UNITED STATES

NUCLEAR WASTE TECHNICAL REVIEW BOARD

FULL BOARD MEETING

Surface-Based Dry Drilling
Underground Testing Program

October 19, 1993

Plaza Suite Hotel
Las Vegas, Nevada

Board Members Present

Dr. John Cantlon, Chairman, NWTRB
Dr. Patrick Domenico, Co-Chairman, NWTRB
Dr. Clarence Allen, Member
Dr. Garry Brewer, Member
Dr. Edward Cording, Member
Dr. Don Langmuir, Member
Dr. John McKetta, Member
Dr. D. Warner North, Member
Dr. Dennis Price, Member

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P R O C E E D I N G S

DR. CANTLON: Good morning and welcome to the Nuclear Waste Technical Review Board's fall meeting. My name is John Cantlon, and I'm Chairman of the Board, Vice President Emeritus from Michigan State. My professional field is environmental biology.

Let me briefly introduce the other Board members here today: Dr. Clarence Allen, Professor Emeritus of Geology and Geophysics at Cal-Tech. Garry Brewer will be in shortly. He is the Dean of the School of Natural Resources at the University of Michigan; Dr. Ed Cording, Professor of Civil Engineering at the University of Illinois; Dr. Patrick Domenico, who is the David B. Harris Professor of Geology at Texas A&M; Dr. Donald Langmuir, Professor of Geochemistry, Colorado School of Mines; Dr. John McKetta, the Joe C. Walter Professor of Chemical Engineering Emeritus at the University of Texas, Austin; Dr. Warner North, consulting professor in Engineering and Economic Systems at Stanford University, and a principal with Decision Focus, a consulting firm; Dr. Dennis Price, Professor of Industrial and Systems Engineering and Director of the Safety Projects Office at Virginia Polytechnic Institute and State University; and Dr. Ellis Verink I haven't seen yet, but Dr. Verink will join us soon. He is Distinguished Service Professor of Metallurgical

Engineering Emeritus at the University of Florida.

Our technical staff is seated off there on my left, to your right, and they will be participating in the discussions.

In the 1987 amendment to the Nuclear Waste Policy Act of Congress, Congress created the Nuclear Waste Technical Review Board to evaluate the scientific and technical validity of the DOE's activities in high-level nuclear waste management.

Today and tomorrow, the Board will be hearing about the DOE's site characterization and testing program. At eleven-thirty this morning, Pat Domenico, of the Board, will moderate the first part of our regular agenda, which addresses the basis for the overall testing program, and the part that surface-based testing and deep drilling boreholes play in it.

Tomorrow, Ed Cording, of the Board, will moderate the second part of the agenda, which deals with plans for testing within the Exploratory Studies Facility, and an integration of these activities with the excavation of the facility.

Our operating style is to permit questions from our Board members and our professional staff, but we'll hold questions from the audience until the regular discussion periods at the end of the speech session.

Before we begin our regular agenda, we will hear a number of presentations to bring us up to date on important, timely issues. Many of these presentations focus on the surface and underground testing program. This is not surprising, because of the current level of activity that is in that program.

Our first speaker this morning will be Linda Smith, Acting Associate Director of the Office of Geologic Disposal. She will give us an institutional update on the Yucca Mountain site.

Linda?

MS. SMITH: It's a real pleasure to be here this morning, and especially a pleasure to have you here in Las Vegas with us, and I think your facility is very, very well put together here.

Obviously, there are a lot of management and institutional updates that have occurred since we last met, and it is a real pleasure for me to be able to give you some perspective on that today.

First of all, most importantly, Dan Dreyfus--and this is not news to anyone in the room, probably, or, I would think, to most people--has been confirmed as the head of the Office of Civilian Radioactive Waste Management. Dan Dreyfus brings to us, we believe, and, indeed, is on board, he is in his office, and, as a matter of fact, he will be making some visits with internal staff very soon and will be meeting with you very shortly.

I thought I'd just spend a few seconds giving you a few highlights from Dan's biographical information sheet. Dan is a degreed civil engineer. He has a bachelor's degree in civil engineering, and a Master of Engineering Administration from George Washington University, and he holds a Doctor of Philosophy from American University.

Dan is especially, I think, talented and suitable for the position because he brings a broad range of experience from the federal government, having served in the federal government with the Corps of Engineers, with the Interior Department, and then making a switch from there to Senate staff positions. In 1981, he went to work for Gas Research Institute in a very high--Vice President for Strategic Planning, I believe, was the title of the position, and remained there until he came in with Secretary O'Leary to be her staff assistant.

We have worked with him pretty closely over the last few months, and we find somebody who is open, communicative, extremely, I think, knowledgeable in terms of legislative and executive processes, and we look forward to Dan working with us.

Lake Barrett, of course, will remain as Dan's principal deputy. He has accepted that position, and is in the process of moving to his new office, so I think we have a very strong team. We feel very good about it.

From a budget standpoint, while, certainly, the Senate and the House are now conferencing on some critical issues that are very important to all of us, we know fairly well that $380 million is the level for all of OCRWM programs for fiscal year 1994, that is no secret, and that 270 million of that will earmarked for the Yucca Mountain Project.

Obviously, we are continuing to examine all of our priorities in 1994 to balance what we are doing both in the science programs and the construction programs, to do the best we can do during that critical bridge year.

I think it's also important to note that discussions are continuing with the Office of Management and Budget on a process that will be acceptable to all parties, that would look at a greater share of the nuclear waste fund revenues coming in being dedicated to the OCRWM programs, per se, and, obviously, there are some sensitive issues that have to be dealt with, and there are some political considerations, but, clearly, there seems to be cautious optimism that perhaps we will make some progress in that arena.

As far as an enhanced stakeholder participation is concerned and the Secretary's focus on that important item and her philosophy and way of doing business, we've seen some major meetings occur. OCRWM held a major stakeholder participation meeting to develop recommendations on process in August. Those recommendations have gone to the Secretary, have gone to a number of external stakeholders, and we're waiting now to see what kind of action will be taken on those, and I expect that we'll see something fairly soon. This is part of her overall review process, which is ongoing.

We expect to see a financial management review of our project, the details of that finalized within the next month or so. It will be a broader-based project management review, let me say that, beyond the financial management perspective.

Dr. James Thurber is winding up his review of all recommendations of reports that have been generated with recommendations about the project and the program over a number of years, and that is also in the review process, so there are several things that are pending and underway in that whole arena.

Very significant to us, of course, is the fact that Carl Gertz, our project manager, has been asked and has accepted an assignment to head up a very important self-assessment team that is looking at the Hanford waste storage remediation program. That has been subjected to a lot of criticism and scrutiny over the last few months, and there is quite a comprehensive review going on as we speak. Carl has assembled a team of 15 very talented people to go into Hanford. We think that that will last for three months, although it could be a little longer than that, and in the interim, we have asked Russ Dyer to step in and be project manager for awhile, and he's accepted that with great enthusiasm, and will be rotating among internal staff for a little while, and, of course, Carl is coming back periodically, and we are working very closely on the continuity aspects.

Those are sort of the highlights, and I have asked Russ Dyer to--of course, he will be filling you in on the details of the technical side of it, and I guess I would ask if we have any questions that I could answer?

DR. CANTLON: Any questions from the Board?

(No audible response.)

DR. CANTLON: Thank you, Linda.

MS. SMITH: Okay. Thank you very much.

DR. CANTLON: Russ?

DR. DYER: Good morning. What I'd like to do this morning is just to set the theme a little bit, give you a little update about what has occurred at the project in the last several months, what we have on the plate for the next fiscal year, give you a little overview of the drilling situation at the project, allocation of resources within the project, and talk about some of our major objectives and deliverables that we have planned for fiscal year '94.

One of the major objectives that we had in '93 was to get the starter tunnel for the tunnel-boring machine constructed. We, in fact, did that, and, in fact, that construction effort was accomplished three weeks ahead of schedule.

Where we stand in the grand scheme of things, of course, is in the middle of the site characterization phase. We're approximately here right now. You'll notice that we have a TBD out here for the completion of site characterization and the initiation of licensing.

And that TBD is tied very intimately to future funding profiles, and just to give some idea of how this impacts our planning process, this is a series of options for the drilling program for the 40 deep boreholes we currently have targeted for drilling with a LM-300 type dry-drilling technology, and we have worked this out, the number of feet that needs to be drilled based on our performance that we've seen at UZ-14. Dennis Williams will be talking a little bit more about that later, but depending on what resources are available, we could either spend approximately 29 years in this specific part of the drilling program, down to as few as, oh, one and a half to, perhaps, four years, depending on what kinds of funds are available to the project.

This, of course, is only one part of the program that we have before us. If we look at what we have accomplished as part of the drilling program, out of approximately 160 holes, boreholes that need to be drilled, of which about 110 are relatively deep holes; that is, 50 feet or greater, we still have 76 holes to go. We've completed 33, most of which are relatively shallow. We've only had two 1,000-foot plus holes that we've completed so far as part of the hydrologic program. We've completed some other holes as part of the design support effort for ESF.

This is just a short tabulation of some of the work that's currently underway out at the project. Of course, the starter tunnel is 200 foot into the mountain. We've initiated the construction of the prototype alcove, a little alcove that goes off to the north between 60 and 100 feet, in which we will put in some hydrologic and hydrochemistry tests. That construction of that particular alcove should be finished by mid-late November.

Of course, we've initiated testing in the ESF with geologic mapping of the box cut and the starter tunnel. UZ-14 is drilling. You'll hear more about that today. We completed borehole UZ-16. That was our first deep dry-drilling effort with the LM-300. Testing is currently underway on that activity. At the meeting in Reno, we heard some of the preliminary results from those activities.

We completed 24 boreholes of the natural infiltration studies program. Alan Flint is currently actively engaged in doing the tests that use those particular boreholes for acquiring information.

NRG-7, the designed information borehole that will provide us information for the end of the north ramp of the ESF, we've had the rig on site and we should start that drilling operation, I believe, this week. Perhaps Dennis can give us an update whenever his talk comes around.

We have 17 trenches that we've excavated, looking at some of the tectonic studies, looking for evidence of fault displacement, fault movement. We continue the studies in logging holes.

Preparation for the Fran Ridge for the large block test continues. I believe we have a little more information on that a little later in this talk.

This, of course, as you're aware, is the proposed configuration for the ESF design. This is almost a north/south main drift, essentially parallel to the Ghost Dance Fault and offset some distance from the Ghost Dance, and we'll be doing some studies, mostly of drilling, to look at what makes a reasonable offset distance here.

Similar to the slide I showed having to do with resource allocation in the drilling program, there is a similar consideration that we have to take into whenever we look at tunneling schedules, and depending on what the resources available are--and here's the different options that we've examined--if we are on a eight-hour day, five day a week schedule, then there's approximately 12 years of tunneling that we think are needed. If we have essentially no funding constraints, that can be compressed to approximately 2.1 years, and, again, which particular option we're able to follow or which hybrid we may be able to follow is tied very intimately to future funding profiles.

I don't think this is in your package. You have another one. This shows a cross-section of the north ramp of the Exploratory Studies Facility. I think we made up extras of this. The difference between what you have in your package and this is that this is the cross-section that shows the proposed new configuration which we are still evaluating. It is in the process of going through the change control board to identify all the impacts that would be reflected in the other parts of the program.

But, here we have the starter tunnel here, Exile Hill. This would be the north ramp coming through the various geologic units, the Tiva, the Paintbrush, the Topopah Springs. This would be the takeoff down to the Calico Hills level of the ESF.

Of course, the tunnel-boring machine is on order. We're expecting delivery in the spring. We have talked to you before about the characteristics of this particular machine. We should in, I believe, the April time frame, start receiving 50 to 60 truckloads of parts of machines that need to be assembled. Dan McKenzie will give you an update on the tunnel-boring machine operations and plans a little later in the day.

This is an item of interest, I think, to you, and this just shows our proposed configuration for how we intend to put the train together and the support equipment behind the tunnel-boring machine. This is the TBM itself, with cutter base out here. These are the first three support cars, and this series of cars here with this little movable platform on it is essentially a gantry-way. This is a mapping platform that can move back and forth along this series of cars so that the scientific activities, such as mapping, et cetera, do not necessarily have to be tied to advance of the cutter face of the tunnel-boring machine. You can reposition this mapping platform to essentially investigate in detail whatever kinds of things you need to look at.

This is just a--perhaps I'm stealing some of Dan's thunder here, but this is our current schedule for the construction of the TBM based on what we think are realistic resources that will be available. As Dan will tell you, we are currently resource constrained, not only in this part of the program, but in other parts of the program, also.

August, '94, we expect to initiate TBM operations at the face and the starter tunnel, make the first turn in August of '95, run south along the main drift, with breakout at the south ramp in June of '96. This, of course, could be accelerated if we're able to allocate more resources into that particular activity.

This is just a slide showing the TBM operations, what things need to be done, completed in the near term to support TBM assembly and operations, and, again, a point to make is that this could be done quicker, we could have assembled the machine quicker, we could start operations quicker, but we are funding constrained.

Some of the major accomplishments we've had in the project in the last few months include, of course, the completion of the starter tunnel. We brought on board our underground subcontractor, Kiewit Company. We started blasting of the test alcove, the prototype alcove in October. We received permits that allow us to work on some of the water systems. We've conducted some pretty extensive archeological field work out near Bare Mountain, associated with some of the trenching activities, looking at some of the seismic hazard studies.

There was a waste package workshop that was held, and I believe some members of the Board were present at that workshop. Of course, we completed the second phase, second

12 holes of the neutron drilling program. Semiannual Progress Report No. 8 was released, and we have completed and submitted our '94 annual plan to headquarters.

Let me briefly go through the '94 budget as we understand it now. As Linda said, it looks pretty firm. There is still a possibility that there may be some changes. I guess I don't expect major changes in this funding profile, but there may be some tweaks that we may be able to accommodate, and what we've broken out here is at least a first order approximation of how the project breaks out into technical versus what one might call infrastructure or support, and we have '93 and '94 dollars tabulated here.

Some of the things that we've lumped into technical; for instance, the thing called regulatory, not all of that probably should be in technical, but this particular accounting category is where we include performance assessment and the technical database, so there's a large component of this that does, in fact, in my view, anyway, belong in the technical side.

I guess, conversely, there is a significant part of the ES&H part that is providing environmental information. One could argue, I think, rightly so, that some component of this should be above the line, some component of this should be below the line, but if we take this as at least a first order approximation, you can see from '93 to '94, virtually all of the technical elements show an increase, and while the infrastructure elements show a decrease, this, of course, is part of our effort to reduce the infrastructure costs to the absolute minimum necessary to support the level of effort that we have on the technical side.

We've summarized this down here as a percentage. In real terms, we see a 3 per cent shift in the allocation of funding from infrastructure to the technical side of the program.

There may be some questions about this. This is the financial and technical assistance to the state, the counties, and the universities system, which we really have no control over, so I didn't include that in the calculation. The only thing that I looked at for a basis was the total of the infrastructure and technical to get these percentages.

For '94, the major priorities that we have have to do primarily with exploratory studies, getting the equipment in place to support the assembly and operation of the tunnel-boring machine. Of course, there is a lot of things that need to be put in place to support that effort; commencing TBM operations in the north ramp; initiating testing in the north ramp. This would be in the prototype alcove, but shortly after we start ESF operations, of course, there will be those immediate testing needs that follow directly behind the TBM, that consist mostly of the mapping/sampling activities, and as we'll hear a little more discussion, conducting the surface-based testing needed to support ESF design and construction. This includes putting in tests to look at the pneumatic pathways, pneumatic tests within the mountain, and, of course, in addition to all of this would be the other activities that we have primarily as a part of the surface-based program that provide us information about the suitability of the site.

Compliance, of course, is one of the things that we must maintain, compliance with the applicable laws, regulations, worker health and safety.

If we look at the major deliverables that we have scheduled for the first half of this fiscal year, we're looking at a topical report on our seismic hazard methodology. We've tentatively scheduled that for the month of November. We have a total system performance assessment. This is the next in our generation, in our iterative performance assessments. We're looking at a completion of that in January of '94, and we hope to come out with a DOE document that describes the results of this performance assessment in the spring of '94.

We'll be meeting with the Department of Energy's Energy System Acquisition Board sometime in the first quarter of '94 to re-baseline our program, to say based on the funding profiles that we have and what we think we can project in the future, we're going to lay out a new program for the ESAAB, and then we will go up to the Secretary of Energy, who will either essentially buy into the program that we propose.

We have, of course, many construction activities that are associated with the imminent arrival of the tunnel-boring machine, and those will all be going on in '93.

This is another list of major activities. This takes us through all of fiscal '94. Some of the things I've talked about already up here. There are quite a few design activities that you'll see on this list. There are some drilling activities. We have two deep UZ boreholes with the LM-300 scheduled for fiscal year '94. We intend to start the systematic drilling program. We have two systematic drillhole boreholes scheduled in fiscal year '94. There's quite a bit of information that we need to acquire to support the design effort, and that also is on our plate for '94.

In summary, I'd just like to recap where we've been and where we are headed. The ESF was one of our major undertakings in fiscal year '93, and we made, I believe, significant progress in this. We laid out a target, we met the target. If you have not been out to the site recently, I certainly encourage you to go out there. The ESF is, I think, just one indication of the momentum and things to come that we have in this project.

With that, I'd like to ask if there are any questions of the Board?

DR. CANTLON: Questions from the Board?

DR. CORDING: Ed Cording.

Russ, I was interested in your comment regarding the resource constraint on the TBM operation, and, of course, I'm very pleased to see the progress here in terms of starting underground and getting the TBM ready, but I was wondering what the difference is, or what it's taking to--would take to accelerate the TBM, as you noted, or what is the present constraint on getting the TBM through. It shows it as about a two-year operation to go through the loop with your present schedule.

DR. DYER: Right. I think perhaps Dan might be able to address that in more detail. I know that in fiscal year '94, our constraint has to do with the total number of dollars that we have in the program, and the effort that we have to try to conduct a balanced program.

We are currently looking at ways that we can accelerate the--well, we know that we could accelerate the assembly and operation of the tunnel-boring machine, but it would be at the expense of other parts of the program.

We are in the process of trying to figure out how we might be able to do the things that you're looking at. Initially, several weeks ago, we had a report from the M&O

and the Kiewit Company, who were laying out the detailed schedules of what it took to put together the TBM, what it would take to put all of the support equipment together, and it appeared that there was a substantial under-funding in the ESF in the 1-2-6 funding category.

We've looked at that. We have tried to scrub that as much as possible. That number is coming down, but it still looks like there is a shortfall in there. We're trying to figure out how we can meet that shortfall, either by reprogramming within the project, or perhaps some other innovative ways.

I hope that answered your question, Ed.

DR. CORDING: Well, I was just wondering. I mean, does it have to do with the number of shifts that are going to be operated with the TBM? I mean, for example, was the two-year operation a one-shift operation or something like that, or is it--I'm not quite sure of that part of it.

DR. DYER: Dan, can you address that?

MR. McKENZIE: Dan McKenzie, Morrison-Knudsen.

The delay in the start-up from July to August is purely financial. We took the amount of money that we had available for the ESF in fiscal '94, and spread it over the year. It would be not productive to, as a stunt, to hurry up and get the tunnel-boring machine put together, for example, in the first of July and then have to, you know, turn the lights off for six weeks. So the TBM starting in August is a product of the fact that we didn't have enough money to assemble it, working multiple shifts.

Lance might be able to tell us how many shifts it is working, but we delayed that a month, basically, in order to make the amount of money that we have available last throughout the fiscal year.

As far as the 22 months for making it around the loop, that's been rescheduled by our TBM contractor, Kiewit/PB, and they have, I think, included in that 22 months things like programmatic delays that are unforeseen. I think at the penetration rate, if there were no delays, that the transit around the loop would be significantly faster.

DR. CANTLON: Thank you.

Other questions?

(No audible response.)

DR. CANTLON: If not, thank you, Russ.

We had some interesting questions raised about water encountered, and so we've asked Richard Luckey, a hydrologist with the USGS, to bring us up to date on water encountered in UZ-14.

DR. LUCKEY: Although I'm going to give the presentation on what we've learned in UZ-14 in the last two or three months, this is obviously a joint effort of quite a number of people. Joe Rousseau is the principal investigator on this hole, so he contributed an awful lot of the information that I'm going to be giving you today. Alan Flint gave a lot of the information. Any number of people from these two people on down to the drillers' helpers worked on this effort, and so I wouldn't like to claim any of it as my sole effort.

Just to give you a little background, on July 30th of this year, fluid was encountered at UZ-14 at a depth of between 1256 and 1258 feet below land surface. This fluid was not unexpected. This was one of the main reasons that UZ-14 was drilled, because we expected to encounter fluid at this level.

We were in the lower non-lithophysal unit of the Topopah Spring at this point. After we penetrated this fluid body, the final static fluid level was at about 1250 feet below land surface, and I'll give some more information later about some additional water levels.

When the fluid was initially encountered, it was bailed for chemical analysis. Some good quality and contaminated samples were taken. Later, during some hydraulic tests, we got quite a few more samples of this fluid.

We conducted a series of four hydraulic tests from August 17th to 27th of this year. I'm going to go over some of these tests and the results that we learned from these tests.

During the hydraulic tests, the total depth of the well was 1282 feet, with the water level at about 1250 feet, so we had slightly over 30 feet of water in this well at this point. Conceptually, we kind of divide this 30 feet into about three zones, with the middle zone showing the highest permeability, and the lower ten feet of this zone showing nearly zero permeability.

This is just a diagram of what the well looked like when we did the hydraulic testing in August. As I mentioned, we were in the lower non-lithophysal unit of the Topopah Springs. The bottom of the well was slightly into the basal vitrophyre. We had a little over 30 feet of water in the bottom of this hole.

This shows the pump set up during the hydraulic testing, water level to 1250 feet. We used a Moyno pump, with the bottom of the Moyno pump at about 1273 feet, bottom of the monitoring tube at about 1276 feet for Tests 2 through 4. The top of the basal vitrophyre was at 1277½ feet. We had a few feet of mud in the bottom of the hole that we couldn't get out during bailing.

This is a diagram of some of the wells that I'm going to be talking about; of course, the disturbed area footprint, Yucca Crest, Drill Hole Wash. UZ-14 was on the same pad as UZ-1 that was drilled earlier; Well G-1 to the southeast, Well H-1 to the east/southeast, WT 18 to the immediate east.

This is a little broader overview. I'm going to be mentioning some other wells; Well J-13 in Fortymile Wash, the water supply well for Area 25; WT 6, which defines the northern limit of the large hydraulic gradient. We know that the large hydraulic gradient starts somewhere south of WT 6, and somewhere north of Well H-1. Way up north in Fortymile Canyon is Well UE-29a #2. It's quite a bit north of this area.

Let's start with Well G-1, which is approximately a thousand feet southeast of UZ-14. This well was drilled in the middle of 1980, using a polymer drilling fluid. The polymer contained 1-5 per cent phenol, and 20 to 40 per cent light hydrocarbons per the MSDS for the polymer. This polymer was combined with J-13 water as a drilling fluid.

G-1 was drilled to a depth of 6,000 feet. They had extreme difficulty in maintaining circulation and drill cuttings and fluids rarely ever made it back to the surface. There was approximately 2.4 million gallons of drilling fluid lost during the drilling this well at 6,000 feet. Not all of that fluid was lost in the Topopah Springs unit, but a significant proportion of it was.

Well H-1, which was less than 1500 feet east/southeast of G-1 was drilled immediately after Well G-1 was. H-1 was drilled with air-foam. The TV log at H-1 showed some dripping water in the Topopah Spring unit and in the Calico Hills. It wasn't clear whether this dripping water was perched water or just return of fluid from the air-foam drilling fluid. Consensus is that it was probably just returning drilling fluid, but we can't be sure. The depth of the water in H-1 is approximately 1878 feet, or 730 meters above sea level, so we're in the low hydraulic gradient area. Well H-1 was also drilled to 6,000 feet.

Well UZ-1, and remember that Well UZ-1 was drilled on the same pad as UZ-14, or UZ-14 was drilled on the same pad as UZ-1. It was drilled in 1983. It was drilled dry, and fluid was encountered in Well UZ-1 at 1256 feet, the same level that fluid was encountered at UZ-14. The final fluid level was at 1251 feet, which translates to 967 meters above sea level.

Fluid sample was collected from UZ-1, and it was found it contained the same polymer that was used to drill G-1. UZ-1 only continued to a depth of 1270 feet, and was terminated because they were unable to seal off this water body, and they didn't want to risk the upper part of the hole contaminated with fluids.

Let's go on to the hydraulic tests that were done in the latter half of August of this year. Four hydraulic tests were done. Test No. 1 started on August 17th, continued for slightly over 13 hours at .91 gallons per minute. When we started monitoring recovery during this test, we saw significantly less recovery than we had draw down, and, initially, we thought we had somewhat depleted the water body. Then the driller looked at us and he said, "What would the test results look like if a monitoring access tube was plugged?" We said, "Exactly what we're seeing." And he said, "Well, I've been dreaming about this last night, and I think I put that tube down in the mud," so we pulled up the tube, cleaned out the tube, put it back in, and the water level miraculously recovered a number of feet.

So we took Test No. 1 away, did Test No. 2, essentially the same kind of test, 13 hours at .9 gallons a minute. That turned out to be a good test, and I'll show you some of the results of that.

Test No. 3, we doubled the pumping rate. At the end of 9.3 hours, we were in danger of pulling the water level below the pump intake, so we had to end the test prematurely.

Test No. 4 was a long test, approximately a three-day test; again, at roughly .9 gallons per minute. I'm going to show you some results from that test.

This shows the water level during Test No. 2, the draw-down phase. We started at approximately 1250 feet below land surface. Final water level at the end of pumping after 13 hours was about 1260 feet, then the recovery period; very typical draw-down recovery during a hydraulic test.

This shows the recovery phase during Test No. 2. It's residual draw-down plotted against the log of the ratio of time since pumping began, divided by time since pumping ended, so this is early time in the recovery phase here on the right-hand side of the graph, and late time in the recovery phase on the left-hand side. This should be a straight line. It's roughly a straight line, although there's a lot of curvature in the early time of the recovery.

Looking at Test No. 4 of water level versus time since the test began, the initial water level, again, was approximately 1250 feet. The final water level was about 1263 feet after three days of pumping, then several days of recovery is shown on this graph.

This is the semi-logged plot for Test No. 4 of residual draw down versus the ratio of time since pumping began, divided by time since pumping ended. So on the right-hand side of the graph is early time in recovery. As we approach one on the graph, we're at late time in recovery. This looks like a straighter line than the previous graph, primarily because we have a much longer recovery time, but we're not looking so much at early recovery time.

A summary of the four hydraulic tests that were done at UZ-14, the starting water level was 1250.05 feet on August 17th at the beginning of the test. There are some water levels near the end of the test. The one on August 30th was about two and a half days into the recovery phase from the final water level. On September 7th, the water level was at 1251 feet, on the 10th it was 1250.7. That's the last water level we got in UZ-14 before they tried to cement off the zone and seal it up.

If you do just a straight-line projection of those water levels, you would see recovery by about mid-September. If you use a more realistic, logarithmic projection, probably have full recovery by about the end of September. We pumped a total of approximately 6200 gallons in four tests over about 102-hour period of pumping.

These are some transmissivity estimates that we've made based on the hydraulic tests. The first estimate was actually based on a Bailer Test that was done in the core track before the hole was reamed out. It was a semi-logged plat, very similar to what I've already shown you. We estimated the transmissivity of that 30-foot zone to be 7 $ft.^2$ per day during that test.

In Test No. 2, based on the draw down phase, we estimated the T value to be 6 $ft.^2$/day. Based on the recovery, depending on which part of that recovery period you pick, you can estimate transmissivity from anywhere from 6 to 10 $ft.^2$/day. For Test No. 2, on the recovery phase, we have estimates of 8 to 10 feet per day.

For purposes of hydraulic testing, these are virtually all of the same numbers. There is easily that much uncertainty in these kinds of tests.

These hydraulic tests all appear to be consistent with each other. They're showing virtually the same transmissivity values. None of the tests showed that the cone of depression had reflected off of any boundaries, and we had almost no residual draw down after all four of these tests. This tells me that whatever size fluid body we're dealing with is large compared to the 6,000 gallons that we've pumped.

Let's look at chemical and biological evidence. I mentioned that we took water samples out of UZ-14. We detected the polymer that was used in G-1 in UZ-14. It was at a very low concentration, but the polymer had been sitting there for close to 13 years. Of course, the polymer was also detected in UZ-1 in the same drill pad, so this is not a particularly surprising result.

The total organic carbon concentration was very high in the water at UZ-14, thousands to tens of thousands of times background. For the last several years, we've been noticing an increase in carbon dioxide concentration in the lower zones of UZ-14. We believe that this carbon dioxide is being generated by organisms working on the polymer that's in this fluid body.

We took water samples and gave it to UNLV to do an analysis on it. They found approximately 40,000 organisms per milliliter of sample. This is just an estimate, because it wasn't diluted enough to get a good solid count. By comparison, at the same time we took water samples from J-13, and they found 10 to 20 organisms per milliliter there. All of this points to degrading drilling fluid.

Isotopic evidence to date: We've done a tritium analysis on the water from UZ-14, and tritium is at background levels, which means that this water is at least 100 years old. The information is not any good beyond that.

We did a Carbon-14 analysis on the water from UZ-1. It indicated that the water was approximately 3600 years old. For comparison, J-13 water is 9900 years old, and that was the water that was used to make up the drilling fluid in G-1. UE-29a #2 has the youngest water anywhere around Yucca Mountain. It's in upper Fortymile Wash, very shallow water. It's about 3800 years old. We don't have any Carbon-14 results yet for UZ-14. We've sent a couple of samples in. It's a fairly expensive analysis, so we had to wait until the first of the fiscal year to send in any more samples.

Some conclusions: The fluid that we encountered in UZ-14 is obviously the same fluid that we encountered in UZ-1 13 years ago. This fluid contains the polymer used to drill G-1. When Rick Whitfield wrote a report on G-1, on UZ-1 a number of years ago, he gave three possible interpretations: One, that the drilling fluid is only degraded G-1 drilling fluid. The second possibility is that the fluid is a mixture of perched water and drilling fluid. Number three is that the fluid was the contaminated natural water table at that point. Based on the information that we had as of the end of August, none of these interpretations could be eliminated.

So, where do we go from here? Obviously, we can deepen UZ-14 to resolve if the fluid is at the water table. I wanted to leave some Xs in here so I could give you the latest information. As of yesterday, UZ-14, the core track was down to 1422 feet, just slightly into the Calico Hills. There's been some wet core below the 1280-foot level, a considerable amount of dry core. It looked like we have encountered a slight amount of water right at the base of the Topopah Springs, although we can't be sure that that's not just leakage from above. As of yesterday, we had about three feet of standing water in the bottom of the well, so the current water level in the well would be at 1399 feet, so it looks like, at this point, based on the information, that we were not at the water table, but we're still above the water table.

We intend to do further chemical analyses in hopes of resolving this issue. We think that Carbon-14 data might be our best information for resolving the issue. It's still kind of a mystery of why the Carbon-14 age from the fluid in UZ-1 was so young. I think we will, perhaps, be unable to determine if natural perched water is involved in this.

The problem with this is the water used to make the drilling fluids came from J-13, which gets its water out of the Topopah Springs. If this is naturally-perched water, it's also in the Topopah Springs, so any perched water ought to have very much the same chemical signature as J-13 water.

I think the best that we can do is by the end of the planned drilling program, we will probably know whether perched water is very common or very rare at Yucca Mountain, and perhaps we can make some decisions based more on that overall idea of how rare perched water is.

Thank you. I'll try to answer any questions that you have.

DR. DOMENICO: Pat Domenico, Board member.

Two questions, Richard. How far did you encounter this water above what you anticipated the water table would have been at that point? And the other has to do with the fact you have grouted the hole off, is that correct, to progress downward?

DR. LUCKEY: Yes, we have.

DR. DOMENICO: And did it take an extraordinary amount of grout, or would you consider this a successful operation? There has been some concern about that raised.

DR. LUCKEY: Well, first of all, we're quite a few hundred feet above where we expected the natural water table to be. We anticipate that the natural water table should be at about 730-740 meters, and we're at about 960 meters above sea level at this point, so we should be quite a few hundred meters above the natural water table.

Now, we did grout off this zone. In fact, it was grouted off twice. The first grouting job was marginally successful. It reduced the inflow, but didn't stop it completely. The second grouting job appeared to stop it, with not a very large amount of grout. We drilled through that and we got a certain amount of inflow from fractures below this point. We're not sure what this inflow represents. It's probably water that got around the grouting job and has entered the hole below the grout.

DR. DOMENICO: So you didn't use an extraordinary amount of grout?

DR. LUCKEY: No.

DR. DOMENICO: The other questions is: Do you have any idea how thick the zone that presumably contributed the water to the well is? You mentioned it was three zones. Two were relatively impermeable, and the other one was relatively permeable. Do you have any idea how thick that that zone was?

DR. LUCKEY: The permeable zone--well, we did the coring at ten-foot intervals, and so we really have sort of a information over a ten-foot interval. One of the three ten-foot intervals appeared to be fairly permeable. The zone is probably 10 or 20, or possibly 30 feet thick.

DR. DOMENICO: That transmissivity number doesn't mean too much to me. What would the permeability be? Did you calculate that, taking a 30-foot zone?

DR. LUCKEY: Yeah. It would be a tenth to a thirtieth of that. We're looking at permeability equivalent to sort of a dirty-fine sand or something like that.

DR. DOMENICO: Thank you.

DR. CANTLON: Yes. Don?

DR. LANGMUIR: Langmuir; Board.

Looking at your age dates, you mentioned, Dick, that you had corrected one age date but not another. I just want to know, first of all, why an attempt had not been made to correct the age date, the C-14 date. I think you had a 3600-year relative date.

DR. LUCKEY: Maybe I mis-spoke, or you misunderstood me.

DR. LANGMUIR: Okay.

DR. LUCKEY: Both the 36, 3800, and 9900-year dates are all uncorrected C-14s.

DR. LANGMUIR: Okay. How much off do you think they are from the corrected dates? The 9900-year date for J-13 is presumably a corrected date?

DR. LUCKEY: I believe it's also uncorrected.

DR. LANGMUIR: So they're relatively indicative of differences in time.

It would seem to me if you were looking at J-13 water coming up there, and you're diluting the Carbon-12/13 with the drilling mud carbon, you'd be getting older dates if J-13 was the source of the water in the shallow perched system, but you're not. You're getting much younger dates. It's going the other direction? This suggests to me that it's a different water, at least in terms of the age date information and how it would be affected if you'd started from 13 and gone to the shallow hole.

DR. LUCKEY: That age date is certainly problematic. I agree with you that if you start with old water, and you mix drilling fluid with it, it should only be older, particularly if this is kind of a hydrocarbon-based drilling fluid, it should, presumably, have a very old signature.

DR. LANGMUIR: Has anybody looked at the Carbon-14 in the drilling mud itself?

DR. LUCKEY: We don't have a sample of that to deal with anymore, so we can't supply that information. I'm a little concerned about what the old information from UZ-1 indicates, because, in my mind, it would take a very large amount of very new water to drive the age to what we're observing, and it's hard to imagine how you could be adding that much new water, even if we were dealing with a contaminated perched body. It seems like the perched body ought to be relatively old, compared to the 3600, so I'm anxiously awaiting the new Carbon-14 data from UZ-14 to see if it confirms the Carbon-14 data from UZ-1.

DR. LANGMUIR: Has anybody tried to establish how much dilution has probably occurred since the drilling mud was injected and that hole was constructed; in other words, looking at the current water coming out of that hole, can you estimate from some components--I would presume you could--how much dilution has occurred through time in the sample you are now drawing out?

DR. LUCKEY: Just a, you know, ball park figure, we have to dilute it about three times with virtually modern water to get that kind of an age date on it, and that's why I see that Carbon-14 age as somewhat problematic, because it's hard to imagine diluting it with that recent a water.

DR. CANTLON: Other questions?

(No audible response.)

DR. CANTLON: If not, then, thank you, Dick, and we'll take our break now, so let's reconvene in about ten minutes.

(Whereupon, a brief recess was taken.)

DR. CANTLON: We're back to reconvene just a little bit early, and put Dr. Luckey back up here. There are some additional questions on the drillholes, so if you'll take your seats, we'll start the questions off again.

(Pause.)

DR. CANTLON: There have been some additional questions that have come up on the water encountered in the drillhole, so we've asked Dr. Luckey to come back, and we'll start with those questions.

John Cantlon, member of the Board. I'd like to start off with a sort of bottom line-type question, since we have some people in the audience who aren't up on this esoteric science. A sort of bottom line question is, of what consequence to the site suitability issue is the encountering of the water, taking the most pessimistic interpretation of the data?

DR. LUCKEY: Well, I think it depends in large part whether we're dealing with perched water or just lost drilling fluid, and, of course, the more serious consequence is if we're dealing with perched water, and if perched water is fairly pervasive over the repository block. Now, we don't know that at this point, and this is why I say I think that towards the end of the drilling program we should know how pervasive perched water might be.

Presumably, during the ESF construction, and if a repository is built, during that sort of construction, you can walk around and see how many fractures are dripping. If there's lots of them, obviously, that's a bad sign. If there's just a few of them, you can stay away from them. That's not too difficult, so that's a very qualitative, very non-technical description. I don't think perched water, in and of itself, is a serious problem. It's where it's at and how much of it could get into the repository level.

DR. CANTLON: A second question of a generic sort. You indicated that during the early drilling, they lost over a million gallons of drilling fluid. I presume when you grouted, you used far less than a million gallons of grout?

DR. LUCKEY: Well, the drilling fluid was lost during drilling of G-1, which was a geologic hole drilled with fluid for the purpose of taking core. When we grouted UZ-14, we used the water that we had pumped out during the testing, so we added no new water. Several hundred gallons of water was used during the grouting process, but it was water that we had taken out, so at least not millions of gallons.

MR. DYER: Dr. Cantlon, perhaps I can provide an answer here. Dennis can correct me on this, but I think we left less than 100 gallons of grout in the hole after we drilled out.

DR. CANTLON: Thank you.

MR. WILLIAMS: It was on the order of 150, Russ. What we did is we grouted up the two intervals, and I'll talk to that later this afternoon in the drilling part of the presentation, but, remember, we got--

DR. CANTLON: Would you identify yourself, please?
MR. WILLIAMS: I'm sorry. Dennis Williams, DOE.
We used, I think, on the order of three to four hundred gallons of total cement off those two particular intervals. Of course, we've got a 12½-inch borehole, and we drilled a large portion of that cement out, and there was about 150 gallons left in the borehole wall.
DR. DOMENICO: I've heard that there's been some temperature anomalies in that water, that it's rather cold. It's not in equilibrium with the geothermal gradient. First of all, I guess that's correct. Is that true?
DR. LUCKEY: I think what I better do is call on Joe Rousseau to answer these questions. He's been working with the temperature on that, and probably can give you much better information. Mine's going to be at least second-hand from what Joe told me. I hope Joe's still here.
MR. ROUSSEAU: Joe Rousseau, USGS.
To answer the temperature question, we measure temperature at three zones when we're running the bailing test. To back up a little bit, we did bail every zone into--well, we first encountered the first zone, we bailed that, ran a bail test on it. There wasn't sufficient water to run a hydraulic test using a pump.
Then we drilled ahead, went through about five foot of core that visually did not appear to be saturated, and

then we hit some more water on the next five-foot run, and we stopped, and we did another bail test, and at that point, we could tell that we were going to call in the heavy-duty machinery and actually run a pumping test.

But then I decided at that time, maybe it's the best thing to go find the basal vitrophyre and see what this whole thing looks like, so we went ahead and drilled ahead, and the next three feet, we hit the basal vitrophyre. We actually ended up four foot into the top of the basal vitrophyre before we actually stopped the hole.

We ran bail tests at every level, so the middle level indicated that our permeabilities were ten times that of the upper zone, and 100 times that of the lower zone, and we sampled the temperature of the first water coming up from the very first zone and it was about where the temperature gradient should have been based on the temperature measurements we had at UZ-1.

When we measured the temperature in the second zone, the water was really cold, 23.8, when it should have been reading about 26.8, and my first indication was that was really cold water, but what we found out is that water had actually gone up the string almost a thousand feet and cooled down, came back down, but in the process of running the bail test there, we actually de-watered the hole, and we found the water was still cold.

I can't tell you exactly what the temperature is at this point, because things got a little confusing, but it was certainly colder than the 26.8 it should have been, and yesterday, when we went deeper in the hole and were doing bail tests again, we had cold water. Water temperatures should have been in excess of 27, and we were reading 24, and that bail time running up-hole is about two minutes, so I have to make some adjustments to those figures and figure that the temperature is probably about two degrees colder than it should be, based on a static thermal gradient, using UZ-1 as the basis for that.

DR. DOMENICO: Domenico.

You're in Drillhole Wash, of course; right? That's where you're drilling?

MR. ROUSSEAU: That's correct.

DR. DOMENICO: So you do have a lot of colder water above that level. Is one interpretation that we have some rapid movement of water through those fractures, and it will never come into equilibrium with that geothermal gradient?

MR. ROUSSEAU: Well, when we went through the Upper Paintbrush tuffs, even though we didn't see saturated core, we couldn't see water flowing into the hole. We did have core with huge volumetric water contents, so you figure that core is probably running 35 to 40 per cent. Is that right, Alan? Some of that bedded stuff up in the Paintbrush? Okay, and the saturations were probably on the order of 95, 98.

So you can figure that some were up higher up where the water could actually be colder. We could have a source of water higher up in the section that bypasses the Topopah, makes it down lower, so we could see a water that's fairly old at this location that could be sourced from water that's in storage for a long period of time, so you see sort of a short-circuit effect.

Probably one of the most interesting things that happened yesterday is when we were sampling water, we knew a good portion of that was leaking through the fractures in the basal vitrophyre, coming from the perched zone, and the temperature of that water was 25°. Now, we're down in a zone where the temperature should exceed 27, so the fractures of the basal vitrophyre, at least in a close proximity to the borehole, can drain water, and they are draining water right now on the order of about six gallons per hour.

DR. DOMENICO: Are there any plans to do any long-term monitoring on the temperature to see how long it might take, if at all, to equilibrate with the geothermal gradient at that depth?

MR. ROUSSEAU: We do have plans to do in situ monitoring in that borehole, so we can set temperature probes at these locations and see what temperature they equilibrate to. The thermal profile of UZ-1 up to the point where they stopped--

now, they backed up, but their first instrumentation is right about 1250 feet, so they didn't have it down at the very bottom. They didn't have it in the water, and that profile's pretty smooth, pretty smooth, and here we're going to see, if this is true, a very large kick in that thermal profile.

DR. DOMENICO: Thanks, Joe.

DR. CANTLON: Don?

DR. LANGMUIR: Joe, I gather you're doing oxy-deuterium analyses on all these waters, and, hopefully, that will tell us something about whether this is actually a different water up there, or simply something that's moving around in the system, perhaps some of it having been injected.

You've said you have two and a half, 2.4 million gallons of drilling fluid. What do you think the thickness of the saturated zone is there in the perched system?

MR. ROUSSEAU: That perched system is normally about 25-feet thick.

DR. LANGMUIR: Okay. If you take that thickness and multiply it times the volume, or look at the volume, what's the areal extent of the perched water you can make just from the drilling of the well?

MR. ROUSSEAU: Well, you have to make some assumptions about the porosity.

DR. LANGMUIR: Right.

MR. ROUSSEAU: The porosity of the system before the contaminated fluids invaded the system, and I've played those geometry games, and one would have to conclude that all the fluids were lost in that horizon at G-1 to bring all the water to the location where we see it today.

It's kind of like taking the problem and looking at the "what if" conditions, and what would you have to buy into as far as assumptions were concerned. I should point out that 50 feet higher up the section, we had found several fracture zones that contained water, but the matrix was not saturated, and from the time that we went through the bottom of the basal vitrophyre to where we are today, which is about a foot into the Calico Hill, we again found several zones of water, moisture in the rock.

So, even though the entire section is not saturated, then one has to go backwards and take a look at that again and say, "Now, what if my thickness is 150 feet? What is the practical realization of seeing the water there being purely sourced from G-1?" And, again, you have to buy into some pretty absurd assumptions, in my view, in my view right now.

DR. LUCKEY: If I can maybe touch on that question, too, Dr. Langmuir, I did some calculations in anticipation of that question trying to see what volume we might be dealing with here, and I took the 2.4 million gallons and assumed 20-feet thick, took a range in porosity and a range in saturations, and if the body is a cylinder, its radius would be about 700 feet, depending on whether you use high or low porosity and high or low saturation, and we're from 300 to about 2300 feet.

I think, in reality, because of the structure there, it's probably more like an ellipse, and calculated the major and minor axis of the ellipse of being 350 and 1400 feet, but it actually--I drew some pictures. Excuse my hand-drawn slides here. It just sort of seemed like a fun thing to do. This is if it's, obviously, not quite at the same scale, but I tried.

But the heavy line here is the best estimate, with the light line being the lowest porosity and the highest saturation, which makes it go out to its full distance. Kind of a similar thing if you look at it as an ellipse, you get something that looks like this, and the minimum ellipse size was too small for me to draw, but with maximum ellipse size, you get some encroachment on the northern part of the footprint, with the most probable--you don't get it, but I'd like to point out that with the most probable ellipse, we don't get over to UZ-1, UZ-14, so it's probably not a cylinder, it's probably not an ellipse. The guy that reviewed this for me says we probably ought to call this thing an amoeba, which is probably much closer to the truth.

DR. CANTLON: All right. I think we better close this one off now and proceed with the next speaker, Daniel McKenzie. Dan is a mining engineer with the M&O contractor, and he'll talk on the update of the Exploratory Studies Facility.

MR. McKENZIE: Good morning. He said I'm Dan McKenzie. This is my first time in front of the Technical Review Board, so if I forget to breathe and pass out or something, just hang with me. I'll come back in a little while.

(Laughter.)

MR. McKENZIE: Okay. As he said, this is an update on the ESF, what's going on right now. We're going to talk about current ESF activities, what's going on right this minute, and what's going to go on through FY94. We're going to look at the status of the TBM procurement for a minute, status of the proposed changes to the ESF that we talked about would be in July, a little bit about the preliminary TBM start-up schedule, and I have the same chart that Russ showed as far as the ESF schedule goes, and then we'll talk a little bit at the end about the NRC letter that we received back in August.

So, first, we're going to talk about what we're doing right now and what we plan to do. In the design area, right now we're nearing completion of Packages 1B and 2A.

That means they're past the 90 per cent review point and design is complete. The review comments from the 90 per cent review have been incorporated, and we are currently preparing to go into design verification, which is the next process after our basis for design document is accepted by DOE. Then we will use that for verification, and then we'll go to DOE acceptance after that.

You'll notice on 2A, it has a title of conveyor/electrical transportation. I think the last time you all saw this we were talking about using 2A, and part of that was extending the starter tunnel several hundred more feet by drill-and-blast method. Because we didn't get as much money as we would have liked to have gotten--stop me if you've heard this before--we dropped the extension of the starter tunnel and we stayed with the design studies that are part of that conveyor, procurement spec, electrical work, and the transportation study.

Also ongoing now are Packages 1C and D, and Package 2B, which is a whole load of design analyses that have to do with the north ramp, and some of them actually would carry on into the rest of the underground facility, and 2C, which is the actual design from into the starter tunnel down to the end of the curve in the Topopah Spring Level.

As I said, we had our 90 per cent review for 2A in the July-August time frame. We're looking at starting 2B's design review on 30 November, and for 2C, we're talking about 21 February of '94. We're also going to start early next year, next calendar year, Packages 8A, which is the main in the Topopah Spring Level, and Package 8B, which would be the north ramp extension. Of course, that tells you that we're assuming that the new ESF will become the one true ESF design here in the near future. We'll talk about that in a minute.

Okay, in the construction area, as you've heard a couple times already, we finished our 60-meter starter tunnel a little bit ahead of schedule, 9 September, and we're working on the first alcove right now. As of yesterday, they were in a little over 6 meters. They plan to shoot today, so we ought to be in a couple more meters by the end of the day. I'm showing here 20-25 meters long. I think they actually have a range of 18 to 33 meters, and that depends on what the conditions look like in the face of the alcove. When they feel like they've gotten as far away as they can from the effects of the starter tunnel excavation so that they're in good representative rock, that's where we'll stop, so we don't have a distance, we just have a range, and we're also right now putting in the 69 kV power lines and system to the north portal pad.

Just a little bit about the TBM procurement. We awarded the contract 27 May of this year to CTS out of Kent, Washington. Here's a little bit of information about the tunnel-boring machine. I noticed on Russ's slide it was only 720 tons. Mine probably includes the operating instructions and the manuals and whatnot.

(Laughter.)

MR. McKENZIE: Current activities: The procurement is going real well. We had a series of dates that we had to meet to provide information to CTS so they could continue their design activities, and we've met all those dates, and we don't anticipate any problem. We still expect delivery in early April, which was the delivery date we established whenever the contract was awarded. We expect TBM start-up in August. We talked about that a little bit earlier, and we're still evaluating the budget that we have. We'd like to be able to start earlier, but we have a lot of things to do, a lot of other systems that have to be installed to go along with the tunnel-boring machine, and we have to try to marshall our funds to get the most bang for the buck.

Now, we'll go a little bit into the status of the changes. If you recall in the full Board meeting in July in Denver, we talked to you a little bit about an enhancement to the ESF layout that we wanted to make, and we're making progress in making that happen. I'll talk about it for a minute. First, I'll run through a few pictures here that sort of jog your memory.

This is the current baseline layout, 6.9 per cent ramp, 4.7 per cent slope in the main drift, fairly flat south ramp; cuts through the Ghost Dance right there in the main drift.

This is the enhancement that we talked about, the biggest change being that in the baseline design, the Topopah Spring level drift is superimposed over the Calico drift. We've rotated it that way. It's actually two straight segments connected by a short curve, but the important thing is at its border, it runs along the Ghost Dance Fault on its west side for about 400 feet nominal from the fault.

What that's allowed us to do is flatten the north ramp significantly, down to just under 2.1 per cent, and flatten the main drift significantly, so that we have in what would be the repository block area nothing over 2 per cent in the main drift, and we've steepened up the 2.6 all the way out to the south border.

This results in a longer north ramp, a shorter south ramp. The main drift is about the same. We've also made a change to have the north ramp extension and south ramp extensions in order to look for north/south trending features in the block. Lowering these grades helps us in several ways. It'll improve the constructability of the ESF, and it also preserves the rail haulage option for a potential repository.

This is a repository layout that would fit well with this concept here. I'll just kind of lay it over there and you can see how it fits. You can see that the ESF main drift would run along the east edge of the main block of the repository. This would be a repository that would be composed of two blocks, an upper block and a lower block. The next chart is this A, A' section that can show you what the relationship is between them.

This is a repository concept which would match the current layout, but one of the beauties of the--excuse me, it would match the enhanced layout, but one of the beauties of this is that it's a very flexible layout. We could conceivably go to any one of a number of very different repository concepts with this ESF concept.

This is the A, A' section. This is the upper block that we looked at. That's the lower block. The green line is where the current baseline, potential repository that goes with the current baseline ESF would have that sort of a slope.

And now, the status of the enhancements, it's going fairly well. The design analysis describing the changes has been prepared and has been reviewed internally. It's been through a technical review while on the project. It's now been submitted to the M&O's change control process, and if it's approved it has to be reviewed again, of course, by the Change Control Board. I haven't heard any rumblings from anybody that they would oppose it. It seems to have clear sailing.

When it is approved by the Change Control Board, it will result in a change to the baseline, and then it will become the one true ESF design.

Okay, now I'll talk a little bit about the TBM start-up schedule. This is in very general terms. We're talking three-month spans because, again, there's a lot of uncertainty about what the schedule may be.

As I said earlier, we do anticipate the machine arriving on time in April. In August, we feel like we can begin limited operation, and by that I mean there's no conveyor. We're going to be running in the muck cars and doing sort of a batch process of excavation in order to move ahead so that we can make room for the trailing gear, the mapping cars, and some of the particulars that Russ had. It has seven or eight flatcars that house the mapping arrangement.

We also have two more of the TBM support cars which will go on behind the mapping arrangement, so there's quite a lot of room we have to make before we can put all the train in, and then after that, we have to make room for the belt storage unit so that we can install the main conveyor.

So we'll be moving along in what we would call a limited fashion starting in August. In the first quarter of fiscal '95, we would install the cars I've mentioned, and sometime in the second quarter of fiscal '95, we hope to get full speed with the conveyor in operation. And, again, it's contingent on our funding. Stop me if you've heard this before today.

You've seen this schedule before. Russ showed it. It's the arrival of the tunnel-boring machine in April, start of limited operations in August, and down here, these are the Packages 8A and B, the main drift. This is all design, this is all construction.

Okay. The last topic that I have deals with our letter that we received from the NRC back on 20 August. That's the date of the letter, and the NRC basically expressed concerns with our design and design control process, and the concerns basically resulted from audits that showed that we had some conditions that needed attention and correction.

In the letter, they asked for our rationale for proceeding with the design while we were fixing the deficiencies, a corrective plan, and a date when we would submit them an ESF design integrated with a repository design for their review, and a detailed plan for ongoing submittal of information so that they could keep apprised of what we're doing.

Okay, in the response, we feel that there's no reason to stop ESF design or construction activities. We've worked on each of the identified deficiencies, and carefully examined it, the root causes. Public safety, of course, has never been compromised. The questions that were raised didn't have anything to do with, really, the design itself. The quality of the design was not in question. It was the process and, in some cases, we didn't fill our forms out right, but we didn't understand the procedure, so we didn't follow it correctly, but the design didn't have to be corrected for any of these deficiencies.

We already have in place a plan to correct the deficiencies that were noted, and we've developed this process improvement plan, and it's been formally communicated to the NRC at this time.

Here's some more response. There was a management meeting that was held on September 17th, and then here in Las Vegas, on the 4th and 5th of October, we had a real good technical exchange with the NRC staff, and Mr. Holonich, the next speaker, I think will talk about that some. From our standpoint, we thought it went real well. We gained a lot of understanding about what they do, and I think they learned a lot about our design control process, and I think they felt a lot better about it after the meeting was over, and we are going to make our response to DOE to the NRC on the 18th of November, as requested.

Okay. You saw this picture once. I thought it was a great picture, so I put it back up there again. This is sort of the fruits of our labor through this year, and I have another one here that shows just near the face and looking back out, and I liked them so much I thought I'd put them in the briefing, even though I didn't have anything to say about them, but this is all I have to formally present.

If you have any questions, I'd be glad to take a try. There are a lot more view graphs in here. Most of those are backup. They have the contents of the other design packages, 1A, B, C, D, 2A, B, C, 8A and 8B.

DR. CANTLON: All right, thank you.

Questions from the Board? Yes, Ed?

DR. CORDING: Yes, Ed Cording.

I had a question on your enhanced ESF layout which, you know, these gradients really look like an improvement, and a real positive change to the layout. I was wondering about the north ramp for the Calico Hills, or for the Calico Hills itself. Has there been some consideration of trying to put it underneath the--sort of line it up underneath the repository level drifts so that one can compare more or less in a vertical section?

I know we've had different discussions over the years on that, and I was just wondering what your thoughts were or what the current status is.

MR. McKENZIE: Our focus here was really on the upper level, and when we conceived of the change, we really didn't mess with the Calico Hills. We didn't consider it broken, so we didn't fix it, but as we went on and started evaluating the change and had more people look at it, it occurred to us that it would be better to leave it the way it is because it gives us another opportunity to discover north/south trending features across the block.

One of the--I don't know if it's a weakness or not, but without the cross-drift in there, you know, one of the things that we want to find is north/south trending structure, and without writing on our slate in here, we didn't want to do it in the Topopah Spring level, except out here on the edges, so it occurred to us that it would be better to leave it there in that direction, because it does traverse a block in the east/west direction.

DR. CORDING: I see. I have one other comment. I mean, we've been very concerned about having multiple operations out of a single heading, where they interfere with one another and actually slow progress. I think that was one of the plans earlier in the program several years ago, and it certainly seems obvious that the support that is needed for the underground operation is not more in terms of mucking volume, or of what is required to support the big TBM, and then, you know, once the big TBM is through, then other operations can get started and the muck requirements are perhaps not as great as for the larger machine.

And the utilities as well. Certainly, the utilities are really needed to support one operation, and so I think that's very obvious with the way the system is going, and I think that's good, but the thing that does concern me is that the other side of the coin is, of course, that once one starts with these sorts of operations, you've mobilized a lot of people and a lot of support for that, and the most efficient way to spend one's resources is to be able to make good progress, and make sure the machines go at rates of which they're capable, and to be able to bring in 18-foot machines without delays, and so that's one of the aspects of the program, and, of course, that has to do with the allocation of funding and the total funding, and I think that's a major concern at this point, I'm sure, with you, and also my own personal feeling is it's something that is very important to take a careful look at, because letting machines sit there for months is a wasteful process, and it's wasteful of the overhead money that isn't going into actually getting--making progress in some of those areas.

MR. McKENZIE: I'm not sure there was a question there, but...

DR. CORDING: I really wasn't asking a question so much on that. I kind of brought that up as a statement, but if you did have a comment regarding it, I'd sure be interested in hearing it.

MR. McKENZIE: Well, we do intend, I believe, to run the main loop first, pretty much unimpeded by other excavation. I will admit that that's at least as much a product of the fact that we don't have enough money to do any other excavation as it is a desire to make rapid tunneling progress.

I think if we felt like we could accelerate, for example, the start of the heater test by doing something different, then maybe we would examine that closely, but with our funding situation, we are going to run a loop, and that's pretty much where we're at.

There's one thing I wanted to bring up. Mr. Luckey's talk earlier was about UZ-14 and the water, and I wanted to point out a little bit about that. UZ-14 is not on this figure, but it would be down in this area somewhere, and the elevation at which the water first, when they stopped and did the pump test, that elevation is about 250 feet below the lowest point in this ramp. You'll see this ramp has a minus and a positive grade. It goes down and then back up, and at the point where the ramp is at the lowest, the water level in UZ-14 is about 250 feet below the bottom of that tunnel.

DR. CANTLON: Okay. Max has asked to make a comment. Max?

MR. BLANCHARD: Max Blanchard, Department of Energy, Deputy Project Manager.

Dan, just for the record, to make sure there's no confusion here to the people in the audience that are listening, and to the Board, one of the view graphs you presented which talked about the status of the proposed ESF enhancement, I think there was a slip in the wording that you gave.

You indicated that the change is now in the change control system in front of the M&O/CCB, and if it was approved, the project technical baseline would be changed. Before the project technical baseline is changed, it has to go before the Project Office CCB, and impact analyses that would be required would be significantly more than just the design analysis, and because the Board has had briefings on this up in Reno, I think they know that there's a series of Change Control Boards, and they get bumped up depending upon the sensitivity and the level of control in the program.

An enhancement like this, where we have commitments to the NRC, to the Board, and to other parties will take a great deal more than just a change at a Level 3, which would be the M&O Change Control Board.

MR. McKENZIE: I apologize for that. You would assume that Max would notice that. He's the chairman of the Project Change Control Board. What he says is absolutely correct.

The M&O Change Control Board is kind of a step in the process. Once it gets--since it's a design analysis, basically, a calculation, it doesn't go to the second Level 2 change control by itself. It will be an attachment when Package 2A--talking about it going through verification and DOE acceptance. The next step is to go to the CCB with that, and at that point, this design analysis would be included as an attachment with Package 2A and it would then, at that point, be reviewed by the Project CCB, and that's where Max's guys come in.

DR. CANTLON: Other questions from the Board?

(No audible response.)

DR. CANTLON: If not, then, thank you. I think we'll proceed. Dan McKenzie has more or less introduced our next speaker, Joseph Holonich, who's going to talk about the QA questions that NRC has had on the design.

MR. HOLONICH: Before I start, I would like to apologize. We had tried to Federal Express out copies of my presentation so I wouldn't have to carry a hundred of them on the plane, and, unfortunately, Federal Express's guarantee didn't work this week, so she is handing out copies now, and there are copies available back on the table at this point. I know some people had asked about it.

As the slide said, as I was introduced, I'm Joe Holonich. I'm the Project Director of NRC's Repository

Licensing and Quality Assurance Project Directorate in the Division of High-Level Waste Management.

I'm here this morning to talk about our August 20th letter on the ESF design and design control process, and what I'd like to do this morning, is I'd like to cover about eight different things, and, in my mind, the presentation falls into three phases.

The first four slides kind of set a context, talk a little bit about the NRC and its philosophy, DOE's QA program, why we believe DOE's QA program is important, and how it works within our regulatory framework. The next three, or the second phase, kind of give the background on what happened and what led up to the August 20th letter, and then the third phase, which would be the final three slides, talk about what was in the letter, what's happened since the letter, and kind of what some of the conclusions are we can draw.

First off, I'd just like to give folks a little overview of what our regulatory, independent regulatory role is under the Nuclear Waste Policy Act, and basically, there are three things:

First off, the NRC is charged with developing the regulations and the regulatory guidance that need to be in place to help us conduct our review in the program, and what that involves is 10 CFR Part 60, which are the Commission's regulations. Those are requirements that are promulgated by the Commission, and really are two basic guidance documents, which are the license application format and content regulatory guide, and the license application review plan.

Both of these are documents that are developed by the NRC staff, and basically offers the staff's interpretations on how to implement the Commission's regulations that are in Part 60.

The first one is guidance to DOE. Here's what we'd like to see in your license application. Here's how we'd like to see it structured. The second is guidance to the staff; basically, here's the criteria that the staff will use to determine whether DOE has shown compliance with the Commission's regulations. We like the two to match, which they do. We encourage DOE to follow this format, because then its license application will match our review plan, and it will help expedite our review.

In addition, during this pre-licensing phase, this pre-application phase, we're undergoing a number of reviews and we're looking to do a number of things.

First off, we're looking to identify and resolve issues early at the staff level. What this means is that the staff will reach a point in its review where it has no more questions, it has no more comments on a particular issue. It doesn't mean that the issue is closed, it doesn't mean that, given new information, the staff won't reopen an issue, the issue can't be raised in a hearing, the issue can't be reinvestigated during licensed. It just means today, given the staff's extent of knowledge, it has no more questions on a particular issue.

In addition, we're consulting with DOE to help develop a high quality and complete license application. We are mandated under the Nuclear Waste Policy Act to complete our review of the license application in three years, and in order to be able to achieve that, we need to complete high-quality application from DOE, so many of the interactions we're having with DOE is trying to help it understand our regulatory process and show it where we would need to make sure that the application is complete, and what kind of high-quality information we need in it.

And then, finally, we are required, under the NWPA, to provide our comments to DOE on the sufficiency of its site characterization program. This is not any comment on the suitability of the site. Rather, it's our comments on the suitability, the adequacy of DOE's site characterization.

I'm a little dry this morning. It's a lot drier out here than it was in Washington when I left.

Finally, we have an obligation to review the license application, and what that is, is that first off, the basic regulatory philosophy of the NRC is that the safe operation of any facility rests on the licensee. So the burden of proof is on DOE to show how it complies with the Commission's regulations.

What we will do when we review the license application, is we'll look at how well DOE has made that demonstration. Our job is to see DOE's done its job, not to make sure that DOE's done the job.

To give you some context as to why that's the case, I'd like to just put out a couple of statements that the Commission has made concerning what it perceives the NRC's role is in the pre-license application phase.

First off, when it promulgated Part 60, the Commission noted there was no basis for us to be formally involved in the DOE program; namely, DOE's got to become an applicant and a licensee of ours before we can implement our normal procedures.

The Commission noted that it can't direct the Department to comply with the provisions for involving its site characterization activities, but it further went on to say that although it cannot direct the Department to comply with the provisions for involving it during site characterization activities, any failure to do so is likely to result in imprudent expenditures and subsequent delays, and, ultimately, could result in a denial of the application for the proposed site.

The reason I put this up here is that one of the things that we're doing today, as we've worked with DOE, is we're looking at a number of things and we're building a foundation so that we can gain confidence what DOE's doing is acceptable, and this will help build our confidence when we review the license application. In other words, we're looking at a lot of things today that if we gain confidence they are done right, when we review the license application, we won't have to go back and look into that level of detail. We will build the confidence during this pre-licensing consultation phase.

Once again, we're keeping our eye on our mandate from Congress, which is we've got to do this in three years. What that boils down to is that the Commission has said we, the staff, can take 18 months to do our review, and then the Commission Licensing Board gets 18 months, so we're looking at really about a year and a half worth of review effort, and we want to make sure that we can achieve that, and so we're looking today to help build the confidence that we know what's going on in the DOE program, and we've got the details behind us that when we review the license application, we can do it in the statutory time frame.

One of the ways that we do this is through DOE's QA program. This is one of the areas where we rely on gaining confidence that DOE's doing it right, and what's involved in the DOE QA program are a number of things.

First off, there are requirements, which are spelled out in 10 CFR Part 60, Subpart G, which are the Commission's requirements for the high-level waste repository, and what those do, mainly, is say 10 CFR Part 50, Appendix B, as applicable, and appropriately supplemented by additional criteria are what the QA requirements are for the repository. Part 50 are the Commission's reactor licensings, and Appendix B contains the 18 criteria of what the Commission decides needs to be in a QA program. These very closely match what NQA-1, which is the ASME requirements are.

In addition, the QA program applies to a number of things: structures, systems, and components important to safety; design and characterization of barriers important to waste isolation; and activities related thereto. What this means is that structures, systems, and components are those activities in pre-closure, waste isolation capability are those activities in post-closure, and activities related thereto are design, construction, procurement, so it covers a whole range of those activities.

In addition, the program goes from soup to nuts. It goes from site characterization through de-commissioning of the site, and decontamination and dismantling the surface facilities.

So, first off, one of the things we rely on heavily is DOE's QA program, and the reason we rely on it is--well, the reasons, a couple of reasons. First off, the NRC can't review everything. The staff at NRC headquarters is about 60 people. I think that's equivalent to what OCRWM has at its headquarters, and then you add the YMPO on top of that, the M&O, the subcontractors. We're overwhelmed, so we can't review and inspect everything, and what we do is we rely on the DOE QA program to, number one, provide the framework for a structured and systematic method of obtaining facts and data and performing analyses and documenting these activities; and, two, provide assurances that the work is done properly.

What QA will not do is make sure that the right decisions get made. It's only going to make sure that you've got the procedures in place and you follow those procedures, and you have objective evidence to show that you have done the work in the way you're supposed to do it. What this then says is that DOE has the records, according to documentation for a licensing decision, and that it provides a traceability of the work.

One of the things the Commission found was that in many of the reactor licensing cases, folks just could not produce the records to show that the work was done right, and that doesn't necessarily mean the work wasn't done right. They just didn't have the records to prove it was done right, and so that's why it's very important that if they don't have the complete records when it comes to licensing, it could become an issue, because we're relying on them to make sure they have the objective evidence to show that it was done right.

Given that, I'd like to go through some of the events that led up to the letter, some of the things that we found over the course of about seven months that caused us to want to issue the letter.

The first was an October, '92 audit of the Yucca Mountain Project Office, and in that audit, the DOE QA team identified two corrective actions. The first one was that there was a lack of control of as-built drawings and notification to the architect engineers of the acceptance by the Configuration Control Board in accordance with Administrative Procedure 5.242. Basically, the control of as-built drawings wasn't following the procedure.

In addition, there was a lack of objective evidence that the technical evaluations of field change requests were done. In other words, they were doing field change requests. They couldn't show that they had done the necessary technical evaluations. Going back again to the point, not saying they weren't done, just there wasn't the evidence there to show that they were done.

In addition, on March 1st through the 8th, the DOE

QA staff did an audit of the M&O, and at that audit, they identified four things:

Number one, they defined a problem with the preparation of procedures, and what they were finding, namely, was that the M&O was not following its procedure for the preparation of the procedures; in other words, the M&O has a procedure which talks about what it needs to do to prepare other procedures, either QA or technical, and they couldn't document that that procedure was being followed.

The second thing was that there were examples of where the procedures had not addressed the methodology to fully accomplish the quality affecting activities; other words, the procedure didn't have everything the QA team thought needed to be there to be able to complete that activity.

The third issue was that many of the procedures that were in place at the M&O didn't reflect the requirements that were in the QA program. In other words, the high-level program which had the requirements wasn't being reflected in the implementing documents which were the procedure.

And the fourth thing that was found was that field change requests were not being processed in accordance with Administrative Procedure 3.5Q, which was field change control process.

Based on that, DOE went out on March 24th and did a surveillance, which is a follow-up activity, and what they found was additional issues. Number one, they found a number of areas where they were not implementing line procedures. There were no implementing line procedures for the development, review, and approval of the basis for design documents. There were no implementing line procedures for revising the RSN basis for design documents. There was no implementing line procedure for the process, design, and verification of design changes, and there was no implementing line procedure for the identification and maintenance of information to be determined on design drawings.

In addition, they found that the selection and review of design methods were not being done in accordance with NQA-1. They found that the M&O did not have an adequate procedure in place to control the flow of information between disciplines, and that, finally, that there was a--the M&O procedure did not require the documentation of reviews for inter-disciplinary reviews on drawings, calculations, and other design specs.

These were all things that were identified by DOE QA, and this goes back to emphasize the point, we rely very heavily on DOE QA to make sure that the job's getting done right. We observed these items, and we gained confidence that the audits were done right, and then, based on this confidence, we said, here are a number of concerns that the audits have identified.

In addition, in early May, our on-site representatives had identified an issue to us back at headquarters, which was mainly the traceability of flow-down and design requirements, and what the OR was saying was not necessarily that he had a problem that the flow-down wasn't there, he was saying there was a lack of objective evidence for him to be able to trace it, and there was a lack of a complete design; in other words, once again going back, the records weren't complete. We couldn't see the records, the objective evidence that we needed to have in place to make sure that the things were being done right.

Following that, as we're putting all these pieces of the puzzle together, we went out and we observed the design review for Package 2A, and while we were out there, we identified a number of concerns. In our letter, which we transmitted to DOE the results of this observation in September, we noted that these didn't necessarily mean that there were problems, but what we were finding was that there was insufficient information in the design documents that we were reviewing that we couldn't be sure what was going on, and here were the kind of problem areas we were identifying.

What we do when we observe the design reviews, is we look at this and here are problems we identify in the technical area, but we really want to emphasize to DOE, we'd like to see your process identifying these things, and we gain confidence that your process is working, and we can make sure then that your process is identifying the issues that we would like to see identified. So although it's technical issues related to the design, what we're really focusing on is how well the design review is working, and the kind of issues that the design review's identifying.

What we found were a number of things: Number one, there was a use of engineering judgment instead of data and analyses, and, basically, this was in the determination of importance evaluations, where what we were finding was that there was not data and analysis there. There was not an objective way of being able to concur with what was going on. It was more a use of engineering judgment, and these centered around two things: Number one, the amount of water that could be added during construction.

Basically, DOE said, you take out the rock, there's a volume of water in the rock, you can put back that volume of water whenever you do the construction. What we didn't see in that evaluation was that the water in the rock was matrix. It might be immobile. The water you're putting back in in construction may not necessarily be immobile. What's the consequences of that? What's the effect on waste isolation?

In addition, there were statements in there that the effect of drill-and-blast would not cause preferential pathways. No backup data and analysis was in that design document. We would have liked to have seen it, not to say that this isn't a true statement. It just tended to be, I don't want to say capricious or arbitrary, but an unbacked, undocumented statement that we would look for further documentation to support that kind of conclusion.

In addition, we found that the models may not be sufficient for recognized phenomena, and what we were finding was, number one, DOE said that there was a potential in the ramp for rock falls, yet the model they used were continuum models that didn't necessarily model the rock falls. Same thing with flow. DOE noted that over 10,000 years, they believed that the flow would be fractured flow, but they didn't show that kind of calculation when they did the design, and then they used static analyses for dynamic loads, although they noted that the static analyses were conservative, they were static and not dynamic.

The fourth area was the level of conservatism, and what basically DOE said was that the tunnel support is based on mines and highways, yet what you found was there was an excavation support ratio of one for tunnels and highways, and the ESR for the ESF was 1.3. We weren't sure what the reasoning was for that difference, and we would have liked to understand why they had chose the different value if they were saying their basis for the design was mines and highways tunnels.

In addition, there was a lack of dynamic analysis, which I talked about earlier. Basically, they were using static analysis and the conservative, rather than using the dynamics.

Finally, the specifications in DIE would have--may be tough to meet, and what we did, in addition to observing the design review, we went to the site and went out to the ESF construction site, and what we found were two things: Number one, the water that they said they could put back in, there's one meter out there, and nobody was quite sure how much of the water was going for other things or how much of the water was going back into the mine for construction, or into the ramp for construction. It was one meter, and people weren't quite sure how much of the volume of the water was going to different places.

The second thing we found was that the DOE, the construction procedure said pressure grouting would not be done within 100 feet of a fault zone, but when you got out there and you talked with some of the people who were doing the constructing, pressure grouting was not adequately defined. They weren't sure what was meant by pressure grouting.

And then, finally, some calculations may not meet the criteria of the procedure, and what we found when you look at the procedure, it says the calculations will be sufficient such that a person can independently go in and look at those calculations without needing to go out into other areas and look at other documents, and what we found when we reviewed the calculations was you couldn't do that. You needed to go get some other background documents.

Based on all of this, we started to feel that we weren't quite sure what was going on, and we needed to get some additional information, and so we scheduled a technical exchange with DOE for July 27th. About a week before that, DOE called and said that it just wasn't prepared to go forward with that technical exchange, and requested that it be postponed. DOE gave the reasons that basically they were looking at the issues, they recognized the issues, they needed more time to be able to investigate and understand the issues.

We recognize that. We understand why DOE delayed it, but the one thing that we were concerned about was we were looking at this as an opportunity for us to be able to get more information from DOE, and maybe understand a little bit more about what the problems were that we were identifying, and so what we did was at the July 20th QA meeting--we have a bi-monthly QA meeting--we informed DOE that we did need additional information from them.

What we were looking for were three things: What are the problems you're identifying? How serious are these problems, and what is DOE doing to correct these problems? At that time, we told DOE we would probably be sending them a letter, so they were aware of the letter about a month beforehand.

On August 20th, we issued the letter. We noted in the letter that what we had found was over a seven-month period, there were some issues where we had some concerns. We had some concerns with the design and the surface-based testing integration. In addition, the July 27th technical exchange was canceled, and we saw that as an opportunity to accomplish a number of things:

Number one, understand how DOE is factoring our concerns into its ongoing ESF work; number two, talk a little bit about the design changes that DOE's considering, such as the one that Dan just talked about on the ramp being changed and running parallel to the Ghost Dance Fault; and then, number three, we wanted to make DOE aware of any potential concerns the staff had with ongoing ESF design work, and what this was was mainly the result of our observations of the design review. At that point in time, when we sent the August 20th letter, we hadn't issued our formal observation report on the design review, and so we viewed it as an opportunity to talk about these four or five items that we had identified at the design review.

In addition, we requested four categories of information from DOE. Number one, we wanted to know why DOE believed it had the assurances, that given the problems identified in the design and the construction areas, it believed it should continue with the construction. Keep in mind, on August 20th, they were still going about 50 feet a month into the site of Exile Hill, and so construction was ongoing.

Number two, we wanted to know what were the corrective actions to be found, what's your plan for fixing those, what kind of root causes have you found, and what are you going to do to make sure that these kinds of problems don't occur again?

The third thing was that we were worried about what kind of design information we had in hand. What's happening to some extent is we've got a Title II design package, we've got an ESF summary report, we've got a site characterization plan, we've got a progress report. All of these have pieces of design information on the ESF. We weren't sure. Do these compliment each other? Do you need to take them as a whole to get the complete design? Does one of them contain a complete design, and do the others support that? Is one of them a high-level document that gives you a general description, and the next one a little more detailed, the next one supports all of that detail? We just weren't sure what documents were there, what documents we needed to have, and what documents we had to get a complete picture of the ESF design at this point in time.

And then, finally, we raised a concern about the timeliness of design information and responses to NRC concerns. We want to be involved early in the process with DOE. We want to be able to give them our regulatory perspective, and we want to understand how they can accommodate that. We don't want to hold up the DOE process, but we certainly want to make sure we're involved early in the process so that we can get our regulatory perspective.

And then, finally, we asked that DOE respond in 90 days, and, once again, going back, keeping in mind, they were doing construction at that point, and we were concerned because construction was ongoing. We wanted to make sure the response was timely enough that we could start to address these concerns.

Subsequent to the letter, we've had two interactions. The first one was on September 17th, which was an ESF Concerns Meeting. This was mainly a management meeting between the NRC and DOE. The State of Nevada's Nuclear Waste Project Office was there, and what we talked about were a couple of things.

Number one, we provided an amplification of the points raised in our August 20th letter. We, I don't want to say reiterated, but maybe for the first time told DOE what our perspective was on the design control of the ESF, and the thing we wanted to make sure DOE understood was that we didn't view the design control of the ESF as just controlling the designs and the calculations of the ESF, but also, we wanted to understand how, when design changes are made in the ESF, do you control that so that the information gets fed back to the principal investigators, so they know that the design changes are made; how, when you're down there and you're constructing and you run into something you didn't expect, or something different than what you assumed when you did that design, how does that get fed back into the design, how does the design get changed, how does that get fed back to the PI.

To us, it was more than just controlling designs and calculations. It was the whole process, from scientific investigation through what's actually happened in construction, and how all that gets tied back together.

We provided the DOE two pages of a little more detail on the four items that we identified in our August 20th letter, and then, finally, the Nuclear Waste Project Office suggested that the NRC reinstate Objection 1, which was no work on the ESF until the objection gets resolved, and conduct its own audit of the DOE activities.

At that time, what we told the State of Nevada was that this was a process for us to ascertain exactly what was going on there. We weren't in a position at this time to say we would be ready to do that, but what we were trying to do, and what the August 20th letter was, was a request for additional information so we could ascertain exactly what the situation was.

And, number two, we had the confidence in the DOE audits that they were identifying the things we would have identified had we done our own audit, and so we didn't think that doing our own audit would raise anything else that hadn't been identified. What I did commit to to the state was that we would look at doing our own audit and we would get back to the state. So we are evaluating that, and we will get back with the state, letting them know formally what our decision is on whether we need to do our own audit.

All of that in mind, there are several conclusions that come out. First off, there were a number of concerns. The concerns came from the findings in DOE audits and surveillances, and the concerns centered around mainly a lack of objective evidence. We couldn't find the records to show that things were done right.

The opportunity to discuss these issues was postponed, which, to us, we think was a missed opportunity, but we understand DOE's position, and we understand it wasn't prepared, so we accept that. The burden is on DOE, though, to provide the needed information. Going back to the Commission's basic philosophy, it's the DOE's job to make sure it's getting done right, and it's our job just to see how DOE is making sure it gets done right.

The letter identifies the concerns that we have, that we've raised. The subsequent interactions provided an opportunity for clarification, and I think both parties--and I'll say DOE can correct me if they don't think I'm accurately representing it, but I think both parties felt like the first couple meetings did offer an opportunity to start a process where we can work better together.

We're working at, down here, continuing dialogue. We're working at trying to get maybe bi-monthly meetings where we can start to meet more frequently on the ESF and the ESF design activities, so we think this was a good step, these interactions, and that they did offer an opportunity for both of us to better understand what was going on.

We understood a little bit better what DOE's process is, I think. I hope DOE comes away with a little better appreciation of what our process is, and we're trying to find a way now that we can make these two work so that DOE can get us involved and we can do the reviews that we think we need to do at this point in the program.

We're still waiting for DOE's response. We did tell DOE in the letter that if it couldn't make the 90 days, please let us know in 30, and we haven't received any indication otherwise, so I suspect sometime around the 20th of next month we should be getting the response.

Like I said, we have both agreed that there's a need for continuing dialogue, and we're pursuing that. We're trying to schedule our next meeting for sometime in December in hopes of being able to get together and talk about more issues.

And then, finally, I think DOE recognizes the need for timely submittals to the NRC. I think they recognize we're doing a review, and we're looking at it from a perspective that is somewhat unique in the program. I think they recognize we need to be involved in the process.

I don't know, did I go through that too fast for you folks, or...

DR. CANTLON: No. Very good.

Questions from the Board? Yes, Dennis?

DR. PRICE: Dennis Price, Board.

The previous speaker characterized the letter as being one in which they really--there were no particular design issues, but they had perhaps failed to fill out some forms, and so forth. Is that your position, that there are no design issues involved, or is it that you don't know if there are design issues involved?

MR. HOLONICH: I would say we don't know that there are design issues involved. The last review we've done was really the site characterization plan, which has the two shafts. We've been working with DOE to try to get a high-level summary document that we can do our review and be able to write our comments back. We've been working with the design and review process. We've identified some concerns in that, and, subsequently, we went out in the field, and we've got the evidence, and we've seen those concerns identified; we think are acceptably resolved.

But to go out and say we have no design issues, I'm not ready to make that statement at this point, because the next design review could lead to something, so...

DR. CANTLON: Other questions from the Board? From the staff? Leon?

DR. REITER: Leon Reiter, staff.

Joe, I think you really laid out very clearly the role of QA and the need for it in the NRC review process. I just have one question, that's about the role of staff judgment in doing this kind of process, and just take as an example, you picked up--you mentioned something about they did a static analysis over dynamic analysis, and although you think it may be more conservative, you felt they should have done a dynamic analysis anyway.

I was wondering, does that mean if they had presented some sort of rationale why a static analysis is sufficient, you would have rejected that?

MR. HOLONICH: No. Okay, what I said, Leon, was that they did not do a dynamic analysis, but they said they had done a conservative static analysis. It may not be more conservative than the dynamic, it just was a conservative static analysis.

We would have preferred to see the dynamic analysis, or the rationale for why they think the static analysis was okay.

DR. CANTLON: Other questions?

(No audible response.)

DR. CANTLON: Okay. Thank you.

Our final speaker on these timely issues that the Board has been trying to get caught up on is a statement from Carl Johnson of the Nevada Nuclear Waste Project Office. Carl is Administrator of the Technical Programs for the Agency for Nuclear Project, and the title of his talk is the "State of Nevada's Concerns on Pneumatic Testing."

Carl?

MR. JOHNSON: Thank you, Mr. Chairman. This is the obligatory title slide. I'm going to talk about the State of Nevada's concerns with pneumatic testing.

The first thing, quickly, is a couple of definitions for those people that aren't quite up to speed at least on the letters and everything; that is, the correspondence that has gone on on this particular issue. We've kind of coined the phrase "pneumatic" to kind of encompass gas, air, and vapor.

Secondly--and this will come around a little bit later in the talk--pneumatic conditions are incorporated within the NRC's definition of groundwater.

I would like to acknowledge that we're not the only ones who have had some concern with the pneumatic conditions; that the NRC, in some of their comments, have also touched on this particular issue, and I just point out three of their comments here. Their SCA comment, which dealt with the effects of ESF ventilation on site condition testing; their comments on one of the study plans, which dealt with the potential for ESF excavations to influence diffusion testing by drying of the rock; and, lastly, some comments they made on DOE site characterization Progress Reports 6 and 7, where they commented that air movement from the ESF may adversely impact collection of geochemical data.

Back in 1992, we commented on one of DOE's study plans, and this was the characterization of Yucca Mountain unsaturated zone gaseous phase movement, and I bring this quote, which comes right out of the study plan. "This study was developed in response to the recognition that potential exists for substantial topographically affected gas circulation through Yucca Mountain. Presently, the phenomenon is little recognized, and its potential significance to the repository performance is unknown."

Well, in April of 1992, we issued some comments on that particular study plan, and the two main things that we highlighted was that there was no justification that one study site will produce representative data to provide adequate understanding of gas-phase circulation processes; and, secondly, no justification that understanding of gas-phase circulation processes can be extrapolated across the repository and to the boundary of the accessible environment.

Let me put this slide up first to show you what we are talking about. DOE proposed--this is a cross-section of Yucca Mountain from west to east. What DOE proposed in that study plan was to study holes UZ-6 and UZ-6S, which are at the crest of the mountain, and essentially study the welded Tiva Canyon member, and the results of that study area then would be extrapolated across the site, and that's where we had problems with that approach to understanding gas circulation across a whole repository block, using two drillholes.

As a result of that study plan, that generated a long series of conversations between myself and Marty Mifflin of Mifflin & Associates here in Las Vegas, and the concern evolved from the extrapolation of data to a much larger concern, and that dealt with what would happen if we excavated an ESF facility.

And so, as a result of that, we generated a letter in February, 1993, which--this was a letter to the NRC, and basically laid out our concerns in that regard, and the two main points that we were making was that early excavation of the ESF may preclude adequate characterization of undisturbed pneumatic pathways, and the key word here is undisturbed; and, secondly, may prevent the NRC from making a licensing finding on the issue of fastest pathway.

Now, I'd like to kind of go into the details of how we arrived at that, and what our analysis has been, and I'm going to show a series of view graphs to try and illustrate that.

The first thing I've done is I've pulled a figure here from Joe Rousseau's talk to this particular Board last April in Reno, I believe. Joe was basically talking about a conceptualization of percolation here, but if you kind of re-draw the arrows a little bit, you can get a conceptualization of pneumatic pathways and pneumatic flow.

Essentially, the unit of concern is this PTn unit here between the Tiva Canyon and the Topopah Spring, which is the host rock, and that is a non-welded bedded unit which may or may not move fluids downward, or move air upward. Joe has conceptualized at least the fluid as maybe having some lateral flow in it, maybe some vertical flow, we don't know, but if you look at the--kind of reverse the arrows, there is the question of whether this particular unit impedes the flow of air in an upward direction and out through the top of the mountain, or that it does not impede. We don't know at this point.

I also put this slide in here to show you, again to illustrate. This is from some work that Ben Ross did in 1991, looking at modeling simulations of gas flow at the repository, and he put in a unit which was typical of a gas flow movement, and then did this simulation of movement.

The question then revolves around, and our concern is whether, is this the appropriate model or is it not, and whether data can be gathered to resolve that or not.

I'm going to show a couple of cross-sections now. This more just of a location slide than anything else. I'm going to show cross-sections A-A' and B-B' here. All of these figures come out of the environmental assessment for Yucca Mountain. They were very easy to locate and deal with, and, again, here is the bedded unit described as P here, but it's PTn in some of the other figures, but, again, this is the bedded unit, the unit of concern here to see whether we have a problem or not.

You can see from the cross-sections that in the southern part of the repository block, that the geology is much more complicated than the northern part.

Now let me go to this conceptual figure, which has been shown already a couple of times this morning for various other purposes, and kind of talk you through what generated our comment. Our concern was characterizing the movement, the gas vapor movement in this area below the bedded unit. Our concern was that whether that characterization could be accomplished and would be accomplished before the ESF ramp was put in, because our belief was once you passed the bedded unit in the ESF, you had then a short circuit pathway for any air movement in here to exit right out of the mountain, and you no longer had an undisturbed condition to characterize.

Let me go on to just basically what we want to see, and what we envision. We envision that this should be the goal of a pneumatic pathway study; that is, a study adequate for developing and confirming a pneumatic flow model for an undisturbed site.

These are the key questions that we think need to be addressed relative to a pneumatic pathway study. What are the pathways? Where are the pathways, and how fast is the travel?

Why do we need to know this? We need an understanding of undisturbed pneumatic pathways. We need a determination of the fastest pathway for radionuclide release. We need to have input for the thermal performance modeling at a repository scale, and, lastly, we need this information as to the impacts of thermal loading on the desert ecosystem.

And lastly, what do we think is required to accomplish this? We think there needs to be a surface-based program of sufficient boreholes to develop an adequate database of undisturbed soil gas pressure and flow in response to barometric pressure changes at a repository scale.

That basically concludes what I have to say. I'd just like to follow on by acknowledging the inputs and the views of the U.S. Geological Survey in this particular issue. I've been in this program for over ten years now, and this is the very first time that the DOE or one of its participant organizations has ever substantially and substantively acknowledged that the State of Nevada has an issue that needs resolution.

DR. CANTLON: Thank you, Carl.

MR. JOHNSON: Any questions?

DR. CANTLON: At 1:40 this afternoon, Robert Craig of the USGS will comment on the pneumatic testing and the ESF construction, so I think rather than addressing all of this now, let's try to maybe put that together in one session, so I hope you'll be around this afternoon, Carl.

MR. JOHNSON: I plan to, and I look forward to hearing the USGS comments.

DR. CANTLON: Very good. Are there any burning questions that Board members want to ask of Carl now, rather than discussing the generic topic?

(No audible response.)

DR. CANTLON: Staff?

(No audible response.)

DR. CANTLON: Okay. Then let's hold this main discussion, then, which is a very important question, I think, that Carl has raised here, and we'll try to pursue that in some depth after Robert Craig's comments.

Okay. We're a little bit ahead of schedule, and let's move now, turn the session over to Pat Domenico, who will chair our overall DOE site characterization and testing program, surface and underground.

Pat?

DR. DOMENICO: We're going to begin with two presentations by the DOE on the makeup of the overall site characterization testing program, both surface-based and underground. After a break for lunch, we're going to try to focus on the surface-based testing program and the deep dry drilling program in particular. We will hear about cooperative drilling efforts between Nye County and DOE. This will be followed by a progress report on the field testing activities at Yucca Mountain, and a talk, as John said, on the plans for conducting pneumatic tests in the boreholes that perhaps might address some of Carl Johnson's concerns.

Next, we'll hear about the systematic drilling program under which much of the drill core will be obtained, and the systematic drilling program offers us some means for evaluating the need for deep boreholes of drill core.

Our final talk will be an extensive update on the Yucca Mountain drilling program. After a short break, there will be an hour and a half somewhat informal round-table discussion.

Before we begin with the first speaker, I would like to bring up a concern that the Board has had for some time; namely, the slow rate of delivery of drill core from the surface-based drilling program, and the fact that this might become a bottleneck.

We heard estimates this morning that, at a rate of 15 feet per shift, one shift per day, you're looking at almost 29 years of operation. I think most of the PIs, when they get their core, will either be retired or deceased by that time, so this problem has really got to be addressed, I think, and like I said, there's one LM-300 drilling operation going on now, and it generally operates for one shift.

Some options are to get some more drilling rigs, to drill two or more shifts per day, but we know with the level of funding of recent years, this is may be highly unlikely. Another option is to use different drilling methods, alternative financial drilling incentives; and/or improved equipment to physically speed up the drilling.

Still another option, I think one that's obtainable here, is to rigorously scrutinize and possibly lessen the need for drill core by the various studies. This option would follow the recommendation in the Board's second report to reevaluate and establish priorities for scientific testing so that the essential data are provided to meet objectives.

The study plans are several years old. Several years ago, they may have represented the Cadillac. I'm not saying we should have a Model T, but I think they should be looked at very carefully and scrutinized, because I think this problem has got to be addressed sometime in the near future. Clearly, the effort today on the surface-based drilling program is a token effort, in essence, but saying that, we will also be hearing about some broader-based aspects of the site characterization testing program.

To begin this session, Susan Jones will discuss the framework of DOE's site characterization testing program.

MS. JONES: This is where we are making the shift to some discussions of our ongoing programs, and I've been asked to give an introduction, introductory remarks here on the management perspective, and to set the stage for the discussions you're going to hear from our principal investigators, support contractors, and DOE folks later on today, and for the rest of tomorrow as well, and I've chosen to give that perspective by refreshing all of our memories about the phases that we go through in setting up our testing program.

As it was just alluded to, we do extensive and have done extensive planning that dates back well before the actual issuance of the SCP in 1988. We view our testing program as including three phases that occur both in developing the characterization program as a whole, as well as going through each of these three phases for any individual test, and that's the planning of the test, the implementation of the test--which is the subject of today's meeting and tomorrow's discussions--and I'd be remiss if I didn't bring in the evaluation phase as well.

What I want to do is just lay out the framework of DOE views occurs in each of these phases prior to discussing the actual testing programs.

During the planning phase, as I said, this started with the passage of the Act, the issuance of 10 CFR 60, 960 DOE's own siting guidelines, and it started with an analysis of the regulations, since, ultimately, those are the questions that we are going to have to answer, and a key part of the very early planning in this program was to look at a strategy, how are we going to resolve those regulatory issues.

From that, we developed the testing program. As you alluded to, that program shows up in the SCP itself, and we provide additional detail on those individual studies in the study plans, and you made an excellent point that the SCP, the study plans, can be prepared and issued years before a test is actually fielded, and we're well aware of that fact, and it does require routine updating, which I'll talk about in a few minutes here. But that's our test planning; namely, issue an SCP, take those requirements, baseline those requirements, issue the study plans for review and comment and execution, and finally, we get to the point of being able to actually authorize work.

And this summarizes some of the concerns that we all share, because when you get to the phase of trying to actually put a test into the field, or into the laboratory for that matter, clearly, prioritization has to take place, and we are constrained, and that has been our discussion that we have been having in the past, as well as in the future, and later on today, I'm sure, as well.

The project receives guidance and issues guidance as to what the priorities need to be. Are we focusing on surface-based testing as a priority? Do we need to deal primarily with the ESF as a priority within the project? Are there burning technical issues that require immediate attention?

We also have to integrate the technical data needs of our various end users of data. Does a principal investigator need some information before he can make progress on his study? Do we need design input to the ESF? This is one issue that we're dealing with now. We're trying to prioritize our work, ensuring that the surface-based testing, the geologists are out there in front of the designers, providing feedback to the design organization, and our old bugaboo, resources, of course.

It's important to realize that the test implementation phase, which is what we're discussing these couple of days, that this is where we get our specific work instructions developed, and here we're getting time link instructions sent, prepared; work plans that are actually being executed by the drillers, by the principal investigators in the field. This is how we pull together all of those conflicting needs and priorities and put together a work program that can be executed in the field, and this does occur in a timely fashion, feeding back to the study plans, if necessary, to update them based on previously acquired information. So there is a feedback loop here you ought to be aware of, whereby knowledge gained since the issuance of the study plan can, indeed, be fed back into the process to update a study plan.

At this point, you're ready to go into the field and collect your data and take it to the laboratory and analyze your information, but I would remiss if I didn't remind you that when we're talking about drillholes, when we're talking about the ESF, all we're talking about are holes in the ground. Until you get data from them and evaluate that data, all you have is a hole in the ground.

This is probably the most important phase of the entire program, is evaluating those test results, and that also occurs at a variety of levels. Individual tests are conducted, evaluated, and fed back immediately into the program to guide the next phase of testing. You drill a few holes, you get some experience, you do some analyses, and you decide what you want to do in your next phase of drilling.

You collect information from the ESF or the drilling that precedes the immediate construction of the ESF. You feed that back in to the next design phase to guide those designers.

That's sort of the immediate, the implementation phase, the kind of evaluations that take place on a day-to-day basis. There's also a very long-term--and I don't want to dwell on this too extensively, but the end users of the data are also providing feedback. That's the performance assessment folks, the people looking at site suitability or licensing issues, and the designers, say, the repository or waste package designers are also providing feedback and evaluating the data from a broader perspective.

And it's in this phase, test evaluation, where major decisions can be made, whether you want to continue a test, whether you want to modify a test, whether you have enough information to stop a test, and from a managerial perspective, I'm interested in all three of those answers.

I also want to point out that all of this work, planning of the studies, the day-to-day field implementation of the studies, evaluations of the studies are conducted in the very broad context of oversight, and this is a view graph I use primarily directed at the NRC oversight, but this could just as easily read State of Nevada, County, Nuclear Waste Technical Review Board, any of our oversight organizations, and I highlight this because the NRC had very specific comments on the SCP, some of which we still need to resolve, some of which cannot be resolved until we get more data from site characterization.

The NRC--I might add, also, the states--review our study plans and provide technical comments. At the end, of course, there'll be a major, major role for the NRC and all of our interested parties in evaluating our results, and as Joe Holonich said, they provide oversight of the entire process that we go through during site characterization.

And to set the stage, then, the only thought I want you to hold as you listen to Dennis and then go through lunch and return this afternoon, is that we're only talking today about the middle phase of our process, the actual field work, the collecting of the data. Please do not lose sight of the fact that there is planning that is conducted ahead of time, a key part of the process, and there is a major evaluation phase that occurs after we complete our drilling after we get our data from the ESF.

That's all I need to introduce the subject of the site characterization field testing; if there are any questions?

DR. DOMENICO: Any questions from the Board?

DR. NORTH: Warner North, Board member.

I'd like to have you comment further on the extent to which the project office is going back and looking at the planning phase, given the changes that are occurring in understanding from the total systems performance assessment and the supporting performance assessment activities; for example, thermal loading; for example, the importance of the gas pathways.

It would seem to me that many of the study plans are a bit out of date, and I realize that it's very hard for you to change them, there's a lot of oversight involved, but in some cases, it may be very important to bring a study plan up to date and essentially re-plan it.

The State of Nevada has just expressed its concern on pneumatic testing. The Board has expressed concerns in a number of areas. Thermal loading is certainly high on the list. Explain to us what you're doing in terms of revising the planning on the study plans, and the way these tests are going to be implemented.

MS. JONES: Thank you. Yeah, I can do that.

Every time--the formal process--let me deal with that first, if I may--is every time we do receive a written comment, we evaluate it and prepare a response. In the case of the comments, for example, that Carl Johnson mentioned, we actually thought they made very good technical comments about that particular study plan, No. 226, and if I'm not mistaken --he's shaking his head, but the principal investigator is nodding yes--we accepted those comments and have issued the revised study plan to accommodate the state's comments, and that occurs with the NRC when they issue formal comments as well.

In addition, an individual principal investigator who identifies, say, through processes like this, where a concern is raised, say, through a Board's, let's call it oral recommendation or oral concern that's expressed versus a written comment, the same thing can happen. At that point, we can have a discussion and the study plan can get revised in that fashion as well, and I guess I would disagree that we have taken steps to streamline the process, and revisions are not necessarily difficult to make. Any revision that's proposed with a good, sound technical basis is reviewed and put into place, so I disagree that the process is extremely difficult.

However, I also don't feel that we need to balance, perhaps putting a lot of technical detail into a study plan, versus actually getting the work done.

DR. NORTH: I think we would be interested in hearing more from you in terms of, of the hundred-plus study plans, how many of them have been revised on a significant technical basis, and what are the reasons for these revisions?

MS. JONES: Okay. What I'd suggest I do is take the action and prepare, perhaps, a summary, because we do report that kind of information in the progress reports, and we could just summarize it, though, because rather than have you go through and read each individual update, so I could take that action.

MR. DYER: Susan, if I could add a little bit here for Warner. This Russ Dyer, DOE.

Dr. North, there's a couple of ways that one can accommodate a change in the program. One might be to go back and review the study plan to determine whether the activities are still valid, if the tests are still the tests that are needed.

In the case of the pneumatic testing, we went back and I--Mike Chornack can correct me if I'm wrong, but I believe there's--or either Mike or Bob. There are really a suite of four study plans that cover that, one of which we talked about some potential changes to. The other study plans also were evaluated to determine whether or not changes were made for those.

For the most part, the major change that's needed is a sequencing change at the time at which this particular activity takes place, which one can accommodate by moving resources up in the programmatic schedule, rather than a change in the study plan, the rationale or the objectives or the test details themselves, and that's mainly how we've dealt with this particular issue of pneumatic testing.

DR. DOMENICO: Any further Board questions? Staff?

DR. PRICE: Dennis Price, Board; just a quick one.

Is anything underway to update the SCPs? They're getting a little old.

MR. DYER: Russ Dyer, DOE.

The SCP, of course, was a statutory document that was put out. There is a--and the SCP will not be updated. It was a one-time thing; however, there is a baseline version of the SCP called the SCPB which we do update, and that is the control version of those things, test objectives, et cetera, that describe the--it's the major parts of the SCP, those things that establish requirements for the rest of the testing program, and we do update that particular document. I think we've been through six revisions.

MS. JONES: Ten revisions.

MR. DYER: Ten revisions on the SCPB.

MS. JONES: That stands for site characterization program baseline. If you're very, very familiar with the SCP, the first five chapters were descriptive material; the current description of the site, there were conceptual designs of the repository and waste package, and then the main part of Chapter 8 is, of course, the plans for conducting site characterization. What Russ was talking about is that Chapter 8, controlling the changes to the site programs.

DR. DOMENICO: Questions from the staff?

(No audible response.)

DR. DOMENICO: Thank you very much, Susan.

We'll next hear from Dennis Williams on current testing program, surface and underground.

MR. WILLIAMS: I'm Dennis Williams. I'm Branch Chief, Site Branch, Yucca Mountain Project, DOE, and the presentation I'd like to make this morning has to do with the field activities in progress on the surface-based and the ESF testing program, which is the entire testing program for

Yucca Mountain.

Taking on from where Susan left off, basically, I'm trying to establish the background, a little bit of the framework for what everybody else will talk about later on in the session this afternoon.

I guess with regard to that last comment that was made referencing study plans, I would like it if the other presenters might just note how their study plans have been updated as they move into the beginning of their discussions. That might help us out in answering some of the questions of you.

Somewhat for the record here a little bit, I just want to go through some of the activities that we have in place, again, very briefly. I won't bore you with a lot of descripters or alpha numeric indicators, but we are involved in a lot of parts of the various study plans which we have noted here; various titles and impact, rock chemistry, alteration zones, structural features, where the activity is taking place. You'll see a lot here, ESF sampling, surface and ESF mapping, test pits, trenching, surface mapping, ongoing measurements with regard to the monitoring of programs. Of course, the later speakers will elaborate in considerable detail on these.

The second sheet, which has a couple of the items which we will dig into quite a bit, the percolation and unsaturated zone. That's where UZ drilling is ongoing right now, in the unsaturated zone in the ESF, the 8.3.1.2.2.4, which is our Test Alcove #1, and Ned will give us quite a bit of discussion on that particular activity.

I show this one just to put a little bit of Dan's talk into perspective this morning. We're still dealing a little bit with what we consider to be the current ESF layout which we have depicted here in the bold line, and the proposed ESF layout, which goes along the Ghost Dance Fault, and I think you can see from this and the locations of some of our boreholes, that we are emphasizing boreholes on the block, such as SD-12, which will give us design data, as well as site characterization information to allow us to move forward with the proposed ESF configuration.

This particular diagram does show the areas that we're doing a lot of our work in. Some of the NRG holes on the north ramp, of course, are completed, but we'll be going back into those, doing geophysical surveys, putting instruments in for gas permeability, putting some long-term monitoring in some of these boreholes, as well as the core and the other information that we've pulled out of those holes.

UZ-14 sitting out here, which we're actively working on; NRG-7, which we're getting ready to go to that particular hole; and, of course, SD-12. Arch will give us a real good update on that later on this afternoon

MR. DYER: Dennis, if I could break in for a minute. For the Board members, this presentation is out of order. It's about halfway through the package that you have.

MR. WILLIAMS: This is just a little schematic of the alcove that we are, I think, something on the order of six meters into this alcove off the starter tunnel, and, of course, it depicts the radial borehole testing that will be done at the far end of the alcove. Again, a lot of this is just an introduction for some of the later talks this afternoon. Ned will talk on that one at particular length.

I wanted to remind ourselves of some of the parts of the puzzle, really, or parts of the complexity of the whole program we deal with, including all the individual activities, the studies, how that fits into models, and, of course, then goes into the long-range plan.

In addition, we track this with a variety of milestones, and just a little review on the milestone hierarchy, our Level 0 milestones, which are the ESAAB milestones, our site recommendation report. Level 1 would be program milestones, our interim site evaluation reports; project milestones; and, Level 3, milestones which are the participant milestones. Those are basically the things that they give us at the project level which we start off with, and then we roll up to satisfy the higher level milestones, and then, of course, get eventually to the Level 0 at the ESAAB.

Each of these milestones out here allows us to establish a schedule so that we know things are going to get done in the right amount of time, and often there are deliverables associated with each and every one of these milestones, and as Larry Hayes knows, the deliverable list is quite long.

A little bit on our long-range planning. This is a classic sausage diagram. We try to get it in the context of our milestones and, of course, our submodel components, and our submodel components is the place where a lot of our deliverables come in from the various participants, and eventually, that is rolled up into a submodel, gets up into a preliminary model, an interim model, and on to final, and I use this just as a basis for showing how we exercise all these pieces of information periodically.

The timing of this is set up, basically, on a two-year process. We look at it in a preliminary sense, then we look at it in interim. We add more data, if necessary, to get to a final model.

We've had a lot of discussion about the terminology of model here, but I use it in a very loose sense, in the sense of data sets, a three-dimensional framework model, a design data report, a seismic design basis that goes into the design, so, in that kind of a sense, more of a product than really a computational model or real complex framework model that you may envision.

Each and every one of those study plans that I noted on the first few slides, of course, has activities associated with it. In this case, we have characterization of perc in the UZ, the surface-based study. It has three major activities associated with it. Those all feed into that study plan. The information from that study plan will feed back to a component, as shown on this line diagram, eventually getting to an unsaturated zone description, into a hydrology model, back into the model that is exercised periodically, and then, hopefully, a final outcome such as a license application.

This little line diagram here is I just very simply attached the information out of here going into matrix hydrologic properties. I think you can see that there's a lot of areas in this particular area where we would have ties going back to various components that would eventually lead back to the unsaturated zone description; and, likewise, you would have other studies and other activities that are sitting out here in a more complex diagram that, likewise, feed into some of these components, and then go on up into the descriptive models.

I've included several of these to try to give us a little bit of background of what we're doing. I think this one may answer one of the questions with regard to study plans. This is 8.3.1.2.2.4, characterization of the Yucca Mountain unsaturated zone in the ESF. It has about ten activities in it, and I know with regard to this particular activity down here, 2.2.4.10, which is hydrologic properties of major faults encountered in the MTL of the ESF, Ned Elkins discussed this one particularly yesterday with regard to a component of that, which is the geothermal borehole that we do in proximity of the TBM as we're moving forward in the ESF.

And this is one that we're going back, looking at the study plan and see how that relates to that particular borehole with regard to the TBM as we're developing the ESF. But we really couldn't visit this activity of the study plan prior to this time, when we're putting together the schedule for the excavation of the TBM, so all these things will come in at the right place and right time. I guess the part of it that we have to be aware of, is making sure that we evaluate it at the right place and the right time.

And again, all these tieing back to the study, the line diagrams and the various hydrologic properties, fracture and network studies, gas vapor, unsaturated zone description, back to the hydrology submodel that moves forward in time out to license application.

And again, for your information and for the record, we go through several of these. I've tried to tie as many as we could together from the activities that are in the field. This one is characterization of structural features within the site area, five activities associated with that, back into the geology submodel, back into the work that Rick Spengler in the GS is doing up in Denver on the LYNX model.

Streamflow and runoff, basically data collection, monitoring activities. 3-D min/pet, same thing, basic study plan with three basic activities under it that ties back to a modeling exercise, back to geochemistry, and then again exercising that model to get out to site suitability and licensing.

I just might mention tectonics very briefly. We do have a major effort underway in that particular area. I'll show some overheads of some of the mapping that we're doing in trenches associated with the Quaternary faulting within the site area, and, of course, we have faulting in the regional area, we have faulting within 100 kilometers, we have faulting in the site area, so that becomes a very complex network of time, all these together, again, backed into that modeling component, and then rolling on up to be exercised.

And characterization of volcanic features, Bruce Crowe's work, Lathrop Wells, the various activities associated with that, and of course, this one ties back to the tectonic description and the geology submodels through assessment of tectonic models and preliminary evaluation of relevant seismic sources, so for a totally integrated program, you have to have all these ties back to other submodels in order to come up with the whole, and Tom will give us a wrap on that at the end of the session.

Just a little bit of an understanding of how we keep track of this from a little bit of the deliverable standpoint. This is a recently developed diagram that we're using to show how we identify our various participants in a fiscal year, Level 3 deliverables, those are the ones that come from our participants. We identify those, where they fit into a submodel component, how much information we've got on this. We use a little bar diagram, United Way-type of approach, 0 to 100 per cent, where we're at on the completion of these things, and then how much that is contributing to a unsaturated zone hydrology submodel, and there's obviously a little bit of judgment that goes into our understanding of how much we have satisfied that particular level of information, of data in that model, but then when we exercise the model through PA, we hopefully will get information back that will tell us how far along we are and where we need to go in the next round of data collection.

The ESF guys try to put up pretty pictures of what they're doing underground. This is our CME-850 rig sitting on NRG-2B, and, of course, if we don't get our NRG ramp holes out, give them design data, they don't build ramps.

A little bit of the locale, that's the location for NRG-2B, Trench 14, the ramp coming through this area right here. We've got NRG-2A out here. We had NRG-2 in this vicinity in the Bow Ridge Fault. We've got a Rainier Mesa formation that sets in here that's some fairly poorly consolidated materials and we're doing a lot of data collection, a lot of excavation of trenches and more boreholes in this area to get information to feed into the design.

And, of course, the LM-300, with all of its component pieces, we'll talk about that a great deal more this afternoon on how each and every one of these pieces out here, such as the compressors, the dual wall, the core rods all contribute to that sampling and testing exercise.

We do have a major effort underway with regard to trenching. This is some trenching on the Solitario Canyon Fault. It's part of our Quaternary fault studies, pavement clearing on the Ghost Dance Fault. This is the area on the south flank of Antler Ridge. I think some of us have been out there on numerous occasions for visits. We've got two D-10s working that to clear that pavement to get better exposures for mapping of that feature.

And, of course, the detailed mapping in the trenches, Chris Menges out in U.S. Geological Survey doing the work of mapping the fault offsets in Quaternary fault trenches.

The major points of this part of it, and what I would like you to take away with you is that while these field activities represent a major effort of data collection for the ESF, tectonic studies, saturated zone, unsaturated zone methodologies, a large part of the effort is directed at the unsaturated zone. We are doing unsaturated zone on the surface. That's why we've got UZ-14 underway. We've got unsaturated zone in the ESF. That's the radial borehole tests that we're doing in the underground. A lot of the samples that we are collecting and mapping has to do with the unsaturated zone.

Consequently, we tried to establish that as a unifying theme for the technical portion of this session. There will be a lot of discussions about the UZ, and I think that you'll appreciate that. The UZ effort, like all Yucca Mountain efforts, is an integrated effort. As I showed you in some of these real brief line diagrams, the things have to tie together. If they don't tie together in the end, then we don't have a hole, and we won't get anything with it or get anywhere with it.

And, of course, the success of the effort is, in large part, dependent upon the sampling and testing methods that we use, and, of course, the LM-300 and that system is a large part of that, and we'll discuss that at great length later on this afternoon.

With that, I will conclude.

DR. DOMENICO: Thanks, Dennis.

Yeah, Don?

DR. LANGMUIR: Don Langmuir, Board.

Your next-to-last view graph looks as if it's saying that gas transport properties of the site are 100 per cent known. That's what the little bar tells me, and yet, we're going to be discussing pneumatic gas transport this afternoon and have this morning. Are we talking about the same thing, or am I missing the point? Is this a different analysis?

MR. WILLIAMS: This is a cartoon.

DR. LANGMUIR: This is hypothetical. This is what you would do if you were done, you'd put 100 per cent there on the left-hand side of the view graph, gas transport properties?

MR. WILLIAMS: Oh, the gas water vapor?

DR. LANGMUIR: No, the transport box. I presume the darkness indicates 100 per cent completion of a project?

MR. WILLIAMS: Yes. That would be 100 per cent--I think we're 100 per cent completed on these deliverables that we have in for FY 93. Those deliverables have come in for that component for FY 93, and then we will evaluate that with regard to the modeling effort. However, there are likely--I believe there are components for FY 94 that are out there.

DR. DOMENICO: Any other questions from the Board? Staff?

(No audible response.)

DR. DOMENICO: Well, Dr. Cantlon's kept us right on schedule here. It's a little after quarter to twelve. I would suggest we retire for lunch, and be back at one o'clock.

(Whereupon, a lunch recess was taken.)

AFTERNOON SESSION

1 p.m.

DR. DOMENICO: The first presenter for this afternoon's session will be Les Bradshaw from Nye County, discussing the Nye County/DOE cooperative drilling program.

MR. BRADSHAW: Thank you.

Nye County exercises an oversight function at Yucca Mountain under the Nuclear Waste Policy Act. This presentation is to familiarize the Board with Nye County's program, and to focus in on certain aspects of the program which we believe are pertinent to today's session.

The purposes of the presentation will be to present to you technical oversight information on the drilling component of Nye County's independent scientific investigation, and to describe somewhat the status of the Nye County talks with DOE regarding a coordinated or cooperative on-site drilling initiative.

I note to you that in the handout that we've provided, that there is additional information about other components of Nye County's program. We probably won't go through that here today, but a more full description of Nye County's oversight program, some additional information on the independent scientific investigation component of that program, and a discussion or highlighting of key site performance issues that Nye County is trying to address in its independent scientific investigation, and we advise you to look those over, and perhaps ask questions, but we will not try to cover them at this time.

The Nye County technical oversight program has a number of components. We have an on-site representation function which we are carrying out under the direction of a full-time on-site representative, who is a Nye County employee, and who works at Yucca Mountain a good deal of the time, and we appreciate the courtesies extended to us by the DOE in allowing access to DOE personnel and sites for our on-site representative, and we feel that this relationship is working out very well.

The reactive monitoring component of our program, which consists of document review and comment, and interaction with other regulatory and oversight agencies, such as this group today.

We also have a proactive independent scientific investigation, which we have underway and are gearing up in a major way this year, consisting of surface-base sampling and analysis, analysis and examination of DOE raw data, and doing drilling and data collection and analysis independent of DOE's activities. This component of our program will be the focus of our discussion here for these few minutes, the drilling program that we hope to carry out in cooperation with the Department of Energy.

It is important to note that because of limited resources of the oversight community, and especially the state of the affected units of local government, of which we are one of those, it is important to understand that we intend to coordinate our oversight efforts with other affected parties whenever that's efficient, and whenever it's possible and desirable to all involved.

As to the vadose zone drilling component of our independent scientific investigation, we have that as a component of our program for certain specific reasons, and the principal feature of this program is that it needs to address the costly drilling programs that are currently being undertaken by the Department of Energy at Yucca Mountain. The cost of that program will tend to limit the number of holes that will be drilled and completed, and it will limit the database that will ultimately be available for the licensing procedures, whenever those procedures start.

We believe that under the current drilling program at the DOE, that an insufficient three-dimensional model will be established for these very important geologic issues that are basic to the licensability of the site; soil gas circulation--and we've heard some comments about that today already, the nature and amount and the characteristics of water in the repository horizon, fracture flow and perched water, moisture content of the rocks, and isotope hydrology and hydrogeochemistry.

We believe that there could be an increased risk that model boundary conditions and expert judgment will be deficient or wrong; in other words, that there will be an insufficient database upon which to base a sound licensing decision because of the costs of doing the work in the way that the Department of Energy has presently outlined it.

We're suggesting that there would be an order of magnitude in cost savings per drillhole, using the method of drilling that Nye County would hope to be able to demonstrate through this cooperative drilling program.

Initially, Nye County desired to carry out a drilling program at sites that it had selected on its own, not particularly close to the repository block itself, but in a similar geologic environment in which it could demonstrate the drilling methods which would be more cost-effective and produce much of the same data that would be produced by the DOE program, using dual wall, reverse circulation methods, collecting cuttings, analyzing cuttings and water for moisture content, petrology, isotope geochemistry, and so on, in a controlled sample-collecting environment.

We are still considering the exact parameters of our quality assurance or sample management alternatives, but we do intend to make this data quality data, which would be useful for all purposes connected with Yucca Mountain.

The program would have a Westbay instrumentation package, which would be essentially existing technology, and would be used for down-hole continuous monitoring. Analytical support for this effort would be done by a network of qualified laboratories and qualified analytical scientists who would be under contract to Nye County through its independent scientific investigation manager.

We entered into informal discussions with the Department of Energy early this summer, and we're very hopeful that these talks can come to fruition. We informally explored a coordinated or cooperative effort in trying out this alternative drilling technology, and seeing if it would be useful to address some of the issues that are currently facing the Department of Energy in relation to project costs and the amount of data that can be collected with existing resources.

We have entered into what we would characterize, perhaps, as formal meetings with the Department of Energy. We've had several meetings, starting in about June of this summer. The program would consist of four Nye County drillholes. Three of those would be in conjunction with currently existing water table boreholes. A fourth hole, to be drilled later in this fiscal year, perhaps, would be a parallel hole at some future UZ borehole location that would be jointly decided between Nye County and the DOE.

The advantages to the Department of Energy would be that they would, of course, be able to see the benefits and results of this cooperative drilling using the reverse circulation technology. They would receive an improved 3-D aquifer parameter database to meet certain NRC concerns. In other words, they would have data that they could use to address certain issues that they have to address anyway.

For Nye County, we would be able to collect site-specific data for our own oversight purposes, and we would be able to conduct cross-borehole testing, so there would be advantages for both groups under this demonstration project.

We are currently still discussing these issues with the Department of Energy. We hope that these discussions will come to fruition, and that we will be able to carry this out. We believe it's important for the Department of Energy to work through these issues, to discuss them, to complete their internal discussions, and be able to respond back to us whether they're able to go forward or not under the cooperative borehole program.

We are, however, prepared to go forward with the sites that Nye County has identified that would be off-site, to be able to carry out and go forward with our independent oversight efforts.

This is a table or diagram indicating the relative kinds of data that can be collected and would be useful for both groups, using the method of drilling that Nye County is suggesting; that is, off the shelf, dual wall, reverse circulation drilling, with down-hole instrumentation using the Westbay instrumentation package, compared to the kinds of data that could be collected, that the Department of Energy is collecting itself with their dry core hole testing, or drilling.

One can see that the kinds of data that can be collected with each kind of drilling are, by and large (but certainly we're not saying 100 per cent), identical, but we are simply suggesting that for the extremely reduced cost of doing this kind of drilling, much useful data, comparable to data that could be obtained from the LM-300 drilling, could be obtained.

Naturally, we will never have a piece of core in our hands that we can look at and examine the way that you can a piece of dry core obtained from the LM-300 drilling, and the cuttings will never be useful for looking at fracture apertures, but for much of the other data that is being collected, the data would be very comparable and at a fraction of the cost, and we're suggesting that there may be an order of magnitude reduction in the costs of doing the reverse circulation, dual wall drilling versus the LM-300 drilling, and for the reduced costs, more holes could be put down, a better three-dimensional model could be constructed, and the data that would be obtained would be, by and large, very comparable.

In other words, the data that could not be collected using the dual wall drilling would be offset by the extremely cheap cost of doing that, and the increased data sets that could be collected.

This is a continuation of that diagram, where we are suggesting that these kinds of sampling could be just as well obtained from the Westbay down-hole instrumentation as from the installations that the DOE are putting down-hole in their own drilling program. Again, we are suggesting that the data that could be collected will be essentially of comparable value, but at a much reduced cost and, therefore, allowing a better three-dimensional model to be constructed.

We are currently in negotiations or in a series of discussions with the Department of Energy trying to implement or to craft between the two groups a protocol agreement which would set forth in some formal way the relative responsibilities and duties of the DOE and Nye County in the execution of this cooperative drilling program.

We already have with them a protocol for on-site representation, which allows Nye County access to timely information, to personnel, to activities, to sites, and to sample splits, and to raw, unpublished data. We hope to have in place a protocol for a coordinated on-site drilling initiative, which would define the relative roles of the two groups during this demonstration project.

There are issues such as the environmental liabilities. Can we draw a fair comparison of the costs between DOE's current methods and the way that they report their costs, and the costs that would be derived by this demonstration project?

We believe, and we are very hopeful that the differences can be resolved, and that we can ultimately enter into a formalized agreement with the Department of Energy to enter onto the site, or enter onto those defined drill sites, and go forward with the cooperative drilling program.

Timing is becoming an increasingly important factor in this issue. We understand that the Department of Energy needs to have sufficient time to work through its internal discussions, but Nye County is prepared to go forward with its other sites that it has already identified, which would be off-sites, in order to carry on with the demonstration project, because they would be in a similar geologic environment, and would accomplish much of the objectives of the demonstration, even if we went to the BLM sites that we have previously identified.

And that concludes my remarks on the cooperative drilling effort. I again refer you to the additional pages in the handout for additional details on the independent scientific investigation for information on other aspects of site characterization work that Nye County is going to address with its independent scientific investigation.

Thank you.

DR. DOMENICO: Thank you very much, Les.

Any Board questions?

DR. LANGMUIR: Langmuir; Board.

I don't believe you mentioned it, but I was wondering, I presume that what you discover and determine from your tests and studies would be available to DOE in the licensing process with NRC, or not; how would you handle that?

MR. BRADSHAW: That's correct.

DR. LANGMUIR: Suppose you got some information that they could use to defend the licensing effort?

MR. BRADSHAW: That's correct. The cooperative program would be just a completely free and open exchange of data. We would propose splitting samples at the wellhead, so to speak. They do with them what they want to do with them for their purposes, and we would do with them what we want for our purposes. Presumably, we would be doing parallel kinds of tests for data comparisons, but the idea would be strictly an open and free exchange of data between the two groups so that there is no hidden agenda with either side. Both programs--I'll speak for the Nye County program--would be completely described, the objectives, the methods, and so on, and as results were available, they would be freely made available to the Department of Energy, and we understand that they have--if we're able to go forward and come to fruition, they would have the same point of view, that they would share their data.

DR. DOMENICO: Domenico; Board.

You know, to be fair to DOE, I mean, the high cost of the program is due to demand for core, and that demand for core is the demand of the various PIs, so there's no doubt that this is going to be less expensive than the operation going on at the site now.

But the question I wanted to ask you is, I didn't realize Westbay was prepared or has been modified to take gas pressures. Is that off the shelf, or is that something new?

MR. BRADSHAW: And I'll refer that question, if you don't mind, sir, to Mr. Mifflin, who would be our scientific contractor, who would be formulating the makeup of that Westbay package, and he's right behind you.

MR. MIFFLIN: I think it's something new in the last year or so. About three or four years ago, they did not have that capability, and then early '93, when I talked with them, they can emplace the sensitive transducers for the gas pressure, for the barometric pressure measurement.

DR. DOMENICO: That's very good. Thank you.

Other Board questions?

DR. LANGMUIR: Langmuir; Board.

I was interested in the same question. I'm wondering if this technology is something that the DOE has thought about using in some of its holes as well, now that the technology's there, because it seems like such an appropriate technique. You can't answer that, perhaps, but maybe someone from DOE can.

MR. BRADSHAW: Perhaps it will be answered during the course of the day.

DR. LANGMUIR: Maybe so.

MR. DYER: This is Russ Dyer, DOE. Let's see, do we have anybody from GS that can address that? I was looking for Joe or Mike Chornack.

MR. CHORNACK: This is Mike Chornack, USGS.

When we first formulated our plans to instrument the deep UZ boreholes, at that time, the Westbay technology didn't exist for the ongoing in situ monitoring; and also, with our program, with installing thermocouple psychrometers to measure water potential, I'm not sure if Westbay can do that right now.

So, yeah, we had looked at the Westbay system when we did our G-Tunnel work, and at that time they did not have the multi-port monitoring system, so we went ahead and developed our own instrumentation packages. The big thing to point out is that we will have thermocouple psychrometers in place, and I don't believe Westbay can do that at this time, to measure water potential.

DR. DOMENICO: Domenico.

I think the point is, is the gas pressure. That was, I think, the advantage of Westbay. If this instrumentation is ready, it's a pretty novel approach in which to get it.

Are there any questions from the staff? John?

DR. CANTLON: Yeah, Cantlon; Board.

Since NRC, which is the primary oversight and licensing agency, isn't planning parallel scientific studies, but rather, plans to oversight DOE's own program, other than this particular demonstration of a cheaper drilling method, does Nye County really believe that it can, in a sense, duplicate the scientific studies? I don't quite see what it is you're achieving, other than the matter of demonstrating the lower cost drilling operation, and essentially pressing DOE for a rationale for why they couldn't substitute at least part of their drilling operation for the cheaper.

Could you straighten me out on that?

MR. BRADSHAW: Yes, thank you.

As I understand the question, Nye County, of course, is not attempting to do site characterization work. We believe that is strictly DOE's domain, and, in fact, the Nuclear Waste Policy Act stops short of allowing another entity to come in and do site characterization work.

Our independent scientific program is aimed at focusing independent scientific work on a few, very critical licensability issues having to do with the geologic parameters of the site, and the issue of having an adequate three-dimensional model impinges on the health and safety issues that concern the citizens of Nye County, and, of course, other people, also.

So we are very focused on a few, key critical issues. Of course, we don't intend to address all the issues. In fact, we would say that we couldn't do it, because of the limited resources, so a few critical issues that we believe that should be readdressed or re-looked at in light of, perhaps, new technology or just different methods that would be available that would give a cheaper and a better and a more dense database upon which to base the modeling.

We are afraid that, in the long run, that modeling will be overly relied on, and expert testimony to fill in the gaps--if you've ever been a prosecutor at a trial or been on a jury, the expert witness is the least credible aspect of the trial, and we believe that hard geologic data could be collected by altering the spending patterns and collecting a more dense three dimensional database that would make modeling better.

DR. DOMENICO: Thank you.

Any questions from the staff?

(No audible response.)

DR. DOMENICO: Thanks very much, Les.

Arch Girdley now is going to inform us a little bit on the status of testing activities in the field.

MR. GIRDLEY: Perhaps it's appropriate to state that what I'm going to tell you may not fit in perfectly with the style you have been hearing, it may be more of a travelogue. I might indicate that for the past several months, I represented Russ Dyer, more or less, out in the field, so as Susan Jones indicated, she showed the breakdown of how tests are planned, implemented, and their results evaluated. I fit into the picture in the middle box, with the field implementation, and that job, more or less, has to do with seeing that the requirements or the technical specifications that PIs have set for their tests are integrated with contractor work to prepare a trench, a borehole, or what have you, so that those tests can be carried out and meet the initial requirements.

The people that work with me, that monitor bringing all this together, never use the term "field test coordinator." They look at us as a dating service. There are so many different entities that have to come together to bring off any particular test, that there's quite an effort to coordinate all of that in the field.

DR. CANTLON: Could I interrupt just a moment? I take it we don't have a copy of your transparencies; is that correct?

MR. GIRDLEY: They're out of order.

DR. NORTH: They're two or three sections further ahead in your book.

MR. GIRDLEY: It is important that you do have them, because I'm going to speak from a map showing locations of activities, and not read off of the handout.

DR. CANTLON: Okay. Go ahead.

MR. GIRDLEY: Let me explain what the handout is meant to accomplish. Dennis Williams made a presentation in which he noted that there are a number of activities that relate to the SCP that are being worked on currently, or have been being worked on over the past several years or the past several months.

The tables that I've handed out for your information--I think there are four sheets--simply reiterate that, but the tables specifically address current status of what may be happening out in the field, so it's not my intention to go through these one-by-one. Rather, this one, by the way, is in the packet, but there is another map that I will relate to this, especially if I can make this work.

I use both maps because I thought maybe this one best portrays the real field situation. The other one's a diagrammatic. These are boreholes that are either in the process of being drilled or about to be drilled or have just been drilled, in which testing is going on, currently, and I arbitrarily picked the last fiscal quarter to collect this in.

Now, the table that I handed out will include some other things. Those other things are activities that go on all the time; geologic mapping is repetitive. It may change places, but it continues. Water table wells are monitored by the Survey continuously, and so on, and I'm only going to select those things that are current, where there's some current activity that isn't just a typical monitoring exercise.

So, now, if I may really speak from this sketch, we've completed six holes that are used for design, or the data from which are to be used in designing the north ramp, and the first of those is where the portal is currently located, so that hole's been wiped out, with the exception of a few feet at the bottom, which was plugged.

So, starting along the ramp figure here, they're NRG for north ramp geologic. Borehole 2V was just finished not long ago. There were three 2 holes drilled. The first one, the data were argumentative, if you will, poor recovery, unconsolidated material. We have a question. Is it unconsolidated because of the impact of drilling, or is there really an unconsolidated layer there? So, two offsets were drilled, and the last of which was called 2B, and even as a result of drilling it, there are still some unsettled questions, and there are plans being made for some additional exploratory boreholes, or perhaps trenches in the area just west of Exile Hill.

That's an area where there is a pocket of Rainier Mesa volcanic rocks that are largely air fall and ash fall, maybe some poorly-welded, and I would refer to a USGS person to answer that if we need to. In any case, further exploration is going to happen in this general vicinity.

3 is a completed hole. 4 is one that we just finished in the last quarter. It went to about 750 feet. All of the ramp holes, in their design, at least, were drilled approximately so that at least a couple hundred feet of core would be taken at ramp level, at planned ramp level.

We are currently starting NRG-7. The equipment's on the pad. We're waiting for a few signatures on a piece of paper, and we should start that hole probably tomorrow, is my guess. It's planned for about 1450 feet, again, to look at the rocks, the rock characteristics at some point here close to where this segment of north ramp would--excuse me, I'm sorry if I got on the old alignment here. This is the new concept for the main drift, and the extension of the north ramp coming into it, so this hole was located to check those rock characteristics where that turn would be made. I will try to stay in sequence here.

UZ-14, I think, has been adequately reported on by Dick Luckey, and the only thing I might say is that currently, I mean, as we speak, there are water level measurements being made and monitored, and will be for the next day or so.

As we come this way, UZ-7a has had some work-over on it. It's an old hole, but currently there's been some seismic profiling conducted at that location. SD-12 will be the first of the systemic drilling program boreholes, and, currently, we're building a pad and probably sometime late next month, or in early December, we would expect to drill this hole, and Chris, you might correct me, but I believe it's planned to about 300 feet below the water table, whatever that turns out to be, but in the 2,000-plus feet range.

Certainly, most of these holes are multipurpose, and I haven't alluded to that much in talking to you, but the way the table has been put together for your information, you can see that there are a number of activities that take place in various boreholes, and that's generally the case for most of them. It will certainly be the case for the SD hole, and I believe, even in NRG-7, that one is one, I think, may be considered for instrumentation for gas-phase work.

I think I mis-spoke about 7a, didn't I? Where's the USGS speaking up here? This is a planned hole coming up soon. WT-2 is where we recently did some geophysical testing.

At UZ-16, which has been drilled for some time, nevertheless, there's been a great deal of activity going on by the U.S. Geological Survey since its drilling. There's been considerable logging done, various logging, and I think Dennis will speak to that a little later. The USGS, I think, just completed at least a phase of gas-phase testing, and as soon as we get a stuck packer out, why, I think we'll go to air permeability testing.

Okay, that's the main borehole activity that is fairly recent, and I would just go to one other aspect of field work which may be somewhat out of context with a review of drilling things, but there is a lot of other work that goes on.

This map, Yucca Mountain, Crater Flat, Bare Mountain, Jackass Flats off in this direction.

DR. ALLEN: Arch, this is Clarence Allen.

What is the significance of the green line on those two maps?

MR. GIRDLEY: Okay. On this one, the green line depicts the so-called controlled area. Does someone want to give a formal definition? If a repository were built, everything inside that line is controlled access. Is that--

MR. DYER: This is Russ Dyer from DOE. Let me take a shot at that.

Whenever you look at the regulations in 40 CFR 191, the performance measure you look at is a release of radionuclides to the accessible environment, and the accessible environment is defined as an imaginary surface that surrounds the footprint of the repository, and that is our current concept of what the accessible environment, the boundary of the accessible environment would be.

MR. GIRDLEY: I'd just like to point out that a great deal of current field work does have to do with things other than drilling holes. There's a considerable amount of trenching and tests at excavations along faults, especially, I believe Quaternary faults. There are a series of trenches and test bits that have just recently been excavated along the Bare Mountain Fault, mostly to study the alluvial deposits against the fault and determine agents, and so on.

This complex pattern of dots here represents trenches and/or test pits along the Solitario Canyon Fault system, and, for instance, the main fault trace, I believe, is interpreted to be along like this, but there are splays mapped that I could only guess at how they would go, that are being studied at the same time, so that's more or less ongoing sort of work, too. It's a constant activity.

And I've saved one thing for last, because I know that it would please Alan Flint to have it said that, by golly, after an awful lot of hard work, we were able to finish drilling all of the shallow boreholes for the natural infiltration study, of which 24 were drilled in the past two years to supplement the, I guess, some 75 or 76, Alan, is that about it? So there's roughly a hundred boreholes now on and around the mountain for establishing moisture profiles and monitoring natural infiltration, so it's always sort of nice to, you know come to the end of some plan segment, and that's sort of our first one.

Any questions?

DR. DOMENICO: Questions from the Board?

I have one, Arch. Was it NRG-2 you said you encountered unconsolidated material?

MR. GIRDLEY: Yes. We've encountered in three holes, three that are fairly shallow--the deepest one, I think, is about 330 feet--adjacent to the trace of the Bow Ridge Fault, on the west side of Exile Hill, and all of the holes have been drilled to explore that because the north ramp is going to have to mine through it, and in each of those holes there's been some poor recovery in variable intervals, depending on which hole, that the outcome is kind of a handful of sand material.

What we were unable to determine so far is specifically whether or not it's real, it's really like that, or whether it's drilling-induced. Now, there's been all kinds of attempts to change the drilling technique and bits and so forth to try to get good samples, but, so far, those have failed.

DR. DOMENICO: How thick do you think that zone is?

MR. GIRDLEY: I don't know. A few tens of feet, but probably less; probably more than 10 to 20 feet. Dennis, do you want to address that?

MR. WILLIAMS: Dennis Williams here, DOE. I might be able to elaborate on that a little bit. We did have quite a little workshop on this particular issue yesterday, but we're looking at a zone that may be upwards on the 20 to 30-foot thickness. It's apparently poorly-consolidated material, and right now, we're looking at it being along a 250 linear feet of the tunnel drive after we get to Bow Ridge Fault, so that's where we have some of the boreholes in place.

We're evaluating the materials, doing grain-size analysis. The major consideration right now is the kind of stand-up time we're going to get from this material, but we're in the process of digging two trenches to try to encounter this material in situ so we can do more testing and make more observations on it. Likewise, we're talking about three small-diameter boreholes, where we can use soil-sampling techniques and get some good samples back of this material, so it is a bit of an undertaking. We'll be concentrating on that particular effort in the November-December time frame to try to provide design input for that part of the ramp.

DR. CORDING: Just a further question on that; Ed Cording.

That's 20 to 30 feet fit, normal to the bedding? Is that--

MR. WILLIAMS: Yes, that is correct. I looks like a conformable sequence in there of the lower part of the Rainier Mesa. Now, we did have one of the NTS people over yesterday talking about tunneling through the Rainier Mesa. In his experience, he hasn't seen any material in the Rainier Mesa that does not stand, and he's looked at, also, a variety of surface exposures of the Rainier Mesa around the test site, and most of those do tend to stand without any particular problems.

So, we have cored this with the ODEX system, which is a rather aggressive system for drilling, so we do have some concerns that we may have dis-aggregated the material such that we are not getting back intact specimens. So that's our major effort, is to try to get intact specimens of this material back from the subsurface, either through the trenching exercise on a 20 to 30-foot range, or the drilling down to a hundred foot.

DR. CORDING: So this is not a fault feature?

MR. WILLIAMS: This is not a fault feature specifically. It sets west of the fault in the hanging wall, but it's a down-drop block, because of the faulting on the Bow Ridge Fault. Perhaps, if this is an item of interest, we can bring over a cross-section and maybe have a little bit more discussion on that tomorrow.

DR. CORDING: Sure. Do you have core photos on this?

MR. WILLIAMS: Do we, Arch? I'd have to ask Arch.

MR. GIRDLEY: Yes.

MR. WILLIAMS: We have core photos?

MR. GIRDLEY: Yes.

DR. CORDING: It'd be interesting to see those at some point.

DR. DOMENICO: Any further questions from the Board? Don?

DR. LANGMUIR: We heard this morning from Dick Luckey about the 2.4 million gallons of drilling fluid that was lost, and you're showing a couple of sites there, which one is currently in operation, a drilling hole at NRG-7, and then two that are planned, one next to 7, one SD-9. It would seem that it would very reasonable to be looking in between UZ-14 and the block, now that you know you've got this drilling fluid problem, and try and catch where it's going.

Is that part of the planning? There's no hole suggested in between UZ-14 on the block or on the edge of the block.

MR. GIRDLEY: There aren't any currently planned holes that I'm aware of. On the other hand, we're certainly sensitive in drilling NRG-7, that that's something to look for.

DR. DOMENICO: Warner, did you have something?

DR. NORTH: Yes. I'd like to reiterate in a much more detailed way the question that I asked Susan Jones this morning.

This concerns the need for planning in the area of gaseous-phase movements in the unsaturated zone. You have in the first page in your handout package, which I don't think you showed on the slide, a summary of what's going on with respect to various study plans with regard to the field test activities.

The last one on the first page is 8.3.1.2.2.6, gaseous phase movement in the unsaturated zone, and I'm struck by the fact that we have three UZ boreholes there, drilled by the LM-300 at great expense, and a lot of new information with respect to the thermal loading issues, the convection of the gases, and the importance of that issue for understanding the repository performance, and it would seem to me that there are many more opportunities for getting such information.

We've heard from the State of Nevada and from Nye County, and my question is, what is the Department of Energy doing to reexamine that whole issue and see if the study plan is, in fact, appropriate, or if more should be done through other site field activities to get information on the gaseous phase movement?

MR. DYER: This is Russ Dyer from the Department of Energy.

Warner, the next talk that's coming up is going to address specifically those questions you have. That'd be Bob Craig's talk. It may be out of order in your package, but there should be a talk in there by Bob Craig of U.S. Geological Survey, who's going to address exactly the questions that you just posed.

DR. NORTH: Fine.

DR. DOMENICO: Does the staff have any questions? Apparently we have someone who has a question.

MR. FRIANT: I just want to add two cents to that. My name is Jim Friant, Colorado School of Mines.

Adding two cents to your comments on the core, myself and two other colleagues went out and looked at the cores very carefully, trying to figure that question out. The little pieces that were recovered are very, very rounded, and had obviously been tumbled, so we questioned about the type of equipment used.

I suppose if they had known they were going to get into some stuff that soft, they would have used a different core-catching technique, but, personally, we went away convinced that the ground was probably better than you would think it was if you were just going by per cent of core recovered.

Look at the pictures. You'll see that all the pieces that they did get are very rounded. They've been tumbled.

DR. DOMENICO: Thank you very much for that information.

Thank you very much, Arch.

The last speaker before the break, we're going to get back to pneumatic testing again, so Robert Craig from the USGS.

MR. CRAIG: My name is Bob Craig. I'm with the USGS. I guess after all the discussion this morning, and Russ Dyer just said maybe an alternative title, rather than Deputy TPO, to be Answer Man, I hope.

The title, there's been a fair amount of interest, somewhat starting with Carl Johnson's letter on behalf of the state to the NRC, with some concerns relative to the Yucca

Mountain Project not acquiring some needed pneumatic data prior to the ESF construction. There was also a letter from my boss, Larry Hayes, the USGS TPO, to DOE, at their request, that asked us to review kind of a draft position.

In that letter, Larry pretty much stated that on the technical issues contained in the letter from Carl Johnson, that the USGS was pretty much in agreement. We did have a concern that we needed to get this information, this pneumatic information prior to opening up the Topopah Springs level within the potential repository block.

Based on our discussions with DOE, and going back and looking into our study plans, but I'd make the case a lot of this was already in our study plans. But, anyway, in kind of a general plan, and as I'll develop this, the objectives, though, were certainly to obtain some pneumatic data prior to the ESF construction, but also to monitor the effects of the construction on its baseline conditions or this data set that we got prior to ESF construction, and then, certainly, to try to assess the impacts of the construction on the site conditions.

The data collection aspect of this pre-ESF construction pneumatic issue really is covered by three different study plans, primarily. This one, which is the characterization of the percolation in the unsaturated zone, our surface-based study. I've extracted just a few words out of the study plan that seemed germane to the issue in terms of objectives:

"Determine the in situ bulk-permeability and bulk-hydraulic properties of the unsaturated media; evaluate the in situ distribution of potential energy, temperature, pressure, water potential, the pneumatic and hydraulic properties of the conducting rock."

I might mention--and, fortunately, the meeting wasn't in Arlington or Virginia or some of the places you like to have them, because I was able to run back to my office at lunch time.

This particular study plan received a Phase I NRC review in March of '92, so it's relatively new. In fact, as you'll see, as I develop the other dates here, it is actually, in some ways, the oldest one of the study plans that I'll mention today.

The second study plan--and this is the one that Carl Johnson was mentioning this morning--the characterization of Yucca Mountain unsaturated zone gaseous-phase movement, or, simply, in shorthand terms, gas-phase study, again, just some words I've extracted from the study plan:

"Determine the near-field air conductivities, storativity, and anisotrophy nature of the units by flow, pressure, and gas-composition measurements; monitoring of gaseous-phase circulation with time, and flow profiles with depth, should provide data that can be used to determine bulk pneumatic conductivity by model calibration."

This particular study plan, Rev. 1 of it, was sent off to the NRC 10-7 of '93, so earlier this month. The revision does expand the study out from a limited nature that Carl, this morning, again, commented on; the UZ-6/6s, looking at the topographic effects on top of Yucca Mountain. Just quickly scanning it, there are words in there now that address a number of boreholes, and also a kind of all-encompassing statement: "This does not constrain this to these boreholes." So it certainly has expanded, and, as I said, this study plan went off to the NRC the first part of this month.

The third study plan that covers the data collection aspect of this is the hydrochemical characterization of the unsaturated zone. Again, a few words:

"Understand the gas-transport mechanism and provide evidence of gas-flow direction, flux, and travel time within the unsaturated zone; evaluate the effects of air introduced to the system, both natural or man-made, so that the study can provide valid results."

Rev. 1 of this particular study plan was transmitted to the NRC September 17th of this year. I'll talk a minute about the data we'd be collecting under this, and I think, generally, this pretty well agrees with what Carl had up this morning in his talk.

We're looking at pneumatic permeability. Gas chemistry is an indication of the travel and connectivity of the units; the in situ distribution of moisture, pressure, and temperature.

When you read the various study plans that I've mentioned already, they all point to one as being the primary study plan that will do something with this data that we've collected. That is the study plan for fluid flow in unsaturated, fractured rock. I might here mention that I'm not going to list it here, but it's Study Plan 8.3.1.2.2.8, which covers the site unsaturated zone modeling effort, will also use some of this data, and this study kind of feeds into the 2.2.9 study, also.

Again, words out of the study plan: "Models to help design and interpret hydrologic and pneumatic tests; provide information about model parameters that can be incorporated into site-scale models, again, in the site UZ study plan." This study plan, Rev. 0 received Phase I NRC, a look at it in January of this year. Rev. 1, the PI has made revisions based on comments as of the first of this month. so Rev. 1 is coming through the system, Rev. 0's already received NRC concurrence and Phase I review.

I'll talk a moment about some applicable methods and tests that are called out in these three study plans that cover the data collection, at any rate. I scrambled the order a little bit here that I gave you the study plans, and this really is how I go through it in my mind, that when we go to the field, we actually conduct the tests in the borehole in a general way.

This gas-phase circulation is the 2.2.6 study plan. Data collection involves flow survey. If you're aware of the work that Ed Weeks has done in the past, and we've continued with Charlie Peters and some of the other people in UZ-6 and 6s, looking at movement in and out of the borehole by flow surveys in the open borehole.

Looking at some selected gas chemistry; in particular, methane, carbon dioxide, at least in the UZ-6/6s location, they found some indications that in the Topopah Springs, below the bedded, non-welded unit, if I recall correctly, the methane is depleted, carbon dioxide is increased, and the concentration's relative to what you see in the fractured Tiva Canyon unit above the bedded unit, which, assumably, is in contact with the atmosphere, and you're getting some mixing in the Tiva Canyon unit.

Shut-in pressures, looking at barometric pressure effects in the borehole.

This is the 2.2.7 study plan, the unsaturated zone hydrochemistry. It kind of uses large-scale borehole gas sampling. This is where we're using packers, sealing off a number of zones, doing a broader spectrum of gas sampling and analysis than some of the more specialized, and there's a fair amount of integration. We have some of the same people using some of the same equipment doing these studies, so it's not just kind of a clear-cut dividing line between the two.

Also, under this is long-term periodic gas sampling. This part of this study really kind of falls in down here. After we've gone into a borehole, we've done some gas sampling with packer systems, we'll move that out--and as Arch was talking about in UZ-16, as soon as we can get a stuck packer out of the hole.

Under the 2.2.3 study, the surface-based percolation study, start doing some air permeability testing. Following that, we go on, stem the hole, instrument it for in situ long-term monitoring of moisture, pressure, and temperature. This instrumentation stemming process allows us to go back in periodically, over a period of years, get gas samples from isolated zones.

Just in going through the dry run of the presentation, somebody suggested I put up a simplified cartoon of what I'm really talking about, and this is very simplified. I operate on the KIS principle, that's for my own consumption, just keep it simple.

Generally, though, I'm talking about what's going on across this bedded unit between the Tiva and the Topopah Springs? Is it, as we think, relatively unfractured? Do we get a poor connection in our gas chemistry? We've seen at least a six, that suggests that there's a little movement, that we get atmospheric contamination or mixing in the Tiva, but we're not seeing that impact down on the Topopah Springs.

This would be an open borehole sort of configuration that we would do some of our gas-phase shut-in pressures in these zones. These are meant to represent packers. Also, in a similar vein, this is some of our hydrochemistry gas sampling. Our air permeability packer system will look similar. This arrow just indicates there's more testing going down in the bottom of the hole. Again, I said it was very simplified.

Finally, once we've run our packer systems in and out of the hole, gotten our gas chemistry, air permeability measurements, we'll go in at selected locations, put instrument packages that include thermocouple psychrometers, pressure transducers, thermistors for temperature measurements. We have air tubing to allow gas sampling from these intervals. The system is designed to allow for recalibration, and I'll speak a little bit more about it in a minute.

We do have some experience to date on obtaining similar information or data. We spoke to UZ-1 earlier, Dick Luckey did, in conjunction with the drilling and water that we've encountered at UZ-14. UZ-1, again, drilled about 1983, instrumented it in a manner similar to what we're planning on now, but what we found is some very good information out of UZ-1. It wasn't necessarily good site characterization information, but what we found with the process that we were using then is we had some real questions about instrument drift.

We weren't able, after a matter of a few years, to really tell whether we were getting information that indicated the system itself, the surrounding rock mass was changing, or, simply, our instruments were drifting. We tried to account for that as we've developed this further development of our instrumentation of gas sampling. We found, also, we have a problem in UZ-1, in that when we took this warm, moist air from depth, brought it to the surface, we were fairly certain we were getting condensation, which definitely affects your age determination based on isotopic age dating, so we've tried to account for that.

During the time the G-Tunnel was open, we were doing prototype testing in there. We got a couple of boreholes. One, as I recall, is as long as 150 feet in a horizontal direction. We went in with some new twists, thermocouple psychrometers. Instead of using a voltage method of measuring, we went to a current. It's generally just better instrumentation; actually used packer systems, but what we were able to see in there was very interesting.

You could go and look at the records. You could tell when they shut down the ventilation system over the weekends at G-Tunnel; found that one of the instrument stations that was deepest in the borehole or furthest from the drift, actually was seeing the pressure fronts, ventilation system kicking on and off much quicker than you were at the other stations closer to the drift; well, fracture systems nicely connected into that. Not surprising. It depends on where you're at and how well you're connected to a fracture system how some of these things get transmitted.

More recently, just outside the back of the Hydrologic Research Facility in Area 25, we put in a few auger holes; three of them, to be specific. It's right outside the calibration facility; put in the instruments, the gas sampling apparatus, tied it into the calibration facility system. It's in alluvium, it's not in fractured rock. With the demonstration instrumentation methods it's worked really well; tracked the wetting fronts from the storm systems, you can see the barometric pressure effects as the storm systems move through.

I have alluded to UZ-6/6s, under the 2.2.6 study plan, this has been an ongoing study for some time. We've seen topographic effects, barometric effects. I also want to mention at Apache Leap--and this is actually the NRC/University of Arizona site, very close to where DOE did their prototype drilling of Apache Leap--some existing boreholes, actually, angled boreholes there that some of our people went into, doing prototype testing, air-permeability prototype testing with pretty good results, so we do have a fair amount of experience to date, leading us up to what I feel is a fairly good position to go to the field and collect some information.

You've seen this, I think, a number of times already today in one form or another, and I think every one of us has a slightly different one. I've got extensions on it, some boreholes that weren't necessarily on others. Let me just kind of walk you through it. This is just more for your information.

First, I need to quickly mention, this is not meant to be all-encompassing of everything that we might do in the future relative to pneumatic testing. When I put this together, I was really focusing on FY 94, this current fiscal year. Some of these, like SRG-4, I'm not certain of the current drilling plan, if we'll get it in and instrumented necessarily in '94, but this is kind of a one-year look at what we're doing, what we're proposing to do.

NRG-2b, Arch mentioned. NRG-2, there's a 2a and a 2b. We may well end up going into both 2a and 2b, doing some limited gas-phase testing, and drilling these with the ODEX system, they typically leave casing in the hole. They're extracting the casing out of the hole, but leaving about ten feet in there to maintain surface casing, so they give us pretty good access to these.

NRG-4, 5, just down the ramp alignment, with the idea of going in and getting some shut-in pressure measurements, maybe some selective gas chemistry out of these prior to the TBM coming through; also, our plans are, as the TBM approaches, to be in there monitoring on somewhat of a constant basis, to see if we can pick up the impacts of the TBM, if any, TBM going through.

UE-25a #4 is a borehole that's been out there since about 1979, I would guess. We're going to use it to do some shut-in pressure measurements in conjunction with some work that we'll be also planning on doing in NRG-6.

UZ-14, and I might mention as I mention 14, we're, of course, still drilling it. Presumably, in the not too distant future, we'll complete the drilling there, get into our testing and instrument it. I think the interesting thing between this one, NRG-6 and UZ-14 is we'll have a chance to pick up some scale effects, because they are offset from the alignments, considerably, yet at a later date, after the project makes the loop around here with the TBM, planning on coming back, putting this extension which conveniently runs right up by UZ-14, so that we'll get a fair amount of good information as the TBM passes through here, see if there are any impacts, but then we'll also be able to have a good baseline of data, and then watch TBM or whatever other mechanism we use to come out and open this up come through.

Again, here at NRG-6, somewhat the same situation. I better admit, I might have this somewhat mis-located. It's probably a little closer in this direction, but generally the same idea, that it will give us scale impact. We have these that are very close to the alignment; NRG-6, UZ-14 that are somewhat further away.

Later, again, here, there will be a drift driven out to the Imbricate Fault zone or the broken zone. I might mention this is kind of where Arch got a little confused.

There's an existing borehole, UZ-7, that was drilled a good number of years ago. It's about 220-230 feet deep. It's deep enough to get through the bedded unit of the top of the Topopah Springs. We'd like to go into there, pull the casing, do some shut-in measurements and instrument it, again, looking for the impacts.

SD-12 in this multi-use nature of this project, and it certainly is. You have to, I don't want to say fight your way to get into the borehole, but stand in line occasionally, it seems. We will, after some other people get some other data for design and part of the systematic drilling program information, we will eventually get in there prior to the TBM coming through and instrument that borehole, also, and as we go down to the south end, SRG-4, there will assumably be a few other design holes, the south ramp geologic or geotechnical holes that we'll examine the usefulness, as we get further into the program, of those.

The next few overheads are a little busy, and I don't want to--it's more for your information. I don't want to spend a lot of time walking through each and every thing, but a couple of things I want to point out.

I mentioned UE-25a #4, shut-in pressures to overlap with NRG-6, that's primarily because we're going to instrument with a permanent instrumentation at Stations NRG-6, do a little bit of overlap, so this will continue the data record here in a #4.

Typical sequence for the shallower NRG holes along the ramp alignment--and some of these, by the way, don't necessarily at all go into the top of the Topopah Springs. Some of these, particularly the NRG-2b and probably 4, only go into the Tiva. We do feel there's some useful information to be collected in these boreholes, also, about pneumatic properties.

The kind of typical gas-phase testing flow surveys, selected gas chemistry, isolated gas chemistry and shut-in pressures, if we can get a packer system in there. It's round-robin with the seasons. You come in, typically, get the seasonal changes, make some measurements, see if the borehole is flowing in or out, and then, as the TBM approaches, continuous measurements. Same with 4 and 5.

6, a more complete suite of testing of the gas phase, the UZ hydrochemistry, and UZ percolation with air permeability and long-term monitoring, and periodic gas sampling for a number of years.

It's somewhat inconveniently separated as I go to the next one. As I go down to the next slide, I'll point out very quickly, kind of as a shorthand, consolidated couple of these steps here into--it'll just say gas-phase testing, such as under UZ-14 here, just kind of shorthand for the flow survey and the shut-in pressures and such. It's all pretty self-explanatory.

This, again, is just sort of an informational, a matrix, if you will, of how using the various wells that we have currently, or will have in the not too distant future available to us, and this is studies and, in this case, methods, which holes we're going to do what sort of testing in. Some of these, as you can note here, do require casing to be extracted so we can get access to the borehole walls.

Finally, in summary, we believe that the collection of pre- and concurrent ESF pneumatic, gas chemistry, and in situ moisture, pressure, and temperature data will be accomplished to account for the ESF impacts on site characterization efforts.

I guess, if you'll let me say one more thing--I have no more slides, but I'd just say this, and I meant to say it in starting off my talk. I'll probably say something that's uncharacteristic for the day, in that we actually have adequate funding to do this work.

Now, I'll quickly, before my boss grabs the microphone, say there are other areas in the program that we still need money.

DR. DOMENICO: Any questions from the Board? Don?

DR. LANGMUIR: Langmuir; Board.

I may have missed something here, but I didn't hear a word about monitoring gas flow in fractures, and, to me, that's where the action is going to be. You talk about boreholes, Bob, and you might hit a fracture, you might not.

Just looking at the gas phases in the matrix of the rock, to me, is kind of irrelevant. It's what you're going to intercept, perhaps, in a fracture zone and can block off and measure, or exceptionally could get in a borehole if you happen to hit a vertical fracture, which you won't, then you could pack it off. It's going to matter, and the matrix information is fairly irrelevant, I would think.

MR. CRAIG: You're absolutely right, Don, and maybe I over-emphasized, or simplified or something, but, certainly, as part of our testing process, you know, what we're looking at is identifying some of the fractured zones, where we're getting permeability, and, you know, with the packer system, we currently have an eight-packer system for doing gas sampling. We want to try and get some of these zones set up where you can get adequate gas samples out of the permeable zones. When you try and extract the air, assumably, that's where it's going to come from, unless you happen to catch a zone that's very tight. Then you're going to pull from the matrix.

Certainly, as part of the geophysical process, if you back up, we get a color TV camera running. There's a lot of places we'll be looking for this information and looking at the core, certainly, or other fracture zones, and will, both through the gas sampling, the air permeability testing, and some of these instrument stations, be looking at the permeable zones.

DR. LANGMUIR: It would seem to me that the best thing you could do, at least one of the more useful things you could do--and maybe it's a little after the fact--is as you hit fracture zones in the exploratory facility, you instrument those fracture zones and look at exactly what's coming into the system, perhaps early on in the tunneling activity. But that's, I would think, one of the more important things you might do to check pneumatic effects.

Is that in the study plan, that sort of a thing?

MR. CRAIG: Yeah, and I had meant to, and those of you--this is about the third time I've given this talk in various arenas. I've typically tried to remember to mention the study plan that covers our unsaturated zone testing in the Exploratory Studies Facility is the 2.2.4 study plan, and that's kind of the next step.

During this talk, I'm really trying to concentrate on the pre-ESF construction, but, certainly, as we get underground, part of our testing program is looking at, one, the impacts of the construction on our data, but also, you know, the permeability, how it's connected, how the fracture systems are connected to the various units. I can envision in some cases, depending on where we locate our alcoves and what we find underground, being able, conceivably, to do some cross-hole testing in some of these NRG-type holes and the underground facility.

There are a number of opportunities out there. They're kind of going to be as we see them and as things develop.

DR. DOMENICO: John?

DR. CANTLON: Yeah, John Cantlon.

Is it your position, Bob, that you've answered all of the questions that Carl raised this morning?

MR. CRAIG: I believe so. I didn't sit there and write them all down, but, certainly, I would welcome, if Carl feels I didn't--

DR. CANTLON: Yeah. I think this is an opportune time for Carl to now raise his questions, and let's get the discussion going.

DR. NORTH: Warner North; Board.

I'm surprised to hear you answer that way, because it strikes me, what you've told us is, yes, you can get data, you're going to implement study plans that were designed quite awhile ago and have been submitted back to NRC for review, but, to me, the issue is what data do you need?

Carl talked about the Ben Ross model. We've had much discussion in front of this Board about the various coupled thermal process models, such as the work of Tom Buscheck and colleagues. Is this data sufficient to answer the kinds of questions that are posed with those models? Are we missing a major opportunity by going ahead with the ESF in a way that's going to perturb some of these measurements, put in a new flow path for gaseous material?

Now, I don't really feel that you have answered those questions. You've told us about the data you're going to get, and very little about the data that is needed, and I don't think you can talk about what the data needs are without getting into the performance assessment and modeling activities, and asking those people what do they need to have in the way of information about gaseous flow.

Now, Don Langmuir's question addresses one obvious aspect, that it would appear that the flow through the fractures is the most important; and, therefore, maybe what you need to do is hunt for some fractures, and you might be much more effective doing that with non-vertical boreholes.

And then the next question I would ask is, how many boreholes might you need? If we're looking at a situation where there is large-scale circulation, how much information and what spacing of boreholes do you need in order to either validate or disprove some of these hypotheses that are out there? Now, they may be quite critical in terms of how this repository is going to perform, and I'm disappointed not to see that story laid out, and to hear you answer the question, "Yes, we've got enough data," because I don't think you've made your case.

I invite your response.

MR. DYER: Let me start here, Bob. This is Russ Dyer from DOE.

Certainly, we've had interactions with the performance assessment community, trying to identify their needs. Recently, we had a meeting with the state and the affected counties, and we committed to sit down with representatives from those organizations, go over the plans that we have currently in our program, find out whether those entities feel that they are adequate, get constructive feedback there.

Carl wasn't at the meeting, but I hope that Joe Stroman (phonetic) took the message back to him that that's a meeting that's coming up a little later this year, so we do not have a frozen testing program. I mean, we have, I think, a very dynamic and flexible program. We have made some changes to this particular activity. We think we have something that is adequate at this point in time, but we're going to continue to look at it and assess whether, in fact, it is adequate. We have to go through this iterative process time and again. I agree with you, Warner.

DR. NORTH: Yeah, I like your answer very much, but now let's see the iteration. Let's see it close so you can match the supply of data to the need for the data, and see if there's a balance. That's the piece that, so far, I'm unsatisfied that we haven't seen it yet. Maybe you have it. Perhaps it's coming in one of the next presentations.

MR. CRAIG: I guess the comment I would make, if I could, is one of our concerns is getting that baseline data set, if you will, before we do the ESF construction, and I think we are doing it through this process.

I guess the other comment I would make is our study plans aren't as out of date as it might seem; that some of this information that I just laid was in the original study plans, yeah, that we started developing a number of years ago. You know, I alluded to some of the revisions. Some of that actually is more cosmetic to address the fact, and we now have an Exploratory Studies Facility versus an Exploratory Shaft Facility, but I guess I'd make the case that our program was relatively well thought out. There were interactions early on with performance assessment.

I'm not going to stand here and tell you we have all the answers. That's certainly not the case, but I would make the case that it was fairly well-integrated, and fairly well thought out.

DR. NORTH: What you're saying is, trust me, we did it carefully, accept that we did it properly and it's still up to date, (and what I'm saying is from the layman's point of view because I'm not an earth scientist by background). I don't think you have made that case, and I think you have to go into a lot more detail with respect to the integrated aspects of the program in order to show that the data that you are collecting is going to be sufficient as a baseline to either validate or disprove various hypotheses that are out there, such as there is large-scale gas circulation; and, therefore, there is a relatively fast path that we ought to be very concerned about, and we may lose our ability to determine that by putting in the ESF on the plan schedule, which is what I interpret as the issue Nevada is raising, and it seems to me that's a very valid issue.

Maybe you can explain to your own satisfaction why, in fact, what you have is quite sufficient that, in fact, Nevada's concern is groundless. The point I'm making is, you haven't convinced me.

MR. CRAIG: Well, first of all, let me very quickly say just the opposite. The Survey did not say the State of Nevada's concerns were groundless. Just the very opposite. We said, in fact, we agreed with the technical aspects of Carl Johnson's letter. There were some regulatory things in there that we, at the Survey, did not address, and that's a programmatic concern of DOE's. From a technical standpoint, I think we were in very close agreement with Carl, and I don't think we're out of synch here.

I mean, within the framework of a 20-minute presentation on what are our plans, I mean, this is what you get. We could spend probably a day or more piecing together the integration nature of this program, and, you know, and in various arenas we've done that at various times.

DR. DOMENICO: I think we should go forward here

DR. NORTH: Let's let Carl speak for himself.

MR. JOHNSON: Carl Johnson, and I think I was originally called up here before Warner started talking, and I'm not certain I can do much better than what Warner has said at this point, but since I have the microphone, let me take a shot at it.

I believe where the problem lies is in the objectives. As I think everybody heard this morning, I basically stated that I thought the objectives of a pneumatic pathway study was to develop and confirm a pneumatic flow model for the undisturbed site, and basically, that gets to what Warner was talking about.

Is the Ross model, which is one of many models being proposed, is it valid or is it not? Now, what I heard Bob Craig just say is that the objective is to collect ESF, or collect temperature data to account for ESF impacts during site characterization. Now, that doesn't have anything to do with validating pneumatic pathway models, and I think there is a risk here in the path--and I use that phrase in another way--that the DOE is heading down here is if they do construct an ESF without first collecting the data to define what is an appropriate pneumatic pathway model, and they do find that there are some effects of the ESF, it will be too late, at that point, to collect the information for a pneumatic pathway model, because you've already disturbed the site.

DR. DOMENICO: This is Domenico.

Let's put that in the form of a question. I was going to raise the same point, that if you collect this information, and assumed you're not being disturbed by the ESF construction, do it before, do you have--is the program large enough, do you have enough information, or would you have enough information to come up with at least some preliminary ideas on the natural gas flow in that mountain today in the undisturbed state? Would you have that?

MR. CRAIG: My belief is yes. To some degree, we have some information today, without even doing this testing program. We don't have an adequate database, certainly, I wouldn't make that case, but we have some information. We have started some preliminary modeling through the development of our studies and stuff. I would make the case, yes.

Is it perfect? I'm not going to tell you it's perfect. You know, I couldn't define what's perfect in the sense of an adequate database.

DR. DOMENICO: Do you have any response to that, Carl?

MR. JOHNSON: Let me go at it a little bit differently, Pat.

I think, right now, the plan is to collect information in the boreholes of opportunity; i.e., the boreholes that are already drilled, but it does not get at, I think, the need to have a repository scale model and a repository scale database; i.e., spread out across the whole breadth and width of the repository itself. Having a few selected boreholes that have already been drilled down the middle and following the ESF does not produce, I think, adequate information that will allow one to evaluate the models that are out there.

DR. DOMENICO: I think Larry wanted to say something here.

MR. HAYES: Larry Hayes, USGS.

A lot of interesting discussion here, and pros and cons of do we know what we're doing, are we doing it right, are we doing enough to satisfy everyone's needs. I don't think we're going to answer it today. I don't think we're going to answer it until we do what I suggested we do in my letter to DOE, in which I generally supported Carl's concerns.

In that letter, I suggested to DOE--and I think Russ is giving it serious consideration--that the DOE and the technical participants in the state get together, really talk about our plans, what it is the Survey is going to do, not only in data collection, but we also have some modeling studies, Warner, where we're looking at some of those things you talked about. We need to get together. We need to see if what we're doing is collecting the kind of data that Carl feels we need to collect, and we need to talk about what we're going to do with those data. Are we really going to answer any questions? Are we just out there collecting data?

So I would suggest again to Russ that we give serious consideration to getting the right parties together and seeing if we're going down a road that, in the end, will give us what we need in order to satisfy the job is done.

DR. DOMENICO: With that, I'm going to declare a break. Ten minutes.

(Whereupon, a brief recess was taken.)

DR. DOMENICO: Can we give some serious thought to reconvening?

Moving along, we have two more presentations before the round-table. We're running a little bit late, but we're going to hear now from Christopher Rautman on the systematic drilling program update.

MR. RAUTMAN: Good afternoon. I'm Chris Rautman of Sandia National Laboratories. I'm going to speak today about the systematic drilling program, which is perhaps one of the lesser-known, and perhaps more misunderstood drilling programs at Yucca Mountain. I have a slide which is not in the presentation package, but it's a little outline. I thought it might be helpful.

I'm going to talk about what the purpose of the drilling program is, the SD program in specific. I'm going to show how it is tied to other surface-based testing programs, and to the underground exploration program, because it is tied to both. I'm going to try to get in a little bit about uncertainty assessment, and the evaluation of data adequacy, since I've heard several things about that this morning. How do we know when to say when?

I'll then review the current status and short-term planning for the next year on the SD program, and wrap up. Now, this is my first presentation to this Board, so I was not quite sure what to expect. I'd been led to believe that the Board wanted some discussion of issues related to core requirements. Apparently, there was a letter, or at least a memo that went out trying to deal with the idea of can we cut back on core requirements, what do we give up, what are the issues related to that, and so I have left a fair amount of time and have prepared a few slides that may be helpful in that regard.

Very, very simply, the purpose of the systematic drilling program is intended to be a primary source of subsurface data within the repository block itself. We are trying to acquire engineering information that can be used for the construction of the ESF and the eventual repository, if that should happen. We acquire information on the geometry of stratigraphic units, which fits into some of the work the U.S. Geological Survey is doing. We describe the lithology of the rocks. We obtain a great deal of information on rock characteristics, via sampling of the core and material properties testing in the laboratory. These are material properties.

The boreholes themselves also provide in situ test facilities, like SD-12 that we were just discussing here before the break. Because of the somewhat unusual location of this drilling program within the responsibility of Sandia Laboratories, it is more closely integrated with the PA and design analyses through the three-dimensional models of the site. The whole reason that this particular drilling program evolved was because of concerns expressed by the PA and design analysis community, and while I hope to show how the various drilling programs fit together into a unified whole, this one is perhaps more closely directed towards PA and the ultimate licensing arguments.

This is a map out of the study plan for the systematic drilling program. It's a little bit dated, because, at this point, when the Rev. 1 of the study plan went to the NRC in the early part of this year, we still had the original layout for the Exploratory Studies Facility. I've sketched on here in the purple line where the current version of the main test level would run.

My point in showing this is that if you count the holes within the footprint of the repository itself, they're virtually all SD holes, and there are virtually no other holes, other than SD holes, within the footprint of the repository; notable exceptions being UZ-2 and UZ-3, but this is the drilling program that it was music to my ears when I heard somebody wanting information on a site-scale repository-wide basis. This is the drilling program which can deliver that type of information if the appropriate testing activities are conducted within it.

In terms of ties to other site-based investigations programs, I would again emphasize, this program is focused on the site, as opposed to on a process. That's not mutually exclusive, it's complementary, but, again, as the map tried to indicate, we are focused on obtaining site-specific information. In fact, the actual title of the study is, "Acquisition of Site-Specific Subsurface Information."

It is a systematic complement to the feature of interest based drilling programs, such as the originally conceived UZ program in the site characterization plan, which consisted of holes in a number of very specific locations to test what the hydrologic effects of various types of geologic features were; the H series, the WT series, and in more recent years, the ramp holes.

The drillhole pattern was optimized and continues to be tweaked to provide coherent areal coverage and statistically valid; i.e., unbiased sample. We've revised the program several times. I mentioned that there's been a Rev. to the study plan that went in to the NRC earlier this year, to address the various types of design changes, specifically, when the soil and rock properties study kicked in with the ramp borehole sequence. Obviously, some of these holes took the place or would provide information that otherwise we thought we had had to provide for, so we readjusted our hole locations.

The realignment of the ESF main test level drift certainly has had a profound impact on the positions of holes and our current thinking about where we need areal coverage, how can we optimize the schedule to provide critical information, like the SD-12, pre-ESF construction monitoring site to the best advantage of the overall process, and that's what this NRC request is.

The SD program also provides a window of opportunity, which is not a particularly good phrase, because it sort of implies that things are optional. They're not, really, but there is an opportunity for approximately 10 or 12 other studies that have explicitly called out needs for sample materials or information from the systematic drilling program.

Among these--and I don't pretend to have the study plan numbers memorized--are the unsaturated zone percolation study of Alan Flint, UZ hydrochemistry, the Los Alamos mineralogy/petrology and chemistry of transport pathways. I don't want to read all of these, but there are these testing oriented-type programs, characterization programs which in one form or another have expressed a need or a desire to obtain samples and information in in situ test facilities through the holes provided by the systematic drilling program.

Separated by a slightly larger gap here are two other studies. One is called the 3-D geologic model being constructed, using the LYNX computer software system at the U.S. Geological Survey, and the 3-D rock characteristics models study, which if I take off my drilling program hat and put on my modeling hat, I also have responsibility for.

These two models together are sort of the mechanism and means by which we synthesize all sorts of site characterization data and put it into a coherent, at least self-consistent, if not correct framework from which the performance assessment people design analysts can turn the crank on our models and numerical rocks in their proper geometric form, dipping, faulted, offset, abutting, whatever, and come up with not only the licensing-type arguments about what is the pre-emplacement groundwater travel time, what are the cumulative radionuclide releases, but also evaluate data uncertainty, data adequacy. Do we have enough? Do we need to stop? Do we need to keep going?

Briefly, our ties to the underground exploration program. Well, I wasn't here for the dry run, so nobody brainwashed me as to what I can and cannot say, so I'm going to sneak this one in.

This is the one where first we're going to put in the mine, and then we'll find the ore body. Some of this information is a necessary prerequisite to the location of the Exploratory Study Facilities' workings. We need to know where are rocks suitable for construction, the back's going to stay up in the back, where is it not suitable. Those issues have not all been resolved. We think we have a pretty good idea, but I'm not sure that anybody is ready to proceed blindly with the construction of the ESF. Certainly, when we started constructing the ramp, or at least drilling the ramp holes, there were some surprises; witness the discussion of the non-welded Rainier Mesa and some of the pre-Rainier non-welded tuffs that we got into a few minutes ago.

The drilling program will provide areal coverage versus intensive detail in one relatively restricted horizon. It also provides vertical coverage from the surface through the Tiva Canyon, down to the Calico Hills, the primary barrier to waste migration, and to some of these Crater Flat tuffs, which will form part of the escape pathway of any contaminants migrating in the saturated path zone.

In fact, there is no single drilling program that addresses the exploration of the mineralogy/petrology of transport pathways. Los Alamos did not propose a separate drilling program, although I guess they now have one drillhole. They are planning to use information from this study, and, of course, from other studies that go deep.

There is also a relationship in that the systematic drilling program study plan contains plans for closely-spaced sampling in the ESF main test level and Calico Hills test level, specifically to address the issues of spatial correlation, spatial variability of material properties which are required for input to 3-D numerical rocks, if you will, that the design analyses and performance assessment analyses are based upon.

This I've already touched upon. We do provide samples to a number of programs which otherwise would have no sample material. The laboratory testing of mechanical properties and thermal properties studies, basically, their only interest is within the footprint of the actual repository. You remove the systematic drilling program, they basically have very, very limited data from which to do their testing and analyses.

I suppose I should sneak in a little bit of information here about uncertainty assessment, since that seems to be a big issue.

One of the approaches is what I'm referring to as stochastic images. You have a slightly different version of this in your handout. This is prettier in color, so I thought I'd throw it up anyway.

Basically, we always have this problem. You take a number of samples. They may be boreholes, they may be samples down a borehole, they may simply be boreholes plotted on a areal plan map, and you have to somehow fill in all this white space with information.

We're adopting an approach using geostatistics to try to address this uncertainty in terms of the performance parameter that's important, so we come down here, and what we're trying to do is generate a whole slew of these images which are consistent with the data. You cannot tell them apart from the data. They're three-dimensional, or two-dimensional, or one-dimensional, or whatever dimension model you want of the material properties.

You compute your flow code transfer function, and you end up with a distribution of groundwater travel time, say, that represents the uncertainty, which is all consistent with this data, and we're trying to bring that approach into very, very tightly integrated with the systematic drilling program, so that we know when to say when is enough.

Where are we today? Well, there's a study plan at the NRC. As I understand it, it has gone through their review process. Most of our technical procedures are approved. There are a couple that are still outstanding. We currently have a memorandum of understanding for joint hydrologic properties testing in place with the U.S. Geological Survey, the matrix properties portion of, what is it called, unsaturated zone percolation study.

SD-12 is scheduled to start sometime the first quarter of this fiscal year. The test planning package is in final review, although I have not seen the final copy. I understand the job package for the contractors is in preparation.

SD-9, up to the north, is scheduled sometime--last guess I heard was the second quarter of fiscal '94, and there is a work scope consolidation in process at this very moment.

Our schedule for release of information, we're trying to tie it very closely to the needs of the ESF designers; geologic logs, the preliminary rock properties testing, mechanical strength testing, the various design parameters that the designers have called for.

A quick summary, then: The systematic drilling program is focused on site-specific issues. It's necessary to complement this with a general understanding of what the process is that you're interested in; unsaturated flow, saturated flow, thermal loading of the repository, but we are specifically focused on the site itself.

We like to believe that it has a broad, integrated viewpoint, which is forced on us by the fact that there are multiple users for this site characterization data. This is not simply a drilling program for mechanical properties. It is not simply a drilling program for hydrologic properties. There are a great many users, and this has, perhaps more so than with some of the other programs, forced us to take an integrated viewpoint.

We're trying very strongly to develop this feedback tie to the ultimate users, design, PA analysis, and, again, we have an engineering orientation in addition to providing geologic framework.

Would the Board care to stop here, or should I go through some of the stuff that I had prepared on core requirements?

DR. DOMENICO: Please do, yes.

MR. RAUTMAN: Okay.

DR. NORTH: I think we'd be interested in hearing about the economics of this. Are we proposing to do this with the LM-300? Are we proposing to do it with something that's a lot cheaper? Do we have any problem with fluid getting into the repository block?

MR. RAUTMAN: Yes and no to all of those.

One point, and this, again, is, you know, the fairy tale that has gone on with Yucca Mountain for a long time. There were four LM-300 drill rigs, and it was still fairly tight. We currently have one LM-300 drill rig. The LM-300 drill rig is not a requirement that originates specifically and solely with the systematic drilling program as it was originally conceived.

It is required, as far as I know, that we do our drilling dry within the repository block; witness the 2.4 million gallons of drilling mud that went into G-1, so I don't think we want a repeat of that.

It is impossible to measure water content, water potential, initial saturations, that sort of stuff on core samples if you've drilled them with mud. So, in that respect, Alan Flint's program dies in the water, literally, if we put water in the holes.

Do we need 12¼-inch boreholes? No. We can work with small diameter core, like NRG-6, but then we do not have an in situ test facility suitable for running the detailed suite of geophysical logs, which people at the Survey--and I believe, also, at the project office--have come to convince themselves that, at least in many of the boreholes, are necessary. We cannot instrument the borehole, a la Joe Rousseau, with these instrument stations and down-hole stemming and all that sort of stuff. So, no, if you go with a smaller diameter borehole, you cannot instrument like that. This is where the requirement originally came for the 12¼-inch borehole.

Do we need as much core as we're taking? Well, do we need core in the first place? There was a presentation that talked about we can get, you know, there was a checklist, and basically--

MR. WILLIAMS: Excuse me, Chris, I'd like to make a comment, possibly, on behalf of Russ Dyer and the DOE.

MR. RAUTMAN: Certainly.

MR. WILLIAMS: Okay. Dennis Williams, DOE.

With regard to that question on whether or not everything is going to have to be drilled with the LM-300, I think we'll see when we get into the drilling part of this presentation that we are not drilling all the holes out there with an LM-300 drilling rig.

SD-9, we are going with a different type of rig. We won't be going with a large-diameter borehole, but I think we will also see that as we try to pack more and more information into each of these boreholes to include these large diameter instrumentation packages, that's a requirement that drives the large-diameter holes, but every place that we can get away from that, we are making every attempt to do that.

But, as I say, we will have more elaboration on this particular issue when we get into the next presentation.

MR. RAUTMAN: I've just sort of jotted down here some issues related to the issue of do we need core, which, as I understand, is one of the main reasons we're having this meeting.

The microstratigraphic zonation of the thick welded intervals--remember, Topopah Spring is a thousand-odd feet thick--we need something finer than that, unless it's a homogeneous mass, which, of course, it is not. The Survey, in the Scott & Bonk geologic map, which has been out since 1984-1985, has a zonation which is believed important to the three-dimensional geologic model of the site. This is what Rick Spengler and his crew, who are working on the 3-D geologic model, are focusing their effort on.

There is what we believe to be zonal control of hydrologic properties. What do I mean by that? Well, there are these different names that you can tag onto small pieces of rock, small intervals, some as small as 10 or 15 feet, some of which are several hundred feet thick.

The rock properties are different. This is simply porosity from the Topopah Spring caprock, the Topopah Spring rounded unit, which immediately underlies the caprock, the upper lithophysal, which underlies that, and then the lower lithophysal, simply as an example that for porosity and for properties correlated with porosity, and probably for a lot of other properties that we don't have data for right now. These are very definitely different in these different zones.

To contrast that, if you throw up the same data set, now sorted by geographic location, it basically looks the same. So, what we have from the surface transect work that has been done to date, is that these zones appear to be laterally continuous, and they definitely control the material properties.

Now, if, in fact, they absolutely control the material properties, all of a sudden, if you can figure out a way to identify those zones, you have a lot more information about the site than you actually have numbers on a page. You can say that this unit will go forever, and it has properties such and so.

The problem is, is that it is very difficult to identify the features that define these zones without core, and I'm going to pass around to the Board members, at least, a couple of little samples here. One is a piece of core which has some large vugs in it. These are the lithophysal cavities that form one of the primary distinguishments between TSW-1, which is supposedly not good for repository, and TSW-2 underneath it, which is; lithophysal cavities, and another little bottle of cuttings, and you simply cannot get the same types of information from the two samples.

I mean, this is sort of an exercise in the obvious, I guess, but you cannot understand fracture coatings, you cannot understand vapor-phase alteration, you cannot understand the presence or absence or quantities or form of lithophysal cavities in cuttings because it's nothing more than a chicken scratch, and so, it's the Survey's position--

I've checked with them--it's our position, having logged a lot of core out there from the north ramp holes, that critical features for identification of these zones require core.

In terms of the laboratory testing programs, a great deal of that information cannot be gathered indirectly unless that zonal control can be confirmed and documented, by which time we already have quite a bit of core. The state variables require core samples. Contrary to what was presented earlier this afternoon--I believe Alan Flint would back me up, that measuring moisture contents, matric potentials, that sort of thing on cuttings will not give you the same answer as it will on core. Whether it will give you an answer that's close enough, I'm not going to get into that argument, but you will get different numbers, absolutely.

The thermal and mechanical properties also require core samples. You can't put in a vise one of those little chips and squish it and get a number that is meaningful in terms of the rock strength.

Now, a number of months ago, a year or so ago, there were some comments about this so-called RAAX camera system. It's a fancified down-hole video camera which is involved with a lot of post-processing, and provides a very, very, very superior image of the borehole wall. It is possible that some of the zonation could be developed from

RAAX camera logs; however, the project does not have a camera. There is no service in this country that provides it. We would have to buy our own. That's about a half a million dollars, if I'm correct on that. I don't know.

Geophysical logs, again, there is information there. It is not sufficient for items like this, and for those state variables.

Some people have suggested cutting back on the quantity of core. There really is generally a lack of dollar or time savings from partial core within a hole, because you have to trip one string out, run another string in. You've just used up your time and your dollars.

There is also the issue of preciseness and accuracy versus the quality of information, and this gets into some stuff that perhaps we can discuss more at the round-table session if anybody is interested in it, but, in general, if you have less precise information, you may want more data points, because each data point gives you a little bit less stuff you have to try to confirm it. But the critical thing is: Are we asking the right questions?

If it is only important whether or not the hydraulic conductivity be above or below a certain value, you may attack the problem a different way than if you need to know exactly what the hydraulic conductivity is; ditto for thermal expansion, ditto for mechanical strength, ditto for practically any of the other material properties that go into the performance assessment and design models.

And the bottom line, basically, is that the flow through the PA and design analysis effort, and feedback early on is mandatory. The systematic drilling program study has provisions for that feedback loop to go on on a preliminary basis, even as we drill one hole after the other, and I guess I'll stop there.

DR. DOMENICO: Chris, you know, I have no doubt that you have variations in those properties like porosity and across the board there, but is really all that detail going to be used in a performance assessment analysis? I've seen several performance assessment analyses in these Board meetings. They have a one-dimensional model, a constant velocity system, tremendous uncertainty about the source release term. What the hell's the difference if the porosity varies over a couple of orders of magnitude when you've got that sort of mathematical model? Approach the problem in terms of meeting the release criteria.

I mean, is the detail going to be used? That's my question.

MR. RAUTMAN: I can't answer that. I guess my way to answer it is to turn the question back around. Is this Board, or is the NRC going to be convinced by one-dimensional steady state performance assessment analyses, such as we have all seen and read about, or are we going to have to have a more detailed understanding of flow, be it gas-phase or liquid-phase, within that mountain.

The other things is, even if the final license application-type thing ends up being a very, very simplified model because of all the factors, which you rightly pointed out, are very, very real issues, can we go forward into the licensing arena without detailed, three-dimensional computations as to how flow really goes from a bedded tuff into a fault zone, and then perhaps into or not into a welded tuff. Can you do it without having some detailed calculations, probably in three dimensions, for a very critical performance-related type problems, you know, the idea of water going from a unit into a fault. What is the effect? You can't work that out unless you have multi-dimensional type numerical rocks, and multi-dimensional performance analysis.

DR. DOMENICO: Well, that's probably a better question for the round table, but, you know, one more point is, there's a lot of hidden geologic detail in that mountain that's never going to be uncovered, and some of those questions are of that sort of order, I think, no matter how much you spend.

Do you have any questions from the Board? Ed?

DR. CORDING: Yes. One point on the unbiased sample. I think your vertical sampling is focusing on lithology, and it certainly isn't unbiased with respect to fracture distributions, because you're driving parallel, almost, to most fractured systems, so I think that when you talk about an overall flow model and being able to statistically evaluate that from such a vertical borehole program, it seems to me that, again, you're talking about lithology, but you're not able to talk about the distribution of the fracture systems.

And so, I mean, I think that, I mean, there's some specific purposes for vertical holes, but one has to realize what their limitations are, of course, in terms of the bias, and often, the lack of real good knowledge about where the faults are and how far off they are from your boreholes.

MR. RAUTMAN: The issue of vertical fractures being characterized by vertical boreholes is something I don't want to get on my high horse about, because I've squawked on it for eight years. It's very, very difficult, which is why, perhaps, you know, you picked on my emphasis on unbiased looked more than it should be used.

This is a complement to the horizontal-oriented study within the ESF; absolutely. This, by itself, is insufficient. Absolutely.

DR. CORDING: Sure.

MR. RAUTMAN: If you've got a way to drill to 2600 feet with an angle hole out there the way we have to drill, more power to you. I'd love to have it.

DR. CORDING: Well, I'm not saying you're going to get it all with angle holes, either.

MR. RAUTMAN: No.

DR. CORDING: You also have continuity issues, and you can't see those in boreholes. You can't see persistence of joints, and things like that as well as one would like to, you know.

I think one other point is that it just seems to me like we're locked--it's kind of like it's locked in. Well, we've got to have 12½ inches for the packages, we've got to have core, and then we've got to do it dry, and that's locked into a system that's been a very developmental system in the past, and it's now proceeding at rates that are difficult to achieve all the results, and does one need to put all these things together in one package? Are there other ways to do it? There's a lot of geophysical sampling that's done in holes a lot smaller than 12½-inch diameter to these and greater depths, and there's other systems for sampling that may not allow the same type of testing that's being done here, but just what other options are there?

I almost get the feeling like we're just saying, well, we're locked into this, this is the only way to go, you know. We've got a lot of good reasons why we need to be doing it, and there's no options, and it seems to me we need to be looking more at the options. Maybe we'll have more discussion on that later in the discussion period.

MR. RAUTMAN: I think that's a round-table issue, yeah.

As someone who, as I say, can take off the drilling hat and put on the modeling hat, I would always rather have more information at different locations than less information. My concern is that the option right now to cutting out a number of these SD or UZ or whatever holes, is that we end up trying to characterize and license Yucca Mountain based on, you know, three or four deep holes, period, and I'm not sure that that is going to fly.

MS. JONES: Jones; DOE.

I just wanted to point out that, as Dennis indicated earlier, he's the next speaker, and he's going to be addressing some of these very same points about the way we are trying to move away from a lock-step kind of drilling program, and customize each hole to the type of data that we need, and the drilling techniques.

DR. DOMENICO: Any other Board concerns, questions? Staff?

(No audible response.)

DR. DOMENICO: Fine. We'll get into our last presentation for the afternoon, a drilling program update by Dennis Williams again.

MR. WILLIAMS: I guess I'm here again, Dennis Williams, Chief of the Site Branch. This is the drilling program update. I think this was one that there was a lot of interest in. Jeanne Cooper-Nesbit started talking to me about this some four months ago, and we'll see if we can get through it. From looking at the size of the package, you probably think it's going to be a marathon presentation, and it might be.

(Laughter.)

MR. WILLIAMS: It's titled as the drilling program update, but I changed the title. More appropriately, I call it a borehole sampling, testing, and monitoring program. This presentation is about myths, facts, and data. We will eliminate the myths, state the facts, and present and discuss the data.

Our first myth is that this is a drilling program. It is not a myth. In fact, this is a testing and sampling program using a testing and sampling system. We are not drilling Yucca Mountain, we are testing and sampling Yucca Mountain.

The second myth: The LM-300 is an inefficient drilling platform. Jeanne's really cruising through these. The fact is, the LM-300 is an expensive testing and sampling system to acquire and operate; however, that particular rig cost is commensurate with its size and complexity.

Okay, now an overview of the real agenda, since I got that out of the way. We'll go through each and every one of these points with a variety of overheads, and there'll be opportunities for discussion as we go through them, or when we have the round-table afterwards.

Basically, the sampling and testing objectives, the LM-300 as a sampling and testing system, a little bit of the Yucca Mountain drilling development history, drilling progress from our most recent experiences, research and development emphasis on parts of the drilling, operation in FY94, system utilization, we'll get into some geophysical logging, we have a few things to say about that; our FY94 drill, test, completion and monitoring schedule. That'll put Bob Craig's pneumatic into context. We'll have some long-term considerations, and some specific questions and comments.

When this information started coming in from the Board on what we needed to talk about, we tried to put as much as we could as far as their questions and concerns in the context of this program, but there were some things that didn't quite fit, so what we ended up doing is just having, I think there's eight questions or concerns at the end. We'll go through those individually, and have some of our perspective noted on those.

Sampling and testing objectives. Basically, we haven't changed a whole lot from, I think, the presentation that Eul gave down in Texas in '92 to the Board, and that is to obtain core containing the in situ conditions of the mountain, and provide boreholes without disturbing the in situ, likewise, the in situ conditions of the mountain, so we're after the core, as Chris talked about, and we're after the testing that we do in the boreholes, but the only way that we have any reliability that this data is accurate is if we do not disturb those conditions in either the core or the borehole.

We have an issue of clean versus dirty boreholes. We go to a lot of effort, as you will see, to have a clean borehole. We have to do this because we want those in situ conditions; however, the testing that we do in those boreholes cannot detect contamination in those fractures, so if we dirty it up, we'll never know it, and we have no basis for evaluating the impact of that borehole wall for gas-phase testing if this system doesn't function correctly. So we put a lot of controls on the system to make sure that it's operating correctly all the time, and that, of course, relates to slowed progress, expense, but you've got to look at the value of the data that you are collecting.

The LM-300 as a sampling and testing system. I don't know whether this particular one came out in color in your set or not, but that's the LM-300 testing and sampling system overview shot. What we've done is identified various parts of that particular system. We have the air compressors that drive the circulation system, we have the air metering system, of course, the rig platform, our HQ core rods, our dual wall down here at No. 5. We have our sampling cyclone here, we have the vacuum system over here, which is the other part of the balanced air system, and, of course, we've got our drilling support sample management trailer out here, which does the logging, testing, some testing, and curation of the core before it goes on over to the sample management facility.

What's involved in each of these component parts? What we've done here is identified the study plans that are relevant to this whole operation, and tried to identify how each and every piece of the equipment that we have out there relates to a function of, or an activity in each of the study plans; unsaturated zone infiltration, Alan Flint's area, we've got the percolation in the unsaturated zone. Most of these things either refer back to a core requirement, a dry core requirement, or a borehole, an in situ borehole condition for gas-phase or other testing.

Likewise on this, just for interest, we applied all the permits that we have on this particular project and this system, this sampling system, all the various environmental permits from the air quality permit on the Cummings 600 horsepower diesel engines, dust control permits. We have permits on the sample collecting system, we have permits on the vacuum system. I mean, I think there's about ten permits; underground injection system over here on the air processing meter, so there's a lot of permits associated with running this system.

YMP drilling development history. As Eul probably pointed out to you in Texas, we have had quite a bit of development over the years; prototype development in '89 to '91 to the tune of about $6 million. That established the feasibility of our dual-wall system. It can be used in an unsaturated zone and get samples back. We acquired the LM-300 system, put it in the field in '92, again, around a $6 million price tag on that, to get started on a dual-wall unsaturated zone sampling system. We've got some enhancements to that system going on right now. One of them is the bit testing program.

In '91, we initiated the bit testing program, in large part, through the Colorado School of Mines. We compared Apache Leap and Yucca Mountain tuffs, and we developed some of the different bits that we were going to use on the program. In '92, we continued that program. We had a lot of interest from some of the major tool producers.

We initiated a vibratory core rod simulation study. We'll see a little bit later that as we start using these aggressive bits, like the PDCs, vibration becomes one of our major problems, and unlike the normal drilling operation where you're drilling with muds or polymers or whatever, here we've got air, so we don't have any dampening on this system, so aggressive bits, rapid progress, no damping, vibration becomes a major consideration.

In '93, we spent a half a million dollars, again working on the vibration system, developing a program that we can use out here in the field to watch vibration as we advance the penetration of a drillhole, and continued with our bit development program.

Drilling progress from our recent experience. The major diagram that we use to look at this, and the major comparison that we make is between the progress that we've had in UZ-16 and the progress we have had in UZ-14, and this has a couple of caveats I would like to point out. UZ-16 was the entire drillhole from start to finish. We finished up March 16th of 1993, and for comparison purposes, we used the information from UZ-14, which had drilling through July 26th of 1993. That put us at 1182 feet, right above the perched water zone that we've been testing on for two months.

The bottom line on shift rates, the feet per an eight-hour shift on UZ-16 averaged 9.1 feet per shift; on UZ-14, at that particular point in time, we were at 17.1 feet per shift. That equates to feet per hour of 1.13/2.14.

Some of the things, I think, that are very interesting in this--and we'll discuss it when we talk about coring and can we go faster, can we go slower--we were coring 15 per cent of the time in UZ-16, versus coring 10 per cent of the time in UZ-14, so we were coring less time and we were increasing our feet per shift throughout that exercise.

However, look at our fishing. Four per cent fishing time in 16; however, up to 12 per cent fishing in UZ-14, so maybe one of the things that we're doing is pushing this system faster and faster. We're getting better feet per shift, we're getting more feet per shift, but we're breaking a few things down.

One of the things we also don't see on this is the fact that we were doing 40-foot core runs out ahead of the cycle in this particular exercise. Now, we're in a position where we have to do 20 feet, we can only do 20 feet out in front of the reaming cycle, to try to maintain our deviation control.

The LM-300 in the dual-wall system does not have deviation control on the system, in total. If you start deviating the hole, you have to get very exotic about bringing the hole back to vertical, and if we get out too far, then we're not going to get the instrument packages in the ground. So we've lost everything that we've gained, so it's a real balance between drilling rapidly, keeping the machine from breaking down, keeping the hole straight, and getting the scientific part of the program together.

These are a couple of diagrams to show the progress a little bit differently. This is UZ-16. It shows the average depth in footage that we were achieving going down to, I think that was 1686, is where we finished up that particular borehole. Some of the geologic units that we went through, these are the daily rates of penetration, and then our average is sitting down here, and you see the average coming across and just being slightly below ten feet per shift, which is what we showed on the previous slide.

On this particular diagram, you don't see a whole lot of difference, really, in the formation having any effect on the drilling operation. We will see that on 14.

And 14, up to the time that we encountered the perched water, as of the middle of September, we were averaging right at 15 feet per shift. Core depth was 1282, and, in this case, we're starting to see more progress here, and my drilling engineers indicate to me that at this point, we are starting to see, really, the effect on the rock and the effect of our PDC bits actually penetrating the formation. So we're drilling fast enough that we can start seeing different components of the drilling operation affect our progress.

I threw these in just so you can understand a little bit better from a drilling perspective what we did with the perched water zone. We hit it in UZ-14. Phase 1 of cementing operation, this was in an area where we had water inflows at 1255 to 1271. Basically, we did an open-hole cementing program in that. We reduced the water from 60-plus gallons an hour to zero gallons per hour. We used a Halliburton "Micro Matrix" slurry to seal off the small fractures, and we feel that it was an effective control of that particular problem.

As we went a little bit deeper in the hole, we found another zone at 1275, 1276. Again, we had flows in there. We reduced those flows from three-plus gallons an hour down to zero gallons an hour; again, using the Halliburton "Micro Matrix" cement, and this was a little bit simpler design than the first one.

In the first exercise, we used the packer system to isolate the zone. Since we had the upper zone cemented off, then we could just put the cement down in the area that we were interested in, and close off the water flow in that area.

At this point, I'll show a couple of diagrams that aren't in your handout. When this issue came up early this morning, I had Roy bring over a couple of--Roy Long, he's my drilling engineer in DOE--to show a little bit of a cartoon of what we were doing in the Phase 1 cementing. We had the water inflows from the two zones down here. We set the packer. We pressure-injected cement into this area, released the packer, and then the remaining cement came up to this static water level, and sealed off the upper zone.

Based on our controls, working with Joe Rousseau, we had a limit of the maximum allowable height for cement contamination up at 1234. Basically, Joe told us we could sacrifice this area to get it sealed off, but he wanted to preserve the in situ conditions for the hole above that, so we were able to deal with that with the controls that we put on the system.

Down here in the mud at the bottom of the hole was the fracture that was missing. When we unloaded the hole, we found that fracture was producing water, and we went back with Phase 2 cementing operation, cemented that one off, and we know that we were effective because we run television cameras down the hole, we look at it and see whether or not we've done a good job.

We have extended the hole. We're down at 1422 right now. It's likely that while we were producing water down in the 1406-1407 range, we may have a Phase 3 cementing operation, but the objective when we hit the perched water is that we will test it, we will sample it, then we will seal it off, and then we will advance the hole down to the original target, which was the regional water table.

We can discuss these at more length in the round-table, if you would like, and then I've got copies of these, too.

A little bit of a comparison of what we've done in FY94 and FY93, and what we anticipate doing in FY94 with regard to drillholes on the various programs, and I refer to these as the UZ, unsaturated zone; the SD, Chris was talking about that earlier; the UZ neutron, Alan Flint's program; and the ramp holes, which are the design data programs.

I would also like to point out that we are using these rigs. I mean, there's five rigs here. It's not just an LM-300. We have a CME-550, CME-850, JOY-1, and Failing 1500 that we use on this program, and I think you'll be able to see a little bit on how that helps to balance out the costs of the total program.

FY92 is when we started UZ-16 with the LM-300. We had 800 feet on that hole that year. It cost us 635K just for direct drilling costs on that. That equates to right under $800 per foot, and my rule of thumb, it costs us $8,000 a shift to run the LM-300. That's $2 million a year. If you're making ten feet per shift, it's costing you 800 a foot. If you're making 20 feet per shift, it's costing you 400 a foot; and, likewise, if you're making 15 feet a shift, it's costing you $600 a foot. These other rigs cost you about half that, so what did we do in FY92? 800 feet with the LM-300. We've got almost 2500 feet of drilling here that we did with, largely, the CME-550.

The overall program, then, was 3192 feet, cost us $1.2 million direct. That equates to about $400 per foot.

FY93, we picked up on the LM-300. We finished up 16, we moved on to 14. We had 1280 feet out of UZ-14, and the cost for that year was at 15.91--or $1.591 million. Again, that's running about $800 a foot in that particular program. Down here on the UZ holes and the ramp holes, again, largely with the smaller rigs, less cost on that, but we picked up 52-5300 feet of drilling with those rigs, so twice as much footage was done with the smaller rigs than was done with the LM-300 in FY93. 7500 feet of drilling, $2.9 million, that's around $400 a foot.

What we're planning on doing in FY94--of course, we have certain holes that we have to do with the LM-300--finish up UZ-14, we'll move on to SD-12. SD-12 is an LM-300 hole because we're going 2300 feet, approximately. We have a variety of requirements in that borehole. We have the dry core requirement, we've got the large instrumentation packages, but, remember, the information that's coming out of this hole is going to a variety of programs, including the SD, the UZ, the ramp for the design data, that type of thing, so what we are trying to do in the future--and we'll discuss this considerably over time--is pack as much information as we possibly can into each and every one of these expensive boreholes that we will drill.

Down here on the ramp holes, we'll probably do about 2500 feet to the tune of about a half a million dollars. We'll try to drill out about 8,000 feet of drilling in FY94. We've targeted about $2.7 million on that. We're probably about a million dollars short, but like everybody else, we're short on dollars this year, and we're going to see what we can come up with.

Another part of the FY94 program in addition to all this drilling is a testing, completion, and monitoring program. We've got about five rig months worth of effort, at a cost of about a half a million dollars. This is when we go back into the boreholes and put the instrumentation in it, and we go in there and do geophysical logging and all these other things that I'll talk about in the next few minutes.

Research and development emphasis in FY94. The four main areas that we're going to be talking about is the Venturi feasibility, continuation of vibration analysis, deviation control simulator, and finishing up our core bit testing report.

The Venturi. One of the problems that we're dealing with getting deep in these dual-wall, reverse circulation, balanced air-type holes is the fact that you have to move the cuttings away from the bottom of the borehole. As you get deeper and deeper, this becomes more difficult, where you have your driving systems on the surface. You've got your compressor sitting up there putting air in, you've got your vacuum system on the other side pulling it out. At a certain point in time, it becomes quite difficult to keep that system going and lifting the cuttings and pulling them out of the whole, so one of the things that we have discussed and had some early success with, a prototype bit that acted as a Venturi right down at the bit face, and gave us more lifting power on moving the cuttings up the hole.

This could be essential to provide this balanced air system beyond 2,000 feet, and remember, again, the balanced air system is how we make sure that we keep a clean borehole. This kind of stuff is not readily available. Things like this, when we need them, we have to build them.

The vibration study, and if we get into heavy questions on this, I've got about three drilling engineers that are ready to answer questions on this part of it, because we are really out of my realm.

What they tell me that happens, as we hit critical rotation speeds, 70 to 80 rpm on this particular rig, and when we get certain bit weights--I think this one was done with 5,000-pound bit weight on it--with the air in the hole and the PDC bits, which are very aggressive bits, we start getting tremendous vibrations, and these vibrations start doing the harmonic thing up and down the drillhole, and after awhile, they hit the limit, the strength limit of the core rods. 1200 feet in UZ-16, we broke the core rods off, in large part, we feel, due to vibration.

So there are critical rotary speeds that play in this arena, and nobody really has done a lot of work in here, because nobody deals with the dry-drilling process the way we do. However, this is an area that we're going to have to look at very closely in order to keep the system going. That's all I'll say about it until the round-table, and then I'm going to get Roy up here.

Coring deviation control. Again, this just graphically displays the problem. Once we start moving off vertical, we have a very difficult time bringing it back. We did move off vertical a little bit in UZ-16, and we were able to pull it back with some very innovative activity on the drill rig, but dual-wall does not suit itself well to deviation control.

And the core bit performance comparison. I think Eul had this slide down in Texas. It showed what we could do with the PDCs versus the Carbonado, the improved Carbonado and the original Carbonado, so the PDC will give us rapid penetration rates under laboratory, and even under real live conditions out there in the field, but the system may not be able to handle some of those rapid penetration rates.

We've looked quite a bit at the data that we've collected from core bit performance; impregnated diamonds, Carbonados, PDCs. We look at Apache Leap, what we've done in the neutron boreholes, and these bits don't only apply to the work that we're doing with the LM-300, but all the rigs out there. Any time we're drilling in Yucca Mountain, we can use the PDCs, and they are performing quite well for us, and we look at the average rate of penetration and feet per hour that we're getting out of these bits in the drillholes that we've used them in. Again, the UZ-14 data is only through the first part of August, but you can see over here that the histogram on the average rate of penetration for the PDC in 14 is outstripping all the others by about double.

We've got a little histogram here on bit type versus footage drilled. We did have quite a bit of the use of the PDCs at UZ-16, and almost exclusively over here in UZ-14. However, because of other operational problems, we still were not able to get 16 over about 10 feet per shift, on an average, 9.1, over the duration of that particular drilling exercise.

One of the things that we've asked ourselves with regard to the technical quality of the program, we're drilling faster, we're using a more aggressive bit, are we losing core by doing this? We have compared the rock units of Topopah Springs, UZ-14 versus u-16. We tried to compare apples to apples, so we had this section represented in both boreholes; caprock, 99 per cent recovery. UZ-16, of course, was a slower penetration rate. We had 74 per cent. I think you'll see across the board that we are pretty close on most of the units on getting as good or better core recovery with our faster penetration rates on the PDCs than we did in 16.

System utilization. I think that's the slide that we missed up front as far as on the utilization of the drill rig, but that's okay. It had to do with efficiency. The LM-300 is an inefficient rig. It's not--well, we have no basis for determining efficiencies on this rig, because there's nothing to compare it to. We do know that we have a utilization problem. I'll show you a graph here that shows that we're running pretty close to 21 per cent utilization.

This is a little diagram that we put together as part of our planning exercise for the FY94 budget exercise. We just said: What could we do with the LM-300 if we start out to go forward with the drill, say, from the beginning of the fiscal year, until we're done with a typical 2,000-foot drillhole, to get some kind of an idea of what we could do and what our utilization would be, and this shows a shift schedule that's based on, at the optimum, on 24 hours a day, seven days a week, no holidays, obviously, you're going to get 100 per cent utilization.

Down here on what we're doing, eight hours a day, five days a week, we're only getting five shifts in per week. We've got an equipment utilization down here at 21 per cent. Of course, if you do different things, two shifts, five days, 24 hours a day, five days, 24 hours, seven days, you keep moving your utilization up. Again, that says nothing about efficiency. I don't think we'll ever be able to determine things about efficiency with this type of a system, but utilization is down here.

We have had a couple of periods where we've gone to double shifting on the LM-300. We've put a swing shift on. I think we've come pretty close to that type of utilization by doing that, and we have seen our feet-per-shift rates increase a little bit, too, by eliminating some down time and getting a little bit of competition between the drill crews.

Geophysical logging. There are quite a section, I think three or four view graphs in your package that talks about our FY93 geophysical accomplishments at Yucca Mountain. Geophysical borehole logging was one of them, and I might point out that this year, we were able to get quality geophysical borehole logs out of our operation out there. That's the first time that that's happened on Yucca Mountain. We have got a little--we got quite aggressive into moving into a variety of boreholes and doing geophysical logging. We're evaluating what we're getting out of those activities.

I'll show you a slide a little bit later on that has a comparison of the lithology to some of the logs that we took. They are a subset of the larger log presentations that we have at the back of the room on poster boards, so at your leisure, you can look at the full-sized ones at the back of the room.

Getting into some cross-hole seismic work in preparation for the VSP, I think that--well, some of us think the VSP is going to be a real helpful exercise out there in looking at the fractures as we move away from a borehole. And, of course, geophysics is more than just down-hole logging. We have seismic refraction that we're using a lot in the Quaternary program, and starting to use in the design data collection program. We've got a gravity and magnetics, we've got a geodetic leveling that's been going on for quite some time.

Seismic monitoring also fits in that particular category, with our continuous monitoring of the Southern Great Basin seismic net, and some of the experiments that we do out there whenever we have a non-proliferation type event that we had here about a month ago. And, of course, I mentioned the engineering geophysical tests on rock samples. That's part of our design data program, providing design for the ramps.

In '94, we're going to try to continue to be more aggressive with our geophysical borehole logging program as these holes become available, do the appropriate tests down-hole, bring that information back into the database, into our evaluation, and determine what we need to do as far as collecting additional data.

We do see things like this popping up, WT-2. That's a very old hole out there. We pulled the tubing out of that particular hole, did a variety of geophysical tests in it. Then we'll run the tubing back in. So, not only are we drilling new boreholes out there to get information, but we're trying to take advantage of a lot of the old holes that we have drilled in the past on the site to do things like geophysical logging, or monitoring, or anything that we can do in those particular holes.

And, of course, we have some more seismic reflection work planned, and, of course, the seismic monitoring. I have to continue to remind people of the seismic monitoring, because Tim Sullivan works for me. He's involved in that. We need that part of the action, too, but it also points out, again, the integration of the program. Not only are we concentrating on the boreholes and the geophysics in the boreholes, but we've got all these other programs, again, making those little wiring diagram ties back into that to give us the comprehensive data set that we need for evaluation of the block.

And I think that's the last one, geodetic leveling, and, again, the geophysical tests on the rock samples.

This is a subset of the geophysical logs that I was talking about. This is NRG-6. It had the resistivity and there's going to be people out there who are going to tell me, keep me straight on these; resistivity, the density. Let's see, I think we've got the gamma over there on the far side, probably the neutron on that one, and then being able to pick the lithologies based on those geophysical logs.

Of course, that's where we really would like to get to eventually, so that we have a real good geophysical control that will pick up these different lithologic units. That may be one step in reducing some of our drilling requirements out there on the mountain. We can go back into existing holes, do our geophysics, get the picks. That helps give us a framework for the mountain, helps us with our 3-D modeling, helps reduce the cost of the program.

And this is what came out of 16. Let's see, again, resistivity, I think density, and then density with a borehole gravimeter, and, again, my geophysicists are telling me that we're getting a one-to-one correlation between the density in the borehole gravimeter. If that works out pretty good, maybe we can reduce the number of borehole gravimeter runs that we make on the mountain, and each one of those costs about $35,000, so every time we have a minor breakthrough like this, that might equate to $20-30,000 in that part of the program, but this all adds up, and we can put the money into something else.

Okay. Our FY94 drilling, testing, completion and monitoring schedule, and you've got some schedules in your books. I think some of them are in color. This is a subset of what will be in the PACS schedule. We've got some large-sized ones at the back of the room. I want to go through it a little bit, in a little bit of detail. The colors are the most important parts and the pieces that I'll point out to you.

It's a PRIMAVERA output. That's because it was convenient. We developed this as part of our planning for the FY94 program. Over here on the side, you've got your typical start dates and early finish dates and durations for each of the activities on here.

Let me grab one more of them, and I'll do kind of a--to see how some of the pieces start fitting together. There's four of them, and they really--they're compatible, and they fit on the chart, one, two, three, four, and the time frame--I'll be at the time frame over here, stand back, but the end of '93, FY94, into '95, and we even go out to the end of--or start in the beginning of '96, and what we've tried to do, well, we've called it the drilling, the testing, completion and monitoring schedule. We have tried to put on one schedule everything that we're going to do with regard to our drilling and testing program. That means preparing the pad, drilling the boreholes, doing the completion testing on the borehole. If there's any long-term monitoring instrumentation packages that are required in the borehole, getting those in, and then going into a monitoring program and starting the clock ticking on our monitoring program and looking at the duration of monitoring that we have before the TBM goes by the location. This was an issue that came out in our discussions with Bob Craig with Geological Survey on how long we can have some of these instrument packages in the ground to establish the baseline before the TBM goes by the location.

I don't even imply to say that that tells us whether or not we have enough data after we've done that. All I'm showing you is when the package goes in the ground and when we think the TBM is going to go by that location. We have got our best assumptions from the TBM drivers on when they feel, based on their excavation rates, when they will come by the location and they basically have told us a 40 foot penetration in the early part of the program--a 40 foot per week penetration in the early part of the program and then getting up to 350 feet per week and 400 feet per week on their penetration rates. So, this tries to tie the design, the excavation into the program.

Some of the items that we have on here is our gas-phase testing in some of those ramp boreholes that Bob talked about, NRG-2b; we've got NRG-4, NRG-5. They basically have a testing exercise in here, three phases shown and then the TBM going by out here in the out months up to--well, here, on NRG-5, we're talking April of '95 is when the TBM goes by the location. UZ-16, we're in gas-phase testing right now. Arch mentioned that, that we're pulling out the final trapped packer and then we'll get into some air testing. Part of the schedule that has the completion, will show us putting other instrumentation--or, no, this one is instrumented for VSP. So, UZ-16, then, is instrumented for VSP and it really sits outside of this gas-phase testing. 4a has some long-term monitoring associated with it. We'll be monitoring on that in conjunction with NRG-6, get the packer instrumentation in there and then start our long-term monitoring here in the June of '94 time frame and the TBM goes by some nine to 10 months later in April of '95. However, from remembering the cartoon that showed the location of NRG-6, it's about 2,000 feet off of the alignment. So, we'll make that loop first and then come back and actually go very close to the location when we do the drift out to the east end of the fault zone. But, each and every one of our activities is represented in this schedule and tied into engineering data that goes into the design data collection part of the program.

Completion schedules, when we had the drill crews that will come in and actually drill the hole and then they'll come back in and do the completion, the stemming and the instrumentation, set up on a three crew basis. All the drillholes are represented on this particular schedule and the geophysical logging. We also have on the schedule in more of a sequence, we have our cooperative exercises with Nye County on the holes that they're going to be drilling. Down here at the bottom of the schedule, we have the ESF testing, the development of our alcoves, the tests that we do in the alcoves, and of course, the starts of our ramp construction, the Bow Ridge contact, and the hydrologic properties of major fault tests; the first one, of course, is that geochemical borehole as an element of that test.

Long term, I think you saw this one. Russ had a color version of it. If we base it on the assumption we will still do 40 deep boreholes at approximately 2500 feet per hole, 100,000 foot core program. One crew drilling 3500 feet of core per year, assuming 250 work days, five days a week, 50 weeks at 14 feet per crew, if we do that on a one crew basis, it's going to take you 29 years to do the work at about $151 million. That's $5.3 million a year for that crew. Now, that is not direct drill costs. The direct drill costs are about half of that. By the time you load everything else onto those costs. you've doubled it. When I talked earlier about $400 per foot, those types of numbers, $800 a foot, that's direct drilling costs. That's not loading everything else that's in the system. Once you do that, you've doubled it.

Run the rig around the clock for 7.1 years, you'll get this coring out. I don't know whether the LM-300 can take that or not, but possibly a more rational approach would be to go to two rigs on a five year program. But, I'm not one to get in wrapped up in funding issues, but this very definitely is a funding related issue.

Now, I'd like to get into the specific questions and comments phase. One of them that we pulled out of the set of questions that we had from the Board regarded the large diameter holes versus the small diameter holes. We offer these considerations. One of our major objectives is to preserve the in situ borehole wall conditions. We use a dual-wall reverse circulation system to do that. That works well in our nominally 12-1/2 inch diameter borehole. Whether or not we could achieve that in a smaller dual-wall reverse circulation borehole is in the realm of possibilities.

However, we require the larger diameter holes for those borehole instrumentation packages. When you're putting multiple instrumentation in a borehole that's going down to 2300 feet, you want some room to work in. And, we are--of a 12-1/2 out there right now.

Small diameter holes are being used where feasible. NRG-7 ramp hole that is a dry hole, has dry core, is a smaller diameter hole. SD-9 will be a smaller diameter hole. Where we have to get into these types of situations, though, the way we see it at this point in time is a larger diameter hole.

The drilling/testing decision-making process, I didn't quite know about the origin of this type of a comment, but one of the things that we do in that process is a work-scope consolidation that we have put in effect looks at a borehole and tries to combine as many requirements as we can into one borehole with the possibility of eliminating boreholes or testing out of the rest of the suite of work that we're going to do out there. SD-12 and MDG-2 is an example of this. When we changed the ESF configuration to that north/south alignment, there was a need for a borehole on there for design data purposes which was originally titled MDG-2. We saw the proximity of SD-12 to that particular borehole. Well, discussions with the PIs, we put out heads together and said, hey, could we combine the requirements of both of those programs and possibly other programs, the UZ program, in one borehole and send it down to 2300 feet and satisfy all the collective objectives of the program? Well, that's what we've done with that one. SD-12 will be going in in probably a matter of five to six weeks.

The borehole catalog incorporates the results of our drilling-consolidation workshop. I think that went out to a variety of people including the Board here within the last month or so. What we've done is try to combine testing in a variety of boreholes. Of course, it wasn't updated to include some of these more recent developments, but I think the next slide will show that we have reduced coring requirements by about 25,000 feet.

Who are the organizations that make the decisions? DOE, M&O, and the participants. And, these work-scope consolidation processes, everybody has a voice. Everybody gets in on the decision on what we're going to do. In the end, DOE might have to make a hard call on what we're doing and Bob Craig and others might have to stand in line to get into the borehole to get the information for their tests. But, we try to establish a hierarchy of the needs of that particular borehole and make sure that the primary objectives are satisfied and then the subsidiary objectives are satisfied as we move down that hierarchy.

Intermittent versus continuous core, I couldn't have had a better presentation on that than Chris did earlier on the need for the core and in many cases the need for continuous core. We have a tremendous need for core samples, especially now in the early part of the program. We get to the point where we have a lot of allocation before the hole is even put in, allocation of the various PIs on core. Our drilling-consolidation workshop reduced it 30,000 to 38,000. Of course, those numbers, we'll see how valid they are as the program develops.

And, I'd like to mention some of our experience in the Topopah with regard to non-coring parts of the exercise. NRG-5, which was a ramp hole, we had a lot of discussion with the designers on whether or not we needed to core the entire hole. Well, we decided that we would only core the portion of the hole that was close to the ramp when it came through on a 6.9% grade. Well, we cored the hole and then, not too long after that, the ramp was flattened out to 2%. Where do you think we started coring? We started coring below the 2% grade ramp. So, that didn't help us out a whole lot. Likewise, when we got down into the Topopah, we're coring down into the Topopah and then we get into this--I call it the nondescript area of the Topopah where the contacts are very difficult to distinguish. Now, the geophysical logging may help us out, but at that point in time, our geologists had a terrible time figuring out where they were at in the 600 to 900 foot section of that particular borehole because they didn't have any contacts above them. They didn't have any good vitrophere contacts below them. So, what did we do? We extended an 1100 foot hole down to 1350 feet to find out where we were at.

Sometimes, you go into these exercises, you think you're doing well, but in the end you don't save a whole lot of money.

Need for dry-drilled core, I think we've had a lot of comments on that. That's what we're looking at the unsaturated zone for. We have a hard time dealing with samples that aren't dry to evaluate unsaturated zone when it should be dry-drilling. And, two of the major study plans that that relates back to are the surface-based perc and the ESF-based perc, 2.2.3 and 2.2.4. So, you've got to have the dry core and you've got to have the uncontaminated walls. If somebody tells me something different in a programmatic sense, I'll modify the program.

Contacting options, this had to do with, I think, the REECo as the contractor for our drilling out there. REECo is the M&O for that part of the program. They're responsible for the drilling and construction. We had occasion in ramp-up areas where were moving very quickly and REECo didn't have a capability. They would go over to the test site and get a different rig, the BIR 800 on JF-3 is an example of that, and if we have other areas where they may not have a particular rig or a particular capability, then they will do subcontracting for us to get that capability. But, it is my understanding at this point in time that that's a non-negotiable position.

Borehole testing from within the ESF to try to eliminate drilling through that upper 1,000 feet that we're drilling through with a lot of our major boreholes on the program. Some of the considerations that I would offer is the nominal 25 foot diameter size of your opening. Of course, you can always enlarge that out to get something of a larger drill rig configuration underground. But, dry-drilling underground you would have dust control considerations. Your ventilation system may not be able to handle it. And, of course, you would be looking at all electric power requirements.

Also, we run into this particular regulation on creating the direct pathways from the repository level to a primary barrier which is your Calico Hills, 10 CFR 60.15. Now, that doesn't specifically preclude us from doing that, but I think the words are to the extent practicable don't do these things. And, of course, we tacked on requirements that would--we would have to go through a lot of evaluation in order to do that. I'm not saying that it can't be done, but there are concerns.

New core tools could have a substantial positive impact on core production. Well, on UZ-14, we've increased our coring rate from 7.34 to 21.4 feet per hour which led to nearly doubling our shift rate from 9 to 17. But, as we have pointed out, faster penetrations with these aggressive bits puts greater vibration on the core string. We end up breaking more equipment, we end up fishing more. Of course, we are looking at how to strengthen that equipment and how to control our vibration. Faster vibration, of course, leads to more fishing time which is an outcome of some of these problems. And, coring was 10% of our time component in UZ-14.

So, even if we made major improvements in that particular arena, we aren't talking about a very large percentage of the total time that we spend at that testing and sampling system, the drill rig.

Emphasize testing in the ESF versus the surface-based testing program. I think a couple of considerations that fit into this and there are people in the crowd that are more emminently capable of providing the language on this, but from my point of view, ESF is primarily directed at specific targets and lateral variability of key horizons, the proposed repository level, and the Calico Hills. Surface-based testing is a whole-block framework and I think that rolls right back into some of the things that Chris was saying earlier about that part of his program.

That's all I have to offer.

DR. DOMENICO: Well, thank you, Dennis.

Any questions from the Board?

DR. CORDING: Comment 6 was regarding the underground--I guess, it was underground testing. It says borehole testing from within ESF. There are plans for dry drilling underground, is that correct?

MR. WILLIAMS: Yes. The dry drilling that we're planning on doing right now, I think, in large part, has to do with the radial borehole testing, that's one. They will be basically horizontal or low angle holes that go out on the order of magnitude of a couple hundred to three hundred feet, those types of things. The way I understood this particular part of the comment was we were looking at, say, setting up and vertically going from the ESF down into the Calico Hills or lower.

DR. CORDING: I don't know whether that was the intent of that, but it seems to me that there's a lot of information and that one is going to need to look across major features, such as the--well, particularly the faults and looking at the variability across those from the fault out away from it. That's where a lot of the action is going to be in terms of characterizing the conditions underground. And, that type of information can--I think, would be best obtained from sampling across those features. Certainly, when one is looking at general lithologic characteristics, you're looking--you know, you're looking at the vertical, but if one is trying to sample across faults, then that's where I think a lot of that emphasis should be, you know, from platforms within the facility.

I guess, one question is is there some opportunity there to do more now that we have more access underground to do more of that sort of thing and does that allow you to adjust, you know, the surface-based portion of the effort?

MR. WILLIAMS: Okay. Ned will elaborate considerably on those points in tomorrow's presentation. But, with regard to the faulting and the testing of the major faults, right now, we have basically a two alcove configuration. From that two alcove configuration, we will be going with an alcove parallel to the major faults and then drilling holes back perpendicular across those fault zones. That's all from the underground. Likewise, on an alcove that will sit out at the end of the fault where the fault was encountered in the main drift, the main TBM drift, a small alcove there, and then drilling relatively long, if you will, for underground boreholes, 200, 300, 400 feet range, parallel to the fault. So, again, all this type of activity will be going on underground in the program that we have right now.

DR. CORDING: Well, I guess one of the things is there's obviously--when one does more in one area, there's possibilities of doing--you know, considering tradeoffs and I guess, are there some tradeoffs on being able to reduce one part of the program by the increased information you're getting from another? I guess that's the point.

MR. WILLIAMS: And, I think that that's a real possibility, but I don't think that we will be able to explore the details of that until the program starts maturing. The Bow Ridge will be the first fault that we hit underground. At the point that we will put those alcoves in and start the testing on that, we can look at that information and how that satisfies some of our data needs and then how that would relate to the surface-based part of the program. Now, one of the things that we're doing, of course, from the surface-based part of the program, we're doing a lot of fault mapping out there of the fracture characteristics. We've got a variety of pavements that we've cleared on the mountain to get details of fractures. We have one on the Ghost Dance Fault I showed a picture of earlier of what we're doing with regard to that particular feature. That's part of the surface-based program which emphasizes mapping more than it emphasizes drilling.

MR. DYER: Let me take a shot at this. Of course, our current drilling program has two components to it; a features-based component and a systematic component. And, one of the attractive features of the proposed modification to the ESF would give us a main drift that essentially parallels the Ghost Dance. We could essentially go into the Ghost Dance virtually any place we wanted to. I am not aware of that many features-based holes that that testing program could replace. Now, whenever we get on the west side of the block, over on the Solitario Canyon Fault, the north and south extension of the ESF or the north and south ramp, it will behoove us to look at the possibility that perhaps some of the surface-based holes we haven't a program right now to look at features over on the Solitario Canyon, we will explore the possibility that those might be addressed through some testing program within the extensions.

MR. DOMENICO: At this time, the program calls for a round-table discussion and this is the only table that's almost round. So, with our Chairman's permission, I'm going to have to ask the Board to sort of take a seat and ask all the presenters to come on up.

At this time, I'd also like to add that any questions are open to anybody. If anybody out there has any questions of anything you've heard today, please come up to the microphone, identify yourself, and address the person whom you would like to get an answer from.

Do we have any other presenters out there that would like to come up and sit at the table?

(No response.)

DR. DOMENICO: Like I said, this will be opened up to anybody out there. If there's any particular questions, just address the person that you want to address that question.

Let me start out. We've had a lot of discussions today. Leon Reiter mentioned something to me and let me just throw it out. I don't know how many drillholes we've got in and around that mountain, but who is to say that the gas flow distribution is not already compromised? What's the difference between a drillhole and a ramp that penetrates something that may or may not be impermeable? Any comments? What's to say it's not compromised already? We've got how many shallow drillholes? They all penetrate that so-called impermeable layer. Is that possible?

MR. DYER: I'm trying to think back here. I don't think we have a map here, but if we were to look at a--I can bring one in perhaps for tomorrow. But, if we look at a footprint, the potential repository footprint, and the distribution of existing drillholes, certainly there are very few deep drillholes. I think, perhaps, two or three within the--I'm looking at Bob here who is currently searching his mind.

MR. CRAIG: G-4--

MR. DOMENICO: Does it have to be deep? All we have to do is penetrate that so-called upper layer and that's the thing that you're concerned with. It doesn't have to be--Alan Flint's holes probably all qualify for that.

MR. DYER: If we look at drillholes that are within the footprint that are, say, more than 100 feet deep, I'm trying to remember how many of those are going to be--Chris, Bob, do you have an estimate?

MR. CRAIG: No. But, certainly, most of the boreholes do lie in and around the perimeter of the conceptual--the perimeter drift of the conceptual repository. The thing that Alan Flint and I were just talking about very quickly is the thing to remember, certainly, when you look at UZ-6/6s with that air flow moving in and out of the mountain under different changing weather patterns and stuff at different times of the year, the thing to remember with the boreholes, we're not ventilating the boreholes creating a negative pressure in them like we are in the ESF. I mean, to answer your question, directly have we affected the mountain, I would guess maybe. Maybe it's a question of magnitude, though, have we done it in a way that's really significant to the natural system? You know, if you're looking at then a 25 foot diameter borehole, if you will, that you are actively ventilating, I think it becomes a somewhat different question.

MR. MIFFLIN: Yeah, I think that the UZ-6 is the only borehole, I think, that has probably disturbed the ambient type of situation. It's been open now for, what, eight or so--eight or so years and it is down in the Topopah Spring. And then, the UZ-6s is several in the Tiva Canyon, right?

MR. CRAIG: I'm not certain to tell you the truth. I know it's about 500 or 600 feet deep, wherever that brings us to.

MR. MIFFLIN: But, those could be, as far as from a perspective of, say, plugging them, each of these boreholes could be modified so that you still have the--you may not have the pristine geochemistry of the gas, but you would have an opportunity for the barometric pressure changes if you plug these holes.

MS. JONES: I also want to toss into the discussion here the fact that when we analyze the final performance of the site, it's going to be with a repository in it. That's what we'll actually have to be looking at in terms of looking at health and safety and waste isolation questions. It's with a fully developed repository and with waste in that mountain. And so, the pre-ESF pneumatic conditions may be necessary for looking at the hydrology models and so on of the site, but the final analysis has to be based on a mountain with a repository in it.

MR. JOHNSON: Susan, let me remind you that there is an NRC regulation that deals with groundwater travel time and that is separate from the performance assessment question. So, pneumatic pathways are a very important part of that analysis that will need to be done because pneumatic pathways may turn out to be the fastest pathway.

MR. HOLONICH: Carl, one of the things that I think we at the staff would say is we don't interpret groundwater travel time to cover vapor transport. We haven't responded to the letter yet because we're still working it out with the General Counsel's Office, but right now, we wouldn't consider vapor as part of the groundwater travel time.

MR. JOHNSON: But, your definition of groundwater includes all phases of water.

MR. HOLONICH: All I can tell you is we're working with the general counsel at this point and we'll have to get back with you.

MR. MIFFLIN: I'd like to make a comment on the Susan comment. I think in my perception the performance assessment requires that somehow you get at boundary conditions that are of a repository scale. And, the only stress that's large enough and uniformly applied for the pneumatic continuity that may or may not exist in some of these units is that barometric pressure changes and, therefore, that is the only perceived type of stressing of the system that one could measure the response at a repository scale. So, once you interfere with that by, say, tunneling where you perhaps inoculate the barometric pressure changes throughout the Topopah Spring within the repository block area, you do not have any way to determine how some of those possible natural boundary conditions may respond to changes in pressure on one side or the other. So, it's performance analysis that really we're talking about from that perspective and how do you get a model with boundary conditions.

DR. DOMENICO: Max wants to say a word.

MR. BLANCHARD: Pat, I wonder whether that was a rhetorical question. It sounds very thought provoking, but at least when I distill it down the question seems to be from a natural barrier standpoint. Have you set up a situation in a program like this where you're damned if you do and you're damned if you don't? By that, I mean, if you have to worry about irrevocably destroying a barrier by drilling a hole in a natural site, if that's really a concern, wherever the site is, be it Yucca Mountain or a salt site or a crystalline rock site, then the real question is not do we have a natural barrier in a natural system that can contribute to waste isolation, but just we should go engineer a barrier which has zero leak rates. We can prove that by vacuum testing with a leak detector and a mass spectrometer and do away with characterizing the natural system. And, if the question requires an answer that you have to be concerned about whether or not you've already compromised the site by drilling a hole in it, you obviously have to. But, if you're that concerned about possible gas vapor leak rates, then it seems to me that the answer is there isn't a natural system anywhere on earth that would be a suitable place.

MR. DOMENICO: Would you repeat my question to me, Max? No, I'd said it, you know, that, yes, there's a lot of drillholes there and you have to keep in mind that you're looking at a pneumatic diffusivity of an air/rock system that's extremely large. And, that means any pressure you wave in there is going to travel about the speed of sound. So, any small disturbance of barometric pressure is going to be felt all over that rock body. That pneumatic diffusivity is at large. It's the hydraulic conductivity divided by the compressibility of the air which it's going to be a very big, big number. So, any small disturbance would be propagated through that mountain and that's what's happening today. And so, you don't get barometric responses in the absence of putting wells in. You have to have the avenue of--so, I mean, I just brought it up because there was so much concern about what the exploratory shaft is going to do to the air/gas flow distribution. I didn't say to abandon the site. I may have been a little facetious here.

There's another point, I'm still not convinced that $400 a foot is an average good cost for obtaining core. I'm not convinced that that's a good number. And, again, I'm not convinced that all the measurements that we make on the core are going to be that useful to us. I wish--is Suresh here? Is Suresh here?

(No response.)

MR. DOMENICO: How much information do you get off a core when it comes to the models required for performance assessment which is the key to this? Can you help me out here?

MR. WILLIAMS: First, I'd like to make one comment on the $400 per foot on the LM-300 core. Remember when we're doing that, we're drilling two holes. We're drilling a core track hole and then you're also doing a reaming hole. So, you're satisfying two requirements here. If you look at it from a two hole perspective, the core hole is costing you $200 a foot and the ream hole is costing you $200 a foot. So, it all depends on how you look at it and I don't think that you can look at that from a purely what data that core gives you, in itself. You've got other things that are coming out of that.

DR. DOMENICO: You're defending that cost, right, Dennis?

MR. WILLIAMS: I am not defending that cost. I'm just telling you a way of looking at it. I'm exploring a way of looking at those costs. In other programs that I've been in on drilling core with fluids, getting it for geotechnical purposes, it's not uncommon to have coring costs that cost in the range of $100 to $150 a foot if you're doing any kind of testing associated with it.

MR. DOMENICO: Yes, but still the point is you collect an awful lot of data and I just can't see it being used--I cannot see that porosity distribution being used. You can't use the core to determine hydraulic conductivity or you shouldn't. You're not measuring under fractures because the fractures, you have missed them all. They're mostly vertical. And, even if you did measure apertures, you wouldn't use them anyplace. So, you know, I think, in a lot of cases, we're measuring what we can measure without giving too much thought about what we're going to do with this information. Someone comment on that, someone who knows something about modeling--

(Laughter.)

DR. DOMENICO: Well, let me do this. As long as you're commenting, Alan, let me add one more thing. We are measuring matrix properties in a fracture flow system.

DR. FLINT: Well, I think we have to realize there is a lot of consideration in the testing that we do. And, if you look at the study plan for matrix properties, we say very specifically that we're not going to test every piece of core and we're not going to be able to test every piece of core and we don't intend to test every piece of core. The question is which core do you test and whether or not you have that core available to you.

The way we proposed it in the study plan originally for matrix property was to take one borehole and test at least one piece of core every three feet from the surface to the water table, process that information, and decide what the intensity of testing needed to be to explain the processes that we're going on, and then to provide performance assessment with the information they needed. One to the north and one to the south, that was our original intent and then reduce the amount of core required to one in every 10 feet, one in every 50 feet, so that we met the requirements.

But, one of the most important things was--and, like you say, we're only going to test--let's say, we test 3% of the core. Which 3%? We don't know and we're not going to know until we get to the hole. I think a good example was this idea of drilling past the zone we were interested in before we sampled it. That's the kind of thing that can happen. Getting information, very detailed information, as you heard from the last meeting that I was in, to what was happening right at the water table. We found a lot of information because we had the core available to us at the time. The first water zone, if we had just gone barreling through, we might have missed that. We might have missed it at other locations, too. You're right. We're not going to test every piece of core. The fact that we have it available to us to test and that we can choose specifically which pieces to test give us a lot of information. But, I think the thing is you can't start eliminating core when you haven't drilled one hole through the repository yet. It's a little premature and our plan says test the first hole you drill, find out what you need to, and then you can cut back later. It's in our study plan specifically for matrix properties. It says cut back, cut back depending on what you need. But, we wanted to start off with the first hole with all that information.

DR. DOMENICO: Yeah, I have no problem with testing everything you have. I have a problem with obtaining the core, I mean, because of the time frame here of 28 years. My problem is not the testing procedures that go on; it's the procedures in the field where you core everything that you're drilling, just about. And, the question is the need for that.

DR. FLINT: Well, the first hole--we didn't core everything at the first hole--we needed the data that we didn't core.

(Laughter.)

MR. MIFFLIN: How many of the holes do you think you should core then from your perspective?

DR. FLINT: From my perspective, I think that from the repository area we should core all of the holes that go within the block. I don't think we need to core all of the other holes at the site. Spot coring is adequate when we get outside and there are quite a few holes that we've talked about and, I think, in some of the study plans, they're that way. There's the testing process which I'm not sure you were addressing in matrix property testing. You were suggesting we were testing all the core; we're not, but we have it available to test for geologic reasons for stress testing for doing our geostatistical modeling. And, in the case with matrix properties, we only test the core that's in the liners which is about 20% or 30% of the core.

But, I think that it's hard to answer the question until we've processed the two holes that we've proposed in our study plan years ago; one in the north and one in the south that deal with this issue of the Pah Canyon, Yucca Mountain, the fact that they're more extensive to the north of the mountain. So, we separated it into two components. Once we do that, then I can answer the question how much core do we need and where do we need it? But, my feeling now is that, as Chris said and Chris has done a lot of work on this, the rock properties aren't so much the critical issue now. I think we have a way to extrapolate the information. The critical issues are the saturations and the water potentials. That is, I think, what the big issue is now and I think we can explain why some of those variabilities, why perched water exists, I think we can explain where it's going to exist. But, we need to have the core in places available to us to validate that, to show that those things are realistic and those things are right, what we're trying to think of in terms of water potentials, water contents, and their distribution. I think that's the real issue. I think those are the most important pieces of core to get. Where do you get the water potential? Simple, you just go to the zones where you have perched water and take your samples above and below that. But, make sure you get started above that perched water zone before you get there or you run into the problem of not knowing that.

MR. MIFFLIN: I have one more question in response to that. Do you have to have core to get the moisture contents and the potentials?

DR. FLINT: You have to have--no, you don't have to have core, but you have to have core to get the right moisture contents and potentials. The right ones, the ones that are representative of the formation. The cuttings that you get from boreholes are generally drier in the core or chips because we've done some analysis on chips and cutting from back in the early 80's from Yucca Mountain and we find that there are particular problems with some of those in trying to match those up with core data. But, I don't think the cuttings are adequate for getting good water potential measurements or getting good core saturations.

MR. MIFFLIN: Have you taken the cuttings from the LM-300 and compared it with the core for those types of tests?

DR. FLINT: Not from the LM-300, no.

MR. WILLIAMS: A comment with regard to the coring in the boreholes. I think if we're going to reduce the number of penetrations or try to keep to a minimum the number of penetrations that we have in the block, I think it's incumbent upon us to do every bit of testing that we can do in those penetrations; that we do, in fact, put in that block. And, from that perspective, I think we are headed in a direction of total core as we go 2,000 feet, 2,300 feet, whatever, but try to get as many different programs tied into that as we possibly can. It's not a UZ program, it's not an SD program, it's not a ramp program, but it's a total program. So, we have total core, but we have multiple uses of all that core.

DR. DOMENICO: One more thing, Dennis. With regard to the large diameter holes, how much of that is your choice and how much of that is imposed on what you do out there by REECo?

MR. WILLIAMS: REECo doesn't impose that requirement upon us.

DR. DOMENICO: Aren't you obliged to use whatever machine they provide you?

MR. WILLIAMS: But, the large diameter hole is driven by the instrumentation packages that we put in it. I mean, we're drilling holes out there. We can drill holes with the

Stratmaster. We've gone 1350 feet with the Joy-1 of dry drilling, getting dry core, and smaller diameter holes. So, REECo isn't driving that part of the program. REECo does what we want them to do.

DR. DOMENICO: Is that right? That's marvelous.

Are there any questions out there?

MR. BLANCHARD: I'd like to ask the Board a question. It seemed to me at the beginning of the meeting there was a perception that a fair amount of documentation within the current program is obsolete and that may be the case from your perspective. But, I think that Susan tried to show you that study plans are routinely being updated. She and Russ both talked about the issuance of semi-annual progress report. I think each of the TPOs that are here would probably say they produce several hundred papers a year that are published in national symposiums or published as part of our sequence of milestones. If there is a perception and it's fairly broad across the board and perhaps maybe some of the oversight groups also think--other oversight groups also think that our documentation is obsolete, then it sounds to me like we've got a gap in the communication sequence. Those of us that are working in the program on a day-to-day basis are producing a lot of new information in terms of a site description, conceptual designs, and data interpretation. And so, it could be that--first, you know, is it a problem?

I don't know whether it's a problem or not. But, if there is a concern about that, then maybe we need to look at some ways to produce some sort of a synthesis package, that the current semi-annual progress report really doesn't quite adequately do that. We're assuming that those people that are interested in the details are looking at the hundreds of references that are published in our bibliography that comes out annually and are referenced in our semi-annual progress report. But, if that's not the case and that's not the kind of information people are looking for and, when they look at the semi-annual progress report, they're not seeing what they're looking for, then it isn't a case that we don't have it; it's a case of finding the proper way to package it so that people that want to stay current can stay current. So, I would hope to get some response from the Board, in general, on this as to whether or not the forms of documentation are appropriate for communication.

DR. DOMENICO: I think we found the appropriate Board member to respond to that.

DR. NORTH: Well, it may be that it's a perception as opposed to a reality. I've checked a number of study plans. I can't say I've read very much of them. But, what I've read, my small sample, suggests to me that many of them were constructed back at the time of the SCP and reflect that kind of thinking and, if they are current with the types of issues that are being raised in the discussions about performance assessment that we have had, let us say, over the last six months or so as TSP-92 has been defined and implemented, I'm not aware of it. And, I would really like to see more discussion about why what it is we've decided to do back in 1985 and '86 and '87 makes sense against today's requirements as we're trying to answer very complicated questions about coupled processes and the like.

Now, I freely admit that those of you in the program who spend your professional lives on these issues know a whole lot more about it than I do as a part-time member of this Board. But, I am the type of person that you have to convince that you know what you're doing and that the data that you are getting is appropriate to being able to justify your analyses of the performance of the system. And so, I will speak for myself as a Board member, I won't put this on my colleagues, but I don't think you're meeting that burden of proof with regard to why the study plans are adequate as we actually go ahead implementing a lot of this now that we are doing a lot of surface-based testing and going underground and now that the amounts of money in question are very significant and we have to think about the resource allocation. Can we afford more crews and more LM-300 time? Those are very good questions and I'm not very satisfied as to the answers we're getting of how you're doing in terms of justifying the current plan as it's evolving and being revised.

MR. BLANCHARD: Well, it's a good issue to try to focus management of the program on, Warner. And, I think that your point is well-taken. We have, at least, two perspectives that we have to balance, one of which is because this is a long-term program and staff turns out and a lot of things happen, we don't want to lose control of the original objectives that was the agreement between the Department and the NRC and the SCP, and so from that standpoint, both Russ and Susan talked about the baseline that we have where we've created a planning basis which controls the test objectives and the goals of each one of these investigations in a way that, as staff turns out in the program, new staff doesn't come in and say, oh, I don't want to do that, I'm going to do something different. And, the next thing you have is a program developed on anybody doing what they want to do depending upon who the latest investigator is. So, there's got to be a control, an internal control, on that and an orderly progress to changes. We try to use the change control board process to accomplish that.

Now, at the same time, though, we also look forward to the areas that you're talking about. For instance, just a short time ago, we had a focus meeting in Las Vegas where a lot of that kind of brainstorming went on. One of the chairman of the conference was Allen Freeze who, as you know, was the chairman of the peer review that we had conducted on our unsaturated zone program that we put into the SCP. And, he and a number of other speakers, especially those with a performance assessment flavor, were testing the people in the program from the viewpoint of why can't--or can you look at this program from a standpoint of identifying those bounding features or those bounding calculations that need to be made so that maybe you know the answer now rather than go into all of the detail that Pat was talking about, the program sorts through given the SCP test program. If you could look at this larger wavelength in the scheme of waste isolation, perhaps there are ways to establish what the bounding numbers are that you need and you could put those into the model and find out right now whether you're the right order of magnitude. Now, it takes a while for that kind of thought process to permeate through people's minds and begin thinking should I shift my paradigm and where would I use it? But, I think if you've had a chance or if you do have a chance to talk with some of the people that were at Focus '93, you'll find that that was very much the flavor of the objective of that two or three day symposium. And, I think some of that will be drifting into our program. The challenge will be how to figure out how to deal with that, I think. I don't have any doubt that people are looking, especially as driven from the conceptualizers in performance assessment area. How do you get really smart at determining what order of magnitude is going to make a difference with respect to waste isolation or containment?

MR. NORTH: I'd like to urge that you accelerate the drift and publish it with the same degree of skill as you take beautiful pictures of the entrance tunnel.

MR. HAYES: Warner, you've been very candid and I would like to be very candid in turn. You've asked some good questions and you've given me an opportunity to, through those questions, express a concern I have. I'm following up on the concern Max expressed. I'm going to be very candid and I'm speaking how I feel about this process, not saying I'm right.

I've been coming to these meetings now with the Board and seeing these presentations for a number of years and, frankly, I'm starting to develop a feeling why are the Board members wasting their time coming here, why am I wasting the time, and the Survey investigators to have them take time away from their studies to come here to make presentations? The reason I feel that way is Pat has expressed--Pat came here, I think, if I'm correct, with concerns over drilling, with concerns over study plans. You came here with some concerns over study plans, are they up-to-date, are we doing the right things, and are we doing the right things in the right way. I don't think anything we've said today has probably alleviated either your concerns or Pat's. That's what I believe I've heard here today. You've had legitimate concerns. We feel we've tried to address those concerns, but I go back to what Max says, I think, we're all spitting in the wind here. So, how do we come together? He do we address these concerns? Because I believe the work the USGS and the other project people are doing, for example, on pneumatic testing, we're more in agreement with what your concerns are and what Carl's are than I believe today's discussion has convinced either of you that we are. Okay? I really believe that. But, you're correct, Warner, we can't go on faith. Somehow, we have to find a way to convince you that we are asking the right questions, that we are collecting the right kind of data for the right reasons to address some of these performance issues. We haven't done that, I don't think, today. I don't think we've convinced you that we've got the right program to go out there and do the right kind of testing, do the right kind of data collecting, and come away with the ability to answer the questions you're concerned about. And, I guess, I doubt that Carl's convinced either.

So, where do we go from here? That's the question I ask the Board and maybe anybody else. I mean, we've all got a work to do and, if all we're going to do is come to a meeting and perhaps walk away not gaining much from those meetings, we're all too busy for that.

MR. MIFFLIN: Larry, could I ask you a question? I'm not convinced that the program I heard is staying ahead of the possible effects of the tunnel boring machine and I would like to get your perspective. If I correctly understood the timing of the tunnel boring machine versus the timing or the perceived timing of the installation of the monitoring on some of those holes, there was only months differences in time and, if you put it into a cross-section, the tunnel boring machine would have been or would be in the Topopah Spring before the instrumentation was emplaced in the boreholes. Now, the basic assumption, I guess, is that the pneumatic continuity is very, very limited in lateral extent if that's the approach that the survey program believes is necessary. And, when it was presented, there was first the pre-tunnel boring conditions were going to be determined and then the effects, but I didn't see the pre-tunneling of sufficient lead time which would be particularly for the winter of strong barometric pressure changes to be actually documented.

MR. HAYES: I'll give you a short answer and then a longer answer. The short answer is, I think, until we get together as I suggested with the state, with the TRB, with other interested parties and really go through that, we've never going to come to agreement. I'm never going to convince you and perhaps I'm trying to convince you when I don't really understand your concerns. And, if we get together, you may change my way of thinking to some extent. We have to get together and talk this through or we're just wasting our time trying to convince each other we know what we're talking about. We've got to get together and spend some time on it and honestly listen to each other.

Now, the other part of the answer is perhaps the question is how much is enough? Maybe you and I would have disagreements as to how much is enough in order for us to monitor reconstruction conditions. The other part of the answer is I don't believe in the schedules. Okay? I think we're going to have more time to do some of this than perhaps the TBM schedule would say we will. So, I'm taking a risk. I'm saying I really believe I've got more time than the schedule tells me.

MR. WILLIAMS: With regard to the schedule, we worked with the Geological Survey, obviously, the PI on this gas pneumatic issue, of setting up this schedule and their order of magnitude was in a matter of months of monitoring before the TBM went by. So, that's what we looked at of getting some of these key boreholes in place and getting the instrumentation of these boreholes. That's laid out on those schedules that we gave you. And, I think in many cases we're talking a matter of eight to 10 months of actual monitoring. Now, this isn't the gas-phase testing in front of the monitoring, but this is the instruments in the hole and the starting of long-term monitoring. And, I think, too, as was pointed out in the location of a couple of the boreholes--Bob pointed this out in his presentation--that UZ-14 sets off on that north ramp extension. It may be a matter of years before the TBM is out there and, likewise, NRG-6 which sits more in the interior of the main core test area before the TBM comes by that on the way to the Imbricate Fault zone. So, using those broad--or I shouldn't say broad, but using those time frames that they have come up, we've tried to back off or back out in front of this with the boreholes and with the installation of these instruments. But, of course, if everybody changes their mind on how long it takes, then we'll go back and re-evaluate the program.

MR. CHESTNUT: I'd like to jump into this pneumatic testing controversy a little bit if I could. If I understand what Marty is saying, what we really need is a long baseline of looking at barometric pressure fluctuations above and below the--as a way of trying to look at whether or not that thing leaks on a large scale. And, I agree that that is one way of getting at some answers to the question. I think, part of the problem of communicating here is that none of us really know how to characterize a large fractured rock mass in the vadose zone on the scale that we're going to need for performance assessment. That's why we keep getting bogged down in matrix measurements and all these kinds of things. We know how to do that; we don't necessarily know how to use that information in a large scale. So, somehow, we have to get at the question of large scale response of a fractured rock mass in an air field system.

I'd like to suggest that there's an analogy here. If we were trying to characterize an aquifer, we couldn't really do that completely from barometric response measurements. We would have to put some kind of a large stress on the system beyond what we're going to be seeing from the barometric response itself. When we put that drift through there, if we run a negative pressure on the ventilation system, we're going to put a big pneumatic stress on the system. Now, to me, that's the opportunity to try to plan a program to look at what's coming across that aquifer system because--or pneumatic system. I don't think we can really resolve the issue, but it seems to me some judicious modeling ahead of time using Ben Ross' model or somebody else's and putting in some parameters values, putting in some numbers for what we're going to be pulling out in terms of ventilation, and then making some estimates about what we would see. What can we measure in terms of pressure response at different points in that system with a--we might be able to get at a way to resolve the issue. It seems to me that gives us a pretty good chance.

Another thing I'd like to suggest is there is a lot of data on barometric response that's been obtained in connection with the underground nuclear test program and that has been gathered as a way of assessing the probability of radionuclide release in an underground shop. We've got some after-the-fact verification of the estimates that were made and in terms of whether or not that that's--all that data is unclassified. And, we could be using that information to get some idea of the limits of what we can determine from barometric response analysis. So, I think there's some things out there that we may be able to look at beyond what Yucca Mountain itself is doing. And, I'd like to suggest that we give some serious thought to looking--making use of some of the underground testing data that came out of the containment program.

MR. LUCKEY: I think we have some data fairly close to home that can tell us how much baseline information we need if we look at the barometric response and the water level network. We don't need years of barometric pressure and response data to understand what happens. We need a few good fronts that come through every winter. We'll see a half a dozen or a dozen major fronts that come through the winter. A few months, six months during the winter period is plenty to totally characterize that system. Now, during the summer, the barometer is fairly quiet. So, you probably need a longer period of time. But, I think there's the impression here that maybe we're going to need years and years and years of data to get this baseline and I don't think that's true. I think it's months and months of data; maybe not two or three months if it's in the wrong time of year.

MR. HAYES: John, if I might revisit one more time my concern because it really does bother me. Okay? Warner, I know you'll give an honest answer. Okay? My question is am I correct in my assumption we have these meetings, we spend a lot of time on them, but the Board generally goes away with their perceptions unchanged. Is that the case today, Warner?

DR. NORTH: No, I wouldn't say that. I think if I can extrapolate back over my five years experience on the Board, I think the Board has learned a great deal from these sessions and I think the program has learned a good deal and there have been some major changes as a result on both sides. Maybe we can do it a little bit more efficiently. I must say I would love to see more airing of the questions, the doubts, and the analysis in progress in these presentations and a little bit less of, shall we say, the party line, especially the party line from history as opposed to what the current thinking is. So, I often find the round-table as, far and away, the most valuable part of the meeting because that's where we start talking about what's bothering us.

MR. HAYES: Don Langmuir came up to me after Dick Luckey's discussion. It seems to me this is sometimes the way to go. Don expressed the interest in coming to the Survey and talking to Dick and to some of these other people and in a very candid, professional discussion, kicked these things around with no party line. I guess I welcome that. I hope Don follows up on that because I'm hopeful that if we can do more of that, maybe we can start communicating, as you said, with real issues.

MR. DOMENICO: Is there any other--yes?

MR. KWICKLIS: I don't know if it's a rhetorical question or not. But, I wanted to address the question of density of core measurements and their usefulness to modelers. A rational strategy, I think, for determining the density of measurements that you would need would be dictated by how variable these properties are in space and how variable saturations are in space. And, where they're relatively--changing relatively slowly in space, you would need fewer measurements than where they were changing very rapidly in space. You'd want a lot more measurements.

And, based on my experience in analyzing resaturation profiles, you see, for instance, that in the Paintbrush Tuff unit, saturations are very variable, processes are very variable, and so maybe you would want a higher density of measurements in the bedded units and a less density of measurements in the welded units. In fact, U.S. Geological Survey reports exactly what they've done. They've cored continuously through the nonwelded units and taken selected core samples throughout the density of all the units. Now, when you look at that, you see that the saturation profiles within the Paintbrush Tuff are highly variable and that you can really only explain those observations through detailed analysis of the cores throughout that entire interval.

And, in terms of the utility of these measurements, well, these constitute the observable against which we test all of our models in the natural system. One of the ways we get at the properties for performance assessment model and thermal loading models, et cetera, is that we calibrate our models against the observed natural system in order to estimate the properties throughout the mountain.

Another point you mentioned is that we know it's a fracture-dominated system, which I don't necessarily agree with, but that may be true at certain locations in the mountain. The sparsity of fracturing in the Paintbrush unit suggests that the matrix is going to be a very significant player in controlling the flow. And, therefore, at least in that Paintbrush unit, the matrix properties and their determination go a long way towards understanding flow through the mountain.

DR. DOMENICO: We've heard that the matrix is going to be a big player especially in that Paintbrush unit, but why not pack off the wells and do an air permeability and get a direct measurement? I have no problem with field measurements and I would suggest that if you're going to monitor the unsaturated zone, that model probably will not play a role in the performance assessment, at all. It will play a role in describing how the system is today.

MR. KWICKLIS: I think it will tell you what some of the important hydrologic controls are and those hydrologic controls need not be a huge areal extent thickness-wise. There's some very thin units in there that may really overwhelm a lot of the other influences just by virtue of their low permeability or sparsity of fracturing. And, it's important to identify where those units are and, at least, initially, you want to have a very dense set of measurements if only to see where properties are changing rapidly in space. You don't know how things change in space, you need to make a priori--at least in the beginning, you need to make a certain number of measurements to tell you where things are changing rapidly and where they're changing slowly. And then, that information then dictates your future--

DR. DOMENICO: Like I said, you're characterizing the natural system as it stands. I think the role of your models--well, there will be no role when we start talking about--

MR. KWICKLIS: Where do the parameters for the models come from? Where do the parameters for the thermal loading models come from? They come from measurements and modeling that has been done on the natural system.

MR. MIFFLIN: Let me ask a question. I agree with you that the--particularly, the moisture contents in space--three dimensional space are going to be very important to try to understand the existing hydrology. But, I don't see with this extremely costly chlorine approach, if it takes a long time, how you're going to get that density to make those interpretations in the lateral instead of using GS statistical approaches which you can't if you're talking about moisture. How are you doing to deal with that?

MR. KWICKLIS: WEll, what I'm saying is the variability in measurements that you make dictates the sampling density that you need to fully characterize it. And, in the beginning when you know nothing about the spatial correlation, you make a dense sampling and then the data itself will tell you the sampling density that you need to fill in--

MR. MIFFLIN: Well, what about the lateral dimensions? There's a problem there.

MR. KWICKLIS: Well, are you arguing that we have too many boreholes and not enough--I mean--

MR. MIFFLIN: I'm saying you aren't going to have enough.

MR. KWICKLIS: --that we have too many boreholes.

MR. MIFFLIN: I'm saying you're not going to have enough. You may be able to deal in a vertical sense with the core, but because of the fracture network which may control the local moisture content due to fracture flow that the concern I see is that you may not ever have enough data points to determine in a lateral sense what causes the variations in the moisture content. You know, how important is the fracture flow versus matrix flow and sources and sinks, two various layers?

MR. KWICKLIS: I think that you have to let the data dictate just how variable the system is ultimately going to be and that we can't stand here and postulate here today that the system is going to be this or that variable. I think that after a certain amount of data has been collected we'll be able to see just what amount of variability there is and that will indicate the degree of success.

DR. FLINT: I'd like to just take 30 seconds or a minute. I agree, I think the moisture contents are one of the most important things to know. Right now, with the set of sampling that Chris Rautman has put together, USGS, and others, we have a hole every, say, 3,000 feet. We cover the major topographic settings that we need to cover, but the whole drilling program and systematic drilling is simply collect the data, analyze it and model it, ask the question do you understand or can you explain it, can you predict the next borehole, extend the program? The systematic drilling program does not stop with what you see in there. It goes on if it needs to go on.

The second point is if you stop the drilling tomorrow, I don't think DOE is going to give back $50 million a year. They're going to use up all the money no matter what you do. I really don't think that drilling is that expensive when you look at the cost of the whole infrastructure of this program. Getting the core, I think, is an essential part of the program and I don't think it really matters when we're spending less than the interest we'd make off of the money anyhow.

DR. DOMENICO: It's not the money. It's the time frame. You just need 28 years to collect this stuff. No.

DR. FLINT: That's if you have one shift. If you also notice, you could get the whole thing done in two years if you--

DR. DOMENICO: They can't afford more than one.

DR. FLINT: Oh, then, it is the money?

DR. DOMENICO: Not the money--it's not the money--

DR. FLINT: The total cost for doing it in 28 years or doing it in two and a half years, I think the difference was an increase of about 15% of the cost on the whole system. The amount of money to drill 28 years or three years is almost the same.

DR. DOMENICO: I don't think we can wait 28 years.

DR. FLINT: No. I think we can do it all in four years. But, the idea is put a second crew on it, get a second drill rig. It's not that big of deal, I don't think, to get what you need to know to characterize the site.

MR. MIFFLIN: Alan, I'm not advocating "no more drilling" and I'm not advocating "no more coring" (dry coring). What I've questioned and I strongly question it is whether or not with that procedure you will end up with a sufficient database to be confident about what the hydrology is in the repository block itself. And, the question that I have, are there supplemental databases that are almost as powerful and much lower in cost that would flesh out the overall analysis? So, I'm not arguing against the--I mean, you've got a very powerful methodology there, a very costly one, too, in both time and total budgets. But, are there other better approaches than geostatistics when you start coming to unknown hydrology?

DR. FLINT: Well, one of the things we are doing is we're moving more into deterministic processes versus geostatistical process, we're combining the two together.

There may be other approaches. One of the issues you talked about was using cuttings and not taking core. There's a paper coming out in Soil Science Society of America where we look at the different sized fractions of rock, whether you use small size fractions or larger ones, and what we found was the small size fractions are inadequate for measuring water potentials. Take a core that's 2% porosity, grind it up, make it into 40% porosity, and all of a sudden, you're at 10% saturation versus 100%. So, that's one of the issues we have to deal with. But, I think the program is working to get the good quality core. I think that if we tested every piece, certainly the testing would in no way overwhelm the drilling. But, we're not going to test every piece. We just need to have it available to us, so that when we get to those issues we can address them. I think the variability is, more or less, a vertical issue with the properties and a horizontal issue with the saturation zone. And, I think that the drilling program we have in place is designed to address the horizontal variability of the saturations and the water potentials. I think we can make a good estimate of whether or not we're going to have adequate information and not that much time if we drill, but not one shift five days a week.

DR. DOMENICO: That's my argument, you see. That's--I'm not against--

DR. FLINT: Well, I agree with you on that.

DR. DOMENICO: I'm not against coring and drilling. That's not the point. But, we have a token program out there.

DR. FLINT: Oh, absolutely. We agree with you, too, the whole USGS and half the people in the room--

DR. DOMENICO: And, if we're going to maintain that token program, then I think you have to look closely at the need for that core. I mean, if you're going to maintain a token program, then let's get the need down to token proportions.

DR. FLINT: No, I think the need is great. I think we need more drill crews. I mean, that's--I don't think it's an issue of saying, well, we only have one drill crew. So, we don't need as much core. So, if we get rid of the one drill crew that we have, then we don't need any core.

DR. DOMENICO: Good point.

(Laughter.)

MR. HAYES: Marty, I find myself in a strange position of agreeing with you again. I'm comfortable as it is and I wanted to go back to something you said because I think it addresses a question that Ed raised perhaps, perhaps, not. But, at least, you support something I believe I've been preaching about for a long time. Because of the need for a lot of lateral data, as well as vertical, we cannot replace the drilling program with a tunnel. The tunnel is a lot of information in the vertical along the line, but it does not give us the spatial lateral distribution we need to answer some of those questions you brought up.

MR. MIFFLIN: One of the things that I think is a little misleading is how much actual percentage of lateral testing a tunnel really does. It's a very, very small amount of actual total volume percentage of, say, the repository horizon or whatever horizon you want to--it's not very much. And, my own feeling is that the surface-based program needs to be tweaked in whatever manner necessary to get at this very difficult problem of how important are, say, some of the fault zones or the fractures in terms of fracture flow versus matrix flow and moisture contents at various levels.

MR. NELSON: Now, not having been intimately associated with this project nearly as long as many of you, though I have served on a couple of peer reviews, the number of times that the problem of fractures has come up leads me to suggest and repeat in a way what Larry has said. I would genuinely like to invite the people to come and think with us on the things and the approaches we're taking to do the very best we can to bound what's happening in this fracture system. I say that with all the sincerity that I can muster. There is a lot more thought going into the way we're doing this than what is apparent on these things and there are a lot of problems associated with these fracture things. My plea at this stage is come spend the time and reason with us. I would appreciate it.

Thank you.

DR. DOMENICO: Thanks, Bill.

It's getting late. If there's no further discussion, I would like to turn this back over to our Chairman.

DR. CANTLON: That's easy. We can, I think, have a recess at this point until tomorrow. We'll continue and have a followup and close our session tomorrow.

So, we're in recess.

(Whereupon, the meeting was recessed to reconvene on Wednesday, October 20, 1993.)

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