truly long, many decades, performance confirmation test related to the engineered barrier system.

MR. SINNOCK: I'd like to follow up on that a little bit, and I think there are some implications there that maybe there's information we can learn about validation of models and processes that we won't have in hand at the time we submit an application.

I think currently our program is really focused in reaching some ultimate level of confidence at the time we submit an application, and then confirmation is just sort of checking off and making sure we were right. But I think we all know that we're going to gain knowledge and information and confidence throughout this 50 to 80-year period of observing this system. Maybe we should explicitly acknowledge that this "reasonable assurance" is something that grows after we submit an application, after we're granted an operating permit, if this is the case, and this continues to grow. And then maybe this helps get at that idea, also, over on the outreach side, that we're not making irrevocable commitments, nor are we saying we irrevocably have reached conclusions definitively at these early stages of a 100-year project.

DR. ALLEN: Incidently, Uel, I cut you off a little while ago and I want to get back to you.

MR. CLANTON: Uel Clanton, DOE. We have made several references here to G-Tunnel. I was one of the task force to go out and see what that operation cost us. And, lest we forget, we were at that time in a period of a budget crunch.

And so, considerable effort by several people over several months went in to find out what it cost and what we perceived at that time the benefits of continuing the operation. And the decision, or the recommendation that was made to Carl, was that at this time, we value more keeping staff in the national labs and USGS versus the potential of keeping G-Tunnel open.

We seem to always be in the process of "betting on the come". Next year, we're going to get more money, next year, we can do this, we can do that. In hindsight, maybe the choice was not the best, but certainly, at the time when the choice came to lay off people at the national labs and at the USGS versus keep G-Tunnel open, I think there was a fairly good response throughout the project, "shut it down; keep the staff".

MR. HAYES: Uel, in hindsight from the Survey, we do support your decision because we did keep staff and we did find other ways to complete our tests. So, in our hindsight, and remember, our needs are different from Livermore, maybe Los Alamos and Sandia. But from the Survey's viewpoint, it was the right decision.

DR. STATTON: Wait, wait, wait. Before we get too far afield here, we didn't keep staff. We kept other programs going at the expense. It's not simply a welfare program here, and I don't like the way that sounds. I mean, what we did is we had active activities, other studies ongoing and we weighed the benefit of a G-Tunnel against the benefit of continuing a tectonics program; not keeping staff.

I'd also like to get back to, you know, the fundamental decision we have made here. Russ's last view graph said, Busted Butte is a terrific idea, but we had a fundamental decision to make, and is the trade-off one that says push off the ESF in lieu of trying to initiate at Busted Butte, and the decision was very clear. I don't think Carl had a single voice even trying to sway his head. Quite clearly, the activity is to get the ESF underway so that we can take our fundamental decision on site suitability, which is an observation to get back to where we were this morning, the sanity check. Does it look like what I expect it to look like? I think that is a prime driver and Busted Butte didn't hold a candle to that decision.

So the discussion of Busted Butte is, it's a terrific facility. It offers lots of opportunities to us, but it doesn't offer opportunities worth taking in today's funding environment. And I think that was a decision that Carl made.

DR. ALLEN: May I interject here? We still have subjects we want to cover. Would you like to take a 15-minute break, and then come back?

MR. GERTZ: Can I just close this with one thing?

Talking about scientific confidence and talking about public confidence, you know, I personally have come to the conclusion that making that loop is going to add to both of those elements of the program immeasurably, be able to walk that five miles front to back, and point out this is where the waste is going to be.

DR. ALLEN: Okay. Tom, let's not proceed right now. It's exactly 4:30. Let's take a 15 minute break and come back.

(Whereupon, a brief recess was taken.)

DR. ALLEN: If you won't sit down, will you at least, please, stop talking?

We are going to proceed by hearing a few more things from Russ Dyer about priorities in the ESF.

DR. DYER: If you look at page 4 of the agenda, there is a series of questions outlined there that have to do with the interface between testing and ESF construction, the phasing of ESF. And, I would like to just throw up a couple of viewgraphs that I hope will lead into some discussion regarding that.

One of the first questions that's often brought up is what are the critical interfaces between testing and ESF construction? Right now, we see these as the primary tests that we have to have in our hip pocket, essentially to follow a TBM underground. These three activities are part of a single test or a single study plan. Probably, the most critical of these is a perched water test. If we should run across perched water during the driving of a drift with a TBM, we need an ability to go in and sample that perched water in a relatively timely matter, so that we can acquire it before it leaks away or runs away.

Of course, geologic mapping of the exploratory shaft and drifts is an activity that will follow the TBM in. We would prefer that the TBM not outpace the ability of the mapping team to map the shafts and drifts, or drifts primarily. And, the third activity, water movement test, the Chlorine-36 test, actually this is an analytical test that would use material that was sampled from out of this study plan, primarily.

So, there's really two studies that need to be in place; two teams, if you will, that need to be put in place that would provide the critical testing support following a TBM. Now, this is not addressing the long-term testing in the alcoves or the main test level of the ESF. But, this is the minimal subset of tests that we need to have in place to support a TBM.

DR. LANGMUIR: Russ, the first two tests over there, perched water and hydrochemistry, I'd like Larry to comment on how much we've learned about those from surface-based testing. It seems to me that at least perched water, you've got a better handle on finding it with your surface-based testing than you ever would with the ESF.

MR. HAYES: The perched water test is really what we do if we encounter perched water.

DR. LANGMUIR: That's right. It is not trying to find it?

MR. HAYES: Right. We have a process now. We handle that.

DR. DYER: This is not a systematic search for perched water. This is a contingency test just in case you run across it.

MR. GERTZ: Don, I think what we are trying to point out is that we have an agreement with the NRC that prior to implementing any study plans, we need their acceptance of the study plan and their comments, et cetera. And, as best we know, these are the only two study plans that we need their acceptance on before we start going underground. A 3.1 would be for analysis. So, it's to make sure that as we move underground we have all our ducks in order, so to speak, so we can conduct tests, should we run into perched water.

DR. DOMENICO: Do you have the same contingency plan for the surface-based program?

DR. DYER: I'm sorry, Pat?

DR. DOMENICO: Do you have the same contingency plan for collecting whatever sample you can in the event you encounter that in the surface-based program?

DR. DYER: Yes.

DR. DOMENICO: But, there is preparation for that?

DR. DYER: There are contingency plans if we run across what's called a--what? It's not an unnatural occurrence.

MR. HAYES: Unanticipated event.

DR. DYER: Unanticipated, right. A perverse test is my understanding. Yes, that's true.

DR. ALLEN: Any other comments on this particular graphic?

DR. CORDING: Just one. Russ, the first ones there on perched water and hydrochemistry. Where, with respect to the tunneling machine, do you anticipate that having to be obtained? In other words, is it at the face that you are getting that information?

DR. DYER: I am going to defer to Ned Elkins on this one.

DR. ELKINS: The perched water test would be probably the only exception we currently carry as we plan our ESF test program that would be at the face, or as near at the face as we can allow access. As soon as we have verified that we have indeed hit a zone of saturation or perched water element, we are going to be wanting to characterize that as quickly as we can which would probably be a cessation of construction operations at least for an initial characterization.

The hydrochemistry test and the majority of later fault testing would be deferred behind the construction activities. So, construction would proceed. The only limitation to that philosophy is on the fault testing. We continue to preserve a geothermal element of that program, as soon as we can possibly get a single borehole across fault contact, get it sealed off, packed, and some geothermal testing done. We are evaluating whether or not that can be done directly on machine support or immediately behind the trailing gear of the TBM. But, the majority of all these activities are non-construction, in fact, of testing activities.

DR. CORDING: Is that borehole a sample core hole or is it just a hole?

DR. ELKINS: It doesn't need to be cored. It just needs to be drilled and a packer system put in place and then very carefully monitor changes in moisture content, humidity, and temperature in that zone.

DR. CORDING: It's one of those sorts of things that can be done pretty rapidly if you're set up on a TBM.

DR. ELKINS: Exactly. Exactly.

DR. NORTH: I find myself getting confused by term-inology. Would it be possible to give us a bridge from the items on this chart to the items on the integrated test evaluation model where there are SCP numbers listed? How much of what you've got on that chart is covered under ESF UZ percolation, for example? Or, do these show up somewhere else?

DR. ELKINS: Of these tests that are shown here, that group of three at the top, are three of 10 ESF activities included in the ESF UZ percolation study plan.

DR. NORTH: Okay. So, the top three are under UZ percolation?

DR. ELKINS: Yes. The next one, geologic mapping, is in structural features.

DR. NORTH: Okay.

DR. ELKINS: And the Chloride/Chlorine-36 test there is a critical sampling activity that's covered under a study plan called water movement tests on the table that came in ITE.

DR. NORTH: Thank you.

DR. DYER: I was going to try to stay away from these long numbers, but 8.3.1.2.2.4 is the study plan that includes the perched water test; that's activity 7 within that study. 8.3.1.4.2.2 is geologic mapping; activity 4 within that study. And then, the water movement test is within 8.3.1.2.2.2.

DR. CANTLON: These are based on NRC requirements. Is this primarily for radiation safety in connection with the operation of building the ESF? What's the regulatory basis of this?

MR. GERTZ: No. Our approved study, our approved SCP. The SCP lays out our 106 activities.

DR. CANTLON: But, those are keyed into regulatory requirements?

MR. GERTZ: Yeah.

DR. STATTON: Well, moveover, I think, they're trying to address themselves to site suitability issues. In other words, what we're looking for is, is the mountain dry as our conceptual model suggests? Is the water, whatever water is in the mountain, as old as our conceptual model suggests? And, I think that's part of what that's after. The faults, how do the faults behave within the plumbing system, and then we have a concept of how they behave. This is the, essentially, direct observation of whether that behavior is going on.

MR. BLANCHARD: I think you said it well, Tom. Each of those tests in one way or another adds information to Russ' first list of unsuitability tests. Chlorine-36 water movement gives you some feeling for when the water first percolated into the ground. And, if it was moving very fast in terms of a few years, you would find that out from a Chlorine-36.

The mapping, while it says structural mapping and stratigraphy mapping, it also is looking at fractures in the rock unit as we build a better understanding of hydrologic framework within which water moves in both fracture and matrix flow. And so, that provides a basis even for input to ground water travel time calculations.

And, of course, perched water, like Tom mentioned, if we're lucky enough to encounter a sample of water and it's large enough so that we can make an age measurement on it, that will give us a very valuable piece of information. So, the team that assembled that felt that those were all very useful tests and going to provide us with great insight with respect to the processes operating at the site now, as well as the processes that acted at the site during the last 10,000 years or longer.

DR. CORDING: I presume, there would be situations where you aren't going to see flow, but there is flow because it is evaporating at the surface and perhaps a relatively dry tunnel environment depending on ventilation and the season and all. So, some of the work is to get back in there and back off and see what really is there, isn't that correct?

DR. ELKINS: That's right.

DR. CORDING: As a Board, we saw some testing at Grimsel where they would go into sections of drifts and seal the whole thing and then try to pick out where the flow is occurring across surfaces that they had sealed off because of this evaporation problem.

DR. DYER: Let the record show that Ned shook his head yes.

Let me go onto another item here and this is a list of study plans related to the ESF and this essentially tabulates the work to be done in the ESF. And, we have references of each of the primary testing organizations here that can provide you with more information about the details of these tests, if you desire it. But again, for the first pass through with the TBM, the objective is not to put these tests in place just immediately after the TBM runs through, but rather after the TBM, the initial drift, the horseshoe, if you will, is well underway. Then, we would initiate this testing program.

DR. ALLEN: These are mainly alcoves.

DR. DYER: These are dominantly alcove. I think they're all alcove. Is there anything on here that's not in an alcove--

DR. ELKINS: In situ design verification is not an alcove.

DR. DYER: Okay. But, the rest of them would require some kind of facility.

DR. CORDING: Now, these alcoves could be spread anywhere along the alignment or are some of these going to be concentrated in the MTL, the main test area?

DR. DYER: Well, both.

DR. ELKINS: There are some of these--I don't know if we want to go through them individually, if it would be worthwhile. But, some of them have a specific location or a dedicated area in the core test area of the main test level. Several of them have multiple locations or at least anticipated locations depending upon what we encounter throughout the alignment or construction of the ESF.

DR. LANGMUIR: What does diffusion test stand for? Is that gaseous or fluid or what? What are we diffusing?

MR. SPRINGER: Don, that is just a single borehole test looking at diffusive movement of the water and tracer output away from the borehole and then it is overcored. And so, we can look at it and compare it. So, it's basically a transport test.

DR. LANGMUIR: Okay. Presumably, if it's diffusion, it's not going to go fast enough to matter anyway, if that's what it is.

MR. SPRINGER: No. Presumably, it's done in unfractured rock.

DR. DYER: There is another suite of tests that, although they are not fielded, per se, within the ESF, perform tests or analysis on samples that are collected from within the ESF. So, on the chart that I showed you originally where there were green and yellow highlighted entities from the ITE results or bold and italic entries, many of these would show up on that list. Again, we have people here that can talk about the details of these individual tests.

None of these would require any slow down in construction. They are using samples acquired generally through a consolidated sampling program, generally from behind the advancing working front.

Any comments or questions about this?

MR. DANKO: There is a puzzling item here, laboratory thermal properties. Isn't it Sandia who makes the laboratory testing? Is it a misprint? Is it Sandia who does the laboratory testing on thermal properties?

DR. DYER: Yes.

MR. DANKO: That is mislabeled.

DR. DYER: Oh, is it mislabeled here? Oh, yes, that should be Sandia.

MR. DANKO: Thank you very much.

DR. BLEJWAS: I knew we were going through a transition.

DR. LANGMUIR: Russ, can I take you back to the previous page?

DR. DYER: Sure, Don.

DR. LANGMUIR: Engineered barrier system field test, since we haven't decided that we need an engineered barrier or what it's going to look like, what is the test all about?

At least, I am not aware that there is a real engineered barrier in the plans now.

DR. DYER: Well, let me defer to Dale.

MR. WILDER: The engineered barrier system field tests are those series of tests looking at the hydrology, the geochemistry, and to some extent the coupling with geomechanics around whatever it happens to be, waste package kind of emplacement. The approach has been in the past to take the reference which is vertical emplacement mode. Where we're shifting to possibly considering more strongly the drift emplacement, they will probably be focused on drift emplacement. And, if a decision isn't made before the tests are done, then we will have to provide flexibility for doing both types of emplacement.

DR. LANGMUIR: But, haven't you been talking about a gas space between the waste package and the rock wall?

MR. WILDER: Yes.

DR. LANGMUIR: Without some sort of filling in there, there's nothing to field test, is there? What are you going to do, just look at it? I mean, you've got the waste package sitting in a gas phase. What's the field test all about if there's no backfill?

MR. WILDER: What the field test, at least to date, has been designed to do is to duplicate to the extent we can what we think the design is going to be. So, the field test was designed with a heater in an open borehole with that same air gap and then we're monitoring what takes place beyond the EBS. And, maybe, it is a little bit confusing because you're thinking we are monitoring the EBS. What we're looking at is the near-field environment, and at one time, those tests were called the waste package environment tests. But, because waste package connoted only the container, it was changed to EBS because that also included the boreholes.

DR. LANGMUIR: This is basically a heater test then, isn't it, with the gas phase between the heat source?

MR. WILDER: These are heater tests, not to be confused with the heater tests that Sandia needs to do for some of their geomechanics.

DR. STATTON: These are essentially the same five to six year long-term heater tests we talked about this morning earlier.

DR. DYER: Okay. The last thing I'd like to look at is the ESF will sample some portion of volume of rock within the conceptual perimeter drift boundary. And, the surface-base testing program, the drilling program is also going to sample some of that volume of rock. And, I'd like to compare what we have sampled and what we plan to sample on the same scale.

This chart, which I believe handouts were available for people, shows with--on some versions, it's a black dot; some versions, it's kind of a dark blue dot. These are existing boreholes. This again is not an underground opening, but rather the outline of the conceptual perimeter drift boundary. This is the currently planned ESF north drift/south drift. These are the existing boreholes either within or in immediate proximity to the footprint of the conceptual perimeter drift boundary.

So, we have got seven boreholes within this volume of rock now which penetrate generally to the water table, to or below the water table. Of course, the ESF is going to sample a large volume of rock, but most of it is going to be at a single horizon within the Topopah Springs or above.

The Calico Hills loop which falls underneath here, shown in a dotted line here at least in this conceptual version, the Calico Hills level would fall more or less underneath the main drift here, would provide us sampling down on a second level, down at the Calico Hills level.

The proposed drilling program in its currently envisioned totality is shown on another graphic that I think was distributed. These are the red boreholes and again we have the conceptual perimeter drift boundary. Here's the main test area here and I will point out a couple of things.

Many of the boreholes that you see on here are designed to provide information for ESF design. And, specifically, those are the NRG and SRG series of holes. NRG 2, 3, 4, 5, 6 and SRG 1, 2, 3, 4 and 5 are designed specifically to provide design input for ESF design.

The other holes on here, the SD series of holes, systematic drilling holes, were put into the program to provide systematic statistical sampling to provide input of essentially three-dimensional distribution. Well, it's not quite three-dimensional, but it provides a three dimensional point sample, if you will, of rock properties, hydrologic properties, geochemical properties that could be used for performance assessment modeling. So, that's what the SD series of holes is scheduled to provide.

The other main cluster of holes that you see down here, this would be UZ-16 for those of you that have been out to the LM-300 currently drilling. That's UZ-16, also known as VSP-2. That's this hole right here which provides information on the unsaturated zone, scheduled to drill to the water table and also scheduled for emplacement of a vertical seismic profiling string. A cluster of holes here, the UZ-9 series for the series of interrelated hole-to-hole tests. And then, the rest of the holes that you see in here consist of water table holes, a few hydrology holes. Actually, I just see one. I guess there are no G-holes on here. I guess G-5 is off of this chart.

So, this provides you at least a picture to hang your hat on as to what part of the volume of rock that we're looking at here is sampled by both the ESF and the surface-based program.

This is all of the graphics I have prepared. At this point I would like to throw it back to the Panel. I think, we've given you enough here to start some discussion rolling.

DR. DOMENICO: What is the difference between this slide and the previous one? I lost you somehow.

DR. DYER: Oh, I'm sorry. These are proposed boreholes. The previous slides are existing, currently existing boreholes.

DR. DOMENICO: So, the USW stands for water well hole, USW? What does that mean?

MR. CLANTON: USW is a designation that's used in the test site area to locate where the borehole is. So, you see a UE-25, this tells you it is in area 25, the USW is an indicator to the people using the data that the borehole is located off of the test site.

DR. DOMENICO: So, it doesn't have anything to do with what it's supposed to be testing?

MR. CLANTON: No. The second set of letters there, SD, WT, SRG, NRG, tells you what the main purpose of the borehole is.

DR. DOMENICO: Can any of these be conducted from the test facility? Any of these holes? Obviously, the ones that are testing the water table. I'm referring to testing the saturated zone.

MR. CLANTON: In some respect, we have perhaps done a disservice by not numbering all the boreholes, lettering all of the boreholes uniformly.

Initially, an SD borehole or a UZ borehole was proposed by a PI in that approximate location. When the SCP was being put together, rather than having 50 or 60 boreholes to be drilled, deeper boreholes, we had about 300. So, in an attempt to cut back on the drilling program, we went through an exercise that was called integrated drilling program where we put the various activities, the request from core in certain areas into a common borehole. But, whichever borehole was kind of originally fairly close to that ended up carrying the initial designator UZ, SD, and so on.

But, the boreholes are not a unique application for one PI. People from the national labs and the USGS all are requesting core from the boreholes or alternately are planning to test in the boreholes. We just finished a couple of weeks ago a sit-down with the PI reps from the national labs and the USGS in an attempt to go back and look at the earlier requests and see if what was planned two, three, four years ago now, is still pertinent. Is there any possibility of reducing the number of boreholes? The amount of core that was initially requested, is that still correct? Are there any intervals that we can totally delete and not take core.

And, that one is still being worked.

DR. DOMENICO: My question, I think, Uel, was can some of this--is it possible to drill from the test facility if you're interested in the water table position and things of that sort instead of from the surface?

MR. CLANTON: I think the answer is no, and the reason for that, the total section for the most part in all of the boreholes is being requested. Some people are interested in the top 200 feet; other people are interested in the water table. Some people are interested strictly in the repository horizon. And, each of these boreholes provide samples essentially from surface to full depth, but not to the same PI.

DR. DOMENICO: I see eight water table drill holes that are going to range between 1700 and 2100 feet. They have to be drilled dry. What you're saying is you are interested in more than just the position of the water table there which can be determined from the facility a hell of a lot cheaper.

MR. CLANTON: That is correct.

DR. DOMENICO: So, someone wants some core out of there?

MR. CLANTON: That is correct. Typically, we will have a dozen, maybe more, requests for samples throughout the borehole from different PIs.

DR. DOMENICO: And, I see 12 geostatistical drill holes that are in excess of 1800 feet.

MR. CLANTON: That is correct.

DR. DOMENICO: What is a geostatistical borehole?

MR. CLANTON: Those are the SD boreholes.

DR. DOMENICO: What was that?

MR. CLANTON: SD, statistical.

DR. DYER: The feed for performance assessment.

DR. DOMENICO: That is where you're getting your permeabilities from and things of that sort?

DR. DYER: Well, you can get it from most of the holes we'll be drilling if they're acquiring core. But, this is the statistic based drilling program, requiring information from both above and below potential repository horizon.

MR. BLEJWAS: Those holes were proposed when other drilling programs didn't satisfy the needs to come up with enough of a statistical basis for the parameters that we needed in our performance assessment models. So, we proposed additional holes and those were labeled SD.

DR. DOMENICO: One more point. Seven sets of these holes have to be drilled dry. I was talking to Carl about this earlier and they're deep holes. So, they can't use this model. You have to use your big machine, and just to finish the UZ's at the rate you are going, would take ten years. So, obviously, you are going to buy more machines or something.

MR. HAYES: Pat, you want to be careful in what you're looking at there now because, as Uel said, we've had two meetings, so far, and we are going to have some more to re-strategize the drilling program. And, one of the things that we're talking about, for instance, the SD holes, they were originally planned to be drilled dry because Alan Flint wanted information and he has to have dry core. We are now looking at in some areas, Al will get that information somewhere else, maybe from drifting in the repository or, if that is not enough, perhaps some other hole. But, we are looking at considerable change and maybe some of these holes that are now planned to be drilled dry won't be drilled dry.

MR. GERTZ: But, the major question is, in order to carry out the drilling program--and I gave Pat a schedule that we have four drill rigs, LM-300's, scheduled to be brought on line when funding is appropriated in '94 and '95. And, with four drill rigs going on, we will carry out the program that we've laid out in the SCP.

DR. ALLEN: You mean, when the funding is or if funding is?

MR. GERTZ: Pardon me?

DR. ALLEN: You said when funding is available?

MR. GERTZ: I am always an optimistic project manager. So, when it's available. But, if it's not, we probably won't buy them and we will continue a balanced program. I mean that is the question that Pat also asked. If you start on the ESF, do you hope to get funding to keep going, and I think Congress would see fit to continue the funding that we have at least at the present level which would keep an ESF in a semi-balanced surface-based program.

DR. DOMENICO: Larry, do you feel that it is safe off-block, any dry drilling schedule for off-block may be permissible with fluids? Is that a thought?

MR. HAYES: Some will be. I don't know exactly how many holes we can change our thinking and go to say air foam instead of dry drilling. But, certainly, we're looking at some going to perhaps to air foam.

DR. DOMENICO: Conversely, you probably are not thinking of wet drilling on the block.

MR. HAYES: We are looking at that right now. We think there may be requirements that will not allow us to wet drill on top of the block.

MR. CLANTON: There are on the schedule that you have quite a few boreholes that are a wet drill. The V-holes, the G-Holes, with the exception of G-8, are all wet, mud, polymer, foam holes.

DR. ALLEN: Max, do I assume you are not standing just to stay awake?

MR. BLANCHARD: No, I just wanted to make sure that we answered Pat's question as clearly as we could. And, that is, it's certainly true that when we developed the SCP, we only had a one mile underground test program from the ESF only in the northeast corner. Therefore, we had more holes for both the systematic drilling and the features drilling than what you'd necessarily derive if you were going to develop a borehole test program with a new repository underground configuration. We have intended to re-examine this. What Uel and Larry are saying is there is a process ongoing now and Russ is involved in that, too. And, I think it fits back into re-prioritization of ITE with respect to the tests.

It will take awhile before we can, let's say, have all of the technical justification merged with the regulatory justification, so that we can explain which holes we don't think we need to do and why because it's related to an expanded underground test program. That's where we're going; we're not there yet. It will take a while.

DR. CORDING: In regard to the statistical program, is there a possibility that the need for statistical information is changing focus perhaps towards the statistics not of the matrix, but the statistics of the joint systems or perhaps not the statistics of the lithology which is the vertical hole, but towards what one can get from understanding frequency of the faults and joint system? Is that something that's happening in the system that might say that you can cut back on some of the statistical sorts of information from, say, dry drilling?

MR. CLANTON: Once again, somewhat as you suggest may be possible. But, once again, the driver that you need to be aware of is that even though it is listed as an SD-4 borehole, it's not just Chris Routman in the borehole. We have maybe a dozen PIs that are either testing in that borehole or requesting samples. And so, the meeting that Larry and I were in a week or so ago now and the one a couple of weeks before that, it was an attempt to understand the requirements, borehole by borehole. And, there is a primary need for the borehole, SD, UZ, H, whatever like that, but they are in many instances other PIs who are requesting samples, or who will test in that borehole a secondary need for that borehole.

So, if you eliminate, for instance, the need for something like maybe SD-6, maybe you could convince Routman and the statistical drilling program that that borehole was no longer needed. But, maybe two or three other PIs who initially requested a borehole to be drilled in that area, if you cut that borehole, it may well destroy their program or at least severely injure it.

MR. HAYES: Perhaps, another defense of the SD holes and I think the drilling program in general is the drifting in the ESF generally gives us a massive amount of information in one horizon and pretty well limited to the drift area. The statistical drilling program needs information that is distributed over a broad area and it needs information from land surface down through the potential repository horizon. That kind of reasoning applies to a lot of the other holes. So, just how many wells or boreholes we'll be able to eliminate because of the drifting, we don't know, because we have to maintain this distributed surface through the potential repository horizon arrow view.

DR. DYER: I think Ed's question had to do with whether there was an advantage to putting in at least some subset of inclined drill holes or fractures.

MR. SINNOCK: Originally, we did have some angle holes to intercept the vertical fractures. But, also, I think the whole issue of fracture flow is also closely related to matrix properties. So, understanding matrix properties and in situ conditions of saturation, perhaps pressure, are intimately linked, as well as knowing the distribution of the fractures.

DR. CORDING: I recognize that you're focusing on certain horizons. Although the ramps as they come through are coming from outside of the repository, there's some opportunities there for information on other formations and also then in the Calico Hills.

I think one point is that it was related to one's ability to detect the fractures in the vertical drilling program and being able to pick up anomalies related to fractures. It sometimes can be difficult. And, once you've fixed those fractures underground and those faults and whatever, you know where they are. Then, you go across them and get the information. And, that can be done with short holes which means that you're not working--it's tougher to work in a long borehole, than it is I think to--and I haven't done this. I've worked in long boreholes or I've worked from the surface down long boreholes, but I haven't worked on the moon. But, I always felt that the people working on the moon had a very simple problem in trying to get data back and forth and to get their information and work in the hole.

So, it seems to me that with the short boreholes you have the opportunity to do the hydrologic information. It's easier to instrument and you know where the fractures are, and I am just wondering in some of those areas where you are trying to evaluate fracture conditions, there may be some possibilities of moving more into the underground, recognizing again that we aren't sampling every formation.

MR. HAYES: Yeah, I think the dilemma there is that we need information from the surface on down. And, if we try to do this only at the repository level, I am afraid we are not going to have a complete data set.

DR. CORDING: I'm not trying to get to the end condition there. But, I'm just talking about possibly changing some of the priorities or adjusting to some of the--

MR. HAYES: In fact, whoever brought that question up, it's an interesting one because I am wondering if drilling from the potential repository horizon isn't worth investigating as a way to characterize the Calico Hills rather than drifting into the Calico Hills.

MR. CLANTON: There are two drilling programs that we kind of distinguish between. One of them is so-called neutron boreholes. This is by Alan Flint, USGS. Most of his boreholes are 300 feet or less. And, he is looking at that umbrella, if you will, over the mountain and how those bedded non-welded tuffs near the surface below the Tiva Canyon, how they may shield the Topopah Spring. But then, when you go back and look at NRG-2, NRG-3, so on like that, and then the SRG-2 and 3 in the south and 4, too, I believe, all of those are supposed to be angle holes across faults which will provide some additional information. But, the mountain is tilted 7 to 10 degrees, so even though we are drilling vertically, we are getting an incline section.

DR. DOMENICO: Russ, I don't know, we don't have any multiple drill holes, multiple purpose drill holes, do we? I mean, every hole has a single purpose.

MR. CLANTON: No. Every borehole is a multiple purpose borehole. That's the problem with trying to eliminate one. There are just none--

DR. DOMENICO: Is that right? They don't seem to be labeled that way, Uel.

MR. CLANTON: That's correct.

DR. DOMENICO: It seems to me you've got tens of thousands of feet of core. You would think that you could satisfy a lot of the geologic drillholes. I don't know. Have all the PIs said what they want independent of the other PIs? Or have all the PIs been together and said how much do we need?

MR. CLANTON: Perhaps, the easiest thing to do is to bring you a subset of sample requests that we have borehole by borehole and you can see what the requests are.

Depending on the borehole, when we did the integrated drilling program, as usual, there wasn't time to quite do what we really wanted to do, so we're getting to do it over.

MR. GERTZ: But, Uel, I think the point Pat may have missed is when you originally went out for requests, you had a request for 300 deep drillholes from all PIs, and you've scaled that down now to whatever.

MR. CLANTON: A smaller number, yes.

MR. GERTZ: Eighty or something deep vertical holes.

DR. DOMENICO: Based on mutual needs.

MR. CLANTON: Based on mutual needs. But, individually, by borehole in some instances the requests for core, most of the boreholes are planned full cores, surface to depth, and this is part of the meeting that I alluded to earlier with the PIs and so forth, Larry and I working with them, what is the real need? But, right now, some of the boreholes are committed at 120 percent of the core that we are planning to get. Some of them are only 30 or 40 or 50. But, even though they are not listed as multi-purpose boreholes, in fact, all of them are being sampled, are tested by multiple PIs. They are all multipurpose boreholes.

DR. ALLEN: But, in every hole is some core being saved for posterity; 100 years from now, 200 years from now; 900 years from now?

MR. CLANTON: Some core is being saved. The concern is perhaps a little bit like with the lunar samples in that what we know to do today somewhat limits the use of the samples. In the lunar program, there was an attempt to archive about 80 percent of it to be essentially non-touched, used, fondled, or whatever, like that. The needs that are currently expressed are core from our program. If we started trying to archive very much, it would potentially impact what the PIs want to do.

DR. ALLEN: Well, how much is being archived though, 20 percent?

MR. CLANTON: At the moment, there is no archive set aside, as such. The PI argument has been if the core is removed from the total amount of core recovered from the borehole, they lose the information of being able to correlate down through there.

At the moment, the boreholes that we are drilling, they are not completely allocated. We have, typically, 30 to 40 percent, maybe higher than that, maybe 70 percent left in a borehole. So, we have not made a unique effort to remove some of the core.

The core is 2.4 inches in diameter. And, some of the PIs have to full core in order to do the tests. If the core were larger, we could perhaps slab it and have an archive quarter left behind. At the moment because of the diameter that we are coring, we do not have that option.

The other option would be to come in and selectively remove, say, one foot in ten and save it.

If you look at the core through many of the sections, even that does not make very much sense because in some instances you have several hundred feet. And, if you just take a specimen out of somewhere in there, there are very few people, if any, that can say, oh, this came out of such and such a place. It is uniform through the section. And so, if there is a need to archive, it's going to be a tough one.

DR. STATTON: Let's remember that this program really hasn't been underway very long. We started with the new QA program, what, a year ago? We've got the new drill rig here running. So, a lot of these problems, I think are still being laid on the table. It's not something that's not being looked at or not being thought about.

DR. ALLEN: You still have got more than 9,000 years to go.

DR. STATTON: Yeah, we've got a long time to go and we've got a lot of boreholes to do.

MR. GERTZ: Especially with one shift and one rig, it takes awhile, as Pat pointed out.

DR. ALLEN: We're going to be here a long time.

DR. STATTON: One of the things we are looking at, and I don't know if Uel is going to amplify on it, is the possibility of acquiring larger diameter core.

DR. LANGMUIR: If you've got enough rock to archive it Uel, doesn't that mean that you've got more than you need? That you could actually put more tests into less holes? Are you wasting in the sense that you don't have to have that rock for the studies?

MR. CLANTON: The major problem that we have right now is that in order to save time, save money and so on like this--for instance, at the moment, we may have, say, three or four feet out of ten foot run that the PIs have requested. And, so maybe there's four or five feet left in that interval that has not been requested. If you say, well, why don't you only drill that and core that four or five feet and don't core the other one, that may actually take me longer and be more expensive than doing full core.

The way I need to core and save money to speed up the program is if I can get an agreement among the PIs that there is an interval of this borehole of 200 or 300 feet or something like that that I do not have to core, then I can make some time. The overall cost of the drilling program goes down. But, going from a reduction of four feet of core being requested in this ten foot interval to one foot doesn't buy me time.

DR. LANGMUIR: I was thinking of less drill holes.

MR. CLANTON: Again, we are back to the statistical distribution of the boreholes and the need to correlate both horizontally and vertically the reason for the borehole being where it is.

The samples are typically distributed throughout the borehole. One PI is interested in a particular feature, a particular type of mineralogy, a particular contact. So that smears, if you will, through the total borehole depth.

DR. ALLEN: Russ, do you have more?

DR. CORDING: We had several questions in our agenda. We've covered a number of them. In the 25 minutes or so left in our session, perhaps we can look at some of these other questions.

I think in some of the items, one of the items might be the discussion at this point on the Calico Hills and the access to that from the perspective of the testing requirements, site suitability requirements. So, to put that out on the table, do you have some comments on as we go through the repository with the TBM, what should be the priority on getting into the Calico Hills? When should that be done? How should it be done?

DR. DYER: I thought I was off the hook here, but let me start out on a response to that. If you look at the performance allocation to performance allocated through the elements of the natural system as we have it now in the SCP in section 8.3.5, the primary reliance is in the Calico Hills; the transport, the retardation capabilities of the Calico Hills.

If we develop enough information through some other aspect of the program where we can shift our allocation of performance to some other element of the natural system, then it's possible that you may not need to place that much reliance on the Calico Hills. You may be able to defer some of the testing in the Calico Hills. But, as currently configured in the absence of any information to the contrary, if we maintain the Calico Hills as a primary part of our primary element that we're relying on for performance, we need some confirmation that that barrier will perform adequately to play that role.

If we look at when we need to make that decision as to whether or not to go to the Calico Hills, realistically, I think you have to tie it into the whole underground excavation philosophy. And, let me throw this diagram up again which has some dates on it. Actually, if you have your handouts, if you look at the south portal, the exit from the south portal is about March of '96. At about that time, several months before that, is about when you might be able to support two TBM operations, when you might want to drive a second TBM down to the Calico Hills. That tells us that we need probably to make a decision in late '95 or early '96, if we follow with this construction schedule, as to whether we need to drive to the Calico Hills.

I guess, I personally don't see us being able to acquire enough information about other elements of the natural system to be able to change our performance allocation in that time frame. Right now, I would be very reluctant to take the Calico Hills out of our plan.

MR. GERTZ: Ed, I don't know if you're aware, but we did a fairly comprehensive risk benefit analysis on examining the Calico Hills.

DR. CORDING: I recall that. And, I am posing questions. I'm not giving my opinion on this at this point.

MR. GERTZ: Certainly, that's one of the options I have asked the scientists on the program to look at. Still based on what we know today is the Calico Hills still necessary--

DR. CORDING: I have been with the Board as a consultant during the period when we were discussing this in this Panel. And, we've had experience in these welded tuffs out there and the non-welded tuffs. We've seen tremendous differences in fracture frequencies. We see that from the borings. It is sometimes like night and day. And, that was one of the interests I think we had in seeing what faults look like going through that Calico Hills. If everything just looks wonderful and you aren't going to get any flow through the welded tuffs, then perhaps you're going to say, well, we've got our barrier there. But, I think that the Calico Hills, itself, is a different performer in many respects.

We've had Tom Buscheck and others at Lawrence Livermore talking about some of the interaction between the fractures and the matrix. But, at any rate, it seems to me that that is something that one wants to look at and I find it difficult to see that going out, as Russ says, being taken away from the program.

Now, one thing we had looked at here and perhaps just in one overhead, we might be able to show an alternate for putting the Calico Hills in from a separate portal. There is just one possibility that would separate that from the work you have to do in the main test level, so that you aren't getting the interference associated with tunnel boring machines. Maybe, we could just show a sketch of that and it's just sort of a conceptual sort of thing.

MR. GERTZ: We'd appreciate that. We also had some thoughts about that coming in from Solitario Canyon and other things.

DR. CORDING: I don't think Joe is coming in from Solitario Canyon here, but we looked at coming in from the other side, Midway Valley.

MR. SPERRY: This is a portal in Midway Valley. It comes down on a 11 percent grade, swings around, and it meets the Calico Hills here. And, it stays in the Calico Hills the whole way along here. And, it's essentially a similar type of arrangement that we showed this morning. The idea is to drive all the way to the end here and back up, make this deflection here.

At this point, we get the deflector inserted here. So, we shut down after we get over here and insert the deflector here. We can excavate the Calico Hills fairly easily and put the deflector in there. So then, we drag it back and go off on this to the Ghost Dance again and then come back out and go over to the Solitario here.

There's an alternate that we can go back up here into the Topopah Springs on the main test level.

DR. CORDING: And, the potential up there for using that machine for development in that area, again that would depend on timing.

MR. SPERRY: This was a schedule for the program. And, without boring you, here, I used 120 feet a day in the welded tuff; 170 feet a day in the non-welded tuff. It comes down to about 24 months. It, essentially, goes through that same program that we did on the upper level.

Is there any question?

MR. STANLEY: What's the total feet of drifting that you have on there or total feet of excavation?

MR. SPERRY: The 23,200 in the basic and, including the option ramp, the optional ramping adds 6,900. So, it's 30,000 feet including this ramp that goes up to the top.

MR. GERTZ: Where was your second access on there? It's the ramp up to the top?

MR. SPERRY: There's one access. This doesn't come out to a portal.

MR. GERTZ: Yeah, okay. That assumes we didn't need two accesses for MSHA.

DR. CORDING: Or you could tie it into the ramp up to tie it back into the repository level. So, you would get your two accesses. Sure, you would get that.

MR. GERTZ: That's the dotted line he has up there.

DR. CORDING: Right. And, the location, I see the benefit of putting things vertically so you can look at a section and see what a fault looks like in one section and look at it underneath. This is shown a little bit off of the upper repository level. It was partially to try to see if you couldn't get closer to some of these areas you wanted to get across to these faults without having to do a lot of side drifting. But, I am not sure you want to do that. Maybe you want to stay right underneath. There are some advantages to seeing faults in the same vertical profile. So, certainly, you would have to look at moving things around.

MR. HAYES: Just an observation from my viewpoint about that much drifting in the Calico Hills. If it is going to be a main barrier, I think we have to be careful that we don't somehow damage the integrity of that main barrier and I guess I'm a little concerned of that much drifting and what could be our main barrier. And, I think that encourages us always to characterize the Calico Hills. I think we all agree we have to do it, but how can we best do it to maintain integrity of the Calico Hills and get the information we need.

DR. CORDING: I think one item here is that the--I don't recall precisely what the other length of drifting is, but it's the part that's within the repository. I wouldn't guess it's much different from what is planned in the present baseline.

MR. HAYES: I think you are right, so my comment applies to the baseline.

MR. ROBERTSON: I would like to ask a general question. Will this get us into a problem of access to the external environment out through that parallel tunnel? In other words, you are now into the Calico Hills and one of your paths now has to come back up through the repository to get out to the accessible environment. You've just now created access to the outside environment from the Calico Hills by that portal.

MR. SINNOCK: I might point out that we spent consider-able time looking at the risk of excavating the Calico Hills and basically concluded the size of the facility is so small compared to the whole site, really. This overestimates; that line wouldn't even show up to scale.

The studies really don't anticipate any real problems. Again, we might have a perception problem, but again, I think, this is a different issue than do we really think it's a technical problem? It may be a big perception problem.

DR. ELKINS: This is Ned Elkins. I hate to do it, but I'm going to bring up the alternative studies for just a second. We spent a tremendous amount of deliberation during the time that we evaluated these options. And, a very important feature of the final selected configuration was the fact that you did not have a direct line of access between the Calico Hills excavation and the upper excavation. I think, Robby, that is the very point you are making. It was an important consideration in the selection of the configur- ation.

DR. CORDING: So, Ned, that relates principally to coming up the ramp and coming back into the repository.

DR. ELKINS: Yes.

DR. CORDING: But, if one were to come back up that ramp and just run it back up to where you were planning to come out anyway, then you have taken care of your concern?

DR. ELKINS: Then, you would be fine. Yes.

DR. CORDING: So, this idea of perhaps gaining an advantage by having another TBM in the repository is one that you wouldn't take advantage of or if you brought it up, you'd move it around and bring it back down or something. Okay.

DR. NORTH: I wanted to ask a question as to the state of study plans that are addressing the Calico Hills investi- gation, specifically. How much of that has been done, and especially how much has been done since the Calico Hills Risk Benefit Analysis?

MR. SPRINGER: Let's take the diffusion test as one example. Okay. After the Option 30 selection, it was revamped to include Calico Hills in that particular test.

Now, let's go to the demonstration of applicability of laboratory data. Well, it's going back to the NRC now. That study is much further behind and, basically, it's just now getting off the ground. And, it's not very well developed, relative to the Calico Hills in terms of getting a study plan out the door. The conceptual design and experiments and everything have come forward though.

DR. NORTH: Russ gave us a list of study plans related to ESF. There are about eleven of them and we discussed two more earlier in the day; the water movement with the Chlorine-36 and the manmade materials. Are you saying that really only the diffusion tests, 225, is up to date addressing Calico Hills and then there are some others you're working on?

MR. SPRINGER: No. I am saying from that Los Alamos perspective, they are. I can't answer the GS's comments on this totally. But, I think they are revising. I believe it is correct to say they are revising study plans in terms of their ESF percolation tests and stuff that account for Calico Hills testing.

DR. ELKINS: We currently have a schedule for revision of our study plans to consider the full suite of Calico Hills activities. And, Larry, you may want to expand a little, but currently USGS is back revising the UZ ESF percolation study plan to expand those activities to include locations in the Calico Hills to perform those tests. And, similar activities are going on under schedule to incorporate those.

MR. BLANCHARD: Let's see, Steve and I were probably the only two in the room that were involved in the elicitation on the Calico Hills Risk Benefit Analysis that are still in the program. We were also involved in the ESF Alternative Study as participants who were elicited. And, I am not sure my memory is well enough to remember all of the complexities that were discussed there.

But, in an attempt to address your question about timing, Ed, if I remember right, the bottom line on the Calico Hills Risk Benefit Analysis, to put it as simple as I can, was that if we believe the hydraulic and the mineralogic, the radionuclide retardation properties of the Calico Hills as a rock unit, if we believe they are the way we think they are, then by going down there early, we build very high confidence that the site is going to perform something like the performance assessment predictions.

If, on the other hand, our current model is more or less destroyed when we go down there that the hydraulic properties aren't what we think they are, and that the occurrence of radionuclide and retarding minerals is not there or it's in a peculiar distribution that doesn't benefit waste isolation, then we learn something fundamental with respect to the viability of the site. Can we rely on the Calico Hills as a principal barrier, natural barrier or not? And, the role of the Calico Hills with respect to where the

Ghost Dance Fault transgresses it or any other faults and whether or not water migrating from the surface or radionuclides migrating out of the waste package down that zone, if it is very permeable or not permeable, is of fundamental importance to the performance of that barrier.

And, so those people that were elicited for the Calico Hills Risk Benefit Analysis quickly came to the conclusion that, as early as you can verify that information, good or bad, the better off you were. And, if you really wanted to focus on should that site be disqualified, that was one of the fundamental questions that needed answering very early-on.

Steve, would you say I am very close to the bottom line essence of what was in the Calico Hills or not? Would you care to add?

MR. BROCOUM: The only thing I can add on the Calico Hills and the ESF alternatives, even the Board recommended that we pick an alternative that got us down to the Calico Hills as quickly as possible. That was a Board recommendation. And, we spent a long time telling you about ESF alternatives in Denver. We spent a day and a half or two days.

DR. ALLEN: Tom Buscheck, I cut you off just before the break and you had something you wanted to say about the Calico Hills.

MR. BUSCHECK: Thanks for asking about that.

At one of our meetings with Alan Flint and others on the project, Alan said he had dehydrated some samples of zeolitized Calico Hills and found the matrix permeability increased by five orders of magnitude.

It's questionable whether an unconfined oven drying test is relevant to in situ heating. And, that's one of the reasons why I think dehydrating the rock in situ with the actual lithostatic stress is so critical.

But, just back a couple of years, the way the Calico Hills was viewed as a barrier was with respect to matrix dominated flow and did the zeolites chemically retard nuclides. Well, now, as we've been understanding how non-equilibrium fracture flow can occur, we also understand that predominate means of retardation is matrix imbibition. If you increase the matrix permeability, you tremendously increase the ability of the system to retard fracture flow. So, increasing the matrix permeability by virtue of dehydration could be an incredibly favorable response to the system.

So, I would be very reluctant to disqualify the site based on the ambient properties of the Calico Hills when the ambient properties won't prevail. I would rather look at the properties of the Calico Hills under the ultimate thermal loading conditions which are decided. And so, I think the decision should await that type of interaction. And, I think it's critical to address that. It's critical to get that interaction because, as I was saying, Alan's data indicated you could have orders of magnitude change in the properties and our performance assessment calculations could vary immensely depending on whether that physical evidence is relevant or not.

MR. BLANCHARD: At the time the Calico Hills Risk Benefit Analysis was being considered in the plethora of references that were cited there by the subject matter experts, they didn't have benefit of your modeling or your test results, Tom. And so, it may be that they're only partly thought out. And, that the points that you bring up are well taken, especially if you take a different paradigm for the role of that principal barrier. But, more modeling and more testing needs to be done, especially some of it from the Calico Hills.

With respect to another entry of the drifting to access the Calico Hills, I think if my memory trusts me and it may not, if you go back to the 30 options in the ESF alternative, there was some options where we looked at other entries. The thing in the end, the group came down with the view that we would probably learn the most, hence get the most synergism from all the geology, hydrology, geochemistry and rock mechanic tests, if we had those drifts coincident, so that when we did intercept the fault zones, we could learn something about water flow or the mechanical properties or thermomechanical properties that were directly above and right into the Calico Hills so that you could study what happens to the very thing you were talking about. When these fractures or when these fault zones intersect that bedded unit, how is the water distributed around that intersection? Is there some sort of a matrix barrier or not? And, to what extent does either the fault zone or the fracture zone make it all the way through in an identifiable manner? What happens to this hydraulic property? Is it changing by one or many orders of magnitude?

So, we came down with the interpretation that we'd probably learn a lot more by having them coincident and intersect the faults more or less at the same location, but over one another rather than have them in different locations.

DR. CORDING: I wouldn't disagree with that. I think you could do that with a separate entrance. But, I think coming underneath is important. Briefly, in the way the program is set up at this point, would you be feeling that we should be placing more priority on getting to that Calico Hills or drifting across the repository or even getting into the heater experiments? I mean, what is the priority if you had to choose one, an environment and a limited budget?

And, perhaps, you'd say you could only come down one--you know, if you're coming down from the main test level, you can make one, put in one additional machine, you're going take it out from the ramp and go down to Calico Hills, or possibly go in with a separate portal and decouple it. Should that take priority over getting into the main test level and doing a heater test in a limited budget environment?

MR. GERTZ: I'll let Max talk first and then I'll give you the project manager's view.

DR. ALLEN: Max, you have got 30 seconds.

MR. BLANCHARD: It is a rhetorical question. I think that we have got a method that allows us to add apples, oranges, and potatoes. And, that is a regular elicitation method that we used on Calico Hills Risk Benefit Analysis on ESF alternative, on ITE. If we get the right subject matter experts together, I think we can figure out a way to come up with a defendable way to make a decision on this, and it uses expert judgment and the elicitation process in decision analysis. That's the easiest way I would try to answer that question.

DR. CORDING: That decision may be coming up pretty soon, though.

MR. GERTZ: Well, let me give you the project manager's view. Certainly, I think that they are probably all important. But, I have to look at what will sustain support for the program in the constituency that funds us relevant to the U.S. Congress. And, it's my view that they are not interested necessarily in a Busted Butte or something at the Calico Hills. They would like to see as soon as possible what the repository horizon looks like so they can take that five mile walk from the north portal to the south portal and come up with some kind of conclusion of whether we continue or not.

DR. CORDING: But, they may not be interested in heater tests.

MR. GERTZ: Yeah. They may not be; that's what I am saying. They haven't been interested in a lot of data we have given them. All they are interested in is--

DR. ALLEN: A final comment from Bill Simecka and then we're going to adjourn.

DR. SIMECKA: Okay. The point I wanted to make is that the heater test is not so much driven by site suitability. It's driven by this thermal loading issue and the extended drive trying to prove or validate the extended drive model. And that, in my view, is a very critical and urgent thing to do in parallel with the site suitability issues. So, what we shouldn't worry about or concern ourselves with which should we do because it is not an either/or/and situation.

DR. CORDING: It's which we do first.

DR. ALLEN: I want to thank everyone here for expressing themselves the way they have. This has been a very different format than the Board has used before or the Panel has used before, but in this particular subject matter, I think it has been very effective and look forward to continuing tomorrow.

Don't forget we meet at 8:00 o'clock tomorrow morning. So, you now have a recess of 14 hours minus one minute.

(Whereupon, at 6:00 p.m., the meeting was recessed.)