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Surface-Based Dry Drilling
Underground Testing Program

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P R O C E E D I N G S

(8:30 a.m.)

DR. CANTLON: Good morning. If you'll please take your seats, we'll get this session underway.

My name is John Cantlon. I'm chairman of the Nuclear Waste Technical Review Board. This is the second day of the Board's review of Surface-Based Drilling Program and the Underground Studies Program. Since we spent yesterday looking at the surface-based drilling issues and had, I think, a very fruitful discussion at the end of that, today we're going to focus our attention on the Underground Testing Program. This session will be chaired by Dr. Ed Cording, the geo-engineer on our Board and he will have a few introductory remarks to make when he takes over.

But, first, let me introduce Dan Dreyfus, the newly confirmed Director of the Office of Civilian Radioactive Waste Management. Dan, would you like to make a comment or two?

DR. DREYFUS: Well, good morning. I just stopped in for a brief cup of coffee. I'm out here for the first time and the purpose of this trip is to meet the employees and the people working on the project. So, that's what I'm going to go do. I do expect to spend a lot of time with this Board, however, and I hope to draw on all of their expertise and all of their time and absorb them fully in our efforts to try to address some of the issues that they call to our attention. So, I expect to be at the Board meetings whenever I can be and be interacting with the Board on a steady basis.

Thank you.

DR. CANTLON: Thank you very much.

Ed, you can take over?

DR. CORDING: Thank you.

I will be this morning chairing the session and then in the afternoon we're going to have again a round-table and we're very interested in input from all of you in that session this afternoon.

I wanted to make a few comments in regard to our session this morning which is focusing on the exploratory studies facility. I think one point, before we get into the exploratory studies facility, we must recognize, even though the way we have divided these sessions yesterday and today and the way a lot of our plans in the program are developed, there's a separation between surface-based and ESF for underground testing and, certainly, we need to be aware and we need to be focusing on the overall site characterization problem. The two must go hand-in-hand.

I think just one brief comment in regard to that. One of the things that we see with putting boreholes around the site is the need to obtain information on lithologic characteristics, the lithology at various depths, and then to get some idea of variations. To me, that also needs to be integrated with what we see underground. You can't get all of the lithology, of course, with a horizontal drift at one lithologic location, at one elevation, but certainly you can obtain a sampling in that lithology of local variations. And so, all that sort of information, I think, has to be put together and, as we look at the program, recognizing limited budgets and the two shouldn't be fighting against each other. The surface-based versus ESF, that should not be versus, but a cooperation of the two programs.

I wanted today, though, to focus on another integration issue and that's regarding ESF construction and ESF testing. In a program, such as this that involves cutting edge science and major, major heavy construction, this is obviously a major challenge and one that requires the best thinking and resources of everyone in the program. We have a recent report out on ESF in this last few days which addresses some of these issues and we're looking forward to further discussions with DOE on that. The title of the report is Underground Exploration and Testing at Yucca Mountain, a report of this Board.

Until very recently, the ESF strategy involved multiple excavation operations and testing principally from the north portal and this became increasingly compressed, this testing and excavation schedule, as funding continued to be delayed or not meet the expectations and these were compressed in order to meet the licensing goal of 2001. The increases in the annual budgets did not materialize to allow this goal to be achieved. Now, we're looking at a more extended program for the underground exploration and testing. Certainly, simultaneous operations that interfere with each other can be detrimental to schedule and to cost and one needs to minimize those sorts of things so that the program doesn't suffer. Once the main loop is excavated, however, there's going to be opportunity for more, much more, access to the underground for multiple operations in terms of testing, testing opportunities, and further excavation operations; starting, for example, another 18 foot machine, another machine which would be a smaller diameter machine to do further excavation. And, if these opportunities aren't taken in a timely manner, then, of course, the cost and schedule of the program will also suffer. And, we really do want to see the momentum that--and much of the progress that has been built has been gained in the last two years--for it to continue and for the program to be able to move forward.

I think we're very interested in learning more today about how we tie together testing and the construction and the exploration. We know much about the test plans that have been described and are being updated, but we would like to learn, I think, today not only about what is the test plan, but how is it to be sequenced? How does it tie into the excavation and construction?

Late last year, the project office at Yucca Mountain published a report entitled Planned Exploratory Studies Facility Tests and this document described 42 tests and the locations, in general, with ESF. The test plan at that time described 88 alcoves through the ESF in a core test area which would be approximately 9,000 feet of tunnel. In examining these 42 tests, we grouped them--I was able to group them into four different categories. There were tests associated principally with exploration sampling along the lengths of the tunnel, 16 tests for that. Thermal testing involved five tests. The hydrogeologic chemical testing was 12 and then geomechanical and the engineering type testing was nine. This seemed to be a breakdown, at least, that allowed us to look at the program and be able to assess more how they might be tied in with the construction.

The tests associated with exploration, some of which would be conducted during excavation and others after the excavation walls were exposed, include geologic mapping, sampling of perched water, testing across some of the major faults. The second area, the thermal testing, was certainly a very high priority issue that we are very concerned gets started as soon as possible and it's the thermal testing particularly for the evaluation of the groundwater vapor transport issues. Further discussion on this needs to be done and we need separate sessions, perhaps, for that. But, certainly, there's a--you know, it's important that underground thermal testing be started as soon as possible. It certainly provides a major driver to the way the underground facility is to be opened up and plans developed to allow that work to start.

The other area, the hydrogeologic or the geochemical type testing, this area with particular emphasis on tests in the unsaturated zone and the unsaturated zone percolation test plan have been also--also, really are high priority tests. These tests are described as being conducted in the alcoves throughout the ESF and in the core test area.

I hope that the discussions today will focus on what the objectives of these tests are, how these tests are to be conducted, the timing of the tests, and the manner in which they are integrated with construction. Certainly, there needs to be flexibility in these programs, but I think some outline of how these things will be tied with the construction would be of interest to us.

The geomechanical engineering testing, the fourth area that I described, makes up the remainder of these 42 tests we described. And, it's certainly important to perform these tests to develop appropriate rock support systems, evaluate long-term stability, to evaluate design and construction issues for the repository, as well as for the continuation of the work in the ESF. But, for the most part, these items on geomechanical and geoengineering are not as closely related to site suitability issues as are the hydrogeology or geochemistry tests. I think with careful planning that many of these tests can be conducted as add-ons to the thermal testing, for example, when we're concerned about the thermal issues and many of these tests also can be conducted as targets of opportunity during the excavation or behind the excavated areas in the exploratory studies facility.

With some of these thoughts in mind, I'd like to begin our presentations today. Our first presenter would be Ned Elkins with Los Alamos Labs and he's going to be reviewing the ESF program.

Just briefly, as Ned gets up here, we're going to have a review of the unsaturated zone percolation tests by Mike Chornack from the USGS, and then after the morning break, Dale Wilder from Lawrence Livermore Labs will provide an update on thermal testing.

So, Ned, we're looking forward to your presentation.

MR. ELKINS: Thanks, Ed.

I'm going to break our discussions today, at least from the test coordination standpoint, into two primary components; one, I will talk about for a few minutes here at the beginning of the morning and then, at the end of the morning, I'll come back. The first of these talks will be somewhat of a review of the preliminary test planning process, the current status of our ESF test program, and then at the end of the morning would like to spend some specific time talking about future test programs, specifically in the environment of the TBM, post-TBM testing.

Some of the questions, I think, Ed, that you raised will probably be addressed during some of the discussions given during the morning, as well as some of them I'll come back to, I think, in the second presentation. But, if you'll bear with me and, in fact, you've done a better job of describing breaking this test program up than I could, I think, and maybe even got me where I can shorten up this first presentation some. But, what I did want to do is back up and go over very briefly with you what the initial test planning process has been and where we currently stand with our testing.

The steps that we go through, not in sequence necessarily--in fact, most of this is an iterative process--but the steps in developing our test program underground, beginning at the time that we picked our new configuration coming out of the alternatives study, has been an initial or preliminary definition of testing and ongoing effort to consolidate and prioritize the test program underground and incorporation of the high-level test criteria requirements into facility designs and construction plans. Then, detailed test planning, sequencing, preparation, take these test activities in the field, and lastly, field implementation and iteration.

As I mentioned, following completion of the ESF alternatives study, the first thing that the underground test community did was to go back and take a look at the SCP, the SCPB, and scrub that against the general configuration of the ESF and the opportunities that we believe are going to be present in the ESF for fielding this test program. We then developed a preliminary test plan, Test Planning Package #91-5. That's the base of the information that Ed mentioned a few minutes ago. The input to that document was prepared by the U.S. Geological Survey, Sandia National Laboratories, Lawrence Livermore, and Los Alamos who were the primary participants in the underground test program.

Immediately, upon finishing that test planning package and getting an idea or an arm around the entire underground program, we began two processes; one of which is certainly still ongoing and the other which will be revised, as necessary. The ongoing activity are evaluations to streamline and sequence our underground test program. Forty-two activities were identified in 91-5. Of those 42, the vast majority, 85 or 90% of those activities, are multiple location activities underground, either continuous or at various points of opportunity underground. Very few of those tests are single point tests where you do that test one time and one time only. Primarily, those tests are the very large-scale thermal tests as they are currently planned.

The process of getting that preliminary test program into a design basis where we can begin to integrate our construction design activities with testing began immediately upon development of Test Planning Package 91-5 through the complete revision of Appendix B of the ESFDR which is the exploratory studies facility design requirements document. Appendix B test by test goes through the high-level design requirements, what the facility must provide in order to field these activities. So, we use the basis of 91-5 in preliminary fashion to go through and provide a high-level look at all the design requirements underground for the test activities. As a part of detailed test planning, what we do then is go back and take each of these activities in sequence and do a detailed test plan which includes detailed design construction support requirements prior to taking those activities into the field.

As Ed very capably summarized, 91-5 defined 42 tests. These ranged in complexity, if you will, from something as simple as going down and taking a bulk sample of rock out of this facility, just basic sampling type activities, through small-scale test activities which require perhaps a single borehole or a small niche in order to provide some space or application forecast to very large-scale in situ programs, the largest of which--and, current plan--certainly is our large-scale thermal test program, waste package environment test, a Lawrence Livermore activity, which will dominate, if you will, the core test area in the ESF. The results of this test planning activity, preliminary activity, are fully consistent with and represented by site characterization program baseline, the SCPB, and have been reported to the NRC in Semiannual Progress Report #4.

Currently in the field, in the ESF, five test activities are underway. The first of these, geologic mapping, actually began before we went underground. We did detailed mapping and geologic summarization of the slot & box cut area. We're taken that mapping program underground both through photogravimetric processes, as well as actual mapping of fracture surfaces and the beginning of our line surveys.

Perched water, we have in the field as a contingency. We're prepared, if we encounter any saturation-zones of moisture in the ESF, immediately to begin characterization and sampling of perched water.

We have a consolidated sampling program underway, as well; primarily, at this point in time, emphasizing the mineralogy and petrology elements of a program and water movement tests which we've initiated. This consolidated sampling effort, I think I'll talk about a little more in detail in a moment. But, it's one of those efforts that we have gone through to consolidate and try to streamline our test program by taking essentially nine of these 42 activities and combining them into a single field activity whose only real purpose is to allow for a design, support, and construction support that lets us go in and take samples for these nine activities so they can be taken to laboratories and various analyses.

We have initiated construction monitoring activities, both tied to site characterization plan, as well as an additional component of construction monitoring by our test community to support safety analyses and ongoing support of design.

Fran Ridge large block experiment is underway in terms of the setup of that activity. We've done experimental saw cutting from a block at Fran Ridge, are currently drilling and blasting in preparation of defining a single large block that will remain in place at Fran Ridge as part of Lawrence Livermore's developing test program, and that is, as I say, currently in its setup stage.

In addition to the five that are currently in the field, two additional tests are fully planned and are ready to implement in the first alcove that's being developed in the ESF and that alcove is under construction currently and, in fact, the first of these test activities have been initiated and that's the hydrochemistry test program in Alcove #1. That test activity will actually look at pristine gas samples taken immediately after round firing and mucking in selected rounds as we develop the alcove. Ultimately, the marquee test in this alcove, the large test, will be the radial borehole test, the first of our radial borehole tests, certainly, and this is a non-contact or in an anisotropic radial borehole test to define the upper Tiva Canyon.

Three additional test activities are in final planning and preparation and we will initiate these test activities almost immediately upon beginning TBM excavation. The first is tied to the contact at Bow Ridge Fault when we reach that point. Hydrologic properties in major faults, a USGS activity, part of their percolation of ESF study plan. We will begin in earnest to incorporate Sandia's thermal properties program into our consolidated sampling test at that point in time. And then, lastly, we will expand our C_2 design verification activities to include excavation investigations. The main element of our excavation investigation will be the beginning of our convergence testing or large-scale access convergence testing program.

The test program underground is sequenced and is currently in a process of sequencing--this is an ongoing iterative process--that sequence being based on a strategy and a prioritization the Yucca Mountain Project Office endorses in going through. And, I've broken the efforts that we used to prioritize this program into three primary components here. The first is an ongoing integrated test evaluation process. We're in the second phase of that process at this time. The ITE gives us a good basis, an integrated basis in our surface-based and underground test programs; priority, which of those activities do we need to be putting early emphasis on.

The second, we have a long-range characterization program planning effort and a long-range plan on the project under which on an annual basis the primary of these activities is the YMP annual planning, the near-term prioritization and resource planning process. And, this annual planning process, again, incorporates both surface-based and underground testing and we use this primarily to define in near-term bytes, given the next fiscal year coming up, what tests we need to be putting maximum emphasis on the planning of to get those programs in the field.

Final prioritization of our underground program, however, has always been based primarily on a three phase process. They ask the question of irretrievability or the retrievability of data. If we have one of our test activities that the data from which cannot be retrieved if we don't do it at the time of early excavation during construction, then we feel that the test must be put in place at the time excavation is there. We do not want to lose data. Therefore, irretrievability is the first concern or the first issue we raise on a test. If the data is retrievable, we at least have a candidate for a deferrability or for deferring to that test until such time as a window of opportunity allows without any impact to ongoing construction program. We always try to maximize our ability to field this test program with minimal impact on our ongoing construction activities.

If a test is basically retrievable, however, is very key to our determination of site suitability. Those tests tend to be those that we prioritize most highly. We feel it's very important to field those tests that give us an idea of suitability of the site as early as possible and the determination of site suitability as evaluated through our ITE process and that's being reviewed annually through our annual planning process is the basis on which we make that prioritization call.

And, lastly, some of our tests, even if they're a design related test or an engineering test and may not directly feed site suitability, if it has an extremely long fuse, if it's a long-term activity, given the fact that we're trying to meet our milestones in testing and we would like certainly not to have a test that must have a six year duration deferred until the end of the test, we allow that concept to come into the planning process to where we may prioritize the test activity simply because its duration is not compatible with a long-term deferrability.

Basically, the first part of the talk is encompassed by that. I wanted to show a couple of best available pictures. These are drawings the test coordination office essentially keeps and updates. Just very briefly to give you some idea of the upper region of the north ramp, our Title 1 design, our early design process, preliminarily identified potential locations for alcoves. These locations, some of them, are shown in your packet. You'll see several potential alcoves. In our Title 1 design process, we looked at a maximum field of test program where we looked at those potential points of opportunity where we felt that we may need to field underground tests; the purpose being we wanted our early conceptual design to be fully capable of supporting the maximum test program. These should never be looked at and read into that there will be a given number of alcoves in a given reach of tunnel or in a given reach of the ramp; only the fact that this was our initial planning currently for Package 2c which is the north ramp design or Title 2 design.

The test community is actively working to define early or critical alcoves necessary. The final number of alcoves post-construction in the north ramp is something I can't answer right now, but our best current basis for that approximation or for our best guess for that is still our Title 1 design. And, these are the alcoves that are shown here.

The first 1,000 foot section of the north ramp, I've shown blown up here and the test planning packages and job packages being developed for those activities. Again, you can't read them here, but in that first 1,000 foot reach, two alcoves, the one currently being constructed in the starter tunnel and the second being the Bow Ridge Fault alcove complex that we intend to put in upon passing through with the TBM this fiscal year.

I will throw this--it's in your package. I'll put this up, but I want to come back and spend more time with this later in the morning when we talk about our test program, sequencing of that program, along with construction. This is just a little bit of the stylization of the cartoon that Russ showed yesterday of the TBM and its setup and I do want to spend some time talking about how we will use the TBM capability to gain some early test information and how we'll sequence some of our testing behind that. But, if you don't mind, I'll defer that discussion until the second phase of these talks.

And then, lastly, you may have seen--at least, taken a glance at this one yesterday. In your package, there's a set of drawings that show the primary test activity in Alcove 1 which is in an isotropic radial borehole test. You can get an idea of the size and configuration of our first alcove that's currently being excavated. In fact, yesterday, we shot in that alcove and are now essentially 28 feet excavation depth in on this alcove. We have a design depth on this alcove at about 65 feet. The final depth will be determined with the U.S. Geological Survey at the time we pass through a shear zone which runs through and is identified by our mapping activities across the ramp and across this alcove. We want to pass through that shear zone because this non-contact test is a test that we don't want to be in a shear zone or an anomaly at the time that we run this test. You also will get an idea of the configuration, spacing, orientation of the primary core holes that will be drilled for this activity. I'll talk a little bit more about the radial borehole test activity and fault properties testing that I just wanted to talk about.

Ed, with that, certainly, any questions you want to have at this time, recognizing we'll talk in a little more detail about the test program later in the morning.

DR. CORDING: Okay. Any questions from the Board?

(No response.)

DR. CORDING: Ned, in describing the second test--or the second alcove, you described as being in the Bow Ridge and that's the second one that's shown on this sketch, this cross-section. You say that would be done right behind the machine or is that to be done later? How are you planning that now?

MR. ELKINS: At this point in time, Ed, we have not been able to determine whether or not we'll do it immediately behind the TBM or whether we'll do it some distance behind TBM. It's an open question. We would like on the first of our fault tests to get that alcove in just as quickly as we can. One of the reasons--as well as the first alcove, Ed, one of our main drivers for getting that first alcove in and for wanting to have the first ramp--or for the first fault property test as quickly as we can is we certainly have some question about the deferrability of some of our hydrologic permeability tests. We need to get some of those tests in and we need to collect the early data from those to help us determine what impacts or effects waiting one month, three months, six months, a year after primary ramp excavation will have on the collection of these data. It could modify the test plans, it could also modify our construction approach. Our concept is that some of these tests, certainly we believe we can defer for no other capability by just constructing a little deeper alcoves and getting out of the influence of the ramp. However, it's very important to us that that first alcove for the first fault property test be put in just as quickly as we can with the TBM.

So, the construction community, as well as testing is working day-by-day to define what that best window of opportunity is. Certainly, our Title 2 design process is maximally looking at ways to get alcoves started behind TBM without large-scale impact to construction where the machine has to sit down and sit idle for long periods of time. We believe there are ways to at least initiate our alcoves as the TBM passes through and then construct and complete those alcoves soon after excavation.

DR. CORDING: Will we have some opportunity maybe perhaps to describe some of those possibilities? I know that they're in the plan--I assume they're still in the development stage.

MR. ELKINS: The ability to talk about what construction has in mind for getting some of those started, Dan, I don't know who might be here from design construction today if we want to get into those in the free discussion in the afternoon.

MR. McKENZIE: Well, I think if you refer to the briefing that I gave yesterday, the backup data, there's an excavation study that's shown--I believe it's in Package 2b

--and that is supposed to contain an evaluation of what are some of the ways of getting these alcoves started with a minimal delay and indeed what process we ought to use to excavate them. But, it's not here yet. 2b is--I think, 90% review is on another month from now or two, but it is in process.

MR. ELKINS: We had discussed that at various meetings and workshops, if you will, what some of those methods might be and I would imagine that we have enough people, as I see looking around the room, that have been involved in those to, at least, discuss some ideas and certainly to hear ideas that you and your staff may have, as well.

DR. CORDING: Could we have some of those then this afternoon? Perhaps, that might be a good time for some discussion of that. I think that would be very beneficial.

Questions, John Cantlon?

DR. CANTLON: Were there any changes suggested in these tests in the alcoves and so on after the pneumatic properties impact question came up?

MR. ELKINS: No, sir. No change of the tests in the alcove.

DR. CANTLON: Thank you.

DR. CORDING: One other, Ned, I'm sorry. The radial borehole testing and the hydrochemistry testing in Alcove #1, did you say you were going to describe later what that radial borehole testing would involve?

MR. ELKINS: Yes.

DR. CORDING: Okay, fine.

MR. ELKINS: We'll talk about that a little more--

DR. CORDING: We'll talk about that later. Thank you.

Any other questions? Staff?

(No response.)

DR. CORDING: Okay, thank you. Oh, one? I'm sorry. Russ McFarland?

MR. McFARLAND: One question. Ned, looking at your test Alcove #1, the drawing you presented, I'm curious that you have an alignment to the nearest second of arc. What is the basis for that accuracy needed for the turnout of that alcove?

MR. ELKINS: It was a calculation of accuracy that's shown on the drawing. We have no field requirement for that accuracy to be met. But, this is a drawing that was developed. This is not the design drawing. This is a drawing developed in our own office. The reason that that alcove is not a perpendicular alcove, Russ, is because of a decision made in our design construction test integration program where the original location for that alcove based on preliminary mapping was to take off and be perpendicular to the ramp at Station 1+50. And, at that location, given the fact that we probably were not going to be continuing excavation of the main, we had some gripper pad problems right in that area in that we were too close to TBM activities that would be putting stress on that area. We didn't want to have an opening there. We backed up 10 feet, but it was important to end up that alcove at the opportunity that we saw from mapping. We wanted to be at that location. So, we backed up 10 feet and came in kind of at a dogleg and it's just a calculation accuracy that you see in that.

MR. McFARLAND: Okay. Thank you.

DR. CORDING: Thank you very much.

John?

DR. CANTLON: I didn't see any mention of any in situ corrosion tests for the study area. Are there none?

MR. ELKINS: The Lawrence Livermore study plan is still being developed for their waste package program testing. Dale Wilder is going to give a talk today. I believe that there probably are components of that not only in ESF, but probably as well going to be worked into our large block program and laboratory program. But, I'd almost rather Dale discuss those in detail.

DR. CORDING: Bill?

MR. CLARKE: I couldn't come up unless you called on me. That's the protocol.

Yes, indeed, we have a full range of corrosion tests planned for the ESF and also for the large block test.

In the holes that we were going to do the geochemistry, we are going to put specimens down that simulate the current design materials that we are working on with in situ monitoring sensors for both corrosion potential pH and various anion species and that will also be simulated in full scale because we are now developing sensors for the actual ESF operation, hopefully which will lead us into actual monitoring for the eventual repository.

DR. CANTLON: Before you get away, is this now with the base plan container or with the new thinking of the larger in-drift placing?

MR. CLARKE: It's going to be both and it will cover a suite of materials which will involve all the range from cold to a hot repository.

DR. CANTLON: Thank you.

DR. CORDING: You've been trying to take that off for several minutes, Ned.

MR. ELKINS: Sorry about that.

DR. CORDING: Thank you very much.

Our next presentation is by Michael Chornack with the USGS. It's the characterization of the Yucca Mountain unsaturated zone in the ESF.

MR. CHORNACK: Thank you, Ed.

Between Ed's introduction and Ned's talk, I think I'll just do a summary here because they've pretty much covered a lot of ESF tests. But, what I'm going to try to do today is give a little more detailed presentation of what we've got planned for some of our tests that will be connected with the study plan characterization of Yucca Mountain unsaturated zone studies facility.

There was some discussion yesterday as far as how current these study plans are. This is one study plan that's been quite extensively reviewed. When we first wrote the study plan, we were looking at one shaft and one shaft facility. With the change in the design from shaft to two ramps, we've had to modify the study plan quite extensively. So, this actually is Revision One of the study plan. And, because the study plan consists of eight A tests, some of these tests are construction phase tests and some of these tests are at the main test level. There are actually--sections of this study plan that are actually being written right now.

This is a brief outline of how I'd like to structure my presentation with the purpose and objective and rationale for the study and then, more important, I'd like to get into the description of the test activities as outlined in the study plan. And, I'll talk a little about the--use the studies in the starter tunnel of the first alcove, although Ned has pretty much given you everything there is, a good update on that already, and I'll conclude with some summaries.

We've seen quite a few versions of this diagram of the ESF. Basically, starter tunnel and the first testing will also be conducted in the north ramp. We've got an extensive testing program in the south ramp which pretty much mirrors the north ramp testing and we've also got some tests that will be conducted in the main test level in the TSw_2, the Topopah Spring welded.

The schematic of the lithologic units that comprise Yucca Mountain, we've broken them into stratigraphic units and also geohydrologic units and you can see that in places the stratigraphic units and the geohydrologic units do not coincide. The geohydrologic units are based primarily on hydrologic properties units trying to group the welded fractured tuffs together and the non-welded and non-fractured tuffs together.

I'll have to apologize. This diagram is not in the handout, but I've had copies made and distributed. This is a fairly recent diagram and it shows the north ramp and it also highlights some of the test locations for some of the unsaturated zone tests that we'll be conducting in the north ramp. As Ned pointed out, this is the first alcove and in that alcove we will conduct our radial borehole test and also our ESF hydrochemistry test. And, as Ned also pointed out, we have already conducted the first ESF hydrochemistry sampling in this alcove. And, the various other test locations going down along the projection of the north ramp testing both intact blocks of rock, contacts, and also some of the structural features that will be intersected by the north ramp.

Basically, our study for the characterizing of the unsaturated zone in the ESF, I've broken into two types of tests; construction phase tests and what I call post-construction phase tests. What I'm going to concentrate on today in my talk are the construction phase tests which consists of these five tests; the radial borehole tests, excavation effects, perched water tests, hydrochemistry tests, and the major fault tests. Now, these are not listed in any order in which the tests will occur. This is basically the order in which they are in the study plan. And then, at the main test level, we will conduct also these other three tests, but because of the length of time it would take to describe all those tests, I'm going to concentrate on the construction phase tests. But, they are the intact-fracture tests, percolation tests, and bulk permeability tests.

Also, listed beside these tests are the principal investigators who will actually be conducting these tests. I'm fortunate today that I do have the three principal investigators for the construction phase tests. They are present in the audience today. So, at the end of my talk, they will be able to answer any detailed technical questions because one person can't know all the technical details of all these tests. They're quite involved.

Here's a block diagram that just shows how the various tests feed into the characterization of the unsaturated zone and connects to our site unsaturated zone hydrology study. And, all these studies--the regional hydrology site saturated zone study feed into the geohydrology program.

Okay. The purpose of the study, three main purposes. The first is provide hydrologic parameter input for the resolution of design and performance issues, a very important purpose of this study. Secondly is to provide an understanding of the impacts of ramp and drift construction on the in situ hydrologic characteristics. Thirdly, the studies will contribute an understanding of the in situ hydrologic characteristics of the unsaturated zone.

I also wanted to make a very important point here that this study is not a stand-alone study. In fact, none of the studies at Yucca Mountain are stand-alone. But, the hydrologic evaluation of the unsaturated zone will be conducted as an integrated set of surface-based and ESF activities with a common objective to provide an understanding of the past, present, and future fluid flow characteristics in the unsaturated zone at Yucca Mountain.

There was a lot of discussion yesterday as far as characterizing the unsaturated zone in the vertical sense with boreholes in a horizontal sense in the ESF ramps and drifts. And, what we will do in the final analysis of all this data, we'll combine all this data and hopefully have a very good understanding of the fluid flow characteristics in the unsaturated zone at Yucca Mountain.

Okay, the objectives of the study. I've sort of broken these down into technical and what I call regulatory objectives. The technical objectives are to characterize the in situ unsaturated zone hydrologic conditions. We will do this by analyzing core and fluid samples obtained from the boreholes that are drilled in the ESF in connection with this study. From borehole logs, both the geophysical logs, lithologic logs, and tv camera logs to look at primarily the fractured characteristics encountered in the boreholes, the in situ fractured characteristics. And, also, we will conduct in situ borehole testing and monitoring. The in situ borehole testing monitoring is the major emphasis of the ESF studies. We're also trying to characterize the spatial distribution of present day fluid flow within the unsaturated zone and characterize gas and vapor flow in the unsaturated zone.

Here's another block diagram that sort of illustrates this flow of data gathering to answer the final questions of the hydrologic program primarily through the input to the various geohydrologic models; in this case, the unsaturated zone hydrologic model.

And, regulatory objectives. The regulatory objectives are primarily designed to answer design and performance issues. One is to provide hydrologic data for calculations of unsaturated zone groundwater travel time. Secondly, provide hydrologic data for the predictions of radionuclide releases to the accessible environment. This is primarily through some of the gaseous or water vapor studies. And, also, to provide hydrologic properties data to design analyses of the underground facility, repository seals, and waste packages.

And, this is just basically another block diagram that shows how the unsaturated zone studies feed into the various issues and some of the breakdown of the performance issues/design issues in characterization programs.

Okay. The rationale for the study, why do we want to conduct these studies? First, hydrologic testing in the exploratory studies facility or ESF will supplement or compliment surface-based testing. I think this is a very important fact again stating that the surface-based testing gives us a lot of--because the boreholes penetrate the unsaturated zone in vertically, we get a lot of site-specific vertical information from the vertical boreholes because the ramps give us an opportunity to intersect these units and structural features in more of a horizontal sense. We get more opportunity to investigate contacts and different structural features in situ in the exploratory studies facility.

The ESF provides an opportunity to evaluate hydrologic parameters for a wide range of scales and this will be pointed out when I get into more of the test descriptions. The ESF provides a testing environment that is suitable for three-dimensional characterization of the hydrologic properties of the rock mass. The effects of excavation on the host rock can be studied directly in the ESF. And, ESF tests will provide data for multiscale numerical modeling of the unsaturated zone.

All right. Now, the meat of the program, description of test activities. As I go through the test activities, I'm going to try to follow as closely as I can the schedule and basically point out the activity objective for the individual tests, the five construction phase tests; the rationale for the activity selection; and then, lastly, go into a very brief description of the test activity itself. What I'd like to do, I'd like to leave as much time as I can at the end of my talk, since I do have all the three PIs who are associated with these tests in the audience. Like I say, then they can fill in any information or answer the questions that come up as far as the technical description of the test activities.

The first test I'd like to talk about is the radial boreholes test and this is one of the tests that will be conducted in the first alcove in the starter tunnel along with the ESF hydrochemistry testing. The activities of the objective are to quantify gas permeability and anisotropy of the hydrogeologic units within the unsaturated zone. Estimate the tortuosity and effective porosity of drained flow paths within the unsaturated zone hydrogeologic units. Quantify the boundary effects at the hydrogeologic unit contacts. And, last, compare pneumatic and hydraulic test results, especially at the hydrogeologic unit contacts.

All right. The rationale for conducting the radial borehole tests. It's hypothesized that most fractures in the unsaturated zone are devoid of significant liquid water. The upper movement of water vapor may indicate the potential for upward movement of gaseous radionuclides. The downward movement of water may indicate the potential for radionuclide-solute transport and also downward flowing water may be diverted laterally at unit contacts.

All right. The test description. There are four test programs for testing in two ramps in the ESF. These four test programs are we will conduct air permeability-anisotropy testing within hydrogeologic units; primarily looking at the air permeability of fractures in these units contained within individual hydrogeologic units. Air-injection testing across unit contacts and see what effect the actual unit contacts going from a non-welded to a more welded tuff, what effect this has on air-injection and later relating that possibly to the percolation of water. What happens to water when it reaches these contacts. We'll conduct long-term monitoring of selected boreholes that were drilled for these other two tests. And then, as a final phase of the activity, after long-term monitoring, we will conduct water-injection testing at contact sites in selected boreholes at these contact sites.

All right. We were going to conduct gas-injection and -withdrawal testing in these boreholes. For this, we will utilize single-hole, constant-flow-rate, transient tests; single-hole, steady state, gas-injection and -withdrawal tests. After we do the single-hole testing, we will conduct at selected sites cross-hole, constant-flow-rate, transient tests and also cross-hole, steady-state, gas-injection and -withdrawal tests.

All right. The first test we will conduct will be the air-permeability anisotropy test. And, this is a schematic, a cartoon, of what we visualize the configuration of these tests to look like. These tests will be conducted from three boreholes drilled from an alcove. This will be the first type of testing that is conducted, the first type of radial boreholes test that will be conducted in the first alcove in the starter tunnel. As you see here, three boreholes drilled from an alcove. The boreholes will be configured in an expanding equilateral triangle. At the face where we spread the boreholes into the drift wall, the boreholes will be approximately two meters apart and configured in an equilateral triangle. The boreholes will be approximately 30 feet long and they will expand out from the initial equilateral triangle at approximately an 8 degree angle to where, when we terminate the boreholes that are approximately 30 feet, the distance between the boreholes should be about 9.3 meters. This will allow us to look at fracture permeability in both close to the boreholes and then look as we get out in the equilateral triangle and see if we can actually see air-flow when we do our air cross-flow testing at various distances across the boreholes.

DR. NORTH: A point of clarification.

MR. CHORNACK: Yes?

DR. NORTH: Your slide says 30 meters and you've been saying 30 feet.

MR. CHORNACK: I'm sorry, it is 30 meters. Thank you. Yes, 30 meters long boreholes, excuse me. Primarily, the length of the boreholes are determined to extend beyond the excavation disturbed zone.

As in all our boreholes we've drilled for ESF tests, to the extent possible, core samples will be collected for unsaturated zone hydrochemistry and matrix property studies. And, these boreholes will be dry-cored. They will be HQ3 size boreholes and, like I say, they will be continually cored to provide samples for hydrochemistry testing and also for matrix property testing.

The second type of test we'll conduct in connection with the radial boreholes test is the air-permeability--excuse me. I'm sorry, this is a further description of the air-permeability anisotropy testing. With the air-permeability anisotropy testing, we're trying to quantify the permeability, anisotropy, effective porosity, and tortuosity of fractures in the unsaturated zone. To do this, packers will be installed in the boreholes for air-injection monitoring and testing. We will conduct single- and cross-hole pneumatic testing. Nine preliminary sites have been selected, but the final sites will be determined as the ESF and the ramps are excavated. Also, a long-term monitoring of up to five years will be conducted on these boreholes following testing.

The stratigraphic column is the one I showed previously. This shows our preliminary test locations for conducting the anisotropy testing. You see, we have two tests in the Tiva Canyon welded unit, the first which will be conducted in the starter tunnel alcove; one test in the Paintbrush nonwelded; and then, two tests in the Topopah Spring welded unit, one in the TSw_1 and one in the TSw_2. The other numbers indicate that we also will repeat this testing in the south ramp also.

All right. Now, the second type of testing that will be conducted in the radial boreholes is the air-injection testing. The air-injection testing will be conducted in four boreholes drilled from an alcove again. The boreholes will be configured in a rectangular pattern. The boreholes will be 30 meters long, again to extend along beyond the excavation disturbed zone. And, in the other boreholes, corehole samples will be collected for hydrochemistry and matrix hydrologic properties testing.

This test, the air-injection testing, will be the test that we conduct at the contacts. And, the schematic here shows again that the boreholes will be drilled in an alcove, two of the boreholes above the contact, two below the contact, and the boreholes will be drilled up to 30 meters out perpendicular to the face of the alcove to extend beyond the disturbed zone caused by excavation.

All right. Further description of the air-injection testing. By conducting the air-injection testing, we want to quantify the hydrogeologic contact effects on air and water flow in the unsaturated zone. Again, packers will be installed in the boreholes for air-injection and monitoring. We will conduct single-hole and cross-hole pneumatic testing. Four preliminary sites have been selected for these activities in the north and south ramps. And, again, long-term monitoring of up to five years will follow the initial injection single- and cross-hole testing.

The two contacts we would like to test both in the north and south ramp is the contact between the Tiva Canyon welded and the Paintbrush nonwelded unit and then again between the Paintbrush nonwelded and the Topopah Springs welded unit, the TSw_1. And, again, we will conduct this testing in both the north and the south ramp.

As I stated before, after we conduct the air-injection testing, we'll conduct long-term monitoring. We'll instrument and monitor intervals in selected boreholes for up to five years. The boreholes will be instrumented using an inflatable packer and also pressure transducers, thermistors of thermocouples, and most likely, most of the boreholes, also thermocouple psychrometers. The boreholes will be monitored to detect barometric influences, water movement, and/or construction effects in these boreholes. Also, in these boreholes, we will have access where we can do gas sampling. Gas samples will be periodically collected during monitoring and these samples will be collected for the UZ hydrochemistry test.

Following the long-term monitoring period, we're going to conduct water-injection testing. The water-injection testing will be conducted at completion of long-term monitoring. We will use injection and monitoring boreholes. The reason we're going to do this is to determine the usefulness of effective air permeability in calculating hydraulic conductivity.

All right. The next test, excavation effects test. The activity objectives are to estimate the magnitude and extent of modification of the hydrologic properties in the Topopah Springs welded unit caused by excavation of the ESF.

The rationale for the activity selection is excavation in fractured rocks can significantly alter the physical properties of the rocks near an underground mined opening. The permeability, before and after excavation, is a parameter required by other ESF tests to estimate errors in hydrologic properties caused by construction. Also, evaluation is needed to determine the significance of excavation effects and to develop methods to correct for changes in hydrologic properties caused by excavation. So, we basically will use the results obtained from the excavation effects test to make any corrections in the hydrologic properties determined from the other testing.

All right. The test description: the evaluation parameters needed. To conduct the excavation effects test, we need pre-mining fracture permeability, rock stress, and water saturation. We also need to measure the stress changes, fracture deformation, and permeability changes resulting from the excavation. These will be the actual parameters we monitor during the excavation effect. And, also, for the excavation effects test to be considered significant, first, the change in fracture permeability needs to be measurable. Secondly, final permeability values need to be statistically different from the initial values encountered.

Okay. The general approach for the excavation effects test. One, the test will be conducted from alcoves on both sides of the planned excavation. A quick schematic of what that will look like. Boreholes will be drilled parallel to the proposed ESF opening. Air-permeability testing before and after the excavation will be conducted. This will give us our pre-mining permeabilities and our post-excavation permeabilities. In situ stress and mechanical property measurements need to be conducted before, during, and after excavation.

There are basically two approaches we're going to use for the excavation effects test. The first is the physical approach. This is a schematic of the borehole layout, alcove and borehole layout, for the physical approach. Yours are in order; mine were out of order. Okay. The physical approach is a deterministic approach where all parameters are measured. And, you can see from the borehole layout, we've got stress boreholes, permeability boreholes, and also deformation boreholes. So, we're monitoring all these three different parameters in connection with the physical approach. The measured parameters are used to support the geomechanical model and the coupled hydrologic-mechanical model is used to analyze results and to predict excavation effects where in situ conditions are different.

So, you see basically in the physical approach around the mined opening, we have a series of boreholes; stress boreholes, permeability, and deformation boreholes at varying distances and distances away from the mined opening. In these boreholes, we will construct the alcove, drill the boreholes, emplace the instruments, and then as the ESF is excavated past the boreholes, we will monitor for changes in these various parameters in the boreholes.

We also apply the statistical approach during the excavation effects test. The initial statistical test is required to verify that changes in permeability are measurable and that final permeabilities are statistically different from initial permeabilities. In the sequence of testing, the statistical tests would be conducted first because, if we don't find that we meet these conditions, we know that there's no reason to go and continue with the physical approach in the testing. We also need to know that the statistical test measurements are repeated at several locations to minimize prediction uncertainty. And, lastly, predictive permeabilities are only valid in areas where the in situ physical properties, stress, and excavation methods are the same. So, the statistical approach cannot be--it has to be, as stated there, the results can only interpolate to areas where these three properties or these three conditions are the same. Whereas in the physical approach because we measure so many different parameters, the results of the physical approach can be interpolated to other hydrogeologic units and other excavation methods in ESF, also.

DR. CORDING: Mike, you have a lot of different tests to describe here and perhaps we--would this be a good--I thought we might break it into some sections where we could ask questions on some of them because you have a long presentation also.

MR. CHORNACK: Yes, sir.

DR. CORDING: Would now be a good time to talk about the previous tests?

MR. CHORNACK: Yes, sir. That would be fine, Ed.

DR. CORDING: Okay. Are there questions regarding the testing and the information that he's provided to us at this point? Don Langmuir?

DR. LANGMUIR: Mike, just something for clarification for me. When you're running a test and you're trying to find out the properties of fracture zones by injecting in these radial boreholes, is the only way you establish what the properties are the recovery in an adjacent hole in that same alcove or do you look in other alcoves at some later date? Is there any cross-referencing away from individual alcoves?

MR. CHORNACK: At the moment, the way the plan is done --and luckily we have Gary LeCain, the principal investigator--but we will look for the perms in two ways. We will do single-hole injection and just look for a pressure decay response, but also we will do cross-hole testing. But, the cross-hole testing will be contained within the boreholes within one alcove. We don't think that we'll be able to monitor from one alcove to another because, first of all, the space in the alcoves is quite distant between the two alcoves. And, we don't think that--because of the fractured nature of the welded tuffs and the way the fractures are connected, we don't think, it would be highly unlikely, we could inject into one fracture and monitor any great distance away. I don't think we'd want to put that kind of pressure in the ground.

Gary?

MR. LeCAIN: No, that's exactly right. All the testing probably--

DR. CORDING: Could you use the microphone there? Thanks. And, identify yourself?

MR. LeCAIN: Gary LeCain, I'm the PI for the radial boreholes testing. And, Mike has described it exactly. The testing will be between boreholes in a single alcove. The distances would be too great between alcoves.

DR. LANGMUIR: Okay. There are no alcove setups planned in the ESF where you would actually hit the same fracture elsewhere at a different position, I take it?

MR. CHORNACK: Probably not, Don. The only thing we-- where we could know is the same fracture would be in major fault zones in the north and south ramp and there's no way physically possible, I don't think, that we could test across that great a distance with cross-hole testing.

DR. LANGMUIR: You're using a chemical tracer in the gas, are you not?

MR. CHORNACK: Yes, we are.

DR. LANGMUIR: Is this--

MR. CHORNACK: The tracer choice, whatever that is.

DR. LANGMUIR: Carbon hexafluoride, I think is what the compound is, one of the--

MR. CHORNACK: We have used sulphur hexafluoride.

DR. LANGMUIR: Sulphur hexafluoride.

MR. CHORNACK: And, we're also looking at using Suva and I know the DOE has an ongoing program. They're looking at various other tracers that are environmentally acceptable that we could use, Don, also. But, right now, yes, the major tracer is sulphur hexafluoride for the air-injection testing. Is that correct, Gary?

MR. LeCAIN: Correct.

DR. DOMENICO: Probably to Gary. I know you have mathematical models to interpret cross-hole tests in saturated material developed by people in Arizona. Do you have similar mathematical models to interpret quantitatively the cross-hole tests when you're dealing with air?

MR. LeCAIN: It's being worked on right now, Pat.

DR. DOMENICO: You mean, you don't have them?

MR. LeCAIN: Not at this time. We have modeling that we can do to try and match the results that we might get, but you're exactly right. The methods need to be modified to work with air.

DR. DOMENICO: Yeah, they had the methods with the saturated zone that have been tried successfully, I think, in some of these cases and that's a current matching procedure, too. But, I didn't think you had the mathematical models developed yet for the pneumatic--

MR. LeCAIN: Well, what we hope to do is adapt the saturated zone models for the unsaturated zone.

DR. LANGMUIR: Just one more thought on this. I'm expecting and you're probably expecting, as well, that when you inject a gas with a tracer in one hole, you may only get 5% back.

MR. CHORNACK: Yes, exactly.

DR. LANGMUIR: So, you'll be able to interpret these kinds of results quantitatively in terms of fracture properties?

MR. CHORNACK: Yes. Yes. We don't assume that all the gas we put in one fracture--to the best of our ability, we will try to isolate single fractures that occur in both boreholes. Now, whether we can do this is all going to depend on the fracture systems we encounter in the borehole.

DR. LANGMUIR: What about fracture zones where there's a whole series of closely spaced fractures?

MR. CHORNACK: If we have closely spaced fracture zones or swarms of fractures, we will try to isolate these both in the monitoring--excuse me, the injection hole and also the monitoring hole. Yeah, and we will try to inject across either fracture zones or single fractures. But, no, even if we are fortunate enough to isolate a single fracture, we still don't think we will recover--we will get all the tracers that we inject in one borehole because of the dispersive nature of the interjection testing.

DR. LANGMUIR: When you alcove into a fracture zone, do you get any more than characteristics in the immediate area? In other words, can you have any way of knowing how far into a fracture system can you go from an alcove to get a sense of another dimension?

MR. CHORNACK: With borehole drilling, Don?

DR. LANGMUIR: Yeah?

MR. CHORNACK: We've stated right now we're going to try to limit the boreholes to 30 meters or approximately 100 feet. Gary might be able to elaborate on it a little more.

MR. LeCAIN: Yes, we're limited to 30 meters, Don, for interference factors. But, I think what addresses your point is the reason we use an expanding equilateral triangle. That is to try and get different scale.

DR. CANTLON: Are the investigators doing the surface-based hydrology and gas studies the same as the underground group?

MR. CHORNACK: Yeah. Fortunately for Gary's position, he is the principal investigator for the surface-based air-injection testing and also the underground air-injection testing, also. Yes.

DR. CANTLON: The second question, has there been any instance in which the study plans have been modified through feedback from the initial performance assessment run?

MR. CHORNACK: I'm not familiar with any right now. Gary?

MR. LeCAIN: The only feedback we've had is from the review of the study plan. I imagine things will change once we start getting the initial data in from the testing.

DR. CANTLON: Have the people getting ready to make the second performance assessment run been in consultation with the PIs collecting the data?

MR. LeCAIN: Not that I'm aware of.

DR. CANTLON: Thank you.

DR. DOMENICO: I know we can do air-permeability tests in the laboratory. Has anybody ever done any field air-permeability tests either in a single borehole or any other way? Pneumatics is not exactly my field, but we do have hydraulic tests that I'm quite familiar with and I don't know if you have similar kinds of models to quantitatively look at the response and obtain from that high permeability which is a number and which is something you want. Is that--

MR. CHORNACK: Right, we're fortunate this is one of the tests where we have conducted prototype testing. In fact, Gary conducted quite an extensive program testing down at the NRC Apache Leap site and he can elaborate on this more.

MR. LeCAIN: Yeah, Pat, we've done prototype air-permeability testing in the field in five inch boreholes in tuff and, fortunately, the University of Arizona under Professor Evans has also conducted air -withdrawal and -injection testing in the same holes. We were able to match our results with theirs. They came out very close and the methods that we have adapted for doing the air permeability testing really required very minor modifications to the hydraulic test methods.

DR. DOMENICO: Thank you, Gary.

MR. CHORNACK: Gary, could you elaborate a little more on how we plan to use the water injection test results, possibly to--

MR. LeCAIN: One of the big questions is what good are the air-permeability estimates in extrapolating those values out to possible hydraulic conductivities which is exactly what we hope to show is possible or not possible by following air-permeability testing with the water-injection testing.

DR. CORDING: One question on these air-permeability tests. You tend to pack off a fracture that you locate within a given hole. I think that was what you described. And then, would you be able to monitor then the multiple packers in the other holes so you could pick up--you can identify other fractures and then identify which fracture is flowing through, is that the intent?

MR. CHORNACK: Yeah, exactly. Our practice is we're going to use--as you stated, we're going to use a multiple zone packer system where we will, having identified various fracture zones in the boreholes, we will pack off these zones in the boreholes and, in those boreholes, we will have both --probably, in the case of the injection, the cross-hole and single-hole injection testing, we'll have pressure transducers and also some sort of either a thermocouple or thermistor to look for pressure changes and also any kind of temperate changes. We will also have the ability to sample for our tracer gas in case, if we're just getting very, very small flow through the boreholes, hopefully, by some of the tracer gas sampling, we can detect the presence of the injected air in the monitoring boreholes, also.

DR. CORDING: I guess going back to yesterday, our discussion yesterday, on the surface-based holes, would somewhat the same sort of process be used in the surface-based holes with multiple factors where you're injecting and observing?

MR. CHORNACK: Yes, exactly. Right now, when we get our multiple borehole complexes up, Gary will also inject--will conduct surface-based air-permeability testing in those boreholes, also, using similar methods to what we use underground.

DR. CORDING: Single-holes and, I think, in some cases, cross-holes, is that right?

MR. CHORNACK: Exactly, yeah. It will first be a single-hole test and, in fact, we're getting ready to start the single-hole surface-based air-permeability testing in Borehole UE-25, UZ-16, hopefully, within the next week or so to start that testing. And then, eventually, we will conduct cross-hole testing when more boreholes are drilled in that complex.

DR. CORDING: Then, once that's done, then is it where you're going to do a passive shut-in testing, is that correct?

MR. CHORNACK: We've already done our shut-in test at UZ-16 in connection with the gaseous phase circulation studies. And, I think, after we do the air-injection testing, we'll go back and repeat the UZ hydrochemistry sampling from that borehole and again conduct possibly some more pressure shut-in tests. Hopefully, over the winter, we get some more--

DR. CORDING: So, you continue to monitor over some--so you can get some of those seasonable storm effects, is that correct?

MR. CHORNACK: Yes, exactly. Yeah. Unfortunately--and then, UZ-16 is our VSP hole. So, eventually, there will be an instrument string put in that hole for--a geophone string for vertical seismic profiling. But, in the other surface-based boreholes, we will again put a long-term monitoring system similar to what we'll use in the ESF boreholes in those holes that collect water potential from thermocouple psychrometers, pressure from--obviously, pressure transducers. We'll have thermistors to look at temperature changes in the boreholes and also a fairly elaborate gas sampling system in those boreholes.

DR. LANGMUIR: Just a minor clarification, maybe.

You've been talking about excavation effects test plan work and it wasn't clear to me whether this started where the TBM is going to begin or whether it looks at the drill and blast portion of the tunnel, as well as the TBM portion.

MR. CHORNACK: Right now, the location for the excavation effects test is scheduled to be where we start the turn for the first--the first turn at the bottom of the north ramp. Is that correct, Falah?

MR. THAMIR: That's correct.

MR. CHORNACK: And, are we going to look at in the main test level at drill and blast effects?

MR. THAMIR: We're still looking into that because we know that the TBM machine needs a starter tunnel and so we would not be able to drill the site rooms and then start the TBM. However, where Michael mentioned where we might do the test at the turn, we may have some extra room to drill the holes ahead of the tunnel. And, we may or may not repeat the test where drilling and blasting is used because we're looking at differences where the waste will be isolated and, if it's going to be isolated in rooms that will be drilled with a TBM machine, then we will not repeat it in places that will be excavated with drilling and blasting.

DR. CORDING: Would you identify yourself?

MR. THAMIR: Falah Thamir with the USGS.

DR. CORDING: Thank you.

Just one question in regard to this excavation effects test. It's something perhaps we can discuss more this afternoon, but to do that and to drill ahead and--of course, you have to wait and--any advance of the TBM has to await that work to be completed. So, you're talking about delay there of, I would assume, it's certainly in excess of a month. And so, I guess, one of the points is that maybe what you're trying to do is to see if you can't find a target of opportunity where you're doing something else where the TBM would have to otherwise be stopped. Is that correct?

MR. CHORNACK: Yeah, that's correct. Another option we have, and if we do go to the Calico Hills, would be to do the test where the Calico Hills ramp comes off the main test ramp because that would leave us--give us plenty of time to go and set up and do the test and not delay the excavation with the TBM, at all.

DR. CORDING: So, you might be able to do that, in other words, after the main loop is done and then come in and drill across before the Calico Hills excavation were done?

MR. CHORNACK: Exactly, yes. Yeah, that would be another--that would be a good window of opportunity to come back to those tests, yes.

DR. CORDING: Sure. I think one other possibility is in the core test area for the thermal testing. One of the things we've been suggesting is using a TBM to do some of the excavation there for those tests which, I think, it's needed in order to have the right type of surface to evaluate something that will be used in the future repository. And so, there might be some opportunities there also.

MR. CHORNACK: Yeah. As Falah said, we're trying to pick a location to where we're not going to delay the progress of the TBM significantly.

DR. CORDING: Okay. Thank you.

Pat Domenico?

DR. DOMENICO: Probably to Gary, it was mentioned that permeability of air is not the same as permeability of water. So that's why you're going to run the hydraulic tests afterwards to check the values. But, they must have had that same concern at Apache Leap and did they do such a study and what did they learn from that?

MR. LeCAIN: The only comparison they did between air- and water-injection was laboratory work. And, they were generally within one order of magnitude and they did differ.

DR. DOMENICO: But, it was not based on the field comparison laboratory--

MR. LeCAIN: Not that I'm aware of.

DR. DOMENICO: Well, lab work is easy to do.

MR. LeCAIN: We hope for the best, Pat.

DR. CORDING: Okay. Staff had a question. Russ

McFarland?

MR. McFARLAND: Yeah. On your size of your disturbed zone, looking at earlier illustrations, your drilling out 30 meters from the face of your alcove. Your alcove looks to be about, oh, 10 meters. Are you reaching beyond the disturbance caused by the excavation of the ramp or the disturbance caused by the excavation of the alcove?

MR. LeCAIN: That being just a schematic, the distance we actually go out with the alcove will probably vary. The first alcove is actually planned on being from 70 to 80 meters away from the ramp and it will be outside the zone.

MR. McFARLAND: Why are you out 70 to 80 meters from the ramp?

MR. LeCAIN: In this particular case, there was a shear zone. The shear zone being that there was unstable rock, basically, that we had to get through. We didn't really want to conduct our testing on that unstable rock because it wouldn't be representative of the rock of the mountain, most of the rock.

MR. McFARLAND: The reason I ask, is the alcove necessary to allow you to reach farther out or is the alcove a means of providing a drill platform? You could just as easily, if possible, drill from the face of the ramp, for example, in some cases in lieu of having an excavated alcove.

MR. LeCAIN: Both, exactly. It's to provide a point to drill from without being in the way of the TBM operating and it's also to get us away at least two diameters from the ramp to make sure we are testing relatively undisturbed rock.

MR. McFARLAND: One additional question. Perhaps, it could be addressed by Ned, but a viewgraph was shown on the second page of the presentation showing the layout of the ramp that I don't think has ever been presented to the Board before. It shows two runouts. It shows a runout on the north ramp and it shows a runout on the south ramp which was not presented at the last--

MR. CHORNACK: Excuse me, what illustration is that in?

MR. McFARLAND: Pardon me? Your presentation, second chart. I wonder if we could have that explained some time this afternoon or this morning, whenever appropriate?

MR. CHORNACK: This one here?

MR. McFARLAND: That one, yes.

MR. McKENZIE: Those ramp extensions are in the new--you know, the enhanced ESF layout. I have a better picture on the one I showed yesterday, the color one. It does show those ramp extensions on it.

MR. McFARLAND: It might be appropriate to explain those changes that have occurred since our last meeting to the north ramp.

MR. McKENZIE: Okay. Those are on--this is the same layout. The only thing that I noticed is it looks like there are three Ghost Dance drifts when, I think, we only planned on having two originally. But, this is the same layout that we showed to you in July in Denver.

MR. McFARLAND: With the runouts on the end?

MR. McKENZIE: Right. Those are in lieu of the two cross-drifts that ran across the block before.

MR. McFARLAND: And, those were presented? I stand corrected.

MR. LeCAIN: I'd like to clear something up here. I was just informed I said the alcove was going to be 80 meters out from the--I meant 80 feet, excuse me.

DR. CORDING: Just a clarification. That's the alcove that's being excavated right now?

MR. LeCAIN: Yes, sir.

DR. CORDING: All right.

Perhaps, we could go ahead with your--you've anticipated me with the perched water tests. Why don't we continue with that?

MR. CHORNACK: Thank you, Ed.

All right. The perched water test. As Ned in his presentation pointed out, this is a contingency test. It's a test we hope we don't have to use. But, with some of the developments at UZ-14, we always like to be prepared for everything.

So, the activity objective is to detect the occurrence of any perched water that might be encountered in the ESF. If it is encountered, estimate the hydraulic properties of the perched water zones, determine the implications of the existence of perched water zones on water flux, flow paths, and travel time.

Okay. The rationale for the activity selection. Perched water may imply a particular flow path for water in the unsaturated zone. Perched water ages can be used to estimate groundwater travel times. The conceptual unsaturated zone model indicates perched water may occur within or immediately above the PTn, Paintbrush nonwelded, or bedded tuffs between the Tiva and the Topopah, or at the top of the Calico Hills nonwelded hydrogeologic units. And, in fact, this is approximately the location where we did encounter water in both UZ-1 and UZ-14. The presence of or potential for perching of water in the host rock could interfere with construction, operation, and performance of a potential repository. And, also, perched water could cause modification of geochemical interactions, transport processes, flow paths, and travel times.

Okay. A brief test description. Again, tests will be conducted if perched water is encountered. If perched water is detected, hydraulic tests and chemical sampling will be initiated as soon as the area in the ESF is accessible. Flow-rate measurements will be conducted if large inflows of perched water are encountered. Boreholes will be drilled into perched water zone for sampling, testing, and monitoring of those zones.

Here's a diagram of possibly what one of our perched water boreholes could look like. Basically, drive a borehole into perched water zone. We will have again a multi-zone monitoring system instrument with pressure transducers and probably some sort of temperature monitoring device, either a thermocouple or thermistor, and also it will be plumb so we can do a sampling of the perched water zone while at the same time monitoring for pressure changes during sampling.

Okay. If we just encounter a very small perched water zone where we have just seepage into the mined openings, we will conduct seepage measurements. The seepage estimates will be estimated prior to borehole drilling. Then, we will drill boreholes into the zones where the water is seeping from to sample and also to instrument the boreholes to collect pressure measurements in the perched water zone and also for flow-rate determinations. And, also, from all the perched water boreholes, we'll, of course, sample perched water for hydrochemical analyses.

Okay. The instrumentation in the perched water boreholes. Packers and/or liners will be installed in the boreholes. There will be sampling ports connected to access tubing for each borehole for both pressure monitoring and also sampling. We'll have pressure transducers. We could have tensiometers and/or thermistors in the boreholes to monitor these pressure water potential and temperature.

Okay. The hydrochemistry test. Again, this is one of the tests we've--we've already done some preliminary hydrochemical gas sampling as they're mining the first alcove in the starter tunnel. The plan there is we're after--before they do any excavation, we'll take some gas samples and, as the excavation proceeds, we're taking gas samples from shallow boreholes drilled in the face of the alcove.

Okay. The activity objective is to collect and preserve core samples for extraction of unaltered water and gas. Collect in situ water, water vapor, and gas samples from boreholes in the exploratory studies facility. Obtain hydrochemical and isotopic data for interpretation of transport mechanisms, flow direction, and travel time of water and gas in the unsaturated zone. And, also, to determine the geochemical evolution of unsaturated zone water using hydrochemical and isotopic techniques.

We're also, through the hydrochemistry test, trying to evaluate flow and storage of gas and water within the repository block. Look at the unsaturated zone chemistry and gas distribution to help evaluate chemical transport and flow processes within the repository. Looking at pore-water chemistry and mineralogical data to provide input to the geochemical models to provide information on rock-water interactions in the unsaturated zone. And, also, to provide information on solubility and reactivity of the natural geochemical environment in the unsaturated zone and of the artificial environment created by the engineered-barrier system.

Okay. To conduct the hydrochemistry test, we will do gas sampling in boreholes drilled specifically for this test and we will also conduct gas sampling from other boreholes drilled for other ESF testing. So, hydrochemistry gas samples will be collected from boreholes drilled for other ESF testing. We will do--before we do any gas-injection testing, say, in the radial boreholes test, we will do gas sampling for hydrochemical analysis from those boreholes. As I stated before, we're also drilling short, one to two meter, small diameter boreholes prior to any excavation of alcoves and during alcove construction and also we intend to drill these boreholes as soon as we get access behind the TBM mined openings to provide gas samples that are representative, or as close to representative as possible, of pre-mining conditions. We will also drill long boreholes. If we can get them out to 45 meters, that's fine; but probably some between 30 and 45 meters will be drilled from alcoves at selected locations for the collection of core and gas samples.

And, here, this is an old diagram. So, unfortunately, you can see the ramp is more than a 2% grade. So, if you do it like that, everybody will feel a lot more comfortable with it. These are some preliminary--but, unfortunately, it shadows the faults out quite a bit and makes the units dip a lot steeper. But, these are some of the locations where we're going to do our hydrochemistry gas sampling. As you see, this is the first alcove at the Bow Ridge Fault and various locations down along the projection of the north ramp. As you see, most of these locations are boreholes that are drilled for other activities and not specifically for the UZ hydrochemistry test. Again, the same for the south ramp. We're looking at basically boreholes or windows of--boreholes of opportunity that are going to be drilled for other studies we will sample for the ESF hydrochemistry testing.

Okay. The instrumentation for the hydrochemistry test. Gas and water sampling from the boreholes will utilize access tubing in the packer-instrument systems. Again, we will have a multiple zone packer system constructed where we can put in the borehole and pack up various intervals along the boreholes so we can sample from these various intervals at one time; similar to what we do at the surface-based UZ hydrochemistry testing.

Peristaltic pumps will be used to collect gas and water samples from the boreholes. The samples will be collected for isotopic composition, $^{13}C/^{12}C$ ratio, and also ^{14}C, and also ^{3}H. A lot of these samples have to be sent out to outside laboratories for analyses; some of the analyses we can do within the U.S. Geological Survey.

We might possibly use, if we encounter moist zones in the boreholes, inflatable liners with an absorbent material to collect water samples from moist zones if we encounter any moist zones in boreholes drilled in the ESF. Also, the perched water samples would be analyzed as part of the UZ hydrochemistry test.

All right. The last tests I'm going to describe, construction phase tests, is the hydrologic properties testing of major faults. The activity objective is to measure pneumatic and hydraulic permeability, porosity, and anisotropy of major faults and associated fault zones. Also, to conduct long-term monitoring for the vertical flow of gas, water vapor, and water in the major faults. And, also, conduct tracer tests to estimate the tortuosity and effective porosity of major faults.

Okay. Rationale for the activity. Yucca Mountain contains and is bounded by west-dipping, high-angle, normal faults that may serve as pathways for or barriers to flow dependent on the ambient moisture conditions at the time.

Under wet conditions, the major faults could act as barriers to fluid--excuse me, conduits for fluid flow; under drier climatic conditions, they could actually act as barriers to fluid flow. Laterally, under wetter conditions, they could act as conduits for fluid flow down the fault plane; under drier conditions, they could act as barriers to fluid flow both laterally down-dip and also because of air being in the faults themselves they could act as barriers to fluid flow down the fault plane itself.

It's also expected that hydraulic conductivity varies along faults and fault zones. It's generally believed that major faults effect flow in the unsaturated zone. And, an additional understanding of the factors controlling fluid flow in major faults must be obtained to meet site characterization requirements.

Okay. A test description of the major fault test. To quantify the fault and fault-disturbed zone permeability and porosity, it is necessary to quantify the undisturbed tuff. Equipment and test configuration for this test were designed to maximize the testing range and also to allow for test modification depending on the types of fault zone and the types of fault-disturbed zone that we encounter as we excavate the ESF. And, also, single-hole and cross-hole testing will be conducted. Gary LeCain was chosen as the principal investigator for this test because a lot of the testing techniques we use for the major faults are very similar to the radial boreholes test.

Okay. The alcoves and boreholes. As I believe Dennis said yesterday, he started giving my talk for me, too, but he was describing some of the fault testing that we're going to do and here's a schematic diagram of what we intend to do. But, the question came up yesterday how are we going to test some of these features? Well, basically, they'll be conducted from alcoves and boreholes will be drilled from the alcoves and there will be one fault-parallel and one fault-straddling alcove at each test facility location. Fault-parallel and fault-straddling. Here's the fault indicated by the hatches and the stippled zone indicates the fault-disturbed zone. As you can see, we've got one alcove that straddles the fault and one that is basically parallel to the fault.

Okay. Boreholes will be drilled from the alcove to test undisturbed rock, fault-disturbed zone, and the fault. And, again, we're looking at a 30 meter maximum length of the boreholes.

Here, we have--basically, you see the borehole patterns for Alcove 1 again is a triangle, but the boreholes are approximately five meters apart on the side and the boreholes, as opposed to how they are in the radial boreholes tests, the boreholes are pretty much parallel to each other.

But, the three borehole configuration allows us to do both single- and also cross-hole testing in undisturbed rock, the fault zone, and the fault itself.

Now, in case the fault-disturbed zone is too large to where we can't penetrate into the borehole with a 30 meter borehole, we will drill a fourth hole out away from the fault itself to try to test undisturbed rock with some single-hole air-injection testing. And, again, for the fault-straddling alcove, a maximum of three boreholes configured at one on either side of the fault in the fault-disturbed zone and one, if there is a definite enough fault plane, will be drilled into the fault plane itself.

And, again, we will test the major faults by using, at first, pneumatic testing. Single- and cross-hole pneumatic testing will be conducted in the boreholes in both alcoves. Results from the initial single-hole testing will be used to design the borehole layout. So, basically, we'll drill one borehole, test it, and then based on the results from the single-hole air-injection testing, we will see what kind of spacing we need in the other two boreholes to conduct cross-hole testing. This will provide preliminary estimates of permeability and data for scoping calculations for the layout of the other boreholes.

Okay. Then, we'll conduct cross-hole testing. Configurations will be determined from the single borehole.

I've said that. But, then, the cross-hole pneumatic testing characterized the permeability and anisotropy within the fault-disturbed zone and the fault zone.

And, this is just a schematic of the type of instrumentation we were intending to use. Disregard SEAMIST and substitute borehole packer liner system for that. We're not sure--we probably will not use a SEAMIST system; we'll probably use more of a conventional packer system with instrumented zones in the borehole. But, basically, instrumentation will be the same. We have an injection borehole and then monitoring boreholes where we have pressure transducers and also gas sampling lines to try to detect the movement of any pressure changes or the actual tracer--detect the tracer that was injected in the one borehole into the monitoring boreholes.

Okay. Cross-hole testing will be used to estimate tortuosity in fractures, fracture zones, and possibly within intervals in the fault zone within the fault itself. Cross-hole hydraulic testing will provide the opportunity to compare pneumatic and hydraulic test results. So, hopefully, after we've done our initial interjection tests, we'll come back eventually at a later time and possibly, as in the radial borehole test, do some cross-hole hydraulic injection testing. And, eventually, the boreholes will be instrumented for long-term monitoring to try to detect any water movement, water vapor movement, or pressure changes in the faults that is transmitted down on the fault zone themselves.

Okay. I'd like to talk a little bit about UZ studies in the starter tunnel, although Ned did a better job than I can of that since he's privy to more recent information than I am. But, basically, we started to mine the first alcove in the starter tunnel. Since we started construction of the alcove, we have conducted one episode of gas sampling for UZ hydrochemistry from one of these fairly shallow, one to two meter, small diameter boreholes. And, we will conduct hydrochemistry gaseous-phase circulation and radial boreholes testing in the boreholes drilled in the alcove. What we will do is after the borehole is constructed, the first borehole, we will go in and do our gas sampling studies. Then, we will conduct a pressure shut-in test for a certain period of time in that borehole to see if we can detect any barometric changes, surface barometric changes, in the borehole. And then, lastly, we'll go in and conduct the single-hole air-permeability testing and then, eventually, after we drill the other two boreholes, do our full blown radial boreholes test.

And, the summary. Okay. The results of the ESF unsaturated zone testing, the results will be used in the resolution of Yucca Mountain Project performance and design issues concerned with fluid flow in the unsaturated zone. Principal applications will be in the assessment of groundwater and gas travel times, design analysis related to the underground repository facilities. And, also, issues concerned with the waste package containment and engineered-barrier systems will use information resulting from this test.

DR. CORDING: Thank you, Mike.

We have time for questions now on the--particularly, focusing on the perched water tests, the hydrologic properties of major faults, and the hydrochemistry tests.

DR. LANGMUIR: I guess, it would be better if I would look at the details, but I'm curious. Obviously, it's critical that you don't cause any contamination in the process of doing the sampling and it's very easy in any kind of sampling I'm aware of to contaminate a sample with material around it. Maybe you don't have any overheads that show this, the design of the gas and water sampling devices. Perhaps, they can be discussed very briefly. This may be a little more than this audience needs to hear on how one prevents contamination effects in sampling gases and fluids from the ESF.

MR. CHORNACK: Sure. Let me take a stab at it real quick, but, Charlie, you probably want to join in.

Basically, by contamination, do you mean as the sample is being taken, Don, collected? Basically, what we'll have, we'll have access tubing down to the zones of interest and we'll just use a peristaltic pump and the tubing will be isolated from the atmosphere. And, basically, for the isotopic and gas composition samples, we use a syringe and we purge the syringe so there's no contamination there in that. Am I on the right track?

DR. LANGMUIR: Yeah, that's--

MR. CHORNACK: Charlie might want to elaborate a little more as far as some of the other--the CO_2 and ^{13}C sampling.

DR. LANGMUIR: Yeah, the tritium and the ^{14}C sampling is another critical--

MR. PETERS: Yeah, I guess I need to be specific to what constituents you're thinking about. We'll collect tritium and stable isotopes from the water vapor that we pump out of the hole. And, I don't--I guess I'm not sure where we could cause contamination there. We use teflon tubes. God, I just don't see where--

DR. LANGMUIR: Well, your sampling into evacuated containers, for example, so there's nothing there to give you problems?

MR. PETERS: Right. We'll collect it into a cold trap, a glass cold trap, and we'll dedicate that cold trap to the specific zones. Yeah, as far as the sampling of cores out of the holes, we've looked fairly carefully to date at what we've been doing to the cores as we're collecting them. We're very careful about how we remove the SF-6 that's injected as part of the drilling air. We're still doing studies at surface-based holes. We've done studies at Apache Leap, at UZ-16, and we'll do them at 14. And, basically, the chronology of the holes underground will be we'll drill them with a trace gas. We'll try to remove that trace gas. We'll test the gas to be sure that we have removed it to a level where it's not going to bother us as far as the carbon isotopes and other major gases. Then, we'll collect a complete set of ^{14}C and other gas chemistries. Then, Gary LeCain will come in and do his work. He'll inject some more gas probably using a different tracer. We'll do the removal work again to make sure we clear the hole. Then, we'll collect another set of ^{14}C and we'll monitor over the next four or five years.

DR. DOMENICO: How do you run a tracer test in unsaturated material? That's a new one on me.

MR. LeCAIN: Theory has it that the flow is in the fracture systems and that the fractures are dry. We will inject the tracer into an injection interval under very low pressures, probably other selected intervals, and measure the travel time that it takes between the two injections and the point where it shows up.

DR. DOMENICO: What's driving that tracer?
MR. LeCAIN: A pressure gradient.
DR. DOMENICO: --pressure gradient, probably?
MR. LeCAIN: Yes.
DR. DOMENICO: My understanding of tracer test is you get a combined parameter. You get a ratio of tortuosity to porosity. You never can isolate one or the other.
MR. LeCAIN: Very true and we've thrown in another unknown in this and that's are all the fractures actually dry at any particular time? So, interpretation is not an exact science in this case.
DR. LANGMUIR: Given all of that ambiguity, how does one validate a measurement?
MR. LeCAIN: I think the best way to answer that is that it bounds the measurements. It bounds the values that might be used in models in estimating flow through the unsaturated zone. I would hesitate to say that we can actually give you an exact value, but I would also make that statement about most any hydraulic or pneumatic test conducted in an oil well, a gas well, or in any aquifer.
DR. CORDING: I had one question regarding the test across the faults. It's a sort of sampling that I think should be very useful because, first of all, we'll know where those faults and features are and it's well-mapped in the tunnels. How many of those are you planning to do or what

range--how are you going to make the selection of the fault testing?

MR. CHORNACK: The faults that we actually test?

DR. CORDING: Yes?

MR. CHORNACK: In the plans right now, we intend to test every major fault that is intersected in ESF. That would be the--the first one we get to would be the Bow Ridge Fault. That will be the--you know, there's about seven or eight major faults. I could name them off if you want me to, Ed, but any major fault and these are basically--by major faults, they're pretty much faults that are mappable features at the surface. All of these major faults, we will test and any--if we see any significant or major faults that up until now they haven't been mapped because they don't have any kind of surface expression, we'll also test those, also. Is that correct, Gary?

MR. LeCAIN: Yes. Yes, we've left it very open as to our selection of what we constitute to be a fault that we'd like to test.

MR. CHORNACK: But, we will test--we'll test the Bow Ridge, the Ghost Dance, the Abandoned Wash Fault, the Solitario Canyon Fault, a lot of these major features will be tested.

DR. CORDING: And, the Calico Hills, as well, is at the --

MR. CHORNACK: Yeah, that's one thing I guess I should clarify. At one time, we had a Calico Hills test and we also had a multi-purpose borehole activity in this study. These have been dropped. What we plan to do in the Calico Hills is we don't have a separate test activity. What we intend to do and we stated this in the study plan that if, indeed, we do go to the Calico Hills, any of the test activities that we conduct in the units above the Calico Hills, we will also conduct in the Calico Hills with the exception of probably the excavation effects test; we won't conduct in the Calico Hills. But, all the other data collection activities, we will conduct those in the Calico Hills also.

DR. CORDING: Do you consider that most of these fault tests would be--you'd be able to conduct after completion of the loop?

MR. CHORNACK: Yes.

DR. CORDING: So that you can do the alcoves after the loop is done so that you won't have to do those every time right behind the machine?

MR. CHORNACK: I believe that's true. Isn't it, do you think, Gary, on that? The timing of the tests and the--

MR. LeCAIN: The impacts on the major faults would probably be minimal if we did finish the loop, although I'll always argue that we need to do these right away.

DR, CORDING: Okay. In regard to data collection and data system, I know there's discussion of some sort of a system that would collect data and bring it to the surface and evaluate it, process it, a major data logging system. And, I was wondering just what your--on these tests which are going to be spread throughout the facility, what your approach would be on the collection of the data itself? Would there be basically the data collection effort--are you thinking it could be done right there in the alcove? What do you have to have in terms of that type of support?

MR. CHORNACK: As far as the data acquisition system?

DR. CORDING: Data acquisition?

MR. CHORNACK: Yeah, what we intend for most of the tests, we intend to have stand-alone data acquisition systems, some sort of portable data log that would be right there at the testing location. This data could be transferred into the larger IDS or DAS system that is going to be installed in the ESF. Falah, do you want to comment on that, at all? I know you attend a lot of those meetings.

MR. THAMIR: Some tests that require mobile data acquisition systems, like Gary LeCain, that's what he'll use and then we'll use programs that convert the data collected by those mobile systems to a standardized format that will be stored on a centralized system.

DR. CORDING: Is it something that has to be transmitted to the surface or is it a matter of being able to collect the data there and then transfer it by disk? I mean, are you going to have to have lines and a system running to the surface to do that?

MR. THAMIR: We're currently working on that with the DAS people and it depends on how fast they will be able to install their network underground. If they are able to install their network before we start testing, then it will all be done underground. Otherwise, we'll have to work around this.

MR. CHORNACK: We could go either way, Ed. You know, if there is some sort of transmittal system installed in the ESF, we can go ahead and tap into that. But, we're not dependent on it. We can stand alone. We can actually physically just transfer the data from our collection activities to the surface.

DR. CORDING: I would assume that your activities would be one of the major reasons for having an IDS system, wouldn't it?

MR. CHORNACK: I don't think so. No, I think some of the other--although, I'm not really familiar with this aspect of the program. I think there would be other--some of the other testing activities, like the thermal experiments and things like that, are a little more dependent on the installed--the hard line to carry the data to the surface. Falah, is that your understanding?

MR. THAMIR: That's correct.

DR. CORDING: Thank you. It's time for--well, we have a question from our staff. Any staff questions? Leon?

DR. REITER: Several times in the past, we have visited the Äspö Hardrock Laboratory in Sweden. They're digging an underground facility there. The last time there, we asked the geologists what are some of the surprises they've had. One thing that came out was they said that it was very--although it was easy to see the fractures in the faults, it was very hard for them to predict which of them water would be flowing out of. And, the reason being the interconnection was there; they couldn't understand that. Now, they have the advantage, they have a wet system. They can see where the water is flowing out. You're doing a lot of studies in individual faults. We know that fault zones exist. We know the Ghost Dance is, God knows, how many hundreds of feet wide, the Imbricate Fault system. How are you going to take these studies of these individual faults and translate that to how the fault systems are behaving, particularly at a time when you have--in the future, we may have a lot more water than you have now.

MR. CHORNACK: That sounds like a modeling question. Ed, where's our modelers? I have some modeling support here. Where did he go? Ed, is that a modeling question?

DR. REITER: Excuse me, and part of the concern was, I think, Ed's paper--Ed's presentation to the Board in April where he did a theoretical study showing that depending on how much rainfall, different size fractures were activated.

MR. KWICKLIS: I think we do have a problem in that we are sampling the faults at relatively few locations and I guess it's a question of do we want a little information or no information, at all. We're constrained somewhat by where the ramps intersect these faults. And, while we'd like to have measurements at many more locations, the current layout of ESF dictates that we're going to cross these faults only at certain locations and we have to live with these constraints. And, we acknowledge that the transmissivity of these fault zones is, in part, saturation dependent and there will need to be a lot of interpretive modeling to go with the physical measurements which are measurements only at one saturation. And so, we'll need to depend on laboratory tests on smaller scale features in combination with these field tests and modeling to really understand how these fault zones are going to behave under different saturation conditions.

DR. REITER: Just one last question. How are you going to overcome the problem of interconnection of these systems? You can model--you would have to test every single fault in the system, but how are you going to overcome the interconnection aspects of it?

MR. KWICKLIS: I'd have to say that, you know, you're going to really rely on a complete picture formed by geochemistry, pneumatic testing, modeling, and that this information is going to be complimentary. And, we'll look at things like isotopes, ^{14}C, gas, and liquid isotopes to help us understand just how interconnected and flowing these features have been in the past because we can't test every interval, but we can look at travel times within those fault zones to help us understand how liquid has moved there in the past then. And, in combination with the physical property determinations from air- and water-injection testing and interpretive modeling, our hope is that we can have a somewhat coherent picture of how these faults behave.

MR. CHORNACK: Do you care to elaborate on that, Gary, at all? Do you have any thoughts on this?

MR. LeCAIN: Not a chance.

DR. CORDING: All right. Well, thanks very much.

We have a break until 10:45.

MR. CHORNACK: Thank you.

(Whereupon, a brief recess was taken.)

DR. CORDING: We're ready to reconvene.

Our next speaker is Dale Wilder, Lawrence Livermore National Lab, talking about thermal--the precise title is thermal testing update.

MR. WILDER: Thank you, Ed.

I struggled a little bit, I'll have to admit, with what I was going to say since we had discussed this topic very recently within the last three months. And, I decided what I was going to do is to perhaps review just briefly some of the things that we had talked about the last time and then bring you up to date on what has transpired on the large block test because that's where most of the current work is occurring. And so, I will call your attention to the presentation which was made in July. I guess, if I stand there, you're not going to be able to see, are you? I'll stand over here.

At that time, we did talk about the waste package environment thermal testing. I don't plan to plow that same ground too much today except I would call to your attention that in your package are some of the viewgraphs--for instance, the testing strategy and so forth--that came out of that presentation. I've put that in there for your review. I'm not planning to really discuss too much on this unless there are questions. But, I would remind you that we did talk about the fundamental hypothesis that we were going to be testing, the criteria for the ESF test themselves, and then we talked a little bit about schedule. There were a number of different schedule alternatives, two of them to be exact, which we did discuss. What I'm going to do today is to restrict myself pretty much to talking about the strategy where we're looking at the large block test and how it fits into the ESF testing.

I think that I pointed out last time that the results of these large block tests would be used to help us to revise our study plans and activity plans for the ESF test, but that the test at the large block would not be completed in time to precede the study plan. Therefore, what we would do would be to review those ESF plans in light of the early large block test data. Our anticipation was that we could begin heating some time in the middle of 1994 and that, based on what we were seeing, we would make any changes to the test plans and certainly would modify any equipment orders and calibrations that may be progressing.

I also talked about in terms of ESF testing a concept of using abbreviated testing to provide the data for the license application and a series of tests, a cool-down test and a constant heating test, to back that up at the time when we went to license. I know that some of this material was picked up in your report that I had a chance to review last night and certainly one of the issues that I brought up was that for some of the heterogeneity reasons, we may have to do very long-term monitoring and performance confirmation testing.

Also, during our conversations in July, I talked about the need to begin testing prior to the ESF test and gave the rationalization for that large block test. And so, at that time, we did--I hope you can see this--we did give you a little bit of a status on the large block test. At that time, we had cleaned off the outcrop, we had mapped--I think I showed you some of the fracture mapping--and we had selected a general block location, all this work being done at Fran Ridge. So, now, I would like to then discuss what has happened since July.

As I say I'm going to be stressing the large block test because we haven't really changed much in our thinking in terms of the ESF testing, although we continue to have meetings with the project office and with other participants. There's really not been a lot that's been changed in our ESF test planning. There has, however, been quite a bit of activity on the large block test.

One of the things which did occur was planning offsite. We spent three days discussing the large block test. And, out of that, came several important conclusions and directions. Let me just try to summarize a few of those. One is the recognition for a increasing need for material testing. Our original test plan was to include some metal coupons perhaps on the heaters that were going to be emplaced in the large block and to observe the corrosion, if we could. We recognized, however, that there wasn't going to be much moisture in the area of the heaters. So, we had been thinking about moving the location of those metal coupons down below the heater plane where we would expect to have condensate dripping. I think we may have discussed this at our last Board meeting.

At the offsite, it became quite apparent to us that we not only needed to put the boreholes below the plane of the heaters in order to do metal tests, but we also talked about the number of other needs and one of them was to go ahead and put the metals in the heater boreholes in addition to the ones below because of issues over thermal degradation, thermal issues on the materials themselves. We don't expect to see any corrosion because, as I say, there will be a very minimal amount of water. We also are going to incorporate some rather exciting work that's being done with microelectronics, looking at corrosion potentials and so forth. Those will be incorporated both in the heaters and in the boreholes below the heater plane.

We also recognize the critical need to better constrain our tests for geochemical purposes and we would be able to--in an in situ test and I think probably one of the bottom lines that came out of this offsite was the recognition that even if we were allowed to do as we had originally hoped, in situ testing somewhere, prototype testing, that we would still need something like a block test where we could control the boundary conditions and we could look at some of the issues such as refluxing which have come to the forefront a lot more over the last few months. Part of this is in addressing things like the crushed tuff column experiments at Princeton and so forth and also part of it is a recognition in the difficulty in trying to characterize geochemistry. The advantage that we have with the block is when we are completed, we can take the block apart. We can look at the fracture systems. We can try to understand, at least, the changes in the mineralogy and relate those to the hydrology and geochemistry monitoring that have been done during the test.

We discussed a lot of new instrumentation during this offsite, much of which will include things like fiber-optics. The SEAMIST is going to be very critical for our program in the large block test. We are also looking at, as I mentioned, microelectronics and fiber-optics to look at some of the geochemical parameters.

We also decided that one of the things we needed to do in order to give us some confidence in our hydrology models was to control the boundary conditions. And so, out of this, came a lot of details which are going to be reflected in the activity plan in terms of guard heaters along the edges, the boundaries, as well as just monitoring the temperatures where we can keep controlled temperatures along the boundaries, seal the boundaries so that we do not have any moisture going out of the boundaries, and we will then be able to look at refluxing conditions above the heaters. And, part of this was discussed at our last Board meeting.

A couple of other things that did come out of the offsite planning. The scientific investigation plan had already been prepared, but the offsite planning provided the basis for a very detailed activity plan which is currently in our technical information department for editing and should be out beginning its review process at the end of this month. And so, we anticipate that we will be able to get the planning documents completed as a result of this planning offsite.

A couple of other things that have happened. We did complete the topography maps and started planning how to do the excavation. As a matter of fact, some of the excavation work has started and I'm going to talk about that, as well. A lot of discussion at the offsite. It was how would we excavate the block without damaging the block itself or excavate the material outside of the block.

The other thing that I should mention is that the test frame contract has been awarded. There was a lot of discussion over this one because in the offsite, it became quite apparent that although the test frame complicates our test, we didn't feel that we could go without some sort of loading on the block. One of the problems that we had is that, in essence, with those five boreholes, five heater boreholes, we have created a presplit condition if we're not careful and, if we heat the block, we were concerned that we were going to get a horizontal fracture across the line of the heaters and also at the bottom of the block where we are expecting horizontal stresses that might fracture the block. And, I know that this has been a problem in the past with some of the tests. For instance, the heated block test that Sandia had, they felt they had a disconnect at the bottom. In many respects, we would like to have done that, but we can't control it and so we didn't want a fracture being created. So, we really felt that we needed a vertical loading. And, of course, for reasons of asperity contacts, in terms of pressure dissolution and so forth for the geochemistry, we felt that we did need to maintain horizontal stresses.

Originally, we had planned on a stress ratio similar to what we would expect underground at Yucca Mountain. It became quite apparent, as the bids came back to us, that it was going to be entirely too costly for us to be able to build a test frame capable of 100 bars vertical and 50 bars horizontal. Through a series of renegotiations, we backed off to a 50 bars vertical and horizontal. That does not necessarily mean that they will be the same, horizontal and vertical stress, but we certainly will not be able to go up to 100 bars in the vertical. Our expectation is that the frame will be available in about six months. And so, that fabrication is progressing as we speak.

Let me then share with you--and, I apologize it was--I know you're not supposed to apologize for a slide, but nevertheless, this one, I recognize it's somewhat busy. It's the only one that I had available. But, let me try to walk through this schedule. As you'll notice, there's a preliminary sawing that was scheduled and I will talk about that. We did a test with the belt saw. It's not the full length saw that will cut the block, but it is a similar design and I'll talk about some of the results of that because we're quite encouraged by the results. We also had scheduled leveling off the block and I'll talk about this in some detail with fracture mapping. In essence, we are on schedule with this and expect that we will be able to do the fracture mapping perhaps not the first of November, but certainly very close thereto. With sawing of the block itself scheduled for mid-November and I believe that's still on schedule and then excavation starting of the block. The block support is in active design right now and, of course, it will have to be available at the time we start doing the actual excavation. The characterization work continues in terms of the mapping. We will be doing more mapping after the leveling is completed. I'm going to talk a little bit about some of the drilling, both the vertical and the horizontal drilling. So, I guess, in terms of status, we feel that we are very much on schedule.

I mentioned that we did a prototyping of the saw cut. This is the belt saw that was used. You can't really see it because it's so bleached out, but this is a sump that was provided for the recirculation of the water used in the sawing operation; basically, just a black plastic around here to catch the water. We made two parallel cuts. This is a view looking at the frame of the saw. The other view is one that you already saw, a little bit expanded view with the belt on the pulley system. And so, we did cut two slots approximately four foot deep and I think they were about five or six feet long. We were very encouraged by the results. I do have a video. Unfortunately, I don't have the tv here. I understand it may be available during the break if people are interested.

But, we looked down the cut that was left with a fiber-optic camera and two or three things that we saw that encourage us that we'll be able to excavate this block. One was we did see areas where the rock had obviously had started falling out on us. And, one of our concerns and the reason for doing the prototype testing was to make sure that we weren't going to get the blade of the saw wedged in by chunks of rock coming out. Apparently, what happened is, is these started to fall out. They were just chewed up by the saw and they were not a problem, at all, to us. So, you can see in this little video that there's some areas where the rock has fallen out and those chips were not a problem to us.

We were also very gratified at how straight and even the saw curve was. It was very straight and smooth-walled. We also saw one section which again is visible on the video where you could see the water that had been used in the drilling had run into the fracture and was weeping back out. It looked--well, it wasn't weeping, but it was moist along the fracture surface.

What you're looking at here is after the two saw cuts had been made and these are the two parallel saw cuts. For whatever reason, we decided not to make four of them and I think with a little hindsight wished that we had have made the four. We would have had a block exposed. But, at any rate, after the saw cuts, REECo went in with just a jackleg and excavated out material that was outside of the saw cut.

I should move that up. Now, I think I've got a closer view. Let me move to the closer view so I can--you can't get a good sense for how straight this cut is because of the change in elevation and so forth and also the color. But, you can see some of the blocks that were taken out. So, they were able to actually pop out some fairly good size blocks off the side with no damage to the remaining block.

This block is approximately two feet--or the saw cuts were approximately two feet apart and, as I say, they were as much as four feet deep.

DR. LANGMUIR: Dale, what's the formation we're cutting out of here and making the block?

MR. WILDER: Okay. This is, essentially, the Topopah Springs tuff. We are a little bit south of where the block is and we're right on the contact with the lithophysae. And, as you'll see right at the top here, this is not the zone of interest. It's the deeper zone which will be represented in the block. But, it is the same tuff that we would expect in our in situ tests in the ESF.

DR. LANGMUIR: Is that altered material in the top of the block that you're going to--

MR. WILDER: That's altered and it's also--well, let me go ahead and just put on the other. What you're looking at and the reason it says top and it's kind of upside down is this is the block that was excavated and laid off to the side that I showed in the previous picture. And so, it's kind of like a little wedge and this is the soft surface that matches the other surface over here. As you can see, we do have these lithophysaes present. Part of what you're seeing is the surface alteration and part of it is also the fact that we are right in that lithophysae zone. As you get deeper, as you can see, it does get to be more of the typical Topopah

Springs.

DR. LANGMUIR: Are you going to avoid looking at the thermal effects on the altered portion and try and exclude that from your block test?

MR. WILDER: Yes, a good lead-in for the next viewgraph here. Our intention is to excavate the first couple feet, perhaps as much as three feet, above the block area. We'll level that, so that we can then go in and make our saw cuts for the block itself. After all of that has been done, we will trim off the first--the top foot so that we can remove any damage that occurred during the excavation. One of the things that we're also in the process of doing is we're going to have to build a sump to catch the water from the sawing operation and also to allow us access from this direction to do our horizontal drilling. This work has pretty much progressed on schedule.

What you're looking at is a plan view of this excavation area. It's the excavation plan with the topo shown on top. I would point out that this first portion of this benching operation was performed as a prototype. That is they drilled a series of presplit holes and then went in with these vertical holes and excavated with explosive the way that they were planning to do the excavation. We identified fractures in which we had painted lines across where we could investigate whether or not there was any movement of those fractures as a result of the excavation and then they did their first excavation here. And, that is on the videotape, as well as a closeup of the little grid that was put on the fractures.

DR. CANTLON: Dale, what's the scale there? What's the red dot with--

MR. WILDER: Let's see, our scale--well, let me show you another figure. I don't remember the exact scale. I think this may help us. Six and a half foot? Thanks, Jim. The vertical scale, we're looking at approximately 20 feet of vertical elevation from the point of the excavation here on the east up to where we will eventually be excavating this top leveling bench. The total distance scale, as you can see, is somewhere about, well, 120 feet approximately from this edge up to this edge. The block itself, of course, we talked about it being approximately 10 foot square, though it doesn't show up here, but it's located essentially in the center here.

After the first prototype excavation, if you will, the vertical holes in this part of the benching were drilled. The excavation was not completed because we needed access up to this area in order to do these vertical boreholes. So, a ramp was constructed and the drill rig is in the process of drilling these holes. Now, we did have an accident which, fortunately, was not a serious one. We were very lucky that no one got hurt. But, they did tip the drill rig over. And so, now, they're completing the last--I think it's about a dozen holes, 10 to a dozen holes, by hand with a jackleg and that work is progressing also, as I understand, and should be completed by the end of this week.

After that work is completed, then the plan is to go back to the lower area and excavate out all this material, so that there is then an ability to have access for these horizontal holes which will be drilled so that we can break the rock without doing too much damage to the underlying block area itself. Then, they will detonate the explosive in the overburden and we'll remove it. At that point, we should have access to begin the mapping. As I say, the mapping is scheduled early November and, at that time, not only will we map and select a location for the block, in general, we will put in vertical boreholes because we need to drill those first and we will do air-permeability testing in the first borehole. Based on the results of that testing, we will either decide we're going to have to move the block somewhat to get in rock that's more appropriate for our test or we will then finalize the location of that block, put on a template in which we can then drill all of our instrumentation boreholes, vertical boreholes, and then we can move to make the saw cuts.

DR. LANGMUIR: I'm wondering what your preliminary assessment is of the amount of fracturing that you're likely to find and whether there's still continuity in terms of physical strength across the fractures and what they represent in terms of what you'd expect in the mountain?

MR. WILDER: Okay. We certainly feel that there's going to be a number of major, as well as minor, fractures present. I think I showed the map the last time and I didn't bring a copy of that with me. But, we have certainly fractures on approximately at one every foot kind of spacing. Most of them are vertical, although we are seeing a lot more horizontal fractures especially if we went down the pit that's nearby and looked. There are a number of horizontal fractures, but the predominant fracture is going to be vertical fracturing, approximately one every foot, some of which are very continuous, others terminate on other fractures. So, our expectation is that we'll see the complete range of fracture characteristics that would be necessary for us to really get an understanding on this, both interconnectivity of the fractures, as well as the statistical distribution of our hydrologic responses in either short fractures, tight fractures, so forth. We also have seen apertures that have varied anywhere from maybe as much as half an inch, three-eighths of an inch, on down to essentially completely tight and all you see is just an alteration almost like a pencil line to define the fracture.

Our big concern, as we had expressed last time and I think is still a concern for us, is that the fractures are healed with perhaps--not 100%, but many of the fractures are healed with silica, carbonates, and so forth. We feel that this will not invalidate our geochemistry tests. What's it's going to do is test a different part of the geochemical understanding models than perhaps we will eventually need to validate for the ESF. We don't expect that kind of--certainly underground. We're not sure how much of that is going to die off with depth and we're hoping that we can get out of the major portion of field fracture zones.

I think that that pretty much concludes what I was intending to talk about. I should have mentioned when I was talking about the offsite that this was not just a Livermore offsite. We did invite a number of participants. We had the representatives there from Los Alamos, both the project management office here, as well as the geochemists, Sandia, the M&O, DOE, and we feel that we've got a pretty good relationship developed in terms of making sure our test is going to be useful to everyone. We do plan to use some of the testing that Sandia is developing for hydrology and we are going to be using some of their--specifically, their x-ray tomography and we're going to be trying to incorporate some of the Los Alamos geochemical approaches, as well. So, I think that we are moving. The one slide that I didn't show which was in your packet and somehow I've lost it was the slide showing the test excavation. I guess, I would without trying to dwell on it too much say that, yes, we are moving forward. As the slide says, we're moving dirt. We've excavated and it looks like we're moving on schedule.

DR. CORDING: Thank you, Dale.

Questions, Board?

DR. LANGMUIR: Dale, you mentioned that you had silica sealing of fractures that you observed in the shallow parts of the formation that you're looking at. I'd be curious from the GS whether they've observed the same kind of shallow sealing of fracture zones in their vertical boreholes as you're seeing here and what happens to them as they proceed down. It's a question for someone else perhaps, but maybe you've talked to them about this.

MR. WILDER: Let me first share with you what I know and I'm sure someone from USGS can amplify on this. There is a horizontal borehole very near to where the large block test is located. In that borehole, they did see fractures healing at the very near collar position. When they got to, as I understand it, approximately the equivalent of 30 feet of overburden, that fracture healing started to pretty much die out.

DR. FLINT: In the 24 or so holes that we've drilled on Yucca Mountain in the last two years, what we've typically found is about the first 20 feet to 25 feet, the fractures are for the most part filled with calcium carbonates. As we get below that from 30 to maybe 50 feet, we find a lot of fracture coatings, and then below maybe 50 to 75 feet, we start to find more open fractures. But, about the first 20 to 30 feet are almost always filled with carbonates.

DR. LANGMUIR: Is this a general phenomena that includes what you see in Trench 14? Do you think it's the same sort of surface--

DR. FLINT: It's the same--

DR. LANGMUIR: Weathering and then percolation down?

DR. FLINT: It's the same type of phenomena where we have the calcium carbonates deposited on the surface mostly as dust and then that's dissolved in the water. Then, water moves into the fractures. We don't see very deep flow of the water. So, when the water evaporates, it leaves the carbonates there. In the soils in the area, we see it out two to three meters. We see these big carbonate layers. But, where we have very thin soils or exposed--we get water down right into the fractures and we do see that plugging to about 25 feet or so.

DR. LANGMUIR: This is getting away from Dale's talk, but I'm curious now. How tight does that make the top of the mountain if you're looking at healing at below and moving fluids up through it? Have you got a cap because of these ceilings?

DR. FLINT: To a large extent, I think we do. I think we have a well-healed surface for a large extent.

DR. CORDING: Thanks, Alan.

Other questions?

DR. LANGMUIR: Last week, I was at a workshop, Dale, where Rich Van Konynenburg talked about corrosion of metals and concluded that it was likely to occur when water ponded on the metals around the repository, perhaps, and radiolysis created nitric acid which was then the basis for the corrosion effect. I'm just wondering, have you thought about this or were you aware of his conclusions and how does this tie into your proposed test of metals in your block?

MR. WILDER: Certainly, we have observed that. We observed it at the spent fuel test where we had dripping water and saw tremendous corrosion of the carbon and steel borehole liners. We've done some analysis. Rich Van Konynenburg basically is the one responsible for that in terms of radiolysis and its impact. And, of course, as we've said many times, it depends on what the final design is. If we go with some sort of a self-shielded container, it's going to be much less of an issue. What we've seen in terms of the environment itself, however, is if we went with the SCP kind of a reference design, thin-walled container, in a borehole that the radiolysis is of concern only in the borehole itself, within a couple of centimeters. You no longer have issues of radiolysis within the rock matrix. It's strictly within the borehole. And so, it's going to be dependent upon what moisture conditions are. As Rich says, if you've got water ponded there next to a non-shielded container, that certainly can change the water chemistry. I think it's also going to depend upon what your container material selection are as to how sensitive that is to the changes. But, certainly, the production of nitric acid or ammonium, if you're going to a copper base, would be of some concern. I know that Bill Clarke and his folks have looked at that rather extensively.

In terms of our block test, we are not planning to try to evaluate radiolysis in any fashion. And, we're also assuming that the ultimate design will probably be an in-drift emplacement. There are a number of things you can do in in-drift emplacement to try to moderate any ponding and so forth, although you may get some water film. So, our tests are strictly to look at dripping water on top of the metal coupons, down those holes in the condensate zone, and to look at what happens at the heaters themselves where you do go through the drying out and possibly depositing some precipitants.

DR. CORDING: We're running out of time here. But, I just had one question. When do you see the start now?

What's the latest on the start of the underground testing within the ESF? When do you think you can actually start heating underground? What's your current prognosis?

MR. WILDER: My understanding is that we still expect to have access in like the June of '96 time frame to begin our test installation. We would start heating six months after we have access. So, we're looking, essentially, at the end of '96 to begin our heater tests is my understanding. I think Ned may be able to give you further insight. Is that correct, Ned? Are we still on track for '96? I think Ned said we might even beat that.

MR. ELKINS: We'll talk about it.

MR. WILDER: Okay. Ned will talk about that later.

DR. CORDING: Okay. You know, one of the things that we've--you discussed in your previous presentation was the desirability of having some sort of offsite tunnel type tests. You know, the timing of going underground and the timing of that sort of thing is obviously important. If it takes you as long to develop one at the surface as it does to get underground, then it's no point in doing one off the site. But, if there's--if we're going to look at this three years down the line and not have started anything underground, then people will be saying, well, why didn't we do something earlier prior to this? I'm sure there will be reasons why, but the question is, you know, how long--how long will it take for us to really get started underground and there's a lot of other considerations in terms of how the underground work goes. But, is it going to slip to the point that the possibility of a separate facility is one that still ought to be considered? I guess that's the question I have.

MR. WILDER: Of course, our view has always been that we would prefer to have a Busted Butte or other location to do testing before ESF, but the very practical issue is would it even make any sense if we stay on the schedule? And, as far as I know, we are currently on schedule to get underground in '96.

DR. CORDING: Anything else?

(No response.)

DR. CORDING: Thank you very much.

The next presentation will be Ned Elkins talking about ESF testing and test locations.

MR. ELKINS: What I would like to try and provide for you now is a little more information on the scope of the underground test program and our future test program plans recognizing that we are in the middle of a lot of the actual planning for not only our construction program, but certainly our test program underground, as well. We'll share with you what our current ideas are, our plans are, and some of the main areas that we're actively working, main areas of concern in that ongoing development.

Let me start this by showing you this and also using it as an example of the environment in which we're finding ourselves right now in ESF. It's fast-moving and there's changes. As we begin to settle on configuration, as procurement of TBM and arrival and setup and the beginning of construction begins, this that I've put together a couple of months ago is already somewhat dated. That's why I say use as an example of that environment that we're in.

The construction of Alcove #1 is ongoing. We talked about that a little bit this morning. We won't spend any more time specifically with it now unless there's questions.

Initial hydrologic testing begins and has begun now with hydrochemistry testing in that alcove and will run through June of '94. This date will almost certainly now extend beyond June of '94 as our initial core drilling in this alcove will probably not commence until late December/ early January and we believe we need about three months to drill and set up. I'm talking about three months for initial testing. So, we may be a little too optimistic in thinking we'll close down our initial phase in that first alcove in June.

Start of TBM excavation, I believe is still current. This date still holds at about August 1994.

Entry into the block at TSw_2 horizon, this is information that the test coordination group developed on some preliminary information, March of '95. We don't know if that still holds. That may be a little premature. I don't know if Dan or someone is here that wants to correct that or give us an update on it, but this is the date that we're kind of using as a planning basis.

Our daylight on the south ramp, I'm showing here May '96. I believe I've seen June, maybe a little slight update on that date.

Initial construction of core test area, based on what I am currently hearing from construction design is that it will not be concurrent. Is that right, Dan? Therefore, the beginning of that construction in the core test area coincides essentially with the end of loop construction.

MR. McKENZIE: That's correct, Ned. We're talking about running the loop first and then basically immediately thereafter starting excavation of the main test area.

MR. ELKINS: Okay. Now, given the inability to co-develop a core test area in the main test level of the ESF with loop construction, the dates that we have currently on the books for initiation of our thermal test program which is the large test program in the ESF is obviously going to see change if that doesn't in some way get modified. And, the ways to modify that are two-fold. Either find and we're working on ways to get an underground thermal program going without dependency on the large scale test in the core test area of the MTF. The second is to find a way to concurrently develop that core test area and begin to set up for thermal testing without major impact while TBM loop is developed. Both of those are still being evaluated and being looked at, but the conservative schedule that's being reflected here assumes that for safety and operational reasons, no major development lateral to that loop can be concurrent with TBM operation.

DR. CORDING: Briefly there, Ned, that would put--to develop the core test area for the testing would be, at least, another year or year and a half and so it would be almost two years from that point which you'd really be able to turn on heaters.

MR. ELKINS: Yes, sir. I believe Dan's walking up again, but I believe you're--the time frames you just mentioned are almost exactly right. Dan?

MR. McKENZIE: Pretty close. I think based on that kind of a start in the main test area, we would project a November '97 to flip on the switch for the heater test. So, we're looking at, what, 18 months or something after daylight.

MR. ELKINS: Very briefly, I wanted you to have a feeling for what we put into planning. This is the detailed planning prior to taking an activity in the field. Really getting serious about planning and doing the detailed work on any activity is going to follow this implementation sequence, the prioritization/implementation sequence I named earlier. It will also be driven to some degree by the complexity of the test. A very simplistic test, we don't need to plan on very long ahead of implementation, but something such as a waste package environment test, we're going to need to be in a formal planning and development and design development process probably a year to a year and a half before that test activity would hope to go to the field. So, design and construction complexity, as well as long-lead procurements, might get us into a formal planning activity earlier, but all tests will eventually go into and develop a very controlled planning process.

The elements of that detailed planning are the design requirements both for the facility itself and the design of the test. The test layout, as well as the ESF facility support design must be there for the test. That input must be provided formally through ongoing ESF design and so our scheduling and our test planning must coincide with the concurrent packages being developed on the ESF side.

Test performance criteria are a part of that detailed planning, certainly. We must do detailed interference and site performance impact analyses that are performed to look at the impact of the activity on other activities, also on potential impact of the activity on overall site performance and waste isolation capability. Procurement planning, as I mentioned, is a part of this process making sure that procedures that will be used in the actual implementation of the test are in place, formally there, brought by the PI organization. And then, lastly, taking that planning activity and infusing that into the overall scheduling and integrated network development, and costing through the job package process which is a formal documentation procedural process that all of our tests must go through so that we can track progress, both cost and time, as this test activity gets put in the field.

Our emphasis on planning is always in trying to maintain flexibility, not to over-specify a test in a control document process where we're spending all of our time going through formal changes to formal documents when we get into the field because the field will always provide an environment of surprise to some degree and we must be able to modify our test program, capture those changes in our administrative process, capture those changes in our scientific notebooks and our field activities, and not get them tied up too often in control documents.

Real briefly, to follow on, Ed this morning had given you one way to break down these 42 activities in the ESF. I want to take a little different spin in it real quickly and just take a look at the activities planned underground based on where they're going to be fielded.

Starting with the tests that would be in the ESF ramps and drifts--and this is the initial loop and this is the main drift program in the ESF--are geologic and geohydrologic tests that will be in the ramps and drifts and I'm not going to spend too much time with any of them, but would entertain questions. Some of them, you've heard in detail, especially the percolation type tests. Chornack spent a lot of time on them. Mike did a good job of summarizing those. Some of these others, we won't hear anything about today. I'll, at least, answer questions if you have any in general on these.

But, these are the primary tests that will be performed in our ramps. Mapping, which is ongoing; sampling, ongoing. Intact-fracture testing, percolation, radial boreholes, hydrochemistry, properties in major faults, all of those out of a single USGS study plan that you've heard about this morning. Diffusion testing, tomography/vertical seismic profiling, perched water, which is again USGS percolation test plan. I put asterisks by these that either do definitely or could require the development of a side excavation, a small alcove or niche to perform these test activities.

Also, in the ramps and drifts, non-geohydrologic or more of the geomechanical or engineering tests that we have currently planned. Consolidated sampling again is a part of that effort. Excavation effects testing, which you heard some about this morning. Maybe a quick point of clarification there, I may not have been in the room at the time that we were discussing this. I want to make sure you understand that that test would not be performed in the main. It would not be in the loop. This test is designed right now currently on book to be performed in two areas of opportunity; one is a take-off of the north ramp extension to the Calico Hills, and second, the west extension or the east/west drift in the MTL. In both of those instances, we would have opportunity ahead of time to set up for this test at a place where we're going to come back to a lateral excavation, either a TBM take-off through the Calico in one instance or a mobile miner or smaller TBM drive on the core in the main test level to the west, and this would not directly interfere. That instrumentation package that Falah clarified and that Mike talked about is not designed to be run in the main or in the loop.

So, anyway, excavation effects, a demonstration breakout room that we still have planned for the upper Topopah, TSw_1, high lithophysal zone. We still intend to run a heater test program in that demonstration breakout room. Plate loading tests, excavation investigation activities including convergence monitoring, stability, and ventilation.

Overcore stress testing and in situ seal component testing which is planned for down the line. None of that will be in construction. Most of this is after we've completed our construction activity or seals program. We'll extend right into a confirmatory program.

And, on the mains and drifts, we get to the core test area itself. Our primary program on the book for the core test areas, consolidated sampling; a set of thermal activities, canister-scale heater, heated block, thermal stress, heated room, repository horizon near-field hydrologic environment, and geomechanical attributes of the waste package environment. These activities, the last two, encompass Lawrence Livermore's primary program; second, third, fourth, and fifth of those primarily are Sandia's thermal program. I will talk a little more in a minute about our concepts and where we're headed with consolidation of those programs. But, in terms of specific SCP activities, those are the thermal related activities in the core test area.

Geologic/geohydrologic tests in the core test area include mapping, consolidated sampling, percolation, radial boreholes, diffusion, hydrochemistry, and tomography/VSP work. The geomechanical and engineering tests in the core test area are sampling, plate loading, rock mass strength, sequential drift mining, excavation investigations--we've talked about a little bit earlier--and overcore stress.

I want to shift from actual location of these activities to a little bit about deferrability now and how these tests would be sequenced in construction of the ESF. And, I want to focus on tests that we believe, at least, to some degree are non-deferrable, tests we must be involved with during construction of the ESF and, specifically, here at the loop, the TBM loop that we've spent so much time on this morning already.

The first of those is just the pad area and with the testing that was primary there was just a geologic look and mapping of surface exposures which has been done. In the north ramp starter tunnel, we spent time talking about these. Mapping, which is there in the drill and blast environment and that is ongoing still in our alcove. Limited consolidated sampling and mineralogy/petrology, chloride/chlorine-36 or water movement type sampling activities, and matrix hydrologic property sampling, perched water there as a contingency, and construction monitoring or design verification, a set of activities that are actually looking at construction and doing design verification as that component of the excavation is underway.

As we then go into the TBM excavation following the starter tunnel, geologic mapping will continue to be a non-deferable activity, consolidated sampling to the extent possible. We'll take all the samples we can during the actual excavation and get those out into the laboratory analyses programs. Our perched water program always will be there and be ready to step in if saturation is encountered. Construction monitoring and design verification will continue in that construction environment as it must. Radial boreholes, in which I put both anisotropy and contact testing. Hydrochemistry testing and hydrologic properties and major faults. Especially, and I wanted to emphasize, initial geothermal phase of that program and I don't know if Mike spent any time on geothermal element of that test this morning or not. These are three hydrology tests that I--as I mentioned this morning, we're not certain right now about the deferrability of this entire program. However, I am gratified at the number of witnesses in this room to hear the USGS this morning tell us that these were deferrable in terms of alcove construction. So, I'm going to tend to remember some of that because I don't think we're quite there at that point yet to make that statement. But, we felt it was very important to get an initial alcove in right now to learn some of these types of tests; the hydrochemistry and the radial borehole test primarily to give us some idea about what kind of risk we're running with deferring these tests long-term after that excavation is complete.

Certainly, as I mentioned this morning, we want to get the alcove in on the Bow Ridge Fault and do that testing along that fault just as quickly as we can. The ability after that to defer until post-loop construction or later in the program additional alcoves for radial borehole type testing or fault property testing, if at all possible, these will be deferred if they can be, certainly, outside of the construction impact arena and maybe even until after the loop is there, but I think it's premature to say that we have confidence that those in all cases could or should be delayed until after excavation is complete.

DR. LANGMUIR: If you defer them, do you defer cutting the alcoves?

MR. ELKINS: Well, yes, that's the primary--once the alcove is cut, there is no question in our mind about deferrability. Once an alcove is in place, the tests must be fielded immediately. For instance, in our first alcove that we're constructing now, we have a design depth on that alcove where we believe proper conditions are going to be met to initiate drilling of the triangular pattern of holes that Mike described this morning. However, we are also in the process of getting together our drilling system, dust suppression system, tracer injection system, that whole procurement is coming together now. A requirement we have on construction of that alcove, given the permeability nature and some of the potential drying effects that may be in that alcove, we cannot finish that alcove. We cannot collar up or be at a point of collaring up until within a week or two of the start of that actual drilling program. If we're not ready to drill, we're going to stop short of final completion of that alcove and then finish the last couple of rounds when we know for a fact we're ready to drill. That's how important that is.

The test program consolidation, I've talked about it on and off just a little bit and I'd like to give you a little more detail on some of our ideas there. We are underway with investigating consolidation, wherever possible, in our test program. Highlighted areas of potential consolidation for our test program, I've identified five of them here. One of them is already complete.

Nine of our activities, as I mentioned this morning, are sampling activities. We have combined those nine sampling activities which cross the organizational boundaries of the GS, Livermore, Sandia, and Los Alamos into a single consolidated sampling program, a single field activity primarily supported by our USGS, USBR geologists underground to provide our samples for all of our laboratory analyses and to minimize the traffic and the number of people that at any point in time will be underground looking at that collection of just bulk samples from the ESF.

We have six thermal waste package environment activities that we're looking at consolidating, wherever possible, into at least a single environment where we use co-utilized heater and drift environments to let these activities go forward. And, these are primarily Sandia and Lawrence Livermore. Lawrence Livermore's program is perceived to be the driver or the bigger of those programs and, to every extent we can, we would like to have the Sandia program dovetail or consolidate into that and use opportunities provided by the drift and heater emplacements of the Livermore program.

The third is excavation effects, which you heard some about this morning, and sequential drift mining tests; sequential drift mining being Sandia's program. Excavation effects of the USGS program, we're going to look, at least, at the possibility of having PIs utilize the same opportunity to collect this information. And, we're just very early in discussions on this potential consolidation.

Bulk permeability testing and radial borehole testing, two of the activities out of the USGS percolation program. Pretty much--and I don't know if the GS--Falah or maybe somebody here would like to speak to this a little bit more. For the most part, I think that the USGS is pretty far along that consolidation already. We intend to primarily consolidate those two test activities into a single activity we're calling radial borehole. So, we won't be running bulk permeability tests, per se. That configuration will be combined. And, I don't know, Charlie or Gary, I don't know --Gary LeCain, Mike, do you all want to expand on that a little?

MR. LeCAIN: Yeah, the radial boreholes and the bulk permeability use a lot of the similar methodologies and, as far as planning packages, they probably could be consolidated. The main differences are the locations. The bulk permeability tests are located at the main test level; while the radial boreholes are in the ramp coming in. And, the scale, the bulk permeability test is a much larger scale test than the radial boreholes. But, as far as test planning or design, paperwork, they are quite similar.

I'd like to make a comment, though, to Ned. When Mike Chornack was referring to the deferment possibilities with the major faults, I'm sure he was referring to the pneumatic testing of the major faults which is what he presented to you. There is another component of the major faults that requires a borehole to reach the fault zone previous to the TBM reaching the fault zone. That cannot be deferred or we lose the data from that test.

MR. ELKINS: Yeah, the initial--the overhead that I showed indicated parenthetically an initial geothermal borehole. Let me just make sure that you understand. That's what Gary was stressing. There's a two component activity at a fault. One of them is a borehole prior to major disturbance and, certainly, before we begin to get ventilation exchange along that fault zone, we feel it's important to get that borehole out there.

The second and the potentially deferrable or the one that we want to look at deferrability on is the alcove development pneumatic testing. But, I believe the GS would back me on saying that until we get more data, we certainly don't want to be comfortable with just saying that all of those alcoves are deferrable until post-loop. At least, I've never been comfortable with that from the GS perspective to this time.

Let's see, have I gone through these? Lastly, excavation monitoring test activities into a single program integrated with construction. Essentially, that has already taken place, as well, in terms of field implementation. Sandia, who has these five activities, pretty much run a single construction monitoring activity. We encapsulate that into a single planning activity, a single package of activities that go into the field looking at things such as drift stability, ground support monitoring. These activities are done singularly as opposed to individual in the field.

A couple of overheads. This, I believe, is an overhead that was in the morning package. I'm not even sure I threw it up this morning. But, it was shown--I think, Mike showed a variation of this and it came from the Test Coordination Office. I'll throw it up again. I think, it's the one where Russ questioned some possible--these extensions which are shown here. The Test Coordination Office put some dates on that are not coordinated with or don't reflect the current, I think, design or construction planning, but it's where we started from a test planning saying if we had no programmatic impacts of a construction program, whatsoever, and giving a consistent rate of excavation events, what would primarily be our loop excavation rate and then coming back and getting into these ramp extensions. Test planning needs a basis on which to begin to look at its opportunities, deferrability/non-deferrability of tests and scheduling, its planning. We've used this as a basis and this drawing represents a test coordination representation, not design or construction.

However, one of the things that I'll mention very briefly in terms of opportunities that we haven't begun to spend a lot of time with, but we will certainly, is the current area where the core test area would be developed as opposed to the opportunities that may be presented in the extension of these ramps. It's very exciting to the test community. And, may offer great opportunity to find an earlier opportunity with less development required to get some of our thermal test programs and in situ testing off into these ramp extensions without having to develop several thousand feet of development in the core test area. The opportunities are there; not only better access, but in some cases a better vertical look at the unit in question, TSw_2, where those ramp extensions will see high, middle, and low elements in that profile, not just at one location. So, we're currently beginning to heat up to begin to look at taking full advantage of those opportunities.

DR. CORDING: Ned, those extensions would be after the main loop is excavated or not?

MR. ELKINS: Yes, that's my understanding. I don't know the last--I see Dan's nodding his head in the back. Yes, the last that I have certainly been involved in any planning, we would complete the loop and then using either that TBM or different TBM--I haven't heard what we would actually use to excavate--Dan, I don't know if that's been decided--but come back in and then begin these extensions.

DR. CORDING: I believe that's the drawing that we were referring to earlier which we hadn't--I think it's true that we had not been briefed on that. So, it's good to see that.

MR. ELKINS: Okay.

DR. CORDING: And, we may have some more discussion of that perhaps after lunch.

MR. ELKINS: Sure. The other thing that I wanted--because I heard some comment about the lack of ability to look at our faults in multiple locations. This configuration and one that in testing we haven't yet been able to fully embrace, but has always, since we first saw this configuration, had one very exciting opportunity with the Ghost Dance Fault is that this ramp--or this drift system that comes in and parallels the Ghost Dance allows us--and, we've shown two, but I could just as easily say we might want five. These are very short stub drifts. If we can get them in and they can come in post-excavation of the ramp, come in and look at multiple locations across the Ghost Dance, I think we're going to get a much stronger look at, at least, one good fault system that is going to be very important to us.

The other opportunity I think we have here is this boring, the possibility of a geothermal program which doesn't even require driving a drift out there, but just an alcove off of the main where--to run a series of these geothermal type holes, I think are going to be things the test program are going to very much want to look at, as well. So, we're excited about some of these opportunities that this configuration allows.

DR. CORDING: And, that configuration, you are able to do all this alcove work in the vicinity of the fault from those extensions and that means that you're not going to be putting that into the delay on the main drift driving with a large machine?

MR. ELKINS: Absolutely. Absolutely.

DR. CORDING I mean, I think one thing that in looking at all the things that you're wanting to do here and, when someone says we're going to be drilling ahead to locate--you know, to get information on the fault before the tunneling is in the vicinity of it and recognizing what the width of some of these faults can be, that you can get into an awful lot of drilling out ahead. There's a tremendous opportunity for interference here and to tie together the--to me, it's just essential and I know you're working on this, but to tie together what is really needed from a testing standpoint because this is an exploration testing program, that's what it's for, but to tie it together with the construction in such a way that you can make the best progress possible so that you can get to other things that you've got to be doing like the core test area and to put all this together, it's a tremendous challenge.

MR. ELKINS: Absolutely.

DR. CORDING: And, I believe that trying to go in and --for example, I think the fact that you have a large tunnel to work with means that you're going to have some extra room, particularly if you use certain types of haulage like--use rail haulage, you're going to have some extra space in that that might allow you to do some of the drilling out ahead to work off of platforms that won't interfere with the transport of muck and material, men, people, to the heading, so that you can keep going with the tunneling. And, I think that if you put together all the things that you're wanting to do here, then a two year progress through this facility is probably where you're at, but the actual tunneling required here is more like one year for the TBM. So, the more you can gain on that, the more you get earlier to your other--get the whole area opened up for all the other work you're trying to do. I think that's a challenge that it's just going to take some very close coordination working with your contractor, with your design people, as well as your scientific groups.

MR. ELKINS: I agree completely. Absolutely. And, we are certainly not there now. But, it begins with very close coordination and communication with design construction and the testing community and we are there now. And, if that communication is daily and is a continuous interchange, that always has as its focus the ability to continue providing for our data collection needs while not, at least, shutting down and completely putting idle our construction activities. And, we seek that opportunity. We've come a long way from the times of the old vertical shafts, drill and blast construction, where we had better than 1,000 days of construction down time to facilitate testing into a program where we already have down to even anticipating programmatic delays, we're only talking weeks of likely down time in this activity. We're very pleased with that and we continue to seek those opportunities wherever we can to better streamline and organize this program. A lot of challenges, we agree.

DR. CORDING: Thank you.

Don?

DR. LANGMUIR: We heard from Mike Chornack this morning about the GS plans to use radial boreholes to get at the gas characteristics of fracture systems and you've just pointed out and reminded us of the Ghost Dance Fault proximity to that drift. I would have assumed--I would have like to have seen GS proposing that, yeah, we have these things in the plans currently, the alcoves, but here's a terrific opportunity to look at flow within fractures between two points.

MR. ELKINS: Yes, absolutely.

DR. LANGMUIR: And, let's defer some alcove work and go out and start proposing some tests on that Ghost Dance Fault zone.

MR. ELKINS: Believe you me, the GS is anxiously ready to begin. This right now is still not a projects decision. This has been proposed and we're looking at it and testing has embraced it as something that we can fully run our program at and, in fact, we see--and, you just picked up a good example--some real advantages of this program. Once the project has formally accepted this as their technical baseline, then we will begin, I think, very aggressively to see some of our test planning to begin to embrace some of that.

MR. McKENZIE: The whole idea of this enhancement to the ESF is pretty new to the program. Some guys from Morrison-Knudsen, myself, and a couple of others who really had more to do with it than I did, sort of just said, hey, guys, we've got a better idea and, you know, we showed it to them six months ago. So, there's a lot of--they're just starting to try to get used to this plan and, as Ned says, it's not even the baseline yet, but it's getting close. So, if it looks like, gee, there's a lot of opportunities we're missing here, it's not that we're missing them; it's just that everybody has got to get used to the idea that there's a lot of--for example, the drift that's very close to the Ghost Dance all along for 10,000 feet, there's a lot of opportunity there.

MR. ELKINS: I agree. And, we'll take full advantage of that.

DR. CORDING: Don?

DR. LANGMUIR: Just one other. Perhaps, this is not for you. Maybe Gary LeCain can answer the question. But, you mentioned and I'm aware that we're going to have ventilation effects within the tunnel system as we proceed and we're going to have pressure effects. And, I wonder how that's going to be dealt with when we're gas sampling in fracture zones? Because if you're going at low pressures when you inject into the radial boreholes, these pressures won't be very much greater, perhaps, than the pressures in the tunnel itself. How do we prevent contamination effects because of the pressures in the tunnel?

MR. ELKINS: Gary, I see you walking up.

MR. LeCAIN: You've hit the nail on the head, Don. How do you discriminate between the barometric influences that you're seeing--potentially seeing and those that you hope to cause by your gas-injection? But, what we basically do is keep a barometer, air pressure transducer, that tells us any barometric or any fluctuations in the tunnel or the ramp and then try and take them out in the analysis. Now, usually, we hope that the measurements that we make are significantly larger than the smaller barometric fluctuations we might see.

MR. ELKINS: Thanks, Gary.

DR. CORDING: Okay. I think we need to close our session and meet at 1:00 o'clock. We're delaying this a little bit for after lunch. So, we'll have a one hour lunch.

I would like to emphasize to you all that we're going to be having a round-table discussion after one or two presentations. I'd like to make sure that the participants of this morning, as well as those of yesterday, are available to participate in that discussion and we're going to be set up in a way in which you should be moving towards the front of the room to be ready for that discussion which will be held around 2:00 o'clock.

So, thank you very much. We'll see you at 1:00.

(Whereupon, a luncheon recess was taken.)

AFTERNOON SESSION

DR. CORDING: We're ready to begin our afternoon session. If you'd all be seated. We're ready to begin this afternoon's session.

This afternoon we're going to have presentations by Tom Statton and then Russ Dyer will provide closing remarks for DOE. At that time then we're going to have a short break, then we're going to reassemble for the round-table discussion which would be held sometime around two o'clock, and I will be a little bit involved in the presentations and I tend to be sitting in the front row of the chairs that we have set up for the round-table discussion. I believe the round-table discussion will have no table.

So we're ready to start this afternoon and I know Ned Elkins was disappointed that we didn't have more questions for him at the end as everybody wanted to go to lunch, so we also will have during that round-table discussion--I'm sure Ned will receive his wishes on that.

So the Testing Program Coordination and Integration by Tom Statton, who's manager of site characterization, strategic planning and technical integration with the M&O.

Tom?

MR. STATTON: And I made a deal with Ned over lunch, and he can have my questions. I didn't want him to feel left out either.

What I want to get at is sort of a couple things in the purpose of this talk, and I hope that the view graphs that were sort of envisioned a couple weeks ago turn out to be a good vehicle for us to talk about some of these things. The first of which was a comment in the most recent Board report that addressed itself to strategic planning and an expanded strategic plan for the program, specifically the testing program and with inference to testing versus construction and surface based testing versus underground testing and the like. The project office has concluded also sort of simultaneously--probably at the time the Board was preparing its report--that maybe we needed to address ourselves in a more succinct way to what that strategic planning is about. And I think we have organized ourselves in concert with the Department of Energy as the M&O to try and produce that strategic plan, to try to articulate some of the things that I think throughout the morning we've heard.

We've clearly this morning heard that an individual activity has planned, focused on providing specific information. We've heard through some of the presentations that groups of activities have organized themselves to provide some rolled-up understanding of the site.

We started off at the beginning talking about sort of a master plan for the program, whether it's the test and evaluation plan, here's the test planning, here's the implementation and here's the evaluation of that. We certainly began with the SCP and maybe we'll start with sort of a little motherhood bit that says, yeah, we did start with an SCP that articulated a strategy to get from where we were, where we needed to know something, to the end of a process where in fact if this turns out to be the right place to be, we can develop a license application.

Clearly, that strategy forms the basis of our program.

You want it higher? That's pretty good. Nobody's ever asked me to talk louder or more often.

But clearly, this negotiated strategy of the SCP with our regulator in fact forms the basis of our program. We've had a lot of discussion as to whether or not that strategy as identified in the SCP is one that's acceptable in today's environment. We've talked about a deep borehole program and we spent some good time yesterday talking about whether or not we needed to core, all the core that was going to be collected, or indeed whether we needed to drill all those boreholes that have been identified. And I think we need to remember that the strategy of the program is a fairly conservative strategy. It was envisioned at the time it was written to be a low-risk strategy of getting from point A at the beginning to point B, which was the ability to license a site.

I question whether or not, you know, forty deep borehole program at the conclusion of one and a half of those boreholes, it's time to begin to pare that program. Is it time to pare the program down in terms of the number of holes or the amount of core or the number of tests being done, or are we in fact evidencing our frustration with the fact that the funding profiles haven't provided the execution path we wanted, time is too long, dollars are too scarce? And so, we're struggling at this point in time with how to fix that problem when in fact we're at a fairly immature or beginning state of the program that we're talking about. So I think those are some of the things we want to think about as we talk about this planning process, and we'll get into at least what my vision of what the strategy or strategic plan needs to be, what it's role in governing our program needs to be, and then how we translate that global rather low-risk conservative strategy into executable bites in an environment we don't like transpires. How does the program get guided in that condition.

Certainly we start off with the identification of data. We had a bunch of talk about that this morning. We talked in fact very specifically about how some tests address themselves to regulatory issues. We've talked about how some groups of tests relate themselves to some intellectual state of knowledge that in fact does something for us. So we do start with the concept of identifying our data needs and that translates all the way down into defining the facilities that are required for us to go make the group of observations that we make. We have within the program some fairly sophisticated testing. I'm more of a low-key observationalist and so I look at it as an opportunity to make a suite of observations about an experiment that Mother Nature's been running for several million years for us, and what we're trying to do is provide ourselves the opportunity to go read the dial gages; some in a perturbed state in running an active test, some in a very observational state. And it's that observational state that I think has a lot of our interest focused here on the ESF. But nonetheless, as we go through all of that, we need to remember that the specific observations, the specific tests after we've now identified the parameters and the facilities required for those, do in fact need to relate back to the regulatory issues that we're supposed to be addressing ourselves to.

It's this planning exercise that I think relates our thinking, our program, to the opportunity to make the observations, the opportunities to collect the bits of data. We certainly had some discussion as to whether all the right bits of data have been envisioned as we progress down this road of learning about Yucca Mountain, and in fact, those are very useful discussions to us and I think it is through this organization of trying to articulate that master plan that we can gather those bits of information and incorporate it into the baseline for the program.

What I'd like to do is sort of talk through the planning process in sort of three phases. The framework development phase, which to me is kind of the intellectual backdrop. It is the strategy that's articulated in the SCP that is our long-range plan. Now, whether or not each of the pieces along that route ultimately have to be undertaken, whether all of the tasks have to be run, whether all the evaluations have to be made, I think in today's environment it's probably not a relevant consideration anymore than my view do I need 40 boreholes or 39 boreholes out of the plan. The question is, do I have a plan against which I can measure what I've learned and observed to help me shape tomorrow's plan. And I think that's what this backdrop is about. It's the articulation of the strategy in terms of words and specifics that we've laid out in the SCP.

Well, we have some other constraints put on us. The Department of Energy has sort of the one to three or three to five year plan that's a mandated exercise as part of the way they do business. Those are dictated to us both in the budget profiles that we will be planning for, as well as the time term that we'll be looking at. And those come from the Internal Review Board, they come from the Office of Management and Budget, they come from a variety of sources and they say here are the planning assumptions against which you will set your construct. I know that there have been a number of comments made that said the program always plans for a budget that it's never going to get, and those have been fairly blunt words and it isn't that we don't understand that. It's that the constraints internally require us to establish those baselines. So it's the process of filtering this plan into this context that drives us into the planning cycles and the planning assumptions that we make. That's not to say that given the establishment of an intellectual backdrop there aren't alternate strategies that could be developed. But I think based on both the Board report and our internal observation, we've concluded that we need a little better articulation or I think in your words, it was an expansion of the study program into a comprehensive strategy. I think from the vantage point of the project, it's not that the strategy doesn't exist; it exists at various levels of detail. And the question is, is how do you knit that together so that I can see a coherent whole against which I can measure change, or against which I can measure an alternative strategy.

So I think this near-term planning exercise that we go through, while it becomes the frustration of a lot that watch it, that's not optional. I mean, clearly, the department has to respond to that kind of demand.

And then the last, of course, is the annual planning process. Now, at the last meeting I think we talked a bit about the annual planning process. We talked about the concept of getting program guidance translated into specific priorities that allow us to distinguish and select among the various activities that are in fact included in the master plan. We heard a lot about that here today. We heard a lot about it from Ned, for example. And Ned identified three specific priorities, and we'll go back and talk about some of those as we go through.

One of the points of interest as was related to us is how do we go through that, who's involved and what is it that gets done. So if we go back to the long-range plan, this framework development, this intellectual backdrop against which we're going to measure both progress and change in state of knowledge and change in program, the who are all the people that you've heard from today and others. The who that's involved in the development of the long-range plan is in fact the department as putting together the master construct, but capitalizing on the wisdom of all of the various PIs that have come and sort of presented the bits of their program. What we want to accomplish in the long-range plan is to capture the bits of wisdom that we heard in the relation of a specific activity to a specific parameter, a specific group of parameters to a specific understanding. Those are the things that need to get captured and the only way that can get done is by having all of the participants on the program work to help with the construct of the long-range plan.

The plan wants to--we say here well articulated with measurable intermediate milestones. I'm not sure that that's exactly what was behind the comment in the Board report, but I think it may have had something to do with it. It's how long do I remain agnostic in this process before I believe I'm making progress with the program. And I think establishing some of these intermediate milestones, and we'll talk a little bit about what that is, in our thinking at present anyway--helps understand the progress of the program. It not only gaggles together the groups of programs, the groups of subelements, the groups of activities to that end, but I think it provides the network with which they are in fact knitted together so that we can look at the end product.

The other thing is we deal with prerequisites, prerequisites for the observations that need to be made at the program level, and they break themselves down into a surface-based test program and an in situ test program. I like to--even though it may not be exactly the vernacular of the Board--I like to look at an in situ test program as opposed to an ESF. An ESF to me is a tool. It's nothing more than a very large horizontal borehole that provides access for specific observations and specific tests. And I think that's the integration that the program has, but we tend to talk about it in the construct of a construction centric plan or a test centric plan. And when we do that, it doesn't appear that they're held together when in fact they are. The sole purpose of the ESF is in fact--in my not very highly technical vernacular--to be able to walk with my candle in a cup through the mountain for purposes of observing whether or not my master construct of the site looks like what I'm seeing and gives me the ability to collect a few samples to validate my operative hypothesis of what that mountain looks like.

So, I think that's what we want to do. Our surface-based test program, as I think Dennis presented, sort of talked about--and I believe Chris Rautman as well-- sort of the spatial distribution that allows us an understanding of what the construct is for this volume of ground we call a potential repository host.

The in situ testing program is our immediate ability to wander through and validate the model or the vision we've created from disparate observation into what it is we're actually going to be living in. It also provides us the opportunity to take direct samples at the repository horizon clearly to run a couple process thermal tests both of which are important programmatic elements but both of which have perhaps less immediate relevance to the determination of the suitability of the site.

Beginning with the framework that was laid out in the SCP, the data needs, the facilities required to get those data needs, we find a great deal of interrelationship among the various activities of the program, and those aren't necessarily just the interrelationship between a bulk permeability approximation being made from a borehole to a bulk permeability approximation being made in the underground. Or, the relationship between this large underground borehole as measured by changes observed in an adjacent small diameter borehole. That's back to the pneumatic testing exercise that we talked a bit about, getting our boreholes in from pneumatic monitoring prior to the passing of the tunnel so that we could look at the response of the mountain as a whole to these changes in barometric pressures that are being introduced.

What I want to get back to--and I know you've seen this before, and you're probably not happy that you're seeing it again--but the way I think about the program comes through my fish hook diagram, and that fish hook is important to me for a number of reasons. One, it's the opportunity on a single piece of paper to identify lots of parts of a program.

For those of you who didn't get this, there's an extra figure in the back that was reproduced, and I think the Board has a copy of this. And if you don't, you've probably seen it and you don't care. But, what this wants to do is kind of relay the structure with which the program thinking is sort of postured. Clearly, our in-goals are simply a recommendation of this site as either being a suitable place to develop a repository or not and as long as that is our only milestone it's not only remaining fairly agnostic until we get to the end of the process. So clearly, the development of some meaning interim milestones such as what we've done here with these interim site evaluation reports is part of that process. It's a process where we can structure the thinking and the findings through time to identify what the advancement is to the ultimate goal.

Now, given that there's a possibility anyway at this point that this site may indeed be a licensable site, there's some other considerations to be made, and those relate to interim license evaluations. The license ability of a site and the suitability of a site are not necessarily one and the same. There are bits of differences between those two where a suitable site in fact may not be licensable for wholly other reasons.

So what we want to do is structure that process through the long-range plan so there are places in time whereby a state of knowledge is, number one, intended to be achieved, and number two, is articulated as identifying the progress made with respect to specific issues. This was started, of course, with the early site suitability evaluation. It went through the Department of Energy's order that structures how one determines suitability. Clearly, until that's taken away it wants to be included in the structure and format of how one addresses our progressing state of knowledge with respect to site suitability.

Well, the other thing other than identifying some interim milestones in deriving our final goals that wants to be in the long-range plan is recognition that there's a program that's the underpinning to that, and that program as it's laid out here wants to at least notionally accept the interrelationships among the various program elements. Whether those program elements are the design or repository and waste package activities, both of which are important as we progress in our state of knowledge, both of which may put specific demands on a site investigation program. This is the diagram that Dennis showed you earlier that we sort of talked about as the sausage diagram. The sausage diagram is intended to depict the various subelements of a model understanding that get rolled up into a more comprehensive statement of our state of knowledge at points in time throughout the program. Well, it's those design demands, as design begins to mature of either the repository or the waste package, that puts specific demands for information parameters understanding on the site investigation program. We focused a lot here on the site investigation program, the specific hydrologic, geochemical, whatever parameters that are required in fact for our end products, but it's the relationship between those and a maturing design that also has to be in the system.

The other thing that's on here is performance assessment. There were some questions--fortunately I was out of the room--with respect to the feedback loop between performance assessment and in fact the site characterization activity. They do exist. They have not been formalized in the sense that the department would like to see them formalized. And consequently, part of this new organization, part of the articulation of this plan is to formalize that feedback in a much more succinct sense such that it specifically pushes influence on to both the long-range planning exercise which needs to get revised as we go through time with new findings and understandings, as well as the specifics of the annual planning exercise that says from performance assessment I found these parameters to be parameters that outcome is sensitive to; these that outcome is not sensitive to. I think it's through the formalization process here and these feedback loops that one drives into the program the specifics of the response to performance assessment.

The other part of that is clearly to get a road map for performance assessment. Here's the way I, as the performance assessment leader, believe I'm going to make my progress through time. That allows us in a preplanning sense to organize activity such that they're complete in time for those analyses, in time for the development of the process models and the roll-up into the total system performance model.

The other thing that's on here is the ESF construction and testing. What you find here I think is that the testing is not as readily apparent as it probably ought to be on here. We are in a site characterization program that's dominated by testing and analysis. But it's trying to take a look through time in finding both these interim states of knowledge that we want to articulate in terms of the interim site suitability assessments that we make as to the outcomes that we're going to find through facilities that are available.

Well, one of the facilities is the ESF. Clearly, one doesn't want to make some new proclamation about the suitability of this site before we've now had the opportunity to take the construct that we've got in mind and walk through and validate it in a observational sense walking through the

ESF.

The next viewgraph that you've got in your package was trying to do the same thing but I decided that was probably too simple, and what we really wanted to do was go back to something that's clear to me and probably not clear to anyone else. But it gives me the opportunity to talk to it. This is simply trying to say the same thing. It's trying to identify the relationships among program parts with the investigative program driving us to a conclusion. What it doesn't show on here are these interim reports that we're talking about.

Near-term planning I think is driven mostly by, one, our need to forecast in a tactical sense the next several years. And one of the reasons we need to do that as an executioner of a program is that we need some stability year to year in that the activities and the state of understanding we're driving at don't come in annual bites. So we need to have some kind of continuity that goes beyond the fiscal year which seems to drive our lives. It also conveniently ties with what the regulations are that are coming to us from the various organizations, like IRB and OMB for our planning exercise. Again, the players in that are the same. All of the participants play as we begin to forecast with a little more detail the next several years out of this long-range plan.

We go to a little greater detail in the articulation of our schedules in the one to three to five year bite that we do in the long-range plan. It probably doesn't do us much good to lay out a very detailed plan with the execution that Dennis showed us about when I'm going to build a pad, when I'm going to clear a road, when I'm going to have pipe on order and when I'm going to have a drill rig show up for a hole that we're going to do in 1999. That's not very useful to us today. And, in fact, I think it's more the recognition that that might not be the right hole and it might not be in the right place because we haven't learned much yet. Again, we're into this program to the tune of one and a half of forty deep boreholes. We're into this program to the tune of 200 feet out of a five mile tunnel. So detailing of some of those activities down to the level we're talking about for the hole that we're going to begin this week probably isn't very useful to us.

It becomes slightly more useful in the one to three year sense because there's still time for procurement, there's still time for intellectually deciding that we're heading down the right path that needs to get articulated. And I think that's part of the value of this interim tactical plan to us, saying have I got all the right things for the next five to six boreholes that we're going to proceed with.

Also, it gives us the opportunity to take a program that says I want to understand the groundwater flow or transport time in the unsaturated zone down to something with a little more detail. This is the point where work-scope consolidation efforts that you heard about at our last meeting begin to take some preliminary form. What am I going to do in these particular tests? How am I going to pare it down from an understanding of gas flow in the mountain to something a little more specific that might in fact find its home in the next performance assessment evaluation or in the next analysis for some submodel or element?

This is sort of the point where we begin--and again, this is just the icon of that little sausage diagram at the top--to break these things down into program elements. Sort of the submodels that make up some of those things in our little sausage. Those get broken down into some descriptive models and then again down into the components of those models. What now specifically are we beginning to use as the construct for stating what the content of this model's going to be when it's produced. And this model may be off in the future by two or three years, but what are the components of that and then drive down into the subelements of what's the construct for that.

Once I've described the state of knowledge I want here, I have now described in fact the activities that have to be done. And in a world we live in where we're handed a budget and we're handed a schedule, this becomes fairly important to us. It's the content perhaps that we haven't relayed as well to the outside work as we need to have, and that's part of what this new planning function and exercise is about.

So this, then, takes the part of this grandiose understanding and begins to break it down into program subelements where we can describe the state of knowledge we need to have.

Sort of the next level of detail gets us down into the annual planning, and in fact I sort of view that as my annual executable. My job is to understand where it is I'm going, have some tactical plan that allows me to make some achievements over the next several years, but I still have this demand that says I've got an executable bite that I've got to perform in a given year, and how do I go about doing that.

Well, again, the who of what that is all about, it's the same who. It's the same who that helped us develop the overall network down to the intermediate network down to the annual plan bite. The difference here is we now have some fairly specific priorities that are laid out. Ned talked about some of those priorities. Irretrievable data was one of those priorities. Specific site suitability issues, one of those priorities. The long-length or long-duration tests that require an early start are part of those priorities. Those of you who sort have been through the draft annual plan either gained an appreciation of the process or were confused by the process, but we did is we took the whole suite of activities that was planned for nominally this chunk of the program, leave them out and broke them out into the very discreet priorities. The one Ned didn't talk about, because Ned was talking nominally or addressing himself to the in situ testing program within the ESF, is the demands being put on the investigative program to support the design issues for the ESF. Our number one priority for this year in structure in the site investigation program was to produce, albeit the minimum requirement, but to produce those activities that ended up as design bases for the development of the ESF. Now, along with that came this pneumatic testing program that we spent some time talking about, but to make sure that they were in the schedule early enough--and I know there's been some discussion about what early enough is--in the program such that those data weren't lost given the advent of the construction of ESF.

So, those were our priorities; taking the testing program as a whole and biting them up into those things that are design related, fulfilling design requirements for the ESF. We added one other subelement that I think Mike Chornack sort of alluded to, which are during construction tests and deferrable tests. Well, our second priority, were those tests that were required to all ESF to continue. Now, in some sense they probably fall into the next category also, which is the irretrievable data category. As we gain guidance for each year's plan, as we gain advice from you and others as to what each year's plan is, we need to remember that there are ongoing data sets being collected, that we can't just turn the switch off for. We're clearly not going to take a seismic network and conclude that that's not my hot button for the year, so I'll turn that off and I'll come back when it's that turn. So we've encumbered ourselves with a program that has a lot of ongoing monitor. The holes in those data sets are not things that we can afford to lose, and that's why irretrievable data came so high on our priority list.

I guess the last thing I wanted to talk about here is one of things that the annual planning process does very specifically is it tries to capture the state of understanding gained in prior years, the findings gained in prior years, albeit findings from things within the program as well as some things outside the program, such as performance assessment, but incorporate that into the current year planning. And one of the things I think you'll find in the site investigation testing plan will be recognition of where we were in completing last year's work, what state of knowledge we have gained in last year's work, and how that applies and helps formulate what we're going to do in this year's work.

I don't know that I need a viewgraph to tell you how we go about that, but I can tell you that the annual planning process for fiscal year '94 began about last February, and it started first with an evaluation and articulation of where we wanted the program to go, how the things we wanted to do related to the guidance that we received, the advice that we received from your board, the advice we received from others, and that progressed through time. And subsequently--maybe this is a better way to do that--we started off with a draft annual plan. That draft annual plan tried to take from this long-range plan what appeared to be the annual bite and began to sift through it. Recognizing as we do this, we develop annual priorities because they may change with time slightly.

I guess the big part of that is when one gets a budget overlay. When we first took a look at the plan as it was laid out, the plan wanted to encompass about twice as many activities as we can afford to execute in fiscal year '94. That's where the prioritization comes into play. That's where you begin to distinguish among activities, picking activity A and dropping activity B simply based on that prioritization. Not that there were any of the things that were on the plate that were either not worth doing or things that we don't believe would be worthwhile to do this year. Just that that wasn't on our menu.

Then the annual plan comes back. It will articulate and it's final form--it's being finalized at present. It will describe the whys or various tests being selected; it will identify what the cost of those tests are; it will identify where in the schedule they belong; why they belong there in the schedule and how they're linked to other activities, what the demands are. And a lot of the things we're doing this year are in fact linked to the development of the ESF. Those linkages will be existing within the annual plan of the testing program formally.

What I can say is I'm bent a little bit more with some of these, because these aren't new viewgraphs, toward the testing program. The exercise that we're undertaking right now is not focused solely on the testing program. It's focused on the whole of the program. So we'll be developing annual plans for each one of the elements of the program. Be it design, be it performance assessment, be it the ESF construction activities, what we're trying to do is to develop a suite of plans and then marry them together in a project plan, in a long-range plan where we can better transmit to you the fact that there is planning and underpinning to the program as it's going, even though that may not be so clear as we sort of present you a suit of little dots. You need to step back from a Serat to be able to see what the painting is about. And we recognize we tend to punctuate that in some of our meetings with you. But again, in this process is where we very distinctly try to cull out the learnings that we've--the findings, the things we've learned versus how that influences where the program goes from there.

Now, that process is followed--once there's a selection of the activities for a given year, the job isn't over. The next part of that job is to derive some test specific design criteria. The purpose of that step is to, one, as Dennis talked about, and I think as others have talked about, we've gaggled together lots of different activities into single opportunities. Once we concluded that we required a borehole in the block for the development of ESF design, we concluded that that in fact married very well with what we were intending to achieve with the first of our systematic drill holes, SD-12. As we began to look at SD-12, we said, you know, that's a real opportunity for us to get into the pneumatic testing and monitoring program. So those happen and they happen through this step, the description of the test specific criteria.

This also provides the opportunity to know that the test very specifically being designed in fact fulfills the goal that was laid out in the long-range plan and the annual plan. So that's our first loop-back to make sure that what we're executing is in fact precisely what it is we thought we needed to know.

Then we go through the suite of analyses. Ned talked a bit about preparing some of the test planning packages and you talked about the global test planning package, the refinement of that into a specific test planning package, and then the empowerment documents through the job packages. Well, those are all done also for the surface-based test program.

There are some other things that sort of happen as overlays on that. We have an evaluation as to the interference of one test with another test, the interference of construction with the test. We talked a bit this morning about--I think it was you, Don, that talked sort of about how do I know whether I'm getting a contaminated sample. While intellectually at a high level we want to think about that, at the execution level we want to think very specifically about that. We don't want to put salt in a drilling pad for a grounding agent that's required if what we're interested in is chlorine 36 in the groundwater. There are a number of these little things that can get out of sync unless we're careful. Of course, the other requirement is to make sure that the tests that we run don't influence the long-term behavior of the mountain. And then, as this goes through, we go through the implementation of that test and then the reporting and the feedback of that test.

Dennis, I think, showed you this slide, and this is the final control that we have in deriving at whether or not we're getting our achievements.

We've laid out what it is we expected for the year. We've laid out a suite of components of that roll-up, and we've translated that down to not only the activity that takes money, but in fact the product from that activity that feeds to our outcome. And so, the way we've been keeping account of where we are or begun to keep account of where we are is through this kind of detailing. So we've got a network that starts with I'm interested in, in this case, the unsaturated zone hydrologic model down through the deliverable that says I need the gas and vapor flow data, and I'm tracking my progress down to the lowest level.

I think for this board, the interest is probably more in the tracking of higher level goals. What I think we want to transmit is these are important to us. That structure is important to us, but in our annual executable we've got to get down to the individual contributors to anyone of those.

I'm not sure exactly what the questions were or whether I've addressed some of that. One of the things I think we wanted to leave you with is that while we've punctuated these discussions with our plan and purpose and objective and the fact that we've got some idea of what we're doing, that there is indeed a master plan. We recognize that we may have not in the past found the right vehicle to give that to you. That is an exercise that's being undertaken this year such that a master plan can come with text, with a very complete description of the whys behind some of the decisions made, the interrelationships between some of the activities undertaken, and I guess one of the other things we wanted to put across is that the ESF and surface-based testing program to us are simply an in situ testing program and a non-in situ testing program. And in fact, some of the tests planned utilize the ESF as a borehole while others of the test plan simply use that as access to some observations.

Maybe that's all I'll do.

DR. CORDING: Thank you, Tom.

Do each of those little tick marks up there represent a year? I was trying to count when you were going to have a license application.

MR. STATTON: You'll notice they were all empty. Maybe for purposes of today's meeting I should say none of these are short than a year.

DR. CORDING: I had it down to the month. That last one was not quite a year, that last tick.

Questions for Tom?

John Cantlon.

DR. CANTLON: I was the one that raised the question of the interaction of the investigators with the total performance assessment activity, and as you're well aware, the Board has been uneasy about really the level of integration for really our whole existence. And you've touched on the issue as though it were primarily a problem of communicating your integration activity to the Board and outside reviewers. But I would suggest that in our interaction now over almost five years, we've interacted with essentially very, very broad segments of your internal contractors, researchers and so on, and I think you have as big a job communicating it to the people generating your data as you have to communicate it externally.

MR. STATTON: I don't disagree.

DR. CANTLON: And with that in mind, I go back to my question this morning, and that is, what is the nature of the process by which you bring your investigators into an integrating feedback with the performance assessment process, which is one of your integrating elements.

MR. STATTON: If I look at the very broad integration issue of this program, I'm, I think, as confused as everyone else is. This construct utilizing the plan for the program in its global sense down to its executable sense I think is the centerpiece for that interaction to happen. And I think internally perhaps we haven't been as crisp on some of those boundaries as we need to have been. I can say that I believe internally we have been better at it than it appears we've been at it. And especially based on some of the comments it appears that we don't have any at all, and I understand that. This to me is the tool to do that, and the tool says that my next iteration of total system performance wants to have in place these process models with this degree of fidelity to them. Well, once we've laid that out, to me, those process models drive the data demands back into the various activities. So now we've at least got the communicating vehicle between the performance assessment at a high level and the individual trying to gather the parameter for its use. So, my belief is this is going to be a powerful tool if we could get it fleshed out and put on the table. I certainly didn't try to imply that life inside is wonderful, but I didn't want to say that.

DR. CORDING: Warner North.

DR. NORTH: I like this diagram. It makes it possible now to say that the need is to tighten the links between the fish hooks and the sausages. That's a nice shorthand.

I'm not sure this conceptualization is entirely new, but, on the other hand, I like it. It's concise. I would hope that it's something that people both inside and outside the program can readily understand. I've heard you refer to it as a new tool and talk about it in the future tense as opposed to the past or present tense. I'd like to put on record for myself very strong encouragement. It certainly addresses concerns I was raising yesterday about the need for this kind of interaction.

I'd like you to comment, if you would, on the three time frames you talked about, the long-range, the one to three years and the annual, in terms of where this diagram most needs implementation and your view of the match between the feeds and needs to pick off your term--I used supply and demand yesterday--as to how big is the job in each of these time frames that needs to be done to implement this new planning tool?

MR. STATTON: The short answer is, I think it's a big job. I think it's a huge job. I think it's an achievable job. I think it provides the flag around which all of us with interest in the program can rally. Consequently, the job gets a lot easier once you become a believer in laying out the milestones.

One of the most important things to me is to get a written strategy that's not 8,000 pages long that says here's how I'm going to get from beginning to end. I see that taking several forms. I see that taking the form of a written strategy for an individual element, recognizing the interfaces, as well as an articulated strategy for the whole as it moves across. So I see, for example, a project plan of--I don't know what--25 pages that tries to say here's my global strategy and if you want to see the details of the strategy that play into that, look in appendix A and you'll find a more detailed discussion of that strategy and its interfaces with appendix B which is this strategy.

The reason this is so important to me is I believe you have to have an intellectual backdrop against which you can measure change. If I looked at the single most important function of those three plans, to me, this is it. This is the one that says here is my strategy against which findings can change my future.

The annual executable, to me, is a detailing simply of a one year--I better not show that exactly slice through here saying here are now the elements that I need to pay attention to. I need to pay attention to the next total systems performance and here, when I look at its annual plan, is what it needs.

So the value of that to us at the project level I think is as a management tool. It allows us to do the bookkeeping that says I laid these things out and I'm chugging along and I'm making the progress I expected. At the end of the year, I'm able then to say I'm going to contribute to this, or, what I found doesn't allow me to contribute to that; consequently, I changed the program for the next executable year.

The interim planning I think is important in the sense of providing some continuity of thought and direction, providing a precursor to some things that I'm not prepared to do today. So neither of those two bites to me is unimportant. We started with the annual plan and that was certainly not the way you begin to do this, but you're a little behind the power curve and I need a management tool.

I think the intermediate plan has been started and Dennis showed you some of that, and that's simply because I got resource allocation problems and I've got to be able to anticipate what happens.

What I really feel the most important tool is the intellectual backdrop; do I understand what it is I'm going to say I intend to know at that point in--

DR. NORTH: That's your long-range plan.

MR. STATTON: Yep. Did that skirt the issue so I didn't answer the question?

DR. NORTH: Well, I'm going to summarize your answer as the biggest gap between the need and the feed is the long-range plan, and your incentives are to start with the annual and the intermediate because that's where you get a lot of pressure. You got to have something to deal with the planning function at that level. So, if you get too busy, what slips is the long-range plan.

MR. STATTON: No. That won't happen. One of the things we've organized this year is a very specific function and a specific group of individuals that in fact are not only knowledgeable but talented in each one of the subelements, and their sole goal in life, if any of us ever have a sole goal in this program, is the production of that long-range plan. Now, I can say--and every time you talk to a group like this I worry a bit--my expectations of this thing being the panacea in its first construct aren't great. But I think the first thing we got to do is hold it up and then we'll patch up the holes in the curtain.

DR. CORDING: The subelement, Tom, you're referring to is what? What are the subelements proficient in the subelements you just commented on?

MR. STATTON: Oh, I'm sorry. In that context what I'm talking about is somebody who's proficient, for example, in performance assessment and code modeling. Somebody who's proficient in either the construction or the design or the site investigation; whether it's the hydrology or the tectonics program.

DR. CORDING: Within the M&O basically, working in that area.

MR. STATTON: Yeah. At present that core team sits within the M&O. I'll tell you, I don't know whose cover will be on this product when we're finished, and I trust it will be a DOE cover. But it will in fact represent the sweat and blood from everybody you've heard from and a whole lot you haven't heard from.

DR. CORDING: It seems to me that your interaction with the PIs is not just ask them to revise their program plan.

MR. STATTON: No.

DR. CORDING: It's continually, you know, make changes or adjustments in that, or occasionally make adjustments in that, but some other interactions that you have. And perhaps these people that are proficient in the subelements are the ones that are getting down there and doing that work. Is that correct?

MR. STATTON: Yeah.

DR. CORDING: Talking or meeting. How do you see them interacting?

MR. STATTON: When we facilitated the meeting for the first construct, I guess, for example, the U.S. Geological Survey brought the hydrology program into a room and we began to think about the various activities that were ongoing and where they were headed; what's the tie, how do I get back to relating myself to some very specific understanding for site suitability. We looked at where they are, how you got there, which is what you had learned, and where you thought you were going. And it was that network that through our workshop there began to take form, and it took form of some of these subcomponents that we talked about. I should have brought a hydrology one seeing as we have most of our hydrology folks here today. But it was this kind of construct. Breaking down what it is we wanted to know into some subcomponent and then the activities that address themselves to those subcomponents. So what it was in fact doing is defining the state of knowledge I'm going to have progressing through time, because this may be--one of the conventions we used is, say I want to produce that geology submodel in 1996. What is it I'm going to know in 1996, what is it that I think I ought to be able to know, and what are the elements that feed that. So, now I'm back to where I can drive a program based on a state of knowledge. If my selection of a topic says I want to be able to address myself to groundwater travel time in the saturated zone, I want some hard data that say here's my current understanding and I think I've got a problem or no problem. That quite clearly rolls up in to a saturated zone hydrology model, but it breaks down through a suite of components and in fact goes right back to the first thing you need to do guys is go run us a test at the C-well complex. Well, that's in fact part of the process that drove us to our C-well testing that's on the boards for this year.

I don't know if that--

DR. CORDING: That helps.

Other questions? Staff?

Leon Reiter.

DR. REITER: Tom, let me go back to a very basic question. You said that the basis of everything is laid out in the SCP. I guess the question I want to ask you is what is DOE's long-term waste isolation strategy, and the reason I'm asking that is at various times we have read and we've heard things like the geologic barrier is the primary barrier and then among all the barriers the Calico Hills is the most important element. We've seen statements by people and papers challenging that assumption, promoting strategies that, for instance, the Calico Hills is not that necessary. We've seen studies that depending on where you stop the study you can either conclude that Calico Hills was important or was not important.

Is there a present strategy and where is it articulated?

MR. STATTON: Go ahead, Susan.

MS. JONES: I wouldn't touch that one with a ten foot pole. Is that right?

MR. STATTON: No, no.

MS. JONES: It seems to me that the strategy has always been a system of multiple barriers. That you cannot rely totally on a natural system; you cannot rely totally on an engineered system. You have to combine the two, take advantage of both, maximize both. That is the principal we've been operating under for years.

DR. REITER: I'm sorry. I really should have prefaced my question. Aside from general statements about multiple barriers, where is the waste isolation strategy laid out? It's like in many ways like mother and apple pie, but how is it laid out? What role does the Calico Hills play in this thing?

MS. JONES: At the moment it is considered a primary natural barrier.

DR. REITER: Is it the primary barrier?

MR. STATTON: I would say today in the SCP, in our baseline, not just the SCP, in our baseline it is the primary barrier. Now, we're constantly trying to reevaluate that. Matter of fact, one of the goals for the year is before we embark on the design and construction activity for Calico Hills, is to go back and make sure that we're still comfortable with the decision that was made back in 1988. Which is not to question whether or not in fact that was a good decision, it's to get ahead of the power curve once and say I can sit down and specifically think about whether that's the resource allocation I need to make based on my overall strategy. Today's strategy for this program is represented in the baseline. It is not that it isn't questioned all the time. The way we got from ESF shafts down to ESF loop is in fact that requestioning, sometimes prompted requestioning, and I grant that. But nonetheless, we sit and revisit those decisions. That's a big decision going to Calico Hills. So, it is intended to very specifically make sure that it was the right decision given today's knowledge, but it is not to call into question that it's part of the baseline, because today it is.

DR. REITER: And is the engineered barrier still considered secondary to the geologic barrier?

MR. STATTON: I think the engineered barrier is an additional component. They're being handled nominally independently and they have to be handled independently. We have some engineered barrier requirements. We've struggled with what the engineered barrier system is and some of its terminology; what an altered zone is and does it go all the way to the surface, or does it go all the way to Pahrump, or something like that. But nonetheless, the strategy, the approach to the engineered barrier system is while integrated independent from the natural barrier system, both of which are being developed to be as robust as possible, that's I think today's strategy.

DR. NORTH: I'd like to add a further comment and invite comments from Susan Jones and from you, Tom. In the first meetings of this board we were introduced to the term performance allocation as how one gets beyond the concept of multiple barriers down to the specifics of what are you relying on to what degree among the multiple barriers. I haven't heard anybody from the DOE program use that term in quite a lot while, but I think the concept it represents is what's your strategy when you go in with a license application? What is the mix of elements that will lead you, or should we say will lead to a case that's very convincing that the site is licensable if indeed you believe that to be the case? And then that drives your data acquisition. What do you need to be able to confirm? So, for example, is it very important to get a drift down into the Calico Hills and get all the data that will come from that exercise, or is it in fact not absolutely necessary and the program might be better off using the money for other purposes?

Now, I see the virtue of the sausages and fish hooks as maybe it will allow you to address that question in a somewhat more organized way than what we've observed over the last five years, which is why I very much like the concept. What I hope we are going to get in future meetings of this kind is going beyond the theory and going beyond my frustration at not being able to see what is the increment in the strategy as opposed to the site characterization plan which is now quite old. I'd like to see the 25 page current implementation of fish hooks and sausages for long-range planning, and if that document exists, I don't know where to find it.

MR. STATTON: You'll know where to find it next spring.

MS. JONES: And I was going to make a slight joke here. I've never seen a 25 page document. But, you're right; we need a clear, articulate--clear way of articulating what that plan is. And, to the best of my knowledge, we have not made a complete pass through the performance allocation exercise since the SCP.

DR. REITER: Thank you. That's a very clear response to my query.

MS. JONES: And we have not done it.

DR. REITER: And you are, therefore, assuring us that in the near future we may expect that void to be filled.

MS. JONES: Define near.

MR. STATTON: But it's a topic that clearly does have to be addressed as we begin to put the real meat on this framework. So I think it's within the system of the program to help articulate those strategies. I think we may be a little early in that process as to the robustness of what a waste package is likely to produce versus the robustness of what a site is likely to produce. And we may end up finding that they both produce such robustness the overlay doesn't matter.

DR. CORDING: Okay. Any other questions? I'd like to thank you very much, Tom, for your presentation and we're ready now to go to our final closing remarks. As I've indicated, I'm not sure on the schedule who is making that. Susan are you--Dennis, are you doing that?

MS. JONES: Since I just walked in, I will gladly defer to Dennis.

DR. CORDING: Okay. Dennis Williams.

MR. WILLIAMS: Okay. I'll make the closing remarks on behalf of Russ and the DOE. I won't stand up; I'll just do it from a sitting position if that's okay.

Of course, Russ sends his regrets that he wasn't able to be here. I think as we all know, the newly appointed deputy director--acting--director, we have so many deputies and we have so many actings I'm having trouble with these at times. But anyway, he is in town and that part of duty called.

I don't think I can do much more as far as wrapping up the technical part of this session. Tom did an excellent job on presenting the intellectual framework. I'm happy to see that there's somebody that does appreciate--diagrams sausages and fish hooks as much as a few of us others do. That's probably why we have Tom as kind of the chief integrator on the program. That particular talk isn't that easy to give. I know from experience I tried to give part of it in Reno and abruptly passed out, so--I've had better talks to give today or in this session.

I hope that we've conveyed some sense of the collective planned thought and coordination that has gone into this program here of late, and basically in regard to the ESF testing and construction, how we're trying to tie that together and also tie that into the surface-based testing program. Of course, that's again when we get back to how we tie the whole together. That's the most important part of it, because the pieces really aren't going to mean anything to us in the end if we can't do something with it.

We sense a need from the Board for a more expanded comprehensive strategy on the part of DOE, or perhaps a better articulation of the expanded comprehensive strategy that we do have in place.

There were a couple of areas that I think deserve some specific comment, one with regard to PA. We talked about that quite a little bit. In the round-table discussion I think Jerry Boak may be over here and I would like for him, if you would like, to talk a little bit about his total systems performance assessment road trip that he had recently. Maybe that will offer us a little bit more insight on what we're actually doing in PA.

The other item has to do with regard to a comment made by Larry Hayes yesterday where he expressed a concern shared by some of us in YMPO, that the time and effort put into these meetings would result in a more meaningful or should result in a more meaningful communication. We would like to work on that a little bit and we would like to clarify the needs and expectations of some of the people, especially the Board, whenever we hold these meetings. And Susan has indicated that with the concurrence of the Board, she would like to enter into some discussions later on to see if we can get a little better organization in that fashion.

With that, I'd like to close with just a thank you on the part of all the participants, everyone that has made presentations here, and especially the people, the invisible people that we don't see that help us put all this together and have helped put together the program that Tom has articulated up here, and really a special thanks to the Board for their patience and understanding in trying to sort out some of these very difficult issues.

With that, I'll turn it back over to the chair.

DR. CORDING: Okay. Thank you. We're going to have some final comments later, after our round-table discussion from our chairman, but in terms of the session this morning, I think I very much appreciated much of the--I appreciate the information that was presented and the way it was presented. I think it helped us get an insight into some of the testing that I thought was quite valuable, and so for my part, I'd like to thank you for some excellent presentations today. At least in terms of my responsibility as session chairman, I really did appreciate those presentations.

We're going to be breaking now for fifteen minutes. We're going to set up for the round-table, and I would like people who have been participants so far to be seated near the front, and the others of you should be not more than a couple of steps from microphones so that you can also participate. We haven't had a chance for you all to discuss things as much we would like, and we want you to participate in this round-table in fifteen minutes.

(Whereupon, a recess was taken.)

DR. CORDING: We're ready to reconvene. We do have tables here now, so we're ready for our round-table discussion. If the presenters from this morning would come up to the front also and sit at the table, that would be I think appropriate. We have a couple more places up front for people that may have made presentations yesterday, today; PIs.

Well, let's start. There's several items that we've been discussing obviously in the last two days, and I thought I'd just indicate a few of these general categories that we might find of some interest in discussing and getting more interaction on, and one is the overall strategy for the site characterization, it's implementation and presentation, how can it be summarized in a way that--and well it can be summarized in a way that will help guide the program and provide information to groups reviewing and evaluating the program.

Another item that I think deserves discussion is this integration of construction and testing, and we have people here both from the testing community and the construction people who are quite familiar with underground construction and who are in the process of setting up the underground construction excavation process for the tunnel boring machine. And I'd like to have some discussion on that as well.

And then some of the other areas we've had quite a bit of discussion on has to do with the whole area of hydrologic testing, pneumatic testing, the integration of surface-based and underground testing for that purpose.

And then finally, the thermal testing and thermal strategy. I know we've had most of our discussion on that in previous meetings, just one presentation of Dale Wilder on that, but I'm interested in perhaps some discussion regarding the long-term approach to the thermal testing and the immediate actions being taken in that area as well.

So, let's go back to the first item, the overall strategy, some things we were really discussing as we finished the presentations this afternoon with Tom Statton.

Is the overall strategy that Tom has presented and the way it's organized, the way you see it being organized from your own viewpoint, is this appropriate? Are there other things that are being done that we don't know about that we need to discuss, other things we need to be doing?

MR. WILLIAMS: Dennis Williams, DOE. I was wondering if this is the point that maybe we wanted to discuss a little bit of the performance assessment aspects. Jerry Boak isn't here but Jean Younker can talk to that particular subject I do believe.

DR. CORDING: All right.

MS. YOUNKER: Jerry had some other obligations, so he asked me to speak on his behalf a little bit. We have tried really hard as we put this past total system performance assessment together, which we're completing right now, and the previous one that was done back in '91. We've tried very hard to get as much both informal and formal interactions with participants and the characterization program as we can. This time we did make a real attempt. We took a road show that Dennis mentioned of about I think seven or eight of the key people that worked on the TSPA that was done this summer out to USGS as well as to Los Alamos and got a lot of the key PIs in the room. Talked about what we had done in the previous TSPA, what we were doing in this one, and just brainstormed ideas as to what made sense and what didn't make sense. So I think, Mike, you probably weren't there right at that point in time, as I recall, because I can't remember who was all was there. I know Alan was there. Alan Flint was there. And I don't recall who all was available then but we got as many people together as we could. So, you know, I think the flavor that comes across sometimes when you ask somebody like Mike, well, did someone specifically ask you about your study plan or talk about what specifically they needed from you, well, I think in a sense at least it kind of comes across that, well, just because we didn't talk to that one person we didn't have those interfaces.

Well, the PA people and my team as well as in the Sandia team, as they're going along and trying to establish the data base that is available to them, they're on the phone daily with the PIs trying to find out what's coming down, something that isn't even available yet, what we could possibly get our hands on. So there's a lot of informal as well as this one formal road show that we did have. So I think, you know, as I think Tom was saying, we probably haven't done a good job of letting you all know exactly the kinds of things we do try to do to get that interaction going. And I'd be certainly willing to answer any other questions or give you any other feedback that might help.

MR. WILLIAMS: Jean, one thing that I saw on my desk is --don't you have a local version of that road show starting tomorrow?

MS. YOUNKER: Yes. As a matter of fact, I think there's a chance that Leon Reiter may be going to sit in on some of that. What we've done is we've tried to set some milestones where we would hold meetings that were open to anyone who wanted to come to listen to kind of our status as we stand right now. We're almost done with the TSPA that we've done this year, and so this is kind of a time when all of the people who participated at the analyst level are going to give presentations of their parts of the work and listen to each other as well as there will be some of the managers there to listen to it for the first time really. So it's really our first internal set of presentations on this year's TSPA.

MR. LeCAIN: Excuse me for interrupting here. I'm PI of a couple of projects and I don't think I've ever talked to anybody in performance assessment.

MS. YOUNKER: And I think that's fair enough. I could look over to Alan Flint and say how many times have you been called by either Mike or by Holly Dockery from Sandia to ask you questions about some of the data that we might be able to use from some of your work recently.

DR. FLINT: What a wonderful opportunity. Alan Flint with the USGS, and I do remember this road show. I was involved in it. I was very confused by it and I don't think I came out with a lot better understanding of the way things were going to be done, but I think that there is a key problem that we had--there were several questions I guess that were brought up today by members of the Board and asked if we had changed our study plans based on performance assessment modeling. And I think that the performance assessment modeling is not looking at anything that we're doing particularly, and the work that we're trying to accomplish and the methods and the data we're using is not as well integrated perhaps with performance assessment as we would like. And on many occasions we've asked that performance assessment be involved in what we're doing and help us in making these decisions, because I think that's a real important part. We collect data; we have ideas. We would hope that the performance assessment modelers would take those and test them out in their modeling and then see how important they are to the other parts of the program when they're trying to put all this together. And I don't think we've quite gotten to that point. But one other thing is that we did sit together, many of us, with performance assessment.

There were I think five big projects that we decided to tackle, the importance of the PTN and there were several other ones. I think I was the only PI involved on any of those and the only one of those five that was accomplished, was accomplished because I stayed involved in it. And I think that the performance assessment people have to identify principal investigators and work specifically with them on specific problems. I don't think it gets done by just calling them, giving them a couple pieces of data and going away for a year.

MS. YOUNKER: Can I make one more comment on that? I think what you point out is exactly right. I mean, obviously we have to have some very strong relationships developed, but I do think that one of the reasons why you probably--what you describe is the case is if Jerry was here, he'd talk about the pyramid, you know, the PA pyramid that we presented to the Board a number of times. And that is that right now we've been--for some reasons I think that are good ones--emphasizing the total system performance assessment which sits right at the top of that pyramid and you're operating with one-dimensional, you know, extremely abstractive, highly abstractive models where there's really not very much process in those models for the most part. There's some in the Sandia ones and the ones that--the RIP that we use. You know, it's a very abstract model so that you run many realizations and get some sensitivity studies out of it but at a very high level. I think when you're operating at that level, the link takes a lot more effort because there's some subsystem process models that you have to work through in order to get down to the ones you guys are working with, and, you know, it's a big effort. I mean, I think we're working on it but I don't think the connection is, you know, really easy.

DR. FLINT: I'd like to address that point because I think that's a real important point and I see that myself as a problem. The PA people are working at the top of this pyramid. I think you remember this idea of abstraction going to the top. The PIs are down at the level trying to understand processes and I do not believe that the performance assessment group have demonstrated that they can roll-up these processes to the top level of the pyramid yet. And yet, that's where they're--I think they need to go back down and work with the PIs and make sure we understand the process models first before we work to the roll-up model. And I also believe that there are many people within the performance assessment that are trying to do that. Bill Nelson is one who has spent a lot of time with my group out in the field trying to understand what we're doing. They're back down at that base level trying to say let's get these models working first before we start abstracting. And I do think he's right. I think we need to move at that level.

MS. YOUNKER: I think--just one last comment. That there's certainly a question on DOE to have some kind of a way of showing some status of compliance with something like a total system performance criterion, so I think you have to look back at why we did the total system performance assessment in '91 and why we did another one this year. You can't answer the kinds of questions about how's this site looking with regard to compliance with the regulations down at the process model level. And so, of course, DOE has had to make some difficult decisions about where they want a performance assessment to focus. The emphasis at the top of the pyramid does allow you to, granted with some uncertainties in your process models, does allow you to get at the question of how's the site looking with regards to compliance with total system requirements. So there's a balance and there's definitely been difficult decisions made by performance assessment management within DOE has to how that balance should be played out.

MR. DYER: This is Russ Dyer from DOE. I'll take the blame for that since it was done essentially at my direction, but we came to a realization that we had to work on all levels of the pyramid simultaneously and we constructed some PA models at the top of the pyramid, high level abstractions, with little confidence that we could trace the connection between the top of the pyramid and the bottom of the pyramid. We realize that that has to be done and it's going--Alan, you're absolutely right. It's going to be a long struggle trying to demonstrate that we have incorporated all of the important processes from the process level models into both the intermediate and upper level models. We can't do that now. We're going to have to be able to demonstrate that at some point in the future. But we felt we had to put together some kind of a tool that could give us a yardstick that could give us some idea of where we stood and that we could use to try to feed back and give perhaps some large-scale sensitivity studies to the system as a whole. What part of the system is really the most critical part of the system? Can we make that determination yet and can we believe it. Right now we may get results out of the models but even those results have a certain--a large amount of uncertainty associated with them because we aren't confident we have built into the top level models everything that needs to be there.

MS. YOUNKER: And I think, Russ, if Jerry was here, what Jerry would want to remind you is one of his presentations--I think at the Reno meeting he tried to be very clear you'll never incorporate all of the processes. What you're going to do is figure out which ones it's okay to leave out.

DR. FLINT: Yes. I agree with what has to be done and the direction you're going, and there are certain aspects of it and we've argued this before and this may not be the forum, but, you know, we're looking at next year's total system performance modeling. It's a series of one-dimensional models and I think that we've shown to a large extent in professional papers that we've written, people in the USGS, that this is a two-dimensional system in many, many cases. And one-dimensional models can apply and can work if you're working at the right location. For instance, at UZ-16 the best information we have is you could do a one-dimensional model there. But if you're using 14, if you're in the north part, that one-dimensional model will not work and unfortunately that's several of the locations where the one-dimensional modeling is going after. But I think that kind of information has gone back and forth between total total system performance assessment and some of the PIs that have never been resolved. And whether or not we have to resolve it, that's something that I guess you have to decide. But that's argument that we've made and that we wanted to see a more realistic system where we had two-dimensionality to it.

DR. CORDING: I had a question for Tom Statton. You show these loops and fish hooks and sausages. Have you been able to use performance assessment as a tool in your work at this point, or is what you're doing you're really trying to get inputs into that. You don't find it as much of a tool in your planning at this point. How does that fit into what you're trying to do, Tom?

MR. STATTON: Is this on? Quite clearly the link between performance assessment and the planning of the program has not been as tight as it perhaps ought to have been. I think that was John's comment earlier. I think the organization that's set now has a couple of advantages, one of which is performance assessment becomes a very active participant in laying out the plan, as well as do the PI organizations. Such that as performance assessment articulates its long-term goals, as it articulates specifically the focus of the next TSPA, vis-a-vis the sensitivities identified in the last one, then it becomes truly a program driver. And I think in part, Alan's comments work perhaps more strongly as we begin to understand the specifics of what the next TSPA is. The performance assessment part of this program is in fact laying out a road map for what's coming next. It's laying out its plan as to what parts of the last assessment are taking more focus in the future.

MS. YOUNKER: And I think one other comment on that, that goes along with what Tom just said you saw feed into that planning process, was this integrated test evaluation activity that we've had ongoing in support of Russ' prioritization. In that we had performance assessment people from both Sandia and the M&O as active participants such that the priorities that we fed to Russ--recommendations we fed to him were based on the best intelligence we could get on performance assessment data needs. So, you know, it came in from that route as well.

MR. STATTON: And in the last prioritization, the one we talked about in Reno, if you remember some of those data sheets, in fact the ITE evaluations of each of the various program activities that were being considered for funding in fact was part of the decision making process. So it wasn't simply a new design. It's also how badly do I need this data, how relevant is this data at this point in time to what goes next. So the link in fact with performance assessment while existing, came through I think in part tools like ITE where we may not have had as much face-to-face interaction between the PI and the total system performance assessor, and that's something that I think will get supplemented with the upcoming program.

DR. CORDING: Bill?

DR. DUDLEY: Yeah. Bill Dudley, the USGS. Is this on? The ITE that Jean referred to, integrated test evaluation, stated rather specifically in its reports that the linkage between the lower part of the pyramid, the data collection, and the performance assessment up in the apex of the pyramid was assumed to be fully funded and ongoing. And certainly this is the part of the overall site characterization program that has helped in design of the current testing. The performance assessment models are, of course, too general to really get or provide much help in test design and the exploratories you have, whereas, the process models which in some cases may be a back of the envelope analytical calculation were indeed used. We do tend particularly when funds are short, as was referred to repeatedly yesterday, find that some of these synthesis and modeling activities that result in the level two milestone for unsaturated zone hydrology, for instance, have gone by the wayside in current project planning. Dr. North said will anything fall by the wayside because long-range planning tends to get put off my closer-in planning. Tom said of course not. I would have to say that they're right, Tom. I think the unsaturated zone modeling program, the survey and LBL in cooperation has been rather severely crippled in this year's planning, and it's the type of thing we have to watch out for. Certainly the long-range planning as of a few years ago recognized that the exploratory shaft facility was a small vertical shaft going down to the very limited underground test area. As Ned mentioned, a thousand days of testing delay. There was no question but what the surface-based pneumatic testing characterizing the mountain as it exists with this ambient condition today, had plenty of time before the impact of that underground facility would be felt by the mountain. We did not adequately keep track of everything that was happening when we went from that small shaft to a drift, or ramp and drift, and then when the concept came up of moving through the TBM loop and opening up the entire mountain before we could really get time for a significant testing, and as Larry mentioned and others have mentioned, the survey strongly supported Carl Johnson's warning that we need to be thinking about establishing the ambient conditions before opening up the mountain in the long-range planning sense because it is those fragile or transient ambient conditions that provide the record today of what has gone on pneumatically and hydrologically in that mountain in the last several thousand years at least. And once we destroy the capability to examine the as nearly undisturbed moisture conditions as well as we can, to examine the geochemical conditions as well as we can, and the thermal conditions as well as we can, once we've lost that opportunity we're not going to get it back. So that we need to seriously look at many of places where our long-range planning may indeed be falling by the wayside.

DR. CORDING: Yes, Pat Domenico.

MR. DOMENICO: I said something yesterday. I said I've seen four or five performance assessment models. They're all transport models. They're all one-dimensional. They have little dispersion in it. They have constant velocity in it, and there's nothing in the field that you need to put in that model. There's nothing you need from a core. You don't even need any field data because the model is too insensitive. So if you're looking--and I heard and the point was well taken.

I heard some people understood that. So if you look at it that way, unless you get more sophisticated transport models, require certain things, you're going to need one porosity value. You'll confuse them if you give them two. So if you look at it that way, you're never going to integrate the top and the bottom pyramid.

Now, if performance assessment starts to ask some good questions which are not regulatory questions but which bear on regulatory procedures because the transport model is going to be the key to the release, and that's critical. But if you start to ask how's this system going to respond if we go into a thermal load and Tiva Canyon is impermeable, and how much condensation is going to take place up there, how much moisture's going to move up there and how much water am I going to have to send up to the repository. Ask that question and then you'll run to Al and say, give me your stuff. Give me your data. I need your stuff. Now I've asked the real scientific question and I got a model that's going to address a point like that, which is to me a very critical point. You know, so I think once you get out of the field of developing a transport code just to check releases, regulatory releases to see if you can comply, then you'll be needing that other data.

Now, like I said, if you develop a sophisticated transport core now which I think this is going to be kind of of difficult, you may need some of that data. Now, in that case, performance assessment needs should drive the program. I mean, that's the way it should be from that pyramid. The performance assessment says here's what I need for regulatory purposes and PI's got to deliver that stuff. But right now, the performance assessment needs are nothing because the models are too trivial. But ask some good questions that pertain to performance and then you'll find that a lot of that information will be very helpful.

MR. NELSON: I appreciate a lot the comment that was made, this last one. I think it's very true and I'd like to respond going on from one of the things that Bill Dudley said. There's been some questions asked about our ability to move up and down in this pyramid and it's very interesting that this one study 2.2.9 that was mentioned here has in it the plan, and I suggest that you got to spend some time to do it, that that USGS plan has the prescription built into it for going up and down in this pyramid. This isn't a mystery. We understand how to do it. We've got to decide that we want to do it and are going to do it, and I would suggest that until we do, the haunting question is for any of the rolled-up models, what is the undergirding evaluations that justify what you've done, and if you can't answer that, you cannot use the final answer that comes out of it.

The methods are here. We're not reading some of the very best study plans that are coming out of this and the thing that scares the living daylights out of me is that those are the ones that in this priority sequence were zeroed out this year.

Now, let me suggest in summary that PA is not a one-step process as it is now being visualized by too many in the program. It is a three-step process where you work with the process models at the lower level and through a combination of hypothesis testing and sensitivity, and we've got to do the sensitivity now because we don't have all of the data ranges that we need, but you do it in the range of data needs that are needed to establish what the appropriate conceptual model at the process level or models you have to use in order to represent what's going on appropriately in the mountain. Once one establishes that role, that becomes the basis for testing the roll-ups and the abstractions that we're using. And I would strongly recommend that we better do the three-step process and not rely just on the one run. I shudder.

Let's see now. I guess this is--well, I guess why not go ahead and say it. If you believe it, you better say it. I shudder at our position as NRC which has very capable and competent staff review the official document that's going representing the present TSPA. We very likely--oh, boy. I dislike saying this. You're going to want to shoot the messenger now. Very likely we are going to be literally slaughtered by the questioning processes there and they all center around what is the basis or the undergirding evaluations that justify the roll-ups and the abstractions that are being used in this. And if we don't know what they are, how in the world are you going to expect us to use the results that come out.

DR. CORDING: Thank you.

DR. NORTH: I can't resist following up on that. It's very much on point and well taken that you and the program, as you go forward with the output of the TSPA process toward a license application and the site suitability findings, are going to be subjected to criticism and scrutiny of a level that you probably can't even imagine. And what you get from this board and these kinds of meetings is very friendly coaching relative to what you're going to run into then. So if some of us seem to be a bit critical and frank, take it as very constructive, because where you're going, you're going to need all the practice and all of the sharpening of your tools and your capabilities that you can get in this relatively protected period before you descend into the maelstrom.

I'd like to suggest that performance assessment ought to be used not just in carrying out these big overall exercises like TSPA-2, but in dealing with specific questions and problems regarding Yucca Mountain, where there are hypotheses to be tested and distinguishing among those hypotheses may involve new data needs which then become very important opportunities for the program. The one I'd like to suggest to you for making the discussion we've had in the last twenty minutes very specific is the set of hypotheses that were presented on slide--let's see, this appears to be SCTUZ 1419125. This is Dick Luckey's presentation. It's titled Conclusions, and he has as a third bullet possible interpretations. This is with respect to UZ-14 and the perched water. And the hypotheses are: fluid is only degraded G-1 drilling fluid, fluid is contaminated perched water, or fluid is contaminated water table. Now, I look at this from my perspective and say, gee, that's a very important question. If in fact you've got contaminated water table there, that has potentially some very strong implications for the suitability of a rather large part of the repository footprint. So maybe we ought to figure out what do we know about this issue and have the performance assessment people work with I'll call it the PIs and their staffs to try to unravel what's going on here.

Now, this is a situation where the flow is clearly not just vertical or horizontal. We may look at competing flow paths and along a flow path we can conceive of it being one-dimensional, but the trick is where in the geometry do you reduce the three-dimensions to one flow path and how might you be able to test that. What other data might allow you to discriminate among these hypotheses. Do you need, for example, to go out and do a lot of isotopic sampling which is quite expensive and not in the budget for several years? Is that worthwhile doing for the program? And these then become very important management questions that ought to be in the one to three plan or the annual plan, and I'll bet right now they're not there because nobody has put them on the list.

So I would think it would be very valuable to have some workshops between the performance assessment people and the PIs and their scientific colleagues that are relatively tightly focused on specific questions of hypothesis testing. But what you're in fact looking at links between the upper levels of the pyramid and the base of the pyramid and asking questions essentially in where do we want to invest in better data and better modeling so that we have a better story to support programmatic decision making. And not programmatic decision making that's out five, ten years or whatever but program decisions that ought to be looked at in the near future such as what do we do to have a better story with respect to the perched water question on UZ-14.

DR. FLINT: I'd like to just spend a minute or two talking about that particular issue and the idea, and I think there are several people here who have heard me say this before. I'd like to have one of these PA modelers assigned to me so I can give them some real challenges in understanding some concepts about what's happening at Yucca Mountain specifically. Fortunately, in this characterization program we only have one site to look at. We know where it is. We know a lot about the geometry of the site and we can work with that.

We have in the case of the UZ-14 are setting up a paper that we're writing now for the High Level Waste conference next year to address the issue of the potential for perched water and why it occurs. We're taking those surface boundary conditions and we were putting them in the LBL USGS three-dimensional model of the site to look at where one-dimensional, two-dimensional and three-dimensional modeling will work and where it won't work, and how we can try to resolve that particular issue. We think we have a good plan for it, but as Bill mentioned, that was one of the programs that was zeroed out and that's one of the programs that is I think being funded now or in the process of being funded, but it is an essential part of the program to answer that specific question.

We have the information right now without collecting any more field data to model in one, two and three-dimensions the site and the processes that we think are involved that cause the perched water to occur where it does.

And we've already modeled UZ-14, I have anyway, and found that that's where perched water should occur. We published a paper last year on high level waste that suggested that that zone where it occurred is where it should occur under certain circumstances and UZ-14 was one of the circumstances, and we should have seen it and we knew that from UZ-1. But we have the ability to do this but we're working in our own USGS program and with Sandia to a certain extent in making the connection with the performance assessment modelers in Sandia and now they're at the M&O, and we don't know who they all are yet, is something we have to get across. But I understand the argument that we work at the top of the pyramid, but from my perspective, I have some real challenging questions that were asked by Pat that I think we can ask those questions and I think we have the information available to test some of our ideas about this without a lot of trouble, without a lot of money. I think we're ready to do that. How we do that is something that we're going to have to decide as a group, but I think we're ready to do it now.

DR. NORTH: So your position is you feel that given the opportunity to run this slate of models, one, two and three-dimensional, you can come up with a good story now in terms of which of these hypotheses is correct such that you could defend that against criticism and--

DR. FLINT: I do. I believe that we have enough information, enough understanding to tackle the problem. We have hypotheses that are testable with the information we have today. We also have these tests that will predict in our modeling where we should see other perched water, and we should do that before. It's the same thing with our drilling program. We should predict what we're going to see in the boreholes before we drill them. We should predict where we're going to see perched water before we get there. We should have a model that goes through the ramp and says what are we going to hit, because if we hit the perched water and didn't know about it, that's a problem. If we predicted it ahead of time and see it, that's wonderful information. Perched water is not a problem if we know why it occurs and can explain it and show how it effects a repository. But I don't think I'm going to get a PA modeler assigned to me, but I'd like one.

DR. NORTH: Sounds to me like it would be a very good idea to have some communication on this specific issue, and I would hope somebody's budget could afford it. I realize that may be very difficult. What are you going to give up?

DR. FLINT: They're going to take it from mine, I'm sure.

DR. NORTH: I think that Alan's point is very much on target. Just imagine how things are going to play if perched water is found as a surprise as opposed to finding perched water validates the prediction of an analysis.

MR. STATTON: The first thing I can say is I'm delighted to hear somebody who wants somebody assigned to them other than an integrator. I think we all ought to have a PA guy and I'll go look for mine. In our own bumbling way, I mean, the prediction of perched water in UZ-14 was there. It was not only there, there was a whole suite of plans that were in fact in place because of that anticipation. So I think even though, as I tried to get at earlier, we sort of punctuate what it is we've planned and prethought, and it may not look very coherent, we've either been extraordinarily lucky as in the case of UZ-14 where a plan was there and in fact exercises were there not only on what to do once we got it, but what to do to progress after we hit it, which was the--program--I think predictions of what we expect along the ESF exists in nominally the same way. Perhaps at this point in punctuated ways where it's not coherently knit together, I believe this vehicle of knitting together our plan, our strategy, our expectations, whether it's a one year bite, a three year bite, or a long-range bite will help transmit that information, and back to John's comment, both internally as well as externally. And I think the Board and DOE concluded that this strategy needed a different vehicle than it currently had, and consequently that's why we've organized to produce this vehicle, to try to get that information disbursed.

DR. CORDING: And you'll have to produce something before you got as complete a pyramid as you'd like to have or may ever have.

MR. STATTON: Yeah. Pat's observation earlier to me is exactly a correct one. That we've been dealing at the top of the pyramid and in fact what we've been doing in the executables is trying to examine the bottom of the pyramid. That lack of handshake has led us to an operating philosophy that said seeing as we haven't too coherent long-range visions of where we're going, why don't we at the bottom of the pyramid organize a program such that we can articulate what it is we are going to find that maybe helps formulate the plan, the intellectual pathway of the performance assessment activities. And maybe we're about to cross over that to where the performance assessment activities can now articulate a plan and the handshake becomes complete and we can now drive the underpinnings to meet that.

DR. CORDING: Thank you.

Russ, you had a question or comment.

MR. DYER: Russ Dyer, DOE. Two points I want to make, one of which I think we're wrestling with--right now with probably the most difficult part of this whole project, and that is evaluating state of knowledge and intellectual progress. How do you do it and how do you evaluate where you are and where you need to go and what things do you need to do next. And I don't have an answer for you. I think PA is an important tool that must be used in that process, but I don't think in and of itself it is a panacea. I would like to give you an example of where performance assessment has been useful to me as a manager, at least I think it's been useful.

Bill Dudley and Alan both talked about areas where there were funding shortfalls in our original planning for this year. It was a PA person that came to me and pleaded the case that those activities needed to be funded and we scraped up the dollars out of somewhere else to get the money in the program for those activities, and those are primarily the modeling activities that we're talking about that are so critical.

DR. CORDING: Okay. Carl?

MR. JOHNSON: Just before we close off maybe this section, I wanted to make a comment on a point that Alan made earlier, and that relates to predictive modeling. I have--listening to the discussions over the last two days, I see that as a glaring omission here and I have yet to figure out why the Board over the last few years has visited the foreign countries which have active repository programs going and that seems to be a cornerstone of all of those programs and that is predictive modeling. But I have heard zero certainly from the program as to any plans to develop such a predictive model, especially of the ESF tunnel before the switch of the TBM is turned on.

DR. CORDING: Okay. Any further comment on that?

DR. FLINT: I'd just like to make one comment. I have been involved in INTRAVAL, which is the international model validation program [on radionuclide transport in the geosphere] for some time, and in dealing with most of the European countries that are dealing with the issue of nuclear waste, it's my understanding that although Carl is right in a sense, that's an important issue. I don't know that even though we're not doing a lot in predictive modeling, we are doing some and we're not far behind, if we're behind at all, of the international countries, because they're looking at us for the same information because nobody has solved the problem yet. Nobody has. And we're perhaps as close as anybody, if we just make the right steps in the right direction and make them now.

MR. DYER: Russ Dyer, DOE. I guess I would take issue with that. In fact, just last night I sent a note to Susan about predicting modeling that I was expecting for some things coming up. Before we drill any borehole, I demand a lithostratigraphic log. Before we put in UZ-14 we ask for predictions of where we might encounter water. Those were done. The procedures were in place. We knew what to anticipate. So far I don't think we have gone outside the bounds of our expectations in UZ-14. There are perhaps a variety of physical properties that we might wish to get some prediction on, perhaps a range of values for different units or so forth, and we may try that on a couple of holes. I'm not sure we want to do it for everything but I agree that there needs to be within the program some demonstration of predictive modeling. I don't see how else we can develop a competence in the models that we are using unless we can use them in this way.

DR. FLINT: Actually you took issue with what I was saying but what I was saying is we're actually doing a good job. I hope that's not the issue.

MR. DYER: No, I didn't take issue with you.

DR. FLINT: I do want to point out what happened at UZ-14 and the difference, and we knew there was perched water there. We knew there was water there. That wasn't an issue. We have UZ-1. We knew what the stratigraphy was like because we had UZ-1 there. The difference in what I try to model when I modeled it was that I tried to explain why it was there and looked at why. We did a predictive model of UZ-16 and stratigraphy. We said that there would be a vitric Calico Hills. There was not any vitric Calico Hills at all. We said that we would hit the water table before we hit the

Prow Pass. We hit the Prow Pass well before we hit the water table. But the thing was is that the modeling that was done that Russ is talking about for stratigraphy is important. My view is that that predictive model shouldn't be the sample management facility looking at related boreholes. That model should be Rick Spengler's three-dimensional geologic model because that's the one we're going to use for site characterization. That's the one we're going to use for licensing. That's the model we should be testing and running now. His model should predict the unit contacts of the next borehole we drill out there. It's that model and that's how we're really going to find out how things are working, with that model.

DR. CORDING: We're going to wrap this part of our session up and go on to some other items.

DR. DOMENICO: Domenico. Let me tell you what I think predictive modeling. I think that's fine but when Carl Johnson made everybody aware of the fact that tunnel may penetrate the Tiva I believe it was, nothing really happened. But what could have happened was that you could have taken Ben Ross' model, opened it up and opened up the Tiva and see what would have happened to the pressures. You could have taken anybody's model of air flow in the mountain, imposed that condition and in one day you would be able to address Carl. Say, Carl, you're wrong, or, Carl, you're right.

That's predictive modeling. You got a steep hydraulic gradient there. It's very important. Matter of fact, in a letter from the National Academy someone said it was one of the most important issues. I don't believe it's one of the most important issues. I think they said if it's a dam and it busts, you inundate the repository. Everybody's waiting to drill it. Well, I got two students. I give them some of my walk-around money and they model it. We've been able to reproduce that gradient just by doing some modeling and using information that's already available to everybody. So we've been able to reproduce that model a couple of different ways. One way suggested by Bill and the other way with the fault. There's no evidence for a fault. There's a lot of evidence for your suggestion, and we've been able to reproduce it. That's what I mean by predictive model. And like I said, I got walk-around money and I give it to kids to do. So, it's not a question of what I'm going to hit in the field I think. It's a question of asking questions; like my problem that I have with thermal load and the water accumulation, my problem I had with the steep gradient, my problem I had with what would happen to that tunnel. That's predictive modeling and someone's got to take the lead on that, you know, and it's got to be I think a geologist hydrologist in performance assessment because I think that's what it is.

DR. CORDING: Just one more on this item. Dwayne

Chestnut.

MR. CHESTNUT: Lawrence Livermore. I would like to kind of amplify a little bit what Pat was saying because it's occurred to me more and more recently that what models are most good for is helping you ask the right questions that you can go out and test something in the field with some real data. And if the model can help us to formulate three or four different things that we can go out and test in the field like the list of things that Dick had up there about possible explanations for UZ-14. Now, Alan's model may tell us something about the lithologic conditions that allowed that water to perch there, but it still never gets back and answers the question is this drilling water, is it contaminated perched water, is it from the water table, or what have you. And so we need to use the model to define the next experiment that'll help us to tell the difference among those three different alternatives.

The other thing on the foreign program, I'm pretty deeply involved in both the Swedish and the Swiss nuclear waste program, I'm on a couple of technical advisory committees, and they're using predictive modeling in a sense of let's do a large-scale site investigation, regional. See what we can determine from surface mapping, aeromagnetic surveys so we make some predictions about what we're going to see on a smaller and more detailed scale. We go get some more data, we see how that works until we finally get down to the one meter scale down in the underground repository. The difference is that they've had the opportunity to conduct a program and get underground in a relatively short period of time and actually start testing some of these models. Now, they can make good predictions of the percentages of the different rock they're going to find in the hundred meters of tunnel; however, it has very little to do with the performance of the repository. It only gives you some confidence that you have some picture of what the geology looks like.

Another thing they've been able to do is say we know about where the major fracture zones are going to be, but however, they don't put their construction schedule on the line based on surface mapping of where a fault zone's going to be. They drill ahead of the tunnel face and test it to see what the transmissivity and the pressures are going to be when they get into that zone. So they've got a continuing program with the various levels of detail to test those predictions before they get into it in a situation where they're going to have the Baltic Sea coming--so I think we have to be a little careful about what we're asking of predictive models because I don't think you can predict everything ahead of time.

DR. CORDING: Now, I think we're just about--we need to be done. Alan, you just had a quick response to that. If we could end with that.

DR. FLINT: Yeah, I'm sorry. What I wanted--my models are not stratigraphic models. The models are hydrologic that explain that it's a perched water body and why and whether you need two-dimensional or three-dimensional models to model it. I'm trying to use more abstractive models to a certain extent to explain the large-scale process. And I'm not talking about necessarily predicting each borehole, although I did say that. I'm talking about having a model that will predict what--we're only going to have a small percentage of the area touched. We need to know by the time we have the last hole drilled that we understand how it happened to be the way it is. I'm looking at a large process, not just lithostratigraphic process.

DR. CORDING: Okay. Well, let's go on to another topic that Dwayne Chestnut was referring to: going underground, and I'd like to discuss a little bit this integration between testing and excavation, underground exploration and the excavation process. And we have people that have been involved in the presentations. For example, Dan McKenzie with M&O has been making presentations regarding the underground excavation work and the design aspects of that. And we also have others who haven't been making presentations here and to my left is Dan Koss with REECO and also to his left then is Lance Destalinski from Kiewit-Parsons-Brinkenhoef and other--and we have Bill Hansmire from Kiewit PB in the audience, and I'm sure there are others here as well. So perhaps we could discuss some of these aspects of the testing of--the excavation process and how we're going to fit this testing into it in a way that we remain efficient in the tunneling and meet the objectives of the exploration program.

One of the items has to do with the alcoves, installation of alcoves and then there's some other questions about drilling out ahead of the tunnel boring machine in order to be able to sample faults before the machine gets there. And I think these items can have a very major impact on the construction schedule, and I think the best efforts of everyone are needed to help make it--do it in such a way that it can fit into the construction and you still achieve the testing requirements or testing needs.

So I guess going to this question on alcoves, we've talked about--Ned Elkins talked about an alcove, for example, at the Bow Ridge fault, and there may be others that we're going to need--and then talking also about alcoves in order to explore other major faults as you go through the system. Presently how is it envisioned that these excavations will be made and what is it going to do to the construction schedule. I'm not sure which side of the fence--

MR. McKENZIE: I can tell you what we're planning on right now is if we have to put an alcove in it, if it's one that's required, it's as you would imagine, it's sort of brute force. We're going to stop, we're going to take the tubing and the conveyor and the utilities out of the way. We're going to have to shoot as many rounds as we need to shoot to clear the tunnel to get out of the way of it, then we can put the utilities back in and go. So it is a delay. That's why we don't want to build 45 of them or 50 of them on the way around the loop.

DR. CORDING: So you cannot maintain the machine progress because you have to take out the utilities, you have to take out the conveyor in order to do that.

MR. McKENZIE: Well, there may be some ways to streamline it but I really don't see any feasible way of doing it without some reasonably substantial delay.

DR. CORDING: Lance?

MR. DESTALINSKI: Yeah. You know, there are some ways to work around things. There is going to be a delay. There's no question about that. You know, basically all the alcoves are going to be on the opposite side of the conveyor. The conveyor can be protected. I mean, you can make a screen. Basically the fan lines are going to be on the right side, it's going to be very close to the alcove. It probably won't be affected if it is--utilities will go basically above. The big thing is you can't have rail haulage while you're shooting. Now, we can look at schedule-wise of doing things on weekends, going to a seven day a week, still keeping the TBM on fives. There's some things there I think that we really haven't sat down and talked about with the M&O or anybody else. The question is, do you want to go drill and shoot or do you want to go mechanical. In our original proposal to REECO we suggested some mechanical methods that do exist now.

The question is, how big an alcove do you need? I mean, if you're talking about eight to ten feet, there are some mechanical methods that can be used that exist at this time, and the question is they are generally expensive. I mean, machines just like any other machines, they're not cheap. And under the current procurement system, they are a long-lead time item. But I think there's a lot of need to sit down and probably sit down with the M&O and the scientific group and work out some things.

I think there are some things we can do to minimize the impact. There will be an impact. No question about it.

DR. CORDING: If you are stopping the machine and your crews are going on standby and all, what sort of costs are we talking about or what's involved with that?

MR. DESTALINSKI: I really can't tell you right--you know, my guess right now, we got some estimates and of course

I didn't bring them with me. I think you're talking forty, fifty thousand dollars a day. Here again, my suggestion is if we stop the machines, just don't put the crews on standbys. Let's use our crews to excavate the alcoves. Therefore you may delay the overall project, but you're not impacting total cost. I mean, you got to look at it from--I come from basically a competitive world and hard money contracts, and we're doing quite a bit of work with the super collider things. There are times when we have to do things to slow things down but you look at maximize and minimize your costs, put your people to work and what's the best flexibility, and I think there's some things we can do there. We just got to sit down together and talk about it, work it out.

MR. WILLIAMS: Dennis Williams here, DOE. Maybe a perspective on that, I know that Ned has talked a lot about the alcoves that we're going to put in, but I think in large part we're talking about deferrable alcoves. So we aren't dealing with alcoves that are going to be put in and delay the construction of that primary loop. Was I missing the point there, Ned? I mean, this is what we've talked about for two and a half, three years. The deferrability of these major excavations adjacent to the TBM drive. So I guess I appreciate all of our people looking at what we may have to do if we need to go into an alcove and prepare for that, but

I don't think there's going to be that many alcoves on this first loop.

MR. DESTALINSKI: The statement's been made to me that there most likely will be some, not none. Is that correct?

MR. ELKINS: Let me take a shot at this at this point because we have identified preliminarily just based on targets of opportunity and data needs from our underground program, numerous alcoves potentially in the north ramp, the main Topopah Spring drive in south ramp, the total of in excess of forty alcoves that could be constructed. Ongoing early testing and results of testing will dictate ultimately how many of those alcoves we ultimately need, how many of those test locations must truly be tested, because there's a possibility we wouldn't test in every location that preliminarily we've identified. As important as that, and I think what Dennis is going to at, at this angle, is how many of those alcoves have to be put in during the actual time of construction of the main, and during my talks today I tried to at least allude to the fact that the majority of our test program, compared to back to the old shaft days, is already in a deferred mode. And most of our alcove tests are clearly going to be deferred.

Some of the ones we're most concerned about is, however, some of our hydrologic response tests, some of the USGS testing. And as hopefully our discussion cleared here today, we can't say with confidence today if all of those alcoves can be deferred. We're trying to get the one alcove in now to answer some early questions on exactly what the impact of some time between construction and testing is and quantify the potential impacts or what we anticipate those impacts to be. We believe that getting a very early start on the next alcove at the Bow Ridge fault to do some similar testing at that anomaly is also very important to us to answer some questions on really the ultimate deferrability of these. However, we think there is a good likelihood that during the construction of the loop there will be some targets of opportunity that the test community feels very strongly we need to accelerate or get an early look at which are going to require an alcove just to get those activities out of the main. And so, it is for a very small percentage of our testing that we ask these questions, but we do believe that the need will be there to, in as streamlined a fashion as possible, integrate a test alcove development with a TBM operation, even though it may only be for three, four or five alcoves during that loop. We believe they're important to take a look at.

DR. CORDING: I think that the impression I got in recent months and in the discussion today was that it's going to be more--there's going to be more of these alcoves and more drilling required that would affect or could affect the

TBM progress than perhaps I had thought maybe six months ago or a year ago from our discussions. But the discussion of, for example, the fact that you want to look at the borehole--you want to look at the faults before you encounter them with borehole drilling, and that leads you to thinking now when we talk about a fault, what are we talking about? Are we talking about a series of sheers and fractured zones which total up to several hundred feet, or are we talking about having to penetrate those before the TBM arrives, and then recognizing that if one were to try to set up to do that, that the actual drilling of those is slower than--for the most part would be slower than the advance of the machine, and to set an alcove in there you're talking, you know, those sorts of interferences. You could talk about a week or so to even get an alcove in. You know, those things will start to add up and what we--I mean, part of it has to do with how we're defining this as to what is a minor interference and what's--every time we hit a fault that one has to do that. Now, if you had to do these things, you have to do them. But I think it's time now to look at a realistic view of what is there, potentially what is there, how wide are these faults, how much do you have to do to look at them, and how's that going to affect the construction. And we had--I made a suggestion that we consider, for example, with the large tunnel that is there, there's space in that for certain drilling activities behind the machine. Well, you could set up and do drilling, for example, off of a preestablished platform off to the side, for example, to hit a fault, or you could drill ahead of the machine. That requires stopping the machine to do those machines. But one should be set up to do the things that you might have to do and now's the time to take a realistic look at it because you're not set up to do it. It won't happen properly. It will delay the project too much or delay the advance too much.

Planning now will help and I think that there's a real concern here. I have a real concern about how much we're really talking about here. I don't think that--I'm hearing several different things as to what this impact could be and what's really a small impact versus large.

MR. ELKINS: I think, Ed, that one of the things that I want to amplify on what you've just said is we are talking about two different potential impacts here; one is the construction of an alcove, the second is drilling ahead of the TBM operations for an anticipated feature. Of those two, the one that I think most concerns us in the immediate time frame that we need to really begin to address is the drilling of boreholes in advance of construction. I truly believe there's much greater opportunity for construction impact in that process than there is in the development of alcoves. One is the nature of our test program. The alcoves we believe will allow deferrability better.

The real concern that I think we've identified and have begun to work now is just exactly what must we do in terms of advance drilling and how could we perform that advance drilling. Couldn't agree with you more and the DOE has recognized that along with the testing community. We have now got the construction, the subcontractor on board. We got the right people involved, the design group is up, the test community has polarized on the issue, and I assure you that we will be spending a tremendous amount of time with this question of advance drilling in the near future.

MR. CHESTNUT: Well, on the subject--Dwayne Chestnut, Lawrence Livermore. On the subject of drilling ahead, might be of interest that, if you're not aware, the hard rock laboratory in Sweden is going to use tunnel boring machine for the last part of their tunnel, for their laboratory. And they, as I understand it, are making provisions to allow drilling ahead of the face. So this should give us some direct field experience with--

DR. CORDING: I think there's a lot of experience in the U.S. with this also. I mean, it's not uncommon to drill ahead when you have to take care of water conditions, but it does dramatically slow progress of the machine. And it's something that I think if you're trying to get out ahead and find it, find these conditions, it's just how far are you going to drill. Are you going to drill a hundred feet ahead, two hundred feet ahead? You going to drill ahead every day? If you're doing that, you cut the speed of the machine and the advance rate of the machine at least in half, if not more.

I'm pleased that we're going to look carefully at it but I think that the possibility of going in with side drifts where you can then hit the fault on a side drift where you can take time to do those things, take it out of the main--the construction cycle of bringing the main TBM through the facility. Then that would I think do a lot to mitigate some of these impacts.

MR. DESTALINSKI: Lance Destalinski with Kiewit. Just, I think, a few things just so the Board does know as far as coordinations and working. There has been a great deal of discussion with the M&O and us and I think we're pretty well in agreement now. One thing we are going to do is go with a double rail system in the tunnel. Now, the reason for this, one, it gives us the versatility of sidetracking, leaving a sidetrack for a drill rig, for access into alcoves. It also would allow us to have a platform drawn on the outside two rails and we'll run on the inside. This double track will basically be a 36 inch gage between all three systems so you can run the center two tracks or you can run double track on the outside. So it gives us a lot of flexibility. The other thing it'll do later on, it'll allow us to run two operations. If we go with an eighteen foot machine later on and want to go drill and shoot or whatever else in development of the main test area, you know, it's a lot safer to run a train system that goes in on one track, comes out on the other. Or, you can basically isolate them to one work area. So those types of things have been talked about.

The TBM does have the capability--it has the room right now to mount a drilling system. The drilling system itself has not been procured because of funding. We've been asked do we need the drill. As a contractor, no, I do not need the drill. But if the scientific community wants to put it on, facilities are there to install it.

MR. McKENZIE: The spec was written so that it would house the drill, but the drill itself wasn't bought with the machine. But the ability to mount it on there is there.

DR. CORDING: With a double track system, then, you can be putting some sort of a--as you point out, you can put a drill or a platform back where that could be operating even while you operate your machine.

MR. DESTALINSKI: Correct. Yes. And it still gives us the--it could either go around it, you can set it on one side or the other if they want to drill, say, the--we could set it up or we can build a platform--basically another gantry that ran on the outside rails and we'd go between them. So it does give us quite a bit of versatility and not only from a pure construction point of view but as far as supporting the scientific community.

DR. CORDING: Seemed to me that would allow reduction in the number of alcoves and you could do that for some of these radial borehole tests, for example, without having to put alcoves in. If you had to do those, you know, in the process of advancing the main TBM, or perhaps even later when one is doing other activities after you've gotten through the loop.

MR. DESTALINSKI: It's a possibility. We just have to look at the space available when it gets down to planning things.

DR. CORDING: Okay. Fine.

Other comments from the testing group here on what you see with these impacts or what you need?

MR. LeCAIN: If I could--Gary LeCain, USGS. A lot of the use of the alcove is because there has to be a field crew in there assembling equipment and putting it into the boreholes. Somebody would have to show me some details on how that could be done without an alcove before I think we could agree to anything like that.

DR. CORDING: Perhaps a dedicated platform that's got a door on it or something.

MR. LeCAIN: As long as the crew's safe.

DR. CORDING: Okay.

MR. DESTALINSKI: Yeah. Bring up another, I guess, one of our sore points between Dan and I. We've been pushing a great deal for the use of diesel locomotives and transportation systems. Right now we're basically kind of being told we have to go with the trolley system. And once we put that trolley wire system up, it does limit access up into the top of the tunnel. It also creates a safety problem.

As far as the mining operations and that, we have no problem safety-wise with our people in dealing with trolleys. It's not common in civilian construction but it sure is in mining. We've had the opportunity to visit the mine and talk to people that use it, and I think a lot of my concerns about the safety have gone away. But it does limit your ability to use the tunnel behind you to a great deal. Right now we're looking at probably the trolley system being 1,500 feet behind the TBM trailing gear so that's, say, 2,000 feet from the face. But there's another question in--this whole question of diesel use underground I know is one that is serious to a lot of people. I don't totally understand it and why not, and that has never been explained to us.

DR. CORDING: In terms of your ability to control the diesel and scrubbers and those sorts of things, what can you do in that regard?

MR. DESTALINSKI: Well, basically, I mean, diesel locomotives are common tools in every mining civil construction project in this country. I mean, basically the scrubbers and that are basically controlled by the Bureau of Mines. People adapt to that. Ventilation becomes a key point of view but here, you know, the ventilation is--what they have is very significant. They've taken a very conservative attitude about it and I have no problem with that. I think it's more than adequate for the uses we do need. But that becomes a question. If you want the versatility, you sometimes have to give up something else. And if we wanted to give the community access behind us, the work platforms, we can do those kind of things. But once you put the trolley in, we're going to somewhat limit ourselves.

MR. McKENZIE: The use of diesel or lack of the use of diesel is thrust on us, like he said, by performance assessment. A preliminary evaluation what they did which said that carbon accumulations, soot and whatnot, are a bad thing. And that trolley locomotives, trolley electric would fix that situation. The evaluation that they did was pretty preliminary and they didn't use any kind of scrubber. They assumed the output of soot and whatnot from an engine, a well tuned engine but one that had no ceramic filter or no scrubber or anything on it. So it was a pretty rigorous treatment, but nonetheless, we are building a laboratory and with the ultimate goal that the site is suitable building a repository and we don't want to do something that's going to ultimately cause a early corrosion of the waste packages which is apparently the concern, the carbon and what it does. But I don't know if we have anybody here that can really address the how and why of how the study was done.

DR. CORDING: We've had discussions on some of the effects of organics and colloidal transport and all, and so there's been discussion on that and I think the question would be how much of an impact this is.

DR. NORTH: The issue is mobilization of radionuclide transport. If your radionuclides will complex with organic materials and that allows them to migrate many orders of magnitude faster than they would in the absence of the organics, that becomes an important issue. And how significant it is I think is something where you want a calculation, bring in performance assessment and let's test hypotheses. But I think it would be very unwise for the program to go about making this kind of a decision without doing that analysis. So there's a task for a few more performance assessment people.

MR. FRIANT: Okay. Jim Friant. I was thinking the Board might be interested in a little bit of the work that we have done recently at Colorado School of Mines on this alcove subject. We just submitted a little final report on a study of--one of the things in many of the writings that we're all working to, CFR 60, look at all the technologies, and so we looked at mechanical techniques of cutting an alcove. What's on the market now looks like a road header, but to get one that's powerful enough is 40 feet long, pretty tough to put that in a 25 foot tunnel. And Robbins has a thing called a mobile miner which weighs 324 tons, not exactly my definition of mobile. And Wirth has one that's a relative lightweight. It's only about 200 tons and it does a unique technique of cutting. Now, you know, our marching orders were to stick with existing technology, but what we did find was a parallel program going on in the micro tunneling field that utilizes a very small but high capacity disc cutter. I almost think it's kind of funny because what was discovered was a steak knife works better than a butter knife on a tough piece of meat. This is a little cutter and it's very sharp and it--we tested it against the standard cutters. It takes about one-fifth of the pressure. This gave us the idea that, okay, if we use those kinds of cutters, we can get the forces we need to cut this TSw_2 and that relates back to the chassis size. So I had only about a 50/50 feeling that this might be successful and I'm quite encouraged at this time. The machine looks quite feasible. We went through a concept study and to keep the power low we kept only about 120 horsepower on this machine. It looks like it would weigh about 25 tons. I'm talking about machinery and I really shouldn't because what we did was look at what the rock wants first. We looked at a cutter head and fortunately this testing was going on in the micro tunneling area, so we were to take that actual data and apply it to a small machine and how the cutter head should be held against the rock. And then all we did was look at what kind of a chassis would hold that cutter head up against the rock the way the rock wants it to be held there. And at any rate, this does use the outside of the four track system. It would appear that one shift would clear the tracks. Again, just something that Lance mentioned, you have the option. We clog up one side, one set of tracks but the machinery, the little train that brings this--would bring this thing down would come down on the outside of the four rails and as soon as it's in six feet, one of the tracks then is clear. This thing functions as a bridge and the supply train could go up the ramp, through the train and down the other side. So you would establish one-way traffic. You don't have to take the conveyers down. You don't mess with the trolley wires. You don't have to take the ventilation tube down. It really looks encouraging. I'm sure there will be more briefings on this. Like I say, we only delivered this report a day ago.

DR. CORDING: Thank you, Jim. It sounds interesting.

Yes, Dale?

MR. WILDER: Dale Wilder, Lawrence Livermore. I just wanted to follow up very quickly on the question about diesel and so forth and let you know that there is an ongoing study of diesel. Unfortunately we have not been able to look at exhaust, which is the issue that was being discussed. But certainly the diesel fuel itself is being studied. The question of course will be will those studies be completed in time to really be of value in making decisions on construction methods. But there is a man-made material study going on right now which is looking at the diesel fuel and its potential for breaking down in the water.

MR. CANTLON: John Cantlon. Let me follow up with that. Is that study going to look at an option where you might use diesel during construction and then switch over to trolley during the operating phase?

MR. WILDER: Well, this study is really a scientific study looking at what happens to diesel long term in terms of can we provide a feedstock, if you will, for the organic materials for the biological degradation, so forth, that could either create the colloids for complexing or the corrosion mechanisms. It is not looking at specific construction options, just trying to get a handle on what are the impacts of the diesel.

MR. KOSS: I understand you to say that you're looking at just the diesel fuel aspect of it and not diesel exhaust issues?

MR. WILDER: That's correct. There is no study currently funded to look at diesel exhaust.

MR. NELSON: Just for information. I'm sorry that Jim House, the one who is doing this analysis and also working rather closely with the studies that are being done here, isn't here. We didn't realize that these kind of questions would come up or Jim could have been here and given you much better background for it.

DR. CORDING: I think it sounds like another area for interaction in terms of what the construction people think will be produced there and what the science side can say regarding its effect.

One other question for the constructors here regarding the schedule for the main loop. It's something on the order of what, twenty months or something? I'm not quite sure of the exact time. Twenty-two months. I just wanted to--just maybe a summary of what the assumptions are there in terms of advance rates, machine utilization and then the down time for the testing.

MR. DESTALINSKI: Yeah. We were involved in kind of putting together that schedule that was shown. The assumptions were, one, that we would spend about 25 to 30 weeks in initially getting the machine broken in. And that's over really about the first thousand meters of tunnel, a little over 3,000 feet. That was based on really our experiences with a Robbins machine in Boston and also looking at some of the English Channel break-ins with double--for the rest of the north ramp basically we based our production on working three shifts a day, basically taking the day shift for maintenance. The maintenance here is heightened because of the leak mitigation requirements on the machine and with our crew, so there's a greater deal of break-in. Also basically the scientific community, the day shift, to do the photography work. Basically by the time we get to the bottom of the ramp, we think we should have a pretty good working team. They will up that production to twenty hours a day, basically go four hours for maintenance and photography work. If we look at a 50% to 60% utilization, which is high for TBM. Now, we're getting those kind of utilizations in Texas on the super collider in Austin chalk material, which is a lot softer than this but with conveyor systems. Then you're looking at something like 350 feet a week for the sixteen hours working and about 407 feet a day for the twenty hours. So you got about eighteen months worth of work. We put a 15% programmatic delay in our estimate and at this point that's a guess. It would seem to be a reasonable agreement with all the parties that that seemed like a reasonable assumption to make at this time. So that's where the 22 months came from.

DR. CORDING: Thank you. I guess I'd like to turn to one series of questions here regarding how the thermal test program can fit into this excavation of the main loop. I know there was some discussion of the possibility that the thermal testing--different ways of trying to get the thermal testing started before the main loop was completed, and I think Ned referred to a couple of points on that. And then Dale's been thinking about it. Maybe we could have a little discussion of just what might be done, what is going to be considered regarding fielding a major thermal testing effort, recognizing that it looks like it's four years away if you wait until the main loop is done and then build the underground core test area.

MR. ELKINS: This is Ned Elkins, Los Alamos. I'm not sure that Lance and Dan were here during the part of the discussion earlier where we at least laid out a couple of things that we need to be looking at, and maybe if I can reiterate those, Ed, it would allow them something to wade into a little bit for us.

The two things I mentioned is one is an ongoing uncertainty regarding multiple operations or multiple heading work around the operational constraints that we're going to have, ventilation constraints. The question of whether or not we can start development of an area which would facilitate thermal testing prior to construction of the loop strictly from OSHA, MSHA or Cal tunneling safety considerations or operational constraints continues to be something that we look at and we work towards, but I don't know that we've made a definitive answer yet and maybe Lance especially, with your coming on board, you may have some very specific feelings on that, the ability to get an early start on thermal testing just by being able to prepare an area before or during the process of that loop.

The second thing that I mentioned today was the currently proposed revision of the configuration that we're looking at which has north and south ramp extensions that drop through the horizon at TSw_2 off of the currently defined block. We see those as opportunities to take a look at a thermal test program or in situ test program outside of a core test area and perhaps accelerate to some degree our ability to get those tests started just by utilization of some of these excavations that have not been in previous plans. And with those, perhaps maybe you might want to respond or at least give us some information or insight.

DR. CORDING: Lance?

MR. DESTALINKSI: As far as, you know, going to multiple operations, really it's built into the design. The ventilation is based on multiple operations. The conveyor system is actually based on three operations. There would be some delay but the delay is really just getting yourself in to where you could have an operation run, and that's probably a reasonable delay for the project. I mean, if we can get something else going, we can run a lot of things with the same overhead, it helps on the cost. And it makes it much more effective to do it. It's probably something we have to look at. But if you say we had to shut down the TBM for a month to get a major area open from you and we can use those people to do that work, to me it seems a reasonable thing to do.

MR. McKENZIE: It's certainly not illegal. When we fall back on MSHA, we talk about having two means of ingress and egress. Since this is not a mine and that regulation is kind of gray anyway, there is no legal requirement that really drives us to say that we have to hole out the south portal before we could start another excavation operation. We tend to veer toward the conservative and in this case--guys going to get tired of hearing this, but the funding level doesn't support mobile operations at this point anyway. So we intend to drive the loop pretty much as we stated earlier. If the resources were available, it certainly would be doable to get an early start into the main test area. It would probably enhance the heater test starting date quite a lot.

DR. CORDING: One of the things that I've been concerned with is the core test area or the heater test area excavation technique, and just seems to me that in order to properly characterize particularly the near-field conditions around the tunnel, that you need to be using an excavator, a TBM, full face TBM as an excavator of that. And what's the current status of the layout of the core test area and the type of excavation that's being planned for it?

MR. KcKENZIE: Okay. Right now the main test area still looks like it did in Title I, which I'm sure you've seen, and it was laid out and the concept of being excavated by a mobile miner, which Mr. Friant described to us as not very mobile and not much of a miner either. But there's only been I think three or four of them built and they haven't gotten progressively better. So right now we're between a rock and a hard place on how to do the MTA. If we want an MTA core area like we had before, the concept, we have to either come up with something, as you say, a TBM that can turn much, much sharper than you think of classically of a TBM turning, or we have to go drill and blast or some more exotic probably disc cutter based technology. There aren't a lot of choices. But the main test area is not due to be designed this year and there's only just a little bit of work next year, FY '95.

DR. CORDING: We had some of the consultants that were involved in the November meeting who laid out some plans using short radius TBMs and backing and doing that for a core test. Certainly you reorganize it so you don't put as many cross-drifts in or use limited drill and blast for cross-drifts or something like that. I'm certain there are ways to handle that with current technology. But it does seem that if you look at the funding situation, that the way it's presently planned, that you won't have the opportunity to start another tunnel boring machine into the project at that time.

MR. McKENZIE: That's probably true, but it depends again on which funding scenario you see and it seems like we see two or three a day, and on the revolving fund scenario there would be quite a lot of money available to the SF. Stop me if you heard this before. There's always going to be more money next year. In that case, we would be able to place the order probably next year and avoid a gap basically in excavation once we daylight the south portal. But again, it's totally driven by resources.

DR. CORDING: I think one question I had in regard to acquisition of tunnel boring machines, and I'd like some comment here on that, is discussion of very long lead times to acquire machines. In my experience, and for many people in the construction industry, is that a contractor basically provides a machine and that his acquisition is strictly the time it takes for him to order the machine and have it fabricated or rebuilt if he's using a used machine, and that period is something on the order for standard type machines is on the other--well, it's less than a year. And I'm wondering if that type of approach is going to be used or some approach can be used where these very long lead times on acquisition would not be required.

MR. McKENZIE: I'm not an expert in the--I'm not sure what the DOE's position would be on a contractor procured machine. I'm not sure there would be a whole lot of difference in terms of being a large procurement. REECO actually buys the machines now. REECO bought the TBM and they're a contractor and you had a lot of hoops to jump through I know in that procurement. So I'm not sure there would be a lot of difference if we sent Kiewit out to buy one as opposed to us buying one.

MR. KOSS: A machine might be available from Kiewit on a smaller diameter. We're talking an eighteen foot, say for example.

MR. DESTALINSKI: Yeah, we currently have two of them in Texas that could run at eighteen feet.

MR. McKENZIE: I understand they may be available soon too.

MR. DESTALINSKI: That could be. It dawned on me here. We got the bad news yesterday. The House voted against the super collider. Right now it's about a 50/50 chance if the Senate wants to tell the House kind of to go fly a kite and then not pass the bill, then it'll continue. If not, DOE may own four mining machines here in about three weeks. Maybe we can get one of them transferred, simplify our problems.

DR. CORDING: I mean, there's a lot of ways of acquiring equipment in various public works and federal projects, and I would think that's an area that could be looked at here in terms of providing things so that certainly--I was somewhat disturbed to see a delay in a schedule I think of a year or something to acquire an eighteen foot machine which would mean that it didn't get into the project a year after the main loop had been excavated.

MR. McKENZIE: That was based on a fairly flat funding scenario, something where the money doesn't increase materially at all over the next four or five years. But yeah, that's the--

DR. CORDING: How much money do you need to buy a TBM? It's a small percentage of this project funding.

MR. McKENZIE: The last one was I think 12.7. The next one presumably will be smaller and therefore cheaper.

MR. DESTALINSKI: I think you're looking, you know, at probably six or seven million dollars for a new one. You're looking at a used one. But there seems to be problems in buying used equipment under the government procurement system. You know, you're looking at probably under two to three million dollars, you know, ready to work under the criteria you need here.

DR. CORDING: Rent the machine to the government.

MR. DESTALINSKI: That's a possibility. I mean, that's something we haven't pursued. We got into a discussion last week and we've basically been in an estimating process with DOE here and schedules for about the last three weeks of going through alternatives, you know, based on, one, their funding, and based on, you know, what can we do next year. And there's about three different scenarios. The question was about some equipment, could we actually rent it, and the answer has come back yes, that it can be. Those things can be done. And that's a possibility, that we could basically lease a machine. We do own one that's run at 16.4 right now and it's run at 20 foot 4. It's got the horsepower to do it basically, particularly for the Calico Hills. And there's a lot of scenarios there to look at; new, used, machines we own, machines other people own.

DR. CORDING: Other questions on these topics? We've run out of time. Is there any other pressing comment that people want to make and have been prevented from making over the last few days?

Yes, Dale?

MR. WILDER: If I could just make two quick comments. First is, you'd asked earlier in this session about the schedule for our thermal testing, and I don't know what all the work rounds may end up being, but my only comment would be that if we do experience the kind of slip that was being at least discussed as a possibility, I think we recognize that either one of two things are going to happen. Either we're not going to have the thermal testing completed in time for license application unless the license application slips a comparable amount, or the license application's going to have to proceed at a higher risk without the information.

The second comment I was going to make is relative to the question about drill and blast versus a tunnel boring machine in our main test area. Right now, as Dwayne mentioned, the project in Äspö, the hard rock laboratory is going to be looking at trying to make a comparison between the drill and blast versus the tunneling boring machine. Admittedly that's in granite. It's not in welded tuff but the concern that I have with that right now is that they're looking strictly at the geomechanical kinds of impacts. We're trying to work through the international agreement to see if we can encourage them to also look at the hydrologic impacts, and that might give us some information to help make a decision whether it's critical to go tunnel boring machine versus a drill and blast. And I certainly think that that would be a way for us to start to progress, and I would encourage that kind of international cooperation.

DR. CORDING: I don't think there's any doubt that the geomechanical effects will be very severe. We're trying to understand what's happening, you know, to the stability and stresses around an opening that's shaped with a drill and blast excavation compared to one that's excavated with a TBM. It's two different worlds. That's one of the perspectives I have on that.

Well, we're beyond being out of time and John Cantlon is anxious to close the meeting.

DR. CANTLON: Well, I think this has been an extremely interesting and profitable two days certainly for the Board and I hope for other participants. We've had a great deal of very candid exchange. I think one of the virtues of having this discussion session after the formal presentations is that our ability really to put our own political and other kinds of constraints behind us and really sit down and deal with the facts as we perceive them to be in very candid ways is a very useful way to advance this very, very complicated and challenging session and topic.

When we set this session up, there was--and this was almost a year--well, it was a year ago, there was a perception of a considerable amount of competition between surface-based testing and the ESF, and we felt that that issue needed to be in a sense aired in a kind of public setting. I think I was comforted to see that at least internally within DOE and its contractors, the intensity of that perception is diminishing. It has disappeared obviously because we're dealing with a zero sum gain, and when you're dealing with the intensity of the budget constraint that this program has been under almost from its beginning, there clearly is going to be this problem. But at least it's in a sense driving better integration I think internally within DOE and with its contractors.

On top of that set of issues that led us to set up this session, we put in the later emerging question of the pneumatic properties of the mountain and the interplay between the ESF program and the ability to characterize the natural pneumatic characteristics of the mountain. I think that set of issues got aired in a very candid way and a very useful way. I wouldn't summarize the session to say that everybody came away of one mind about it. On the other hand, I think everybody understands what the level of hard data are on that set of questions and what we need to do to move ahead. There are differences of opinion about how much needs to be done and that's intrinsic to any budget constraint program.

I think Larry Hayes' assessment that the Board meetings are generally unproductive, the Board certainly does not share Larry's view in that. I think we could document in many ways real products that this interaction has generated. On the other hand, we don't have time to engage in that. I think that Dennis Williams' statement following up on that, that there probably are ways that we can make these sessions more productive, and I think we should all of us put our minds to that.

The sessions today on the planned underground testing program have also been I think illuminating. It's clear that the prioritization and the queuing process is moving ahead, and again, the constraint of inadequate funds does much to order one's mind like being told you're going to be hung in the morning.

The Board has, however, continuing concerns that the integration in such a diverse and far-flung population of researches, both research organizations and research individuals, continues to need attention. I think the interchange that we had here this afternoon between Jean Younker and Alan Flint is sort of symptomatic of the realities that exist in projects of this level of complexity, and I talk about that in terms of the technical and scientific complexity. But on top of that, you researchers have to appreciate the fact that the people who are running it at the top live in a much more complicated world of budgets and politics and regulation and so on that the individual researchers really don't have to deal with on a day to day basis. And so, you've got to be a little bit patient with the kind of world that this kind of a project runs in. And I say that with some feeling because for twenty years I was in Central Administration and listened to faculty bitching day in and day out.

DR. FLINT: Does that mean I'm going to get hung in the morning?

DR. CANTLON: I was threatened several times. I think this afternoon here, while we're looking at this interplay between the challenge of doing the construction of the project, which is a fairly substantial construction project, and the interplay between that and the R&D that has to get done in it, and ways in which we can all of us think of opportunities to optimize those two again very different challenges, how do you move a construction project ahead efficiently and competitively so that Congress, when they look at cost per foot advance, don't blanch and have heart failure or budgeteese or whatever it is they get. We do need to look at how to make that process as efficient as we possibly can. But again, these are important exchanges.

I think that Tom Statton's fish hooks and sausages synthesis addresses the issue of integration, coordination, a sense of real coherence that the project isn't drifting, and that's not a very singly held view. There are a lot of people both in Congress and in the public that don't really understand, A, the complexity of the program both technically and scientifically and politically, but then, you know, $6 billion to ask whether or not the place is useful or not isn't a small number. So one can understand the unease. So

I think anything that can be done, as Tom's diagrams and his very lucid presentation of the way in which the challenge of integration--anything that moves that challenge ahead is to everybody's advantage. And communicating with external bodies like the Board is one thing, but as you could see here this afternoon, you got an internal problem that is equally challenging.

We also had a presentation by NRC in explaining the QA and QC aspects of the deficiencies that they saw in the M&O ESF design efforts, and that I think is illustrative of another aspect of this very important project that we're all concerned about. Recall that the U.S., as contrasted really with all of the other nuclear countries in the world, has the most detailed regulatory framework that exists. DOE did not do itself any favors when it then established internally how it would cope with that. They actually I think have complicated the way in which that process moves ahead. We're now apparently frozen in what is a massive bureaucratic exchange, regulatory exchange, which has an extremely high infrastructure and overhead burden on this whole project dealing with detailed QA and QC of an emerging, changing conceptual design. You know, it's like having multiple auditors looking at every sketch that an inventor makes before you ever get to manufacturing the damn thing. So we have really shot ourselves in the foot in this country for the nuclear program, in the nuclear waste program in many kinds of ways.

Now, right at the moment the academy is looking at the technical and scientific basis of the regulation, and it may well be that the climate is right to ask the question, are we forever trapped in this bureaucratic grinding which isn't really paying off in any kind of way except for the people that don't want to see the program go ahead anyway? They're perfectly delighted to see its cost escalate, and it's scheduled to disappear off into the distant future. So I think there is that possibility. I'm not optimistic but I just raise it as one of the interesting things that came into my mind as I listened to this program today.

Let me then close by expressing thanks to all of the investigators and the project directors, the administrators, both within DOE, NRC, the various contractors, the State of Nevada, the affected parties, all of who are here and I think contributed to this. I like the level of candor and I do think unlike Larry Flint--or Larry Hayes--sorry about that. It's a helpful hybrid. I do think that these sessions are useful and I thank you very much on behalf of the Board.

We're adjourned.

DR. NORTH: John, before we adjourn completely, it might be useful to have an announcement from Russ Dyer, something I learned at the coffee break. The CASEY meeting which I think many of us had planned to attend in Pleasanton on the 9th and 10th of November is postponed until February?

MR. DYER: Yes. Right now what we're looking at is a program-wide technical review. I can't remember the exact dates. It's at the Stardust. Do you happen to know when it is, Tom? The 8th through the 12th? Approximately that second week in February. And we'll be getting out information to everybody here in the next week or so.

(Whereupon, the above-entitled matter was adjourned at 4:15 p.m. on October 20, 1993.)