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NUCLEAR WASTE TECHNICAL REVIEW BOARD

STRUCTURAL GEOLOGY & GEOENGINEERING

PANEL MEETING

EXPLORATORY STUDIES FACILITY DESIGN REVIEW

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Las Vegas, Nevada

BOARD MEMBERS PRESENT

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

Dr. Clarence R. Allen, Chair
Structural Geology & Geoengineering Panel

STAFF PRESENT

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

Dr.Edward J. Cording, Consultant

I N D E X

SPEAKERS: PAGE NO.

P R O C E E D I N G S

DR. DEERE: Good morning. Good morning, ladies and gentlemen, and welcome back to the second day of the meeting. I will turn the meeting over now to Dr. Clarence Allen, Chairman of the Panel.

DR. ALLEN: And, I, in turn, will turn it over to Ted Petrie. We're going to have a slight change in the agenda this morning, but I'll let him explain that.

MR. PETRIE: Yes, I can do it right from here. This is Ted Petrie, Department of Energy. The first thing this morning, we're going to have a presentation on some analyses we have done over the past few months comparing different scenarios or different utilizations of excavation machines. Derrick Wagg headed up this activity and he'll be presenting.

So, with no further ado, Derrick, go ahead?

MR. GERTZ: While Derrick is getting ready--this is Carl Gertz--I'd just like to add one other thing. Keep in mind we do have the model up here and Ed Cording and I were talking about it just a little while ago and he indicated he thought the vertical excavation slopes were a little heavy and he didn't know if the open pit system would work very well. And, although he certainly said that in jest, I want you to know we've had many people look at these models at our info office that their first impression was you were going to back up trucks and dump things in. So, that's a perception we deal with every day and, although it may have been facetious in our discussion, it's a reality to some of the public and we have to use mechanisms to show that it's ramps and things.

DR. ALLEN: That's what the word "dump" does for us.

MR. GERTZ: That's what the word "dump" does for us, Clarence, you're right.

MR. WAGG: Good morning, my name is Derrick Wagg and I'm a mining engineer with SAIC and I'd like to give a brief presentation on the preliminary comparative cost/schedule analysis of the construction scenarios using tunnel boring machines.

The intent of this analysis was to provide a summary of additional costs which might be incurred by using more TBMs to meet early testing milestones; on the other hand, conversely to show how construction schedule would be extended if the decision was made to minimize the number of TBMs.

I'd like to point out right from the start that the purpose of this study was not a technical study. It was a cost/schedule analysis and it was performed to aid any future Yucca Mountain Project management decisions on the need for additional technical studies which may be necessary early in Title II Design. For example, if we use utilized two TBMs, one going down the south ramp and continuing along the Topopah Spring level and up the south ramp and another one starting at the intersection of the north ramp going to the Calico Hills, along the Calico Hills level, and up the south ramp again, would be an extended drivage and there may be additional studies needed for ventilation, safety require- ments, power requirements, and modified production rates, et cetera.

The scope of this study was the identification of various construction scenarios for the reference design concept which was the two-ramp concept, using different combinations of construction equipment. Also, to provide a construction schedule for each scenario, identification of important testing milestones for schedule comparison to see how the schedules and what time frame each of the scenarios reached those milestones, and the calculation of capital and operating costs for each of the scenarios which included power distribution costs, capital equipment costs, operating costs per machine, credit costs, ground support costs, con- veyor costs, ventilation costs, et cetera, and also a daily cost; the machine labor crew, the utility labor crews, and the daily cost of power utilization. Also, we included in that construction support costs which covered the whole of the ESF construction, the support you always needed to support or construct.

Then, finally, we prepared a matrix of cost and schedule comparisons so that we could easily see how the various scenarios reached their milestones, and alongside that, what the cost of each of the scenarios would be.

I won't go into detail on the equipment scenarios examined, but as you see, the scope went from two 25' TBMs and two 16' TBMs, down to one 25' TBM utilizing mobile miners and road headers and so on. So, we covered quite a large scope of scenarios.

The testing milestones which we identified were as shown here. It was felt that the intersection of the north ramp and the Calico Hills was an important testing milestone to get down as quickly as possible to Calico Hills. The intersection of the Calico Hills Exploratory Drift with a major fault, that was an important milestone. On the Topopah Spring level, the first intersection of the Ghost Dance Fault and the Topopah Spring main drift was considered important and also the connection between the north and south ramps on Topopah Spring level because this milestone was considered important because testing in the core test area would not commence until that milestone was achieved due to the ventilation. We needed to get a ventilation circuit in operation.

You have in your handouts the matrix of results.

This is the matrix of results. It shows the different scenarios, the testing milestones which are identified at the bottom of the sheet, and the number of days that it took each scenario to reach that testing milestone. Also, the days to the end of total construction of the ESF.

MR. PETRIE: Derrick, just one other thing. These should be considered to be relative costs, relative schedules, not absolute numbers. Okay? Don't say, well, that's what that costs. That's not true, but you can compare--use them for a comparison, but not for an absolute value.

MR. WAGG: Yeah, these costs were only used for comparison purposes and in the column we should have probably just said 202.5. Those are relative costs and shouldn't be considered for use in any cost analysis.

Finally, just a brief summary of results. In Scenario 1 which had two 25' TBMs and two 16' TBMs, this was the most costly scenario with a construction cost totalling $202 million. Scenario #2 which had one 25' TBM and one 16' TBM was the least costly scenario, construction costs were $159.5 million. This achieved the testing milestones A, B, and C in the same time frame as Scenario 1. So, there was not much difference in those milestones. This scenario delayed testing milestone D which was the connection of the drift on the main test level in Topopah Spring. This delayed that by 262 days over Scenario 1.

Scenario 6 had two 25' TBMs and one 16' TBM and the two 25' TBMs started in the north ramp and continued on Topopah Spring level, south around Topopah Spring level, and the 16' TBM was started on the north ramp and continued down to Calico Hills, along Calico Hills, and made the complete circuit on Calico Hills. That was the apparent preferred scenario. I say that, that was our opinion. There's a lot of other factors that would make it probably not preferable, but the construction costs were 195 million. It achieved testing milestones A, B, and C in the same time frame as Scenarios 1 and 2. It also improved testing of milestone D by 37 days over Scenario 1 and also cost $6.7 million less than Scenario 1. So, it was apparently a preferred scenario. However, the overall construction time was increased by 169 days because after all these testing milestones had been achieved we still had to complete the circuit back up to the south ramp. However, this may not be considered necessary if all the testing milestones are met and all the testing has been achieved in Calico Hills. We may not need to make that connection.

So, that was a brief summary of results and that's all I have to offer except to say that this should be considered not to be a technical study, but just an analysis of cost and schedules.

MR. GERTZ: Derrick, for my edification, could you go over the scenarios and the thoughts behind them, each of the scenarios for me please?

MR. WAGG: Do you want all the scenarios?

MR. GERTZ: Yeah, just your thoughts like you went through the last one saying going all the way around with the one TBM.

MR. WAGG: I'll have to get my notes.

MR. GERTZ: All right.

MR. WAGG: Scenario 1--

MR. PETRIE: Derrick, see if you can put the equipment scenarios examined up on the other--

MR. WAGG: Okay.

MR. GERTZ: Or, actually the schedule with the costs and the testing on--

MR. WAGG: Okay.

DR. ALLEN: Are the equipment scenarios numbered 1 through--they're not numbered here, but are they numbered through something--

MR. WAGG: They're not numbered, no. They're not numbered the same as I have the scenarios in here. On the list you have, they're not exactly numbered 1 through 7. Sorry about that.

MR. GERTZ: But, the remarks on that column are a good indication of what--

MR. WAGG: Yes. Yes.

MR. GERTZ: Yes.

MR. WAGG: Scenario 1, we had two 25' TBMs, two 16's. The 25' TBM started from surface and went down north and south ramps. The two 16' TBMs, a 16' TBM started in the intersection of the Topopah Spring and continued down and also in the south ramp.

Scenario 2 was one 25' TBM making the complete circuit on the north ramp along Topopah Spring up to surface in the south ramp and starting--the 16' TBM started in the north ramp, down to Calico Hills, along Calico Hills, and up the south ramp.

Scenario 3 was again one 25' TBM, one 16' TBM. The 25' TBM came down, and after it had made the first intersection of the Ghost Dance Fault, it was demobilized and taken back up to the south ramp and started down the south ramp. Similarly, the 16' TBM started in the north ramp, went to a point on Calico Hills, and was demobilized and moved to the south ramp and then completed the circuit to the south ramp.

Scenario 4 was one 25' TBM which we started on surface. We took it--we bypassed the Topopah Spring, went straight down to the Calico Hills, and at that point we introduced a mechanical excavator on the Calico Hills in the softer Calico Hills rock because we figured that a mechanical excavator would handle that rock.

MR. PETRIE: Derrick, you say that was Scenario 4?

MR. WAGG: That's Scenario 4.

MR. PETRIE: All right. Well, your remarks say two 25 --

MR. WAGG: Excuse me, yes. I'm sorry, Ted. There are two 25' TBMs. The first one bypassed the Topopah Spring, came down, and was moved back up to the Calico--up to the Topopah Spring level and continued drivage from the north ramp into Topopah Spring. The second 25' TBM started at the south ramp portal, went down to Calico Hills, and it was demobilized and that--no, the second TBM just went down to the Calico Hills. The first one did that, then was taken back and completed--back up to the intersection and the second one came down and down to complete the circuit. And, we had a mechanical excavator do the drivage on Calico Hills.

Scenario 5 had one 25' TBM and this involved a large number of moves. We came down from surface down to Calico Hills. Again, we moved the TBM back up to Topopah Spring, drove the Topopah Spring level until we hit Ghost Dance Fault, moved the TBM back up to surface, started down, came down to the Calico Hills, moved it back up from Calico Hills to Topopah Spring, and completed the circuit. Again, we had a mechanical excavator excavating on Calico Hills level.

Scenario 6 was the one I outlined earlier where we had a 25' TBM coming down the north ramp to the Topopah Spring, a 25' TBM coming down the south ramp to the Topopah Spring, and the 16' TBM did the whole Calico Hills circuit.

Scenario 7 was one 25' TBM and one 18' TBM which was reduced to 16'. This was the request of one of the panel. They said if we just need an 18' ramp for muck handling from the repository level, let's take a look at reducing it to--the head to 16' when we get down to the Topopah Spring. So, the 25' TBM started in the north ramp, came around, and completed the circuit to the intersection of the south ramp. At the same time, the 16'--the 18' TBM was started. When it got to this point, we changed it to a 16' head and that completed the circuit around to the north ramp.

And, there were the seven scenarios we considered.

DR. DEERE: Would it be possible to have that sequence of drawings sent out to us?

MR. WAGG: Certainly, yes.

DR. DEERE: Yeah, I mean, we don't need it now, but I'd like to have it in the office so that when we're looking at this we get a little bit better understanding.

MR. WAGG: Yes. That sequence of drawings is part of the report. We could send you the whole report.

DR. DEERE: Oh, that would be fine.

MR. GERTZ: Yeah, let's do that. Derrick, you know, I apologize for putting you on the spot because we didn't do this--

MR. WAGG: That's okay.

MR. GERTZ: This wasn't planned and just late yesterday afternoon we asked you to do it. So, I appreciate you coming in and talking to us about it because it does involved many things that the panel had suggested yesterday. And, I guess I'm pleased because I hadn't seen it that our thought process included these kind of trade-offs that I can use as a manager later on. So, it's very enlightening to me at this stage.

DR. CORDING: Yeah, I think further, refinement of this sort of approach, these alternatives, would--you know, minimizing the start and stop of the machines is where a lot of the problems develop in terms of time. But, going through these sorts of approaches and refining that, I think, is going to be very helpful. And, it would seem that the amount of time to finish may not be that much greater if you can start a machine and take it all the way down.

MR. PETRIE: I think really we're going to be going over this on an annual basis. Whenever we find out how much money we're going to get for the following year, we're going to be saying how can we best utilize those resources we're going to get? So, I see this as a continuing process for the next couple of years.

MR. GERTZ: Further, let me share with the Board some plans for funding because, as you're well aware, our technical process right now, progress is kind of tied to funding and the OMB has indicated to us they'd like to help us plan for the out-years and agree upon an out-year funding profile that we can all agree on and they would support and hopefully then Congress would support. That would make our job a little bit easier and Ted and the scientific people, the engineering and scientific people, wouldn't have to replan every year. Hopefully, we could get a little more stability to it. And, I think right now we're making the first steps towards that. We've eliminated some of the barriers to get on with field work. We're going to demonstrate some progress next year, albeit surface-based testing, not underground excavation, but that's leading to, I think, a basis for OMB and the Congress hopefully agreeing on some kind of approach. I know that's been done on the Supercolliding--Superconducting Supercollider. They've kind of got some temporary agreement on funding. It always changes though as Congress has a lot of flexibility. But, we're sure heading for that. So, I want you to be aware that that's in our thought process to make our project management, engineering, and scientific studies a little bit easier to plan.

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

(No response.)

DR. ALLEN: Okay, thank you. Ted, let's move on.

MR. PETRIE: Thank you.

Well, this morning, we're going to spend practically all the time on the potential repository design features and what we're doing about them to make our ESF compatible with the potential repository or conceptual repository. Mike Voegele is going to be discussing this. He's got about three hours of presentations. Well, we're a little bit late, but we'll be getting off very shortly. And, he's going to be talking until about 10:30 or so and then take a break. And then, Mike will be back on until a little after 11:00. Then, we'll have some discussion at that point and then whatever your pleasure is after that.

I just want to point out that the potential repository/ESF interfaces received considerable attention during Title I and also during the alternate studies and Mike is really going to be talking for the most part about the alternate studies. As I said, that's like a conceptual design for us. He'll be talking about how we treated it in the conceptual design. For your information, these are the drawings that go with the Title I design summary report and the last section here is about, oh, half a dozen drawings, the repository/ESF interface drawings. Some of you folks have seen this. It's not released yet. When it gets released, you'll get a copy of it and you can see what they are.

Let's see, another point I'd like to make is that we also have to be compatible with the surface-based testing program and you're probably not going to be able to see too much of this, but let me just hang it up here. Some nearby can see it. You can come up and take a look at it if you'd like. But, this is a composite of the potential repository, the ESF, and the boreholes that are planned or are already in place in the repository block. Of course, we must try to insure any boreholes we put in don't go through a drift and that's basically what we're doing here is to get our--locate the boreholes, and to the extent we can, locate them some place other than in a drift. In other words, we want them in the pillars. So, again, just to give you an idea of what kind of work we're doing to try to get these interfaces resolved.

As I said, Mike will be talking about many of these things, but the finalization and refinement of the design interfaces will occur during Title II. So, we'll be carrying on the potential repository conceptual design to the extent we need to assure compatibility with ESF and the surface-based testing over the next couple of years.

DR. DEERE: Is that drawing a part of the set of the final report or is that a separate drawing?

MR. PETRIE: That's a separate drawing. It's under development at this stage. Certainly, you can have a copy of it, but like I say, it will be labeled draft with a big stamp on it.

DR. DEERE: That's fine. That's what we're supposed to do.

MR. PETRIE: Yeah, right. Sure. Yes, we'll get you a copy of that. And, by the way, you will find at this point that some of the boreholes go through drifts. Again, that's precisely why we make things like this, to help us resolve issues, those problems. And, these are just some of the major interface points; the seals, drainage, ground support, the ESF and potential access and egress, opening locations, ventilation, utilities, haulage, and transportation. Some of those are some of the major issues we have to address when we do our ESF design comparing it to the potential repository design.

And, at this point, I would like to introduce Mike

Voegele and let him carry the ball from here.

MR. VOEGELE: I'm just trying to make myself a little bit of room. I have a lot of viewgraphs to play with today.

Good morning. I think it's probably appropriate if I spend just a minute or so talking about why I think I'm standing up here this morning. We had several discussions recently involving a member of the Board, Russ McFarland, a staff to the Board, and we're trying to answer a couple of questions in our discussions. And, it occurred to me that it would probably be a pretty simple matter to come up here with about three or four viewgraphs and answer the question that was asked of me. And, the more we talked about this partic- ular question, the more we realized that we would be presum- ing a lot of knowledge of a lot of people in this room and probably individually within the room everything I'm going to say this morning is going to be common knowledge to somebody, but it's probably not going to be common knowledge to the group as a whole. And, so we felt it was probably well worthwhile to go back and review some information, perhaps at the expense of saying things that were well-known to many people.

I'm particularly speaking about the first speech which is going back over the SCP conceptual design of the repository and I'll try to make it as interesting as I possibly can. Believe me, I'm as flexible as I can be this morning. If the Board would prefer to move a little bit faster, we can zip right through this and get to the ESF part of it. But, I believe many of the things we're going to talk about in the ESF Alternative Study portion of this and in the final part where we talk about some of the impacts on future repository design activities will be better understood if we spend just a few minutes reviewing some of the stuff that was done to support the SCP. That's one of the points I wanted to make.

The second point I wanted to make is I'm probably going to make a point far more often than I should. We have stood before the Board, as well as the Nuclear Regulatory Commission, on numerous occasions and talked about the ESF Alternative Study and we've really always talked about it with the focus being on the Exploratory Studies Facility portion of it. We have not really emphasized the repository portion of it. I'm afraid we've assumed that when we put a viewgraph up that had a word "repository" on it, you understood that that was the repository even though we were talking about an ESF part of it or a TBM construction part of it. And, so I'm going to show you many viewgraphs that you've seen before, but I'm probably going to say things about them that are different from what you've heard. So, if I do find myself saying repository far too often, please feel free to stop me. But, really, the focus here on all three of these talks is on the repository; it's not on the ESF. So, with that, I'll get started.

The first talk is, as I said, a brief overview of the reference configuration for the repository design that was included in the site characterization plan. I'd like to start off by talking a little bit about the design bases for that conceptual design; in particular, the SCP, site charac- terization plan--excuse me, let me make one more point that again this is one of these things that's very obvious to me, but it may have never been said to some of the people in this room. The Nuclear Waste Policy Act required that the site characterization plan be accompanied by a conceptual design for the repository. We dealt with that concern by devoting an entire chapter of the SCP to a conceptual design of the repository. Now, there is a large multi-volume document which was prepared under Sandia's supervision which is an actual conceptual design report including a volume of draw- ings and many appendices. We chose to abstract that and put in Chapter 6 of the SCP what we believe is a relatively comprehensive summary of that document. So, there is a conceptual design report, per se, which has Sandia covers on it. We did not use that as the document which really addressed the Nuclear Waste Policy Act requirement for a conceptual design. We tried to embody that in total within the SCP. So, what I'm talking about here is Chapter 6 of the SCP.

Okay. Now, the design bases that I want to talk about this morning have--I'm going to briefly touch the repository design requirements that were in place at the time we did this design and something about the reference design data base. I also wanted you to know that there were other pieces of the design bases in Chapter 6 of the SCP, but I'm not going to speak much about them this morning. And, in particular, there were sections devoted to structure systems and components important to safety and barriers important to waste isolation. Those particular sections of the SCP were really the first portions of our program where we fully addressed what about this repository was subject to the full blown NRC QA program. There's been much work done since that point in time, but I wanted to just highlight that for you today. So, we'll move on into the data base--or the requirements documents themselves.

At the time that we did the SCP, this is the hierarchy of requirements documents that were in place. It looks a bit different from what's in place today, but I wanted to point out the location of some documents for you. Now, those of you who are looking through your books trying to find this document, I have to tell you this. I did the final proof on the graphics masters. This figure was in the graphics masters. By the time it got to xeroxing and into your books, it was gone, and when I went in there this morning to yell, we opened up the graphics masters and there it was. I do not know why it is not in your books. Okay? Somebody deliberately didn't want you to see this figure.

DR. DEERE: It's in our books.

MR. VOEGELE: There are copies of it available on the table if you didn't pick it up. It is in the books for the Board. I was able to solve that problem. Okay.

Flowing down from the DOE requirements, the NRC requirements, NPA, and so forth, the program created a document which was called the generic requirements for a mine geologic disposal system. We often refer to that as the GR. Flowing down from that was a set of system requirements for the repository design and a set of subsystem design requirements. Those documents exist as appendices in the Sandia Report, the Sandia SCP/CDR. So, if you're looking for those documents and care to see them, they were created for the purposes of the design and they are embodied in the design requirements documents.

Subsequent to that--and I think those of you who were in Washington on Monday and saw Ted's discussion have seen a more recent version of what the requirements documents hierarchy looks like. When we get to the third presentation this morning--and if there's interest in the room, I'll show you that document and perhaps Ted might want to say some words to it. Okay. Well, that's all I wanted to say about the requirements. Basically, they were developed and they were in place and they are documented.

I've shown this figure to the Board before. This is the structural features of the general area surrounding Yucca Mountain as we understood them at the time that we developed the SCP conceptual design report. I thought I'd try to lay that figure on top of an aerial photo of the site. Maybe we need the lights off a little bit more. Perhaps you can see it. There's not too much to say about this diagram other than we did recognize a fair bit of structure, some of which was assumed at that point in time and still to this date has not been either confirmed or denied. You can cer- tainly recognize why the geologists believed there is a fault which is called the Ghost Dance Fault. You can see some things up here. It's impossible to make these two diagrams match well. I think it's probably because I had no controls over the air photo. I have no--I cannot demonstrate that, in fact, it's an accurate horizontal photo. I also cannot demonstrate that I have an accurate transcription of the map. This is the best I can do with the information available and it's presented more in the sense of this is what we were using at the time we did the repository design.

Importantly, there are some things that you can take from that diagram, as well as stratigraphic information. The Board has also seen this diagram in an earlier--in fact, the first meeting that I spoke at with the Board. Impor- tantly, I want to highlight some things. The famous turtle shape down here (indicating), which is what we were referring to basically as a primary area--and, I'll show you some expansion areas that relate to the term "primary area"--but I wanted to highlight the fact that there is a requirement that we have more than 200 meters of overburden and that imposes some constraints and said we probably can't go in that direc- tion, a little bit down here, too (indicating).

There is a concern about vitrophyre in the lower part of the Topopah Spring which gives us a constraint on this side, as well (indicating). And then, we've talked about the lithophysae before which give us a constraint on this part of the boundary (indicating). Now, you know that there's been some work recently to look at re-examining that pit for the stratigraphic contact in the northeastern part of the block. We tried very hard to redo this diagram for you.

We didn't have much success. I think probably the scales involved don't make much of a difference. Yesterday after-noon about 4:00 o'clock, a drawing came in from Sandia's Graphic Information System and we decided it probably wasn't enough different to try to convince you that there was a difference, but in fact, we'll talk about that a little later. We are, in fact, examining that, as well. But, at the time that the repository conceptual design was developed, those were the constraints that were in place. The 10% maximum grade was a limitation on the equipment within the repository horizon.

I mentioned, in fact, that particular shape was a --we called it a primary area. We also at that time recog-nized that there were areas that had comparable rock proper-ties and comparable structural features such that, if neces-sary, one could probably expand that area and have more area available to develop the repository, if necessary. The focus has been on the area within this block, this primary area, but there are--we have no reason to expect that we could not expand that if it became necessary to do so. I'll just say one more thing. This is a diagram that was very relevant to our site suitability assessment that was prepared during the environmental assessment for the site. And, basically, we felt that we had less confidence in the rock outside these areas than we did inside that area. And, so basically when we were addressing the question of flexibility and ability to expand this site, we basically took the position that we have not demonstrated that we have flexibility to expand in those outward directions. So, we took what we thought was a conservative posture and said that this is our best understood section of the repository block.

Okay. There's one more piece of information that's probably worth talking about in this data base. The data base is very comprehensive. We have a lot of rock properties and so forth. I'm just trying to highlight some of the features that really have a bearing on the ESF Alternative Study and one of those is the potential for flooding. These are regional maximum flood data and basically I wanted to show you that, in fact, there is a potential for some flooding upland in this part of the area and that has been a significant issue with some of the NRC staff. We've discussed that in the past and we've been trying to accommodate concerns about the potential for flooding in our further design work, as well. But, I wanted you to know it was a consideration in the design at the time that we did the SCP design.

Okay. I'd like to move on and talk a little bit about some of the aspects of the conceptual design of the repository. I'm going to probably just talk a little bit about the operations, surface facilities, the underground facilities, a little bit about seals, backfill. I probably won't mention too much about some of those, but I'll try to give you as comprehensive and quick of an overview as I can so that you have a feeling for what the repository design was like at that time.

This was the artist's drawing of the overall complex. It basically was surface facilities out here in the flats ramped down through Exile Hill into the underground area. The tuff ramp, the waste ramp, actually took the material up here into the north, and you can see a couple of the shafts that were in place at that time.

I'm going to tell you just a couple of quick things about the surface facilities which were located over here (indicating). Those of you who have been out here would recognize this little feature (indicating) as Exile Hill. Okay. It's a rather busy diagram that I will try to orient and basically show you some waste handling buildings, some decontamination type buildings, performance confirmation building, and the portal for the waste ramp, administrative type facilities over here, the rail access to the facility coming in from the east.

The one point that's worth highlighting with respect to that is that the location of those surface facil-ities were arrived at in a study that did a comparison of six candidate areas for the surface facilities out on that side of the block. So, that was actually the best of several possible sites that we looked at from a number of perspec-tives.

Okay. I'd like to move now into the underground facility portion. One thing I did not mention when I had the other diagram up which I'll mention to you now, the shape that we're using in this repository design is worth noting. It's different from the shape that we said was the primary area and the primary area basically had some good rock up in this area (indicating), good in the sense of as comparable to what we believe is in here, and some further on down. This shape was driven more by the layout of the repository and its ability to accommodate the projected waste volumes than anything else. And, so we didn't lose any material out there. This is just the perimeter area of an underground facility that meets the requirements that were laid upon it.

I wanted to talk a little bit about the shafts and ramps. You see me pulling up some diagrams today that are obviously not what we're doing, but remember, this is what we had done before for comparison purposes. The waste ramp came in from Exile Hill. The tuff ramp goes off to the north.

The locations of the shafts at that point in time, there's a men and materials shaft right down here (indicating). There is an emplacement exhaust shaft on the perimeter drift on the far eastern side of the repository block and then there were the two exploratory shafts in here. And, you will count that as six accesses to the facility which was also an issue that we have been dealing with for the past.

You'll see this drawing again in my presentation and it will be entitled Interface Control Drawing. And, the reason I wanted to mention that basically is because this particular piece of the repository which was really laid out to accommodate the underground exploration activities was designed to very carefully fit with the repository and I'll show you that in a little bit. The interfaces were all defined and we believe they were trapped.

Now, what did the accesses look like in that facility? As I mentioned there were six; a significantly steeper tuff ramp and waste ramp than we're considering today, the exploratory shafts--you'll notice that the depth of Exploratory Shaft #1 is 1480 feet. That conceptual design did take that shaft down into the Calico Hills. Okay? Now, you'll also notice something interesting about our second exploratory shaft when you start looking at the diameter of that shaft. You'll see it's a six foot diameter shaft. At that point in time, the second exploratory shaft was envisioned as an emergency egress and it was to have been raise bored. The repository shafts, the men and materials shaft, and the emplacement area exhaust shaft were about 20 foot diameter shafts in both the horizontal and vertical configuration. You'll see momentarily we were carrying two designs with us; one was for horizontal emplacement of the waste canisters and one for vertical emplacement of the waste canisters. You'll also notice that the primary exploratory shaft was only 12 feet in that design. This was still a very small compact facility in keeping with the Department policy at that point in time, trying to keep this a very small facility.

Okay. Let me talk about the vertical emplacement configurations. This is basically the layout of the repository and the development is off the repository mains. We have some things called panel access drifts, and from those panel access drifts, typical panels would be developed and a panel would look something like this (indicating). Within those panels, you basically were able to--we had developed some schemes for disposing of both defense high level waste and spent fuel and you can see that there might have been, for instance, a spent fuel emplacement drift within this panel which had a spacing of about 15 feet between the waste canisters, about a 92-1/2 foot standoff from the panel accesses. Where we were commingling waste, there was a shorter standoff and a shorter distance between the waste canisters. I have one more drawing of that which has additional detail. You can see a little bit. You can see a section of an emplacement drift on either side. You can notice this is the spent fuel (indicating). You can see the depths, about 15 feet length for a canister. Total depth of that hole about 25 feet. A shield plug. The dimensions, these were 22 feet high and 16 feet wide. The aspect ratio of the emplacement equipment would be to swing this thing up and drop it in a hole. You'll see it's different for the horizontal, obviously. For the defense high level waste, the geometry of the hole, dimensions of the canister are a little bit different.

Okay. The horizontal emplacement configuration is a little bit different. It has a different excavation ratio and basically has comparable panel access drifts, but when you get into a typical panel, you'll see a little bit different geometry. And, that looks like this (indicating). Now, the way this is drawn, it looks like those boreholes extend between the emplacement drifts. They do not. It's just the way the artist chose to represent this. They come off of either side of the emplacement drifts into the pillars for depths of about--I think this is almost 300 feet. I remember 363 feet, right, being the total depth. And, you can see the differences here are differences in standoffs and differences in the number of canisters that we'll see on the next viewgraph depending on whether you're looking at defense high level waste or spent fuel. It's a little bit easier to see on a section through that which is the next figure.

Okay. The aspect ratio of the access drifts and the emplacement drifts are a little bit different. To accommodate an equipment which is now swinging this canister horizontally to place it into the walls. And, you can see that there are basically--there's a shield plug, as well. There are dummy containers which are put in to put the spacing to keep the waste back from the emplacement drifts and they go in different lengths. The total length is about 300 feet for the defense high level waste. The total length is about 363 feet for the spent fuel.

I included in the next couple of diagrams the complete sets of cross sections for the vertical emplacement and the horizontal emplacement. I think maybe the best thing to do is for me to just show you them and then lay them on top of each other so you can see where the differences are. These are the ramps and the mains (indicating), here are the emplacement drifts (indicating), and here's the panel access drifts (indicating). This is the perimeter drift for the vertical emplacement. Here's the comparable set of cross sections for the horizontal emplacement scheme and if I lay these on top and just go from top to bottom, you can see that the waste ramp is a little bit bigger in the vertical emplacement, the tuff ramp is a little bit bigger in the vertical emplacement, tuff main looks about the same, waste main is a little bit bigger in the vertical emplacement. You can see here the difference in the aspect ratios between the horizontal emplacement and the vertical emplacement. These are the emplacement drifts. Perimeter drift is the same. Surface main looks the same. Panel access drifts don't look too much different. So, there's very subtle differences in the geometry of the drifts between the two designs.

I thought it would be relevant to show you a little bit about the ground support that was envisioned for that design. Basically, in the typical bored drifts, we envision-ed either friction bolts or some grouted dowels and wire mesh or perhaps some shotcrete on top of those. Vertical config-uration, you have the same situation. The wire mesh would extend not all the way down the walls, shotcrete likewise. And, the horizontal configuration, basically you have a comparable situation. But, we were dealing with four expected classifications--four classifications for expected conditions ranging from quite simple where you might just have a friction type rock bolt spaced as you need them to control the conditions. The next more severe would be welded wire mesh with grouted dowels. Then, you would move to what welded wire mesh covered by shotcrete, and finally, you would have a situation where if the ground had gotten a little bit worse, you would have a primary support which was initially put in, followed by a final support where you came back and added additional shotcrete, if necessary.

Okay. I'd like to show you the drainage that was envisioned at that repository at that time. One aspect of the repository which we felt was a positive aspect, the repository was inclined and we felt that if it would be passably self-driving, we wouldn't have to do anything in the post-closure time frame to insure drainage if water did get into it. It was designed to drain to the lowest part of the repository which was up here at the emplacement exhaust shaft. This was the lowest part of the repository. And so, basically, you can see everything that's running is either running out and around this way (indicating) or around this way (indicating) or draining down across that with the excep- tion that the exploratory shaft at that time--I don't have to say exploratory studies until I get to like my third talk-- exploratory shaft facility at that time was isolated from the drainage in the repository so that it would be internally self-consistent and it would not act as a sump for the repository. You may remember, the NRC had some concerns about precipitation of materials in those shafts which would clog them up and eventually cause the exploratory shaft drainage system to become part of the repository drainage system. So, that was part of the reason that we're discussing flooding of the exploratory shaft locations with the NRC.

Okay. I want to try to show you a little bit about ventilation. Basically, the repository was designed with two independent ventilation circuits and the--I guess the intake is here (indicating), the exhaust is here (indicating) for the emplacement part of the repository. The intake is the men and materials shaft and the exhaust is the tuff ramp portal for the development side of this. This particular plan view is pretty late in the repository development cycle. I'll show you an earlier phase in a moment. But, basically, in this particular diagram, we have emplacement taking place throughout this part of the repository working its way back here and the only development remaining is in this last portion of it.

Let me show you the ventilation--it's a little bit easier to look at--in an earlier stage of the repository where we basically have emplacement taking place back here and development is preceding ahead of it. So, this would mean we have not really started to develop this part of the repository yet. And, you can trace this basically through here. Here (indicating), you have intake to this part and the return and then, likewise, intake through here (indicating) and the returns on the emplacement portion of it. You have a comparable diagram for a late stage in the horizontal emplacement cycle--or emplacement mode in your books, as well as for an earlier stage of development. The general ventilation patterns are quite similar. Basically, the ventilation circuits are separate and that's deliberate. It's required by law, required by NRC's regulation, and basically they use this for emplacement exhaust, this for emplacement intake, this for development intake, and that for development exhaust.

Okay. I wanted to talk a little bit about some of the shaft sealing concepts that were in place at that time. We had envisioned a situation where for the shafts we would basically have an anchor that would anchor us into the bedrock and it would function as a plug and a seal. We would have settlement plugs down the shaft, if necessary; basically, fill the shaft. The stations would also be plugged. Drifts would be backfilled and, in fact, we would have stripped the liner, as necessary, or we could have left the liner in place, as necessary, depending on how the sealing program eventually developed. At that point in time, we did not have--probably did not have as well thought out of a sealing program as we knew we were going to need when we went to the NRC. We felt the sealing program would have to be developed more during the testing program. And, those of you who followed our debates with the NRC over the years know well that we have debated the sealing program with the NRC, as well as many of our other programs.

This is the comparable diagram for ramps. It basically has a surface plug. In this particular concept, we did not have settlement plugs. Basically, we had our primary plug at the base of the ramp, you know, a surface plug. I think one thing that's part of the sealing program that is worth talking about deals with how we were going to control the possible water inflow. The conceptual design recognized that we might have water inflow in regions within that block if we did have some fracture zones which were conductive and there was either water at the time or--at the time of construction we encountered water or found evidence of water. Likewise, if we found evidence of movement upon a fault that we did not know was there, we would take steps to avoid that particular part of the rock mass in terms of emplacing waste.

Some of the schemes that we were looking at at that point in time--and these are also relevant to how you might eventually seal this repository--dealt with what you would do if you had that water. Now, if you happened to have encountered in a drift a water-bearing fracture zone, there are certainly possibilities which are relatively common to build a bulkhead and grout that rock mass to keep that water away from the facility. On the other hand, we also could have just encouraged some of that drainage by bulkheading this off and filling this with a fill material. So, basically, what we were trying to do in this instance is if we had found a water-bearing fracture, we would try to encourage--or a fracture that might have had some evidence of having carried water in the past--we would try to encourage the future drainage of that water so that we wouldn't have introduced any water into the rock mass where the waste was emplaced. Likewise, we had looked at concepts for building sumps and drainage boreholes to encourage that drainage of water. The whole idea was to continue to keep this repository dry if we possibly could. So, as I said, there were contingency plans envisioned in the repository design where you would avoid these types of areas, where you would take steps to control that water inflow so that it would not get into the repository.

There were also contingency plans for things like if you found a fault that you had not expected that had some evidence of movement or was judged to be capable of movement at some point in the future, you would actually stand off from that particular part of the repository block, the idea being that we would not consciously put a waste canister in a zone where there was a potential for movement to shear that waste canister. So, we were going to try to put the waste canisters in the parts of the rock block that looked the best from the perspectives of waste isolation. That was a conscious aspect of that design, as well.

Okay. I wanted to use this particular forum, as well, to show you a couple of diagrams that are probably as relevant to the next meeting we're going to have as they are to this meeting, but I wanted you to know that we did look at temperature effects in this design, as well. These partic-ular diagrams are looking at predicted temperatures on the emplacement borehole walls as a function of time for both the vertical emplacement scheme and the horizontal emplacement scheme. The design goal of 235 degrees on the borehole wall, as you may remember or we'll talk about again soon, was set to insure the waste package temperature of, I believe, 275 degrees. I can check that out momentarily. But, we did the analyses and it convinced ourselves that, in fact, we met those constraints. In fact, we met them much better in the horizontal emplacement scheme.

Okay. I wanted to show you--since this is a geo-sciences panel, we might as well look as principal stresses and strength. We don't often get to look at those things. These are some plots, finite element simulations of the drifts of the waste emplacement drifts. This is, in fact, the vertical emplacement drift and this is the stress situation at the time of the excavation. 100 years in an unventilated situation, you'll notice the principal stresses--in fact, you'll notice tensile stresses along the edge of the drift, and likewise if it were ventilated, you can find out that, in fact, you do take a lot of that heat out because the principal stresses do not grow as much and, in fact, you don't develop the tensile stresses. This is the--you can look at these as safety factors. Well, this is the ratio of the stresses to the rock mass strength. My recollection is that we did--I was thinking about this as I was driving over --that we did do some modeling looking at the potential for slippage along the rock joints, as well, and it was minimal. I'm looking at Al Dennis to see if he remembers that.

MR. DENNIS: I remember something along that--

MR. VOEGELE: Something like that. I'm fairly certain that if I would have turned the page and pulled the next set of viewgraphs up, I would have shown you one that showed the potential for slippage along joints where we did some of those types of analyses. And, my recollection is it was minimal.

Here's the comparable set of drawings for the principal stresses in a horizontal emplacement mode. I think the obvious is obvious. We've got the canisters--in the previous situation, we had the canister in the bottom of the hole causing the heat. In this situation, the canisters are out here in the wall and you can see the tensile stresses are a bit more of a problem to deal with in this situation. But, again, the ratios between the stresses and the strengths look quite good. And, I also remember that this one did not have significant movement on joint surfaces when we looked at that, as well.

I have one more thermal diagram to show you. This is the profile across the repository (indicating). You can see this--here are the--the drift locations are shown by the asterisks and we can just basically look at some of the tensile stresses along these edges of these drifts and basically some stresses that are not terribly high compared to what the rock is capable of withstanding.

So, that was what I pulled out of the old CDR to tell you about the repository design. I think it might be appropriate if there's a question or two on the conceptual design that we might take that right now, rather than moving into the new one. So, if you have questions, it might be an appropriate time to ask them about that.

DR. CORDING: Mike, just one question on those symbols there. On the principal stresses, is that 3579? What do they represent?

MR. VOEGELE: The ratio of the rock matrix strength to the stress.

DR. CORDING: Okay.

MR. VOEGELE: So, they're safety factors, if you will.

DR. CORDING: And, that matrix strength is a cohesive and frictional strength?

MR. VOEGELE: Right.

DR. CORDING: Um-hum.

MR. VOEGELE: Right.

DR. CORDING: So, numbers above one indicate that the stress is less than the strength?

MR. VOEGELE: That's how I read that diagram, right.

DR. CORDING: Thank you.

MR. MCFARLAND: Mike, you have after 100 years ventilated. The drift is ventilated, but the waste holes are sealed.

MR. VOEGELE: Yes.

MR. MCFARLAND: --that would come into the drift.

MR. VOEGELE: Yes.

MR. MCFARLAND: And then, radiated into the air and carried out by the air?

MR. VOEGELE: Yes. Yes. This is probably a good time to tie this together with the next meeting. We've talked in the past and we will certainly talk again about the 57 kilo-watts per acre areal power density that was used in this design and I'll remind you that that was set as much as an operational constraint--in fact, it was set as an operational constraint to keep the drift temperatures down enough so that we could go back in and do retrieval and maintenance type work and basically subsequently found that that probably was --probably handled more heat than that within the constraints of the post-closure impacts. Okay? The 57 kilowatts per acre is really addressed towards an operational preclosure impact.

MR. MCFARLAND: This was rock temperature for--

MR. VOEGELE: Yeah. If my memory is correct on that one, it was, in fact, set as having to maintain a certain rock temperature below--was it 50 degrees C for 50 years, right? Is that what it was, Al?

MR. DENNIS: Yes.

MR. MCFARLAND: Right. Al Dennis is confirming that.

DR. ALLEN: Other questions? Yeah, Ted?

MR. PETRIE: Yeah, I'd like to remind everybody of a couple things. One, as Mike pointed out, this work was done in compliance with the law to provide a conceptual design for a potential repository for the site characterization activity and this, as you can see, has been accomplished. Our intent over the next few years is again to be in compliance with our regulatory agency's requirements that we provide for compatibility between the ESF and the GROA, that is the geologic repository operations area. So, we do not intend to update this design any more than is necessary to maintain that compatibility.

MR. MCFARLAND: One question in that light if I may. One of the drawings early in Mike's presentation showed the waste ramp surfacing in the drawing of the surface facility. It was on the boundary closest to the west. Now, a different layout within the regions of that boundary could have put the waste ramp to the east within that surface facility and altered the slope appreciably. Had that been a consideration in the original design?

MR. PETRIE: Your question is was the slope consideration originally designed--

MR. MCFARLAND: How firm is the portal location that is being used by Raytheon now in looking at those slopes--

MR. PETRIE: Oh, how firm is it? It's preliminary. It will be fixed over the next year.

MR. MCFARLAND: Then, you'll do additional design of the surface facilities?

MR. PETRIE: We will evaluate it.

MR. MCFARLAND: Evaluate--

MR. PETRIE: I'm not going to say to what extent we'll do a design. It will be only sufficient to assure ourselves that we can maintain compatibility with a surface facility.

MR. MCFARLAND: Um-hum. Thank you.

MR. GERTZ: Russ, maybe I don't need to clarify it, but I will just for the record. Our theory would be if we changed location along Exile Hill for the portal, we have to assure ourselves that we could build surface facilities 20 years, 15 years from now.

MR. MCFARLAND: Of course. Of course.

MR. GERTZ: And, that's our consideration and that's what the requirements or the regulations say is make sure when you design the ESF, you consider repository designs.

MR. STREETER: I'd like to add a comment on that. The waste ramp portal is in a fairly steeping slope outcrop. If you move it to the east, you're out into the alluvium and so you are constructing that ramp in cut and fill basically and you'd have operations activities in the waste handling area going across that ramp.

DR. ALLEN: Okay. Mike, let's go ahead?

MR. VOEGELE: Move on, okay.

All right. This second presentation is the one where you're going to get sick of hearing me say repository, but I'm going to. Okay. We're going to talk about--we're going to go through the ESF Alternative Study and try to identify the major repository design features that were examined during that study and I'm going to try to show you how we dealt with repository design concepts during the ESF. So, I will be focusing on just a slightly different focus than you've had previously on viewgraphs that you have seen before. So, I'm going to start out by showing you the dia-gram that every other talk that you've had on the ESF starts out with and then very carefully put that aside and say here's what this really means.

Okay. This is the same diagram (indicating) and I want to talk about different pieces of that study. This basically was the option generation portion of it. You'll recognize the requirements, the combining, the evaluation. This particular piece was preceded on the previous diagram by--let me put them both up and do a multimedia presentation here for you. We get dancing girls and we've got it all, Las Vegas multimedia. Okay. To compare these, okay, what we've always called options generation and screening, I want to really focus on the repository configuration aspect of the options generation and screening. With respect to the methodology, I want to talk about different pieces of what comprised the methodology so you'll--I will be talking about these different things, some of these different things, in the context of repository design features and then talk about how we did the evaluation and what the findings were, again as much in the context of repository features as ESF features. So, I'm going to leave this one over here and I'll try to remember to come back to that and show you where I am.

Okay. I'll start off by showing you where I'm going. I'm going to start out by talking about the requirements and concerns for just probably two viewgraphs. And, the points I wanted to make about that is that when we did the requirements that were used in the ESF Alternative Study, we looked at it from a couple of different perspectives. One of them was its ranking as to its potential for discrimination. So, we did not carry every requirement we could identify through the ESF Alternative Study. We focused on those that we knew could provide discrimination between the different options and there were three categories of those; one where the performance depended strongly on the features of the option, some where you had higher performance could be obtained by certain options, and then there was the much larger group where the requirements could be included readily and they weren't really a discriminator. I'm going to show you how the repository aspects of that bear on this design in the next viewgraph and that's what I'm calling the cross walk to factors in the influence diagram. The other important aspect of the requirements was we did carry the testing requirements through this.

So, what comes off of that viewgraph which is relevant to our purposes this morning really is a diagram you've seen before, but I want to--the box that's highlighted in yellow, I want to call your attention to what those really are. Okay? Those are the repository design features that are in 10 CFR 60, additional design criteria for the geologic repository. And, in particular, you'll find that the ones which turned out to be discriminators, by and large, tend to be in the 133 sequence. And, the 133 sequence is that part of the underground geologic repository operations area that really bears on post-closure performance in the facility. And, I just want to highlight for you the fact that if you remember this diagram, this is the correlation between 10 CFR 60 discriminating requirements and the influence diagrams that were used in the evaluations of these options and I wanted to show you how important the major--how important the design features of the repository itself were in this evaluation for looking at discriminators. So, that's the purpose of putting this diagram up again.

MR. GERTZ: Mike?

MR. VOEGELE: Yes, sir?

MR. GERTZ: I think you need to clarify again emphatically that although we used these requirements as discriminators, we considered all requirements in the performance.

MR. VOEGELE: Oh, most certainly. This particular set of requirements that we--I didn't mean to leave you with that impression if I said that. We did develop a full set of requirements. The ones that were of most use in the ESF Alternative Study were those which provided discriminations between the various options. That does not mean that we ignored the rest of the requirements. It just meant that we felt we could meet those other requirements--I don't want to use the word "indiscriminately" between the options--but the way in which we would meet those requirements with the various options would not discriminate. Okay? So, in fact, I believe the words are right here. The requirements which were ranked low as their potential of discrimination were ranked low because they could be included readily in the option and they did not discriminate between the options. So, we did address them all. We used some for discriminators, okay? So, I think I've probably hammered this one enough, but basically just let me conclude by saying these--reminding you again that these are the repository design requirements and they were involved heavily in the influence diagrams in this study.

Okay. The diagram here also shows the compilation of the ESF--compiling the various ESF options. I'm only going to show you one viewgraph on that just so that we have a complete presentation. We did go through a lot of existing ESF configuration material that was in our architect engineer's design files and we tried to identify construction and access methods, whether they were single access or multiple access--and we did have early in this program a single access exploratory facility. It was not until we wrote the environmental assessments where the DOE General Counsel argued that it was necessary to have the secondary egress. At the time of some of the earlier designs, the first ESF designs, we really believed that what we had was a shaft down to the repository horizon and a quick look around. We did not believe we had an extensive facility. So, some of the earlier designs were, in fact, single access exploratory shafts.

We looked at configuration subsets which addressed access sizing, the depths or the lengths of the access, how we did the ground support. We looked at different underground test level configuration and we looked at some design time lines. From that information, we were able to pull together 52 historical ESF options and there were 13 unique construction and access sets and they had up to 15 configuration subsets. On top of that, there were nine underground test level configurations included as part of each of those 52 configurations. That was the information that was pulled out of the files prior to the start of this.

Likewise, we went into the files and looked for repository information. Now, basically, in this particular study, we drew the line at the time of passage of the NWPA, 1983, and only took repository configurations that were in our files subsequent to 1983. We looked basically at that time at mining method differences, major changes in access location, and different repository orientations. Okay? I'd just call your attention to the fact that these are repository design features that we were looking at for this--at this scheme of things.

So, we summarized the information that we found in our files. We looked at the number, the type, the size, the location of the repository access, the construction method, comments that were included in the files with regard to constructability, cost estimates and schedules, non-radiological health and safety evaluations, and assessments of the need for development and testing of new equipment. Some of these repository schemes would have required the development of new equipment. In fact, the horizontal emplacement scheme would have required the development of new equipment.

Okay. So, what did we find in our files in the historical repository configurations? Basically, there's a table in your books that summarizes some of the attributes of these 15 and let me just highlight some of them for you. We had a couple of pre-conceptual horizontal emplacement designs. We had some two-stage repository developments. Those date basically from '84-85 time frame when we were looking at trying to move the program forward at that time by looking at a staged repository where we would start the repository with a smaller receipt capability and then, while we were taking a little bit of waste and putting it under-ground, we would build a much larger facility with greater capabilities. We had an SCP conceptual design where there was complete separation of the defense high level waste from the spent fuel. There was, of course, the reference layout that was used in the SCP and you'll note that that had 63 subsets that were floating around in the architect engineer's files. We had a base, the SCP/CDR design, essentially raised to a new Topopah Spring lithophysal interface. We had a TBM layout that used four blocks. We had a TBM layout that used three blocks. It avoided emplacement drifts across the Ghost Dance Fault. We had a TBM layout that utilized the SCP/CDR outline in elevation. And, remember, this is all historical. This is stuff that was in the files prior to the start of the ESF Alternative Study.

We had a TBM layout with the SCP/CDR outline with the elevation raised to the new Topopah Spring contact. We had a SCP/CDR conceptional outline, but we had mining from the south access. We had a TBM layout that had two blocks integrated with the ESF. We had a four panel TBM layout within the SCP/CDR area. We had an older TBM layout and we had a pre-conceptual horizontal emplacement. So, those, I believe, span quite a large range of possible ways to build your repository, but this is what was in the historical files.

Now, given the concerns that have been expressed by several agencies, given our understanding of the require- ments, and in fact our understanding of the interpretation of those requirements which has changed quite a bit since we did some of this design work, okay, we set out to combine some of this information, create new options, screen them against requirements, and try to develop a set that we could go into the ESF Alternative Studies with.

Okay. So, basically we set out to develop combinations of ESF and repository elements in the new option configurations that satisfied or addressed regulatory requirements, the testing requirements, and the comments and concerns of the overview organizations. I might say here that one of the biggest drivers of the ESF Alternative Study was, in fact, repository concerns. We had interacted with the NRC and we knew that we had differences of opinion about our ability to demonstrate that we were in compliance with 10 CFR 60.21, in particular (c)(1)(ii)(D), which is the one that says you have to look at the alternatives to the major design features of the repository. That was a driver of this particular study. So, when I say we looked at combinations of ESF and future repository elements, there really was a strong focus in that planning stage for this particular program to look at how the repository alternatives would have to be considered because we were setting out to develop information that we could use with the NRC at the time of licensing hearings that said at the time we did this ESF design and got prepared to go underground, we had looked at a future repository licensing concern. That's the basis of the argument that we've been having with the NRC. I shouldn't use the term "argument" because they are correct. They've been doing what a regulator should do, they've been reminding us that we need to do certain things along this process of getting a license. Okay? And, one of those things is if you're going to build something, if you're going to construct something that eventually becomes part of the repository operations area, there are some procedural aspects in 10 CFR 60 that must be met at this time. So, when I say 10 CFR 60.21 was a driver on this program, it's exactly for that reason. We were trying to make sure that we would put in place documentation that showed we looked at repository alternatives at the time we did this ESF design. So, that's why I keep saying that over and over again and why I'm so sensitive to it.

So, what was the method that we used to identify some of these preliminary new options? Well, we tried to lay out combinations of accesses and ESF test panels on a basic repository area boundary and then we tried to specify excavation methods and the sizings for the openings. We identified functional assignments of these elements of the future repository, as well as the exploratory shaft facility, and tried to identify how they interfaced with the repository, locations of the various components within that. So, that's this little box right up here (indicating) that I'm talking about.

Okay. So, what happened? Well, it resulted in the development of 24 new repository ESF options that emphasized primarily alternative excavation methods, locations of access entries above the regional maximum flood, need for additional exploratory drifting, and flexibility to characterize the site in areas below the MTL. That's not the sum total of the points, but that's probably the most important points that we looked at.

Now, the major design features that were included in this development were the means of access, whether it was by shafts, ramps, or various combinations; the locations of those accesses, whether they were in the northeast, the southeast, combinations. There were accesses in this new set of option generations that came from the southwest, as well. I should have put that on there. We looked at the location of the MTL, whether it was in the northeast corner of the block, whether it was in the south. I put the word "combination" on there because there are some facilities that have--the way they're laid out, they kind of look like you have an MTL in both the north and the south and I'll try to show you that when I get there. But, basically, it was either in the northeast or the south. We looked at the excavation method of the openings, whether it was mechanically excavated or drilled and blasted, and you will see later that, in fact, there were various combinations of these things.

We looked hard at the total number of repository accesses and, in particular we went into this to make sure that we could demonstrate that the ESF accesses are an integrated subset of the total needed for the repository. Now, I'm not going to apologize for anything that we've done in the past, but I will admit that the integration between the ESF and the repository design was probably less than it could have been in an earlier design that we had. And, there are many reasons for that, but again I think that the NRC was particularly correct in this instance when they pointed out that trying to meet 10 CFR 60.21 would suggest that, in fact, you had to take that integration to the point where you could defend that you had the best set of repository accesses, not necessarily the best set of ESF accesses. And, we've been debating that openly for the past couple of years and I think that one result of that series of debates was, in fact, a strong recognition in this study of how well the ESF accesses had to be integrated with the repository accesses.

Okay. Well, what does that look like? Well, first I have to make my point, sorry. We've been flashing a lot of diagrams on the board in our meetings. Every time you see a little isometric sketch of one of the ESF options, you know that it has an A-7 or a B-7 which you'll recognize as Option 30. Well, I think one thing we've probably forgotten to tell some of the people in this room, that that classification scheme is, in fact, a repository classification scheme, so that when you see an A ESF option, it is actually not an-- that has nothing to do with the ESF option. It has to do with the repository configuration that that option is super-imposed upon. And, basically, there were four general repos-itory classification schemes that were used in this study. The first one, the A series, are all single level drill and blast repositories. The B series are all single level TBM repositories. The C series are, in fact, the step block TBM excavated repositories. And, the R series came through from the historical part of this and you'll find there are some drill and blast, as well as mechanical mined repository layouts in the R series.

So, what are the 24 options? I don't want to try to do anything with this diagram other than to show you, in fact, that the individual classifications encompass a range of some of these major repository design features; in par-ticular, whether the main test level is in the north or the south, whether they are accessed by shaft combinations, ramp combinations, only ramps, only shafts, and primarily I want to focus on this one which is how many total accesses there are within the repository facility. And, you'll see that, in fact, we were dealing with options here in the A-Class which is the single level drill and blast repository that ranged from four total accesses to six total accesses. Likewise, in the B series, which is the single level TBM repository, we did look at varying the MTLs between the north and the south. We looked at combinations again of shaft accesses, shaft/ramp accesses, and so forth, and again looked at combinations of total repository accesses. In this case, they range from four to five. And, again, in the TBM step block repository options that were being used, we have the same situation. Vary the MTL location, vary the combinations of shafts and ramps that you use, and vary the total number of accesses.

Okay. That's 24 new options. And now, I would like to turn to the evaluation portion of this diagram and make the remainder of the comments--or not the remainder, but the next group of comments that I have in the context of evaluation and some of these other attributes of this dia- gram, as well.

Okay. The evaluation had some preliminary goals and not the least among those were to reduce the number of alternatives to a suitable number for final evaluations. And, those of you who remember will remember that we got from 24 to 17 and then turned around and made 34. Our goal was to reduce it to a suitable number for final evaluation. Inci- dentally, it wasn't that much harder to deal with the 34 than it was the 17. The basic repository aspects, the basis ESF aspects were not that much different. There were schedule consideration differences, cost consideration differences, but the repository, the interfaces, the ESF testing attri- butes with the exception of the sequencing of some of the tests were quite similar between the first 17 and the second 17. So, we were really generally dealing with about 17 options.

Okay. So, we did want to reduce that number down. We wanted to make sure that what we ended up with, in fact, encompassed the ranges of the major design features that we were dealing with that were reasonable within the option. So, the people who did this screening basically--and, you'll see this, I believe it's on the next viewgraph--developed a set of option classes that, in fact, was built upon these major repository design features from the perspective of making sure that they encompassed the range of the major design features--I guess I've got that in the second bullet --insured the options spanned the range of possibilities. So, basically, it wasn't enough just to have a repository difference between these classes. If that were the case, we would have gotten it down to four. Okay? The idea was to make sure that within these individual A, B, C, and R classes of repositories we spanned the ranges of repository design features which were the number of accesses, the types of accesses, the construction method, as well. And, so they basically got their option classes down here--I think this is 12. I know it's 12.

So, these are the option classes and, as you can see here, they are predicated upon really repository design features and ESF design features, as well. But, here's what the option classes were. They basically wanted to select an option from the 24 plus the historical that had the location of the accesses and the ESF approximately in the same location as the SCP/CDR configuration. They wanted to insure that the ESF and at least one ESF access was in a substantially different location from the one that was used in Class 1. So, we were trying to bound the possibilities.

With respect to access means, we wanted to make sure we had one that had a total number of accesses less than the SCP/CDR which as you remember was six. We wanted to make sure that we had ESF access by two or more shafts, ESF access by two or more ramps, ESF access by at least one shaft and one ramp.

Okay. And then, we looked at construction method. We wanted to have a repository in ESF that were substantially constructed by drill and blast and that would include machine mined ramps, as well, but the emplacement areas had to be developed by drill and blast. The second option that they were looking at, all the construction including the ESF and all the access, which the exception of some testing alcoves, will be done by mechanical mining. Okay? The third construction method option class was to have a combination of mechanical and drill and blast mining. You might have a shaft in the ESF constructed by drill and blast, but the remainder of the repository system would be constructed by mechanical mining and that would include perhaps the second ESF access.

The next one down there is the test area configuration. We wanted to make sure that the ESF layout including the exploratory drifting that was planned was similar to the Title I or the earlier Title II concepts, one to make sure that we had a class where the ESF layout was substantially different from that and that could include either the size or the scope of the designated test areas, and finally we wanted to make sure that we had an option represented that, as best as we could come up with, integrated the repository and ESF accesses. But, that doesn't mean that these other option classes don't have some of those features, but we wanted to select an option class which definitely stood on its own as having that attribute.

So, I want to show you some of the--I think I'm going to show you six of the ESF options that were developed that--excuse me, let me make one more point. The point I want to make is this is 12 and you know we went in with 17. We expanded one of these options to include a number of different mechanically mined methods of the exploratory shafts. So, that's how the 12 got to be 17. Okay. So, let me look at some of those 17.

This particular diagram is an A-Class repository and you can tell that by the shape of the repository and the little ladder in here. If you remember when I showed you the original vertical emplacement layouts with the panel access drifts and so forth, this is the layout that goes with that type of repository. Now, this, in fact, is Option #18 which was the base case, the SCP/CDR design, but it did have an early Calico Hills access. Some of the other things, okay. This particular--has six accesses and, as I was pointing out just a few minutes ago, this is a drill and blast convention-ally mined repository. You'll notice this one still has the small main test level. That was maintained deliberately. I did this deliberately. I chose to talk to you from the plan views rather than from the isometrics. I don't know how often we've shown you the plan views for any of these things, but let me basically show you in the plan view.

The tuff ramp comes down this way (indicating) and forms the mains. The waste ramp comes over from this direction (indicating). In this particular instance, the emplacement exhaust shaft is over here on this side out on the repository perimeter drift. The men and materials shaft is over up here (indicating). Okay. And, there were within the main test level two exploratory shafts. That's where the six accesses come from.

Okay. Likewise, here is an A-Class repository (indicating) that has four accesses. This is #23. Actually, that would make it A-7, I believe. Okay? This is one that does not have a vertical exploratory shaft. The testing, in fact, comes down to the ramps in this particular program. Now, in this case, the men and materials shaft is located up here (indicating). The emplacement exhaust shaft is still located over here (indicating). The other two accesses are the waste ramp and the tuff ramp. So, this is a four access A-Type repository. Notice--the reason I'm pointing this out is when I show you the B-Type repository, you're going to see a difference in this shape. Okay? The longer tail down here (indicating) is a characteristic of an A-Type repository. And, again, this is a conventionally mined drill and blast excavation system for the repository itself.

Now, I believe that this is a B-Type--yes, this is a B-Type repository. It's a bit more compact. You'll notice it's chopped off. We have less need for this down here (indicating.) Now, this still--I didn't make this clear a moment ago. I told you we carried a horizontal and a vertical emplacement scheme through the SCP design process. Okay. At this stage of the game, roughly a couple of years ago, we focused primarily on the vertical emplacement. We are not carrying horizontal as an option. Our primary design is dealing with vertical emplacement schemes.

And so this, although it may have some attributes that look like the old horizontal emplacement repository, the diagrams that I showed you before, this, in fact, is a TBM vertical canister emplacement repository and this one has five accesses and those five accesses are the tuff ramp, the waste ramp, the men and materials shaft, the--I lost my emplacement exhaust--emplacement exhaust shaft is actually within the repository block on this particular diagram. And then, I believe we have another--yeah, they're both up here. There's the men and materials shaft (indicating), there's the emplacement exhaust shaft (indicating), and then we should have an exploratory shaft within the testing facility right there (indicating). There's the fifth access (indicating), okay? More compact--generally, I hope I've--it just occurred to me, I may have selected all the ones that have north accesses and not showing you a south access. I hope I'm going to be vindicated on the next slide. So, time for some south accesses, sure, okay.

All right. This is also a B-Type repository and, in fact, this is Option 30. This is a mechanically excavated repository. Again, you can tell by the more compact area and, in fact, the emplacement drifts turn off a little bit differently from--they don't have the panel access drift development that's characteristic of the A repository. This one does have a southern access for the tuff ramp, a northern access for the waste ramp. The men and materials shaft is down in the southern part of the block outside of the repository block proper. The emplacement exhaust shaft is up here by the mains as it is in the previous cases that we showed. This is a four access situation and, as I said, this is a mechanically excavated repository. One thing again, this has a southern MTL. I just point that out to remind you that the design concept that the engineers went forward into, this revised Title 1 and going on into Title II, was based upon Option 30, but it was not strictly Option 30. They made some changes to it that I'll talk about in a moment and I'll tell you why they did that.

Okay. I think two more I wanted to show you. Okay. They wouldn't be complete without a C block repository. This is the one that is a tri-level TBM with a primary southern access. And, this is one where I'm tempted to--

actually, this isn't the one. The ones where I told you before that I was tempted to say that they had an MTL in the north and the south are the ones where we go look at Ghost Dance's and go look at Imbricate Fault's and actually have a lot of drifting up here (indicating) which is primarily for testing purposes. It's a different one. But, when I said there's some that I could argue had a combination of a north and south MTL. That's why I said that. This one does have a primary MTL down here in the southern part of the block. This is a five access system, and if I can find them all again, this one has a waste ramp in the north, tuff ramp in the south. Okay? It has an emplacement exhaust shaft up on this end of the block (indicating). It has an exploratory shaft right here (indicating) and it has a men and materials shaft right there (indicating). So, that's a five access block and this is also a TBM, a mechanically excavated repos- itory, with a different development sequence than you saw in the previous TBM and this one was designed with a mind to avoid the Ghost Dance Fault in the emplacement drifts. So, that's part of the reason it's laid out the way it is. It also helps flatten out the repository. There are a couple of reasons driving that.

The final one I wanted to show you to show you how we tried to encompass the ranges of these major design features is one out of the R sequence. Now, this has six accesses in the R sequence and you can find that characteristic of these when you had a situation where we would develop a second exploratory shaft for emergency egress. And, the accesses here are basically the waste ramp coming in from the east over here (indicating). The tuff ramp goes out on the southwest corner in this particular repository design. You don't see that well over here (indicating), but you do see it in the plan view. The tuff ramp was actually in the southwest. Incidentally, I can tell you that the people who looked at this in the ESF Alternative Study really didn't like that southwest ramp. They liked the ramps over here. Men and materials shaft is over here (indicating). There are two exploratory shafts within that test facility. This is a little bit different--this is a modified R from the perspective of it has a larger main test level.

So, you can see what I'm trying to do with these six diagrams is try to show you that, in fact, we took four basic repository configurations and changed a lot of things. We changed the access locations, we changed the construction methods, the various combinations of construction methods, and I think that probably shows up best on my next viewgraph. I had to stop somewhere. I was going to color every column to show you the differences, but basically there is no color scheme here, other than to show you the differences between different categories.

As I pointed out, we did have four basic repository option categories and those are highlighted like that. I suppose I should have put the base case as a yellow because it really is more like our R-11. This is close to a base case, as well.

Within the ESF access construction, you can see that we had differences in the construction technique between the different accesses to the exploratory shaft. You can see that we had differences in the construction technique, between the different accesses to the exploratory shaft. You can see that we had differences in the construction technique within the main test level. You can see that we had differences in the location of the main test level. You can see that all the repository construction of the ramps and drifts was mechanical, but there were repository configurations with conventional excavations for the repository emplacement. And, finally, the one that I probably need to highlight as much as anything is the differences in total number of accesses for each of these things.

My point here is if we hadn't buried these things, they'd all be the same color all the way across. And, in fact, I wanted to emphasize for you the fact that we deliberately tried to mix these up so that we did cover the total range of things that you could do with these different features of the repository that we were dealing with in this study. --probability estimates and try to show you how the repository features really fit into that. And, I want to try to remember to tell you about all these different things in the next bit of my talk.

We did look at five probabilities to quantify nature's tree. I think I have nature's tree coming up in a diagram or two. We used that tree to compile some testing outcome probabilities. We needed to assess three other probabilities to solve the decision tree and they were programmatic viability, regulatory approval, and closure, and you'll remember that we looked at retrieval rather than closure at that point in time. We had to assess eight consequence measures for each scenario and the decision tree, develop some scaling functions and weights for the MUA, and then solve the decision tree for the overall ranking. What I want to do is talk to these two parts of this evaluation process (indicating) and try to show you where the repository features and repository concerns form an integral part of those decisions and I'll do that by showing you a little diagram right here (indicating).

Now, this is the decision tree (indicating) that we dealt with and you'll remember that this part was programmatic viability and then there were two sections in here (indicating) that had to do with testing concerns, early testing and late testing. And then, we had a probability of approval, and then we would do construction operation, and then we had the probability of closure. Now, I'm going to try to take this apart for you, unravel it a little bit in the context of the influence diagrams that went into these probabilities. And, the little orange circles that I've colored in these influence diagrams, this is the influence diagram for programmatic viability. So, there's a--take a pen and do what the graphics people talked me out of doing, okay? This is the programmatic viability part right here (indicating). This is the closure part right here (indicating) and this is the approval part right there (indicating). So, we're going to go through that--oh, and then incidentally, I'm going to talk about one of these probabilities, as well (indicating). So, I'm going to try to show you what role repository concerns played in each of those pieces of the diagram.

Okay. I'll start, I believe, with nature's tree. Okay. Any probability that you'll see that's calculated as a result of nature's tree and those probabilities generally include the ones that deal with residual uncertainties; the probability that the site is truly not okay if the early testing and the late testing both say it's okay, those kinds of probabilities that you calculate from nature's tree involve a probability that the site is okay.

Now, these probabilities, the probabilities that the site would be okay from early testing or not okay from early testing and so forth, these probabilities were calcu-lated by the testing panels, okay? This probability over here (indicating), the probability that the site is truly okay, was not calculated by the testing panels. It was calculated by the post-closure health and safety panel. And, the reason it was is because the--well, I guess the primary reason is because the people who thought about performance assessment kinds of things were on that panel--but with respect to what I'm trying to say this morning, the reason it's important is because this particular probability involves the total system. It does not involve just the site. So, you cannot say a site is okay. You have to say a site with a certain repository configuration superposed upon it is okay. And, so the deliberations that led to the evalu-ation of this probability that the site is okay involved discussions of the post-closure impacts of the different attributes of the different repositories. Okay? So, often-times, we don't emphasize that point. We slide right by this and people see the, you know, fancy formulas for calculating these residual uncertainties and, I guess, the point I don't feel we've probably mentioned or emphasized is how that probability depends on the probability that the site is okay which depends on what the impacts of the repository itself are on the site.

So, you go back through the transcripts of the post-closure health and safety panel, you will find that we were debating major features of the repository as the things that would cause these impacts that would lead to a ranking different between whether the site was okay depending on which repository. I guess the other way of saying that is the probability that the site is okay is not a unique number. There are 34 probabilities that the site is okay that were carried forward in this study.

So, back on this diagram (indicating), what that means is this part--that's nature's tree that I have up there. Tying that back to the decision tree, that means that the kinds of numbers that you deal with related to these things are the simple testing numbers. Okay? The kinds of numbers that you come up with in these things that deal with residual uncertainties involve the repository considerations.

Okay. So, let's move on to the piece of that that I was going to talk about and there's no neat way to talk about these. They're all so intertwined that no matter what I say, I'm going to be saying wait until you see the next viewgraph. So, just bear with me. We'll go around in cir- cles for a while. I wanted to talk about the NRC/NWTRB acceptance right here. First of all, since I have the soap- box this morning, let me make a comment about the program- matic viability influence diagram. Many people view that as --I should say they don't necessarily view that as being as technical of a decision as I would personally view it and I would like to go on record as long as I have the opportunity to make some statements about this programmatic viability. Now, there are a lot of things on this diagram that have to do with schedule and things of that nature. There are also a lot of deliberations that were done during the programmatic viability discussions that were highly technical in nature, not the least of which has to do with the NWTRB and the NRC concerns. I'd like to let you know that there were panels dealing with influence diagrams that were faced with ques- tions about the difference between what would you personally as a tester want to do versus what does the NRC think and what does the NWTRB think? Okay. On some of those delibera- tions, we said--the testing panel, for instance, was a good example. They said I would rather not assess the question of whether or not the NRC way of doing it or the NRC suggestions are the best way to do it or whether the TRB suggestions are the best way to do it. I would like to assess how I, as a tester, feel this should be done. And, so that left us with a situation that said, well, somebody has to assess whether or not we are, in fact, making a good technical judgment with what we're doing, whether we're accommodating the NWTRB concerns or the NRC concerns. So, the point I'm trying to make here is this box right here (indicating) is not neces- sarily whether our regulator is going to be happy with us and whether one of our oversight agencies is going to be happy with us; it also addresses the technical aspects of whether or not we're doing the right things in our characterization program. So, I want to give some credit to the people who were on that programmatic viability panel. They were addres- sing technical questions and, in fact, I've said a bit about the smiley faces and the dots and there's nothing subliminal in that. We could have used dots for both of them. It wasn't like we had to make the NRC happy. I mean, it's just basically we wanted to address the concerns. So, don't pay any attention to the bullets on there.

What I wanted to point out here for you though is, in fact, there are a couple of probabilities in this column, as well, that were assessed and considered by the program- matic viability panel that bear heavily on repository features. Okay. As I mentioned previously, the probability that the site is not okay, given that it's okay from early testing and okay from late testing, involves that probability that the site itself is okay which involves a ranking relative to which repository you put in that site. Okay? I want to point out again the probability of regulatory approval was also considered by those people in the programmatic viability panel, as well. You will see shortly that the probability of regulatory approval is very heavily dependent upon repository features.

Okay. So, let's skip the listing of the NWTRB concerns. I always feel guilty reading them to you. I'll just remind you of the NRC concerns just in case you hadn't seen them or don't remember them off the top of your head. They generally have to do with the testing program. More drifting, not clear we can find blast induced fractures. Wanted to see in situ waste package tests. Thought there was some incompatibility between the tests and the construction operations. Thought we had some scheduling problems with respect to our proposal that we would use. Some of the space that had previously been used for one test to run a different test. And, finally, again, very likely to be inadequate. So, those were the NRC concerns.

Let me hop over to the likelihood of construction or operation approval. That's the probability of approval there. And, I want to emphasize a couple of things for you here. This whole thing is going to build up like, you know, a big punch line. So, bear with me. These consequence estimates that were made depend on two things. They depend on some repository aspects that were dealt with with preclo- sure panels and they were cost and schedule, environmental concerns, health and safety concerns, and direct costs. And those were preclosure consequence estimates. There were also post-closure consequence estimates and they were the releases. Okay? Now, where I'm going in this talk is really to end up with a hearty discussion about this release calcu- lation. But, the point I want to make here is the likelihood of approval is very heavily dependent coming up this panel which is the technical confidence part of this diagram on repository concerns. And, I neglected to color in this one, too (indicating). This sequence should also be colored and that's the residual uncertainty estimates which is again one of those numbers that you calculate from nature's tree that deals with the impact of the repository on the site. So, my point is all these points that are coming up through the technical confidence aspect of this influence diagram are very heavily or dependent to some degree upon a repository or a repository features.

The same thing is true for the retrieval or closure diagram that you have in your book. Okay. I'm running a little bit slow. So, I'm going to speed up just a bit here. Okay. Likewise, the same thing is true. These costs here (indicating) are repository costs, but again I want to talk about the prior release estimates, the posterior release estimates, the consequences, the residual uncertainty. So, there's the insufficient technical confidence. Okay? This whole part of this diagram, this feeding the likelihood of retrieval, is based upon things that bear upon the reposi- tory.

I was going to wow you with the next four figures. The next four figures are the full influence diagram for the post-closure health effects portion. I'm going to spend the remainder of these few minutes talking about the releases. The first one is basically the number of health effects and it shows you the population risk and the doses to indivi- duals. The second part of the diagram begins to deal with pathways and you see unsaturated and saturated zone pathways on that diagram. The next diagram has to do with the engineered barrier system part of it and how the seals work and how much water contacts the waste.

The last diagram is the one I really want to get to and that's where you look at the ESF and the repository-induced changes. So, the next viewgraph basically summarizes all four of those diagrams on a single diagram. This is actually the diagram that we used in the ESF Alternative Study. Okay? And, I'm going to try to show you some points on this. Now, the way this worked was we had a question to answer for each of the 34 configurations addressing each of the lowest level bubbles on the influence diagram. Okay? And, the particular way this is laid out, there are three pathways that you can get from this part here (indicating), changes in state of disposal system, up to the releases. And, those pathways are generally gaseous transport, saturated-zone transport and unsaturated-zone transport. You can basically think of them as that.

Okay. So, the questions were like this--let me do one more thing before I do that. There are two general sets of lower level bubbles feeding this point that says "changes in state of the disposal system". What we're dealing with right there is do you do anything in the exploratory shaft facility that would change the releases to the accessible environment of the repository system or the total system? Likewise, is there anything about your repository that you would do that would change those releases? And, so if you look at repository, the things that we identified in the influence diagram that could have an impact on these releases were repository construction method, the number and type of repository accesses, the repository location, the rock support system, the repository configuration. We had a comparable set of questions for the ESF configuration and those were how was the ESF connected to the repository, nature and extent of Calico Hills penetration, fluid materials usage, ESF construction method, the ESF accesses which were fed by the ESF type and the ESF access location. Now, for each of those last bubbles that I just talked about, we had to answer a question for each of the 34 repository ESF option pairs and that question was is there anything about the repository construction methods relative to Option X that would lead to a change in the increase of radionuclide release along this pathway, along that pathway, or along that pathway? Okay? We had to identify those things.

This is the study or the part of the study where the preference for not having a gravity connection between the ESF and the Calico Hills level came out. This is the part of the study that said you do better if you raise the elevation of the repository. This is the part of the study that said those kinds of things that had to do with the number of accesses, the types of sealing that you would put in those accesses, all the repository design features came out of there. This is the part of the study that identified

--that gave the most points to those repository options that used the least water. Okay? This is the one that gave more points to ESF options that used less water, that used, you know--that didn't penetrate the Calico Hills in the repository block.

Okay. I hope I've made my point here that basically the answer to this release question is totally dependent upon major features of the repository and how you vary them and major features of the ESF and how you vary them for the purposes of this study.

Okay. And, I want to close by just showing you a quick summary of the kind of technical features that we debated when we were looking at those questions. If you will, these are our performance measures for answering those questions about whether or not the releases changed along some of those pathways. The kinds of things we dealt with, okay--and this axis over here, if you will, is a release as a fraction of the EPA standard (indicating) and we had a base case and we predicted some numbers and we looked at things. Okay? Fracture flow changes this--okay, well, let me show you the top axis first.

The major elements of that diagram where we established performance measures had to do with the repository location above the water table, the post-emplacement characteristics of the engineered barriers and the seals of the repository. Okay? The repository access types, numbers, and locations, ramps versus shafts, changes in the water table level--now, there is a natural barrier change, not an engineering barrier change--how the ESF is connected to the repository, how much fluid material we used, nature and extent of the Calico Hills, the construction methods, the repository configuration, and the rock support system for the repository. Okay? And, you can see if you want to look in here the kinds of things that we were debating. Now, we were debating effectiveness of seals within ramps versus effectiveness of seals within shafts. We were debating--and you can see basically that we felt that if the seals worked, the ramps were probably better than the shafts. However, if the seals didn't work, we felt the ramps were probably worse than the shafts and there's a logic behind that that can be traced through and it has to do with whether or not we really want to seal that repository block or not. There still is that debate raging within the technical community.

Okay. Locations, we were dealing with the access numbers. We were looking at locations above the flood plains. We were looking at few accesses being better, but on the other hand, if water vapor removal through the ventilation system turns out to be a real plus in this system, then more accesses is better. Okay? Above the maximum flood plain levels, access locations outside of the block which favored ramps were considered. Changes in water level, that's pretty obvious.

ESF connection with the repository, we thought that perhaps it would be better to be not connected if it was outside the repository emplacement area. Fluid material usage, if we were dealing with fracture flow questions less fluid usage is probably better. If we were dealing only with matrix flow, it probably wasn't an issue. Better if no penetration in the Calico Hills, now that's not necessarily what I would call a technical conclusion. That is an argument that says at this point in time before we start site characterization, knowing that we will eventually know more about this site, it might be prudent to avoid a direct connection between the repository horizon and the Calico Hills. It may turn out that that's insignificant. It may not matter, but prudency might suggest that you would rank an option better if it did not have that direct connection.

Likewise, we looked at extend of the damage zone and so forth, extraction ratios, cross sections, and things of that nature. Those were debated in answering those questions that I had on this previous diagram.

So, that's about as far as I wanted to go with the repository attributes of the ESF Alternative Study. I think the combination of these two diagrams says it all to me. Okay? This is what drove the ESF Alternative Study, solving this decision tree for the consequences on each of these different tails coming off the decision tree. And, what I wanted to show you was the pieces of the decision tree involved--we evaluated these probabilities by the use of influence diagrams and my goal of this talk was to show you that, in fact, these influence diagrams were predicated upon a knowledge and understanding of the impacts of the different components of the repository itself. And, I apologize if we had not brought that out hopefully as clearly as I brought it out this morning. We've put these diagrams up so many times and it's clear to me. I guess I shouldn't have expected you guys who didn't spend all those months sitting in the rooms where we argued these diagrams would have the same apprecia-tion for these diagrams as some of us. I really hope that that gives you a better feeling for how the repository played a role in the ESF Alternative Study.

Are we close to your break time, Ted? Do you want to take questions now?

DR. ALLEN: Well, let's see if there are any questions here.

MR. VOEGELE: Okay.

DR. ALLEN: Don?

DR. DEERE: Well, mine is not a question, just a comment. I think that you have done what you set out to do and that's to give us a better understanding because you went through this in a logical way and it was certainly very helpful to me and I'm sure to the others.

MR. VOEGELE: Thank you.

DR. DEERE: Appreciate it.

MR. VOEGELE: Okay.

DR. ALLEN: Not that the previous ones have been illogical, but it's all together in one package here.

Well, why don't we then declare a break for 15 minutes until 10:50.

(Whereupon, a brief recess was taken.)

DR. ALLEN: May we reconvene, please?

Well, Mike, if your voice is holding out, we'll continue.

MR. VOEGELE: While people are sitting down, I remembered a viewgraph--it's not in your package--that I had wanted to show the group this morning. I mentioned earlier that we did do--perhaps did not mention earlier. We did do a small conceptual design study for each of the repository configurations and this is half of the document right here (indicating). I wanted to show you the table of contents of this. And, basically, this is reference material that was given to each of the participants in these evaluation studies and it tabulates information that you've seen before like the concept sketches, the isometrics, the plan views, and so forth. It has a diagram that shows the ESF repository inter-face, the MTL layout, stratigraphic columns and sections where they were available and then some information on sur-face disturbances. Now, those are the sketches that are in this package and there's one of these for each of the 34 repository options.

There are also some data sheets. Now, it says summary of selected data. What's on that sheet are things like coordinates of locations, the lengths of drifting, the diameters, the sizes of the features of the repository. There's a comparable one for the ESF for each of the levels in the surface facility. So, you could go to this diagram and you could pull up how much drifting was going to be taking place, what size it was going to be, and then you could further go on down and find out things like what kind of materials were being used, the amounts of water, a little bit about the schedule. And, likewise for the repository, there was quite a bit of detail. There were narrative descriptions of the repository, descriptions of construct-ability, and operation. These were assessments by the mining engineers who developed these repository concepts. And then, they talked about how the ESF openings would interface with the repository, how this would work together, impact on MTL movements, base case design deficiency comments. These are engineers telling you why this new design might be better than the older designs that we were looking at and so forth, physical features of the layouts, surface disturbances, summaries of repository materials and water usages, and summaries of repository excavation lengths and areas.

That information was available to us during the deliberations and I can assure you that there were many of us who spent evenings going through those tables and tabulating things like water usage and material usage, the types of materials, lengths, and so forth so that we could compare these repository designs one against the other. So, you know, when we said less excavation length is better or ramp sealing is better, we had tabulations that we were using in our deliberations that were captured in the transcripts of those deliberations that summarize just exactly what the differences were.

Okay. I was asked one more question during the break and the appropriate time to answer that question is about six viewgraphs or seven viewgraphs hence. So, if you see a viewgraph that has a picture of the repository horizon on it and I forget to answer your question, just raise your hand and I'll remember what you're talking about.

Okay. The next talk, the final talk, is entitled Potential Impacts of the Revised Exploratory Studies Facility Design on the Repository Interfaces. And, what we're going to do here is going to look at four aspects of the repository design considerations and try to bring together some of the comments that were made in the previous two talks and focus them in the direction of what has to be done in the future to keep the repository program and the ESF program tied together well.

The first thing I want to do is talk about the repository interfaces from the old SCP exploratory shaft facility design. I thought I'd do that by showing you a couple of pictures. This picture (indicating) is the picture that goes with the table that I showed you first thing this morning where the exploratory shaft actually did go into the Calico Hills. This was the exploratory shaft design that was being used at the SCP/CDR time frame. Now, the picture you have in your notebook, I couldn't find a black and white drawing of that one. I couldn't find the SCP consultation draft. The only real difference between the picture you have in your books in this one is the tail going down into the Calico Hills. And, in fact, the picture you have in your books, I believe, is a black and white version of this one. Let me make sure I haven't lied. I think they're pretty comparable. So, that was the only real change between the SCP conceptual design and what went out in the SCP Chapter 8 after it was revised. We took the Calico Hills penetration off of that.

The point that I need to make with respect to the purposes of this presentation, however, is that those design activities were accompanied by a set of controlled drawings which were intended to be of use to manage the interfaces between the ESF design and the repository design. And, they're listed here. This is the interface control drawing package that existed at the time of the SCP conceptual design and the preparation of the SCP. I wanted to show you one of these, in particular, which you've seen in a cleaner version this morning. I thought I'd show you the scruffy version so you would recognize, in fact, it was an engineering drawing. And, basically, the coordinates of a number of points were controlled and the cross sections in several of these areas were actually laid out as controlled drawings so that when the repository designers and the ESF designers were con- strained to do things, it would fit together. So, that was the old interface control drawings.

As Ted mentioned to you this morning, there is, in fact, a new set and I believe that's probably one of the punch lines of my next one which was to talk about the repository design considerations that were relevant to the resumption of ESF design activities. I will get back around at the end of this to talking a little bit more about the repository interface control drawings that came out of a result of the resumption of ESF design activities.

I want to keep that focused, however, initially on the ESF Alternative Study because it was the results of the ESF Alternative Study that were factored into the restart of the ESF design activities. And, I thought I'd put this diagram up just once again as a brief summary to show you the kinds of things that were most significant factors in the Exploratory Studies Facility Alternative Study.

We talked about the programmatic viability technical questions. One of those things was responsiveness to the TRB and the NRC concerns, but remember there were also some repository technical aspects in there. The probability of regulatory approval and the post-closure releases is what we spent most of our time talking about just a moment ago and these probabilities that the site is not okay given that the testing results showed okay. Again, I reminded you that those were, in fact, dependent to some degree on the repository that was built in that site.

Okay. Now, what came out of that study were a number of potentially favorable design features. I just wanted to show you again that the repository aspects of this on this tabulation, the points that are clearly repository aspects--because this is the results of the ESF Alternative Study and this is what was used to start the Title II design up again, to restart the ESF design activities. So, we were talking about minimizing the repository accesses including the ESF openings, we were talking about mechanical excavation of accesses and drifts, no direct gravity connection between the emplacement area and the Calico Hills unit. I think that's clear. I've often said that in other ways. People often say that other ways, but basically we do not have a shaft going to the Calico Hills unit within the repository block proper. Maximize the distance between the repository and the water table, avoid the emplacement drifts intersect-ing the Ghost Dance Fault. Down here (indicating), you tend to get into more testing related features.

So, those are some repository features that came out of the ESF Alternative Study, as well as some ESF fea-tures that came out of the ESF Alternative Study. And, I'd like to show you a little bit about how we arrived at the design concept that was the basis for resuming the ESF studies and then perhaps show you a little bit--let me just do this first, okay, a summary.

Okay. The basis for selection of reference design concept again was the highest ranked options influenced by several design features and they were the MTL location flexibility, the mechanically mined accesses, no gravity pathway, distance above the water table, not crossing the Ghost Dance Fault, maximizing the exposed rock, flexibility for early drifting, two intercepts of the Ghost Dance Fault in Topopah Spring, and a minimum number of accesses. That's just a bulletized tabulation of what was on the previous page.

So, how do we take that and go into a design concept? Well, we all remember that Option 30 was the highest ranked option in the ESF study. In fact, it was the only option that was laid out at that time that did not have the direct gravity connection and it was also very responsive to some of the outside concerns. But, it did not have all of those favorable features that we just tabulated on the previous page. Okay? In fact, the muck pile in that option would have been visible from the highway. The water table distance was not elevated in that particular design. That design did not deliberately avoid emplacement drifts crossing the Ghost Dance Fault. And, the MTL location that we had in Option 30 was, in fact, in the south end of the block and the ESF Alternative Study did not express a preference as evidenced by the sensitivity studies for the location of the MTL. However, there were earlier expressed preferences within the program for an MTL in the northern end of the block. And, so it was basically decided that that would be a favorable feature to enhance Option 30.

So, the second little bullet under each of these things basically said that we did address the question of the location of the muck pile during the design study that was just completed. We will address the question of the distance above the water table being elevated in the Title II design. We will address the question of avoiding the emplacement drifts crossing the Ghost Dance Fault in the repository design and look at the location of the MTL for the earlier preference in the north in that design study, as well.

So, the guidance that was given to the architect engineers was to proceed with Option #30 enhanced by these following three items; locate the MTL in the northern part of the block, transport the excavated rock and dispose of it in an aesthetically more acceptable manner, and include an optional vertical shaft to facilitate acquisition of scien-tific information if needed in the future. That is a result of a residual concern of the testing community in the ESF Alternative Study. Basically, we do not have a direct verti-cal pathway where we can characterize the site within Option

30. I did this for a reason. That is the concept for starting the engineering studies.

We did not have in this particular option an expressed goal to utilize these exploratory shafts--or excuse me, utilize either the--I believe that's the emplacement exhaust shaft and that's the men and materials shaft (indicating) as part of the exploration program for site characterization. And so, as I said, if you're coming in ramps from the east, you do see a vertical section through the site, but you do not see a continuous vertical section through the site. And so, basically, there is some residual concern on the part of the hydrologists in the program that you may need a continuous vertical section to adequately characterize the hydrology above the block--the repository block and that was the reason for adding the third bullet. So, there actually was some design work in that design study to make sure that we would have a vertical shaft as part of this process. And, you can see--I wouldn't even want to tell you what those numbers are for because Ted showed you two diagrams this morning that have his numbers on them.

DR. DEERE: Well, yeah, I was going to ask is this your drawing and did you put those numbers and, if so, what did you mean when you put those numbers? Because I became confused yesterday and this morning.

MR. VOEGELE: Okay. The numbers actually are--the age of these, they need more dates. The age of this particular diagram is such that that was an indication of the phasing of the design studies at the time that this particular drawing was created. It is not a current drawing with respect to the phasing of the design studies. It was the only colored version I had in my notebook this morning when I pulled it out. So, the numbers on here are no meaningful to my purposes. What Ted showed you with respect to his current thinking is, in fact, the Department's current thinking.

Okay. So, for the purposes of this presentation, I wanted to emphasize, in fact, that six interface drawings were generated as a result of this design study and they are, in fact, relevant to interface control for the repository. There's one for the repository/main test area boundary interface. There is a general repository layout and plan. There are some for the ramps, repository main drifts, and there's repository boundary interface. Now, I didn't put copies of those diagrams in my presentation. I only wanted to emphasize the fact that part of the product from this design study was, in fact, interface drawings for the eventual repository so that we do know how that impacts the repository. And, that will be--well, let's go on because I'm going to scoop myself if I'm not careful here.

I wanted to emphasize once again the role of 60.21 in this study and that deals with the comparative evaluation of alternatives to major repository design features. I want to show you a couple of examples of what that means or what the impacts of that are. First of all, let me say that with respect to 60.21, that's (c)(1)(ii)(D)--I have nightmares about that piece of the regulation, slip one by me--okay. It deals with paying particular attention to the features of the repository that will contribute to longer radionuclide con- tainment and isolation. I want to emphasize that it was, in fact, a significant consideration in the scope of the ESF Alternative Study for at least two reasons, okay? First of all, we have to deal with alternative features and the isola- tion related impacts and make sure that those have been considered, and secondly, we have to make sure that the repository features important to the selection of the concept for starting the engineering studies for the ESF have been defined and, as I mentioned earlier, we believe that it is incumbent upon us to make sure that we have documented at this stage of the program that we have, in fact, done that work necessary to meet 10 CFR 60.21, so that if we do eventu- ally go to licensing for the site that we have documentation that this repository requirement was considered at the appro- priate time in the process. Okay. And, finally, the comparative evaluation is, in fact, relevant to defining the trade studies that we need to do for the ESF Title II design.

So, let me, at the risk of--at least, I'm showing you a different version of it every time I show it to you. I could be showing you the same viewgraph each time I say this same thing over again. Okay. Again, I want to remind you about these. These are the kinds of features that are relevant, we believe, to 10 CFR 60.21 considerations. Okay? Those are things like the number of ramps, shafts, and total number of accesses, mechanically mined versus conventionally mined; the gravity connection; the distance above the water table; avoiding the drifts crossing the Ghost Dance Fault; and, I think the rest of these are testing related. So, those are the kinds of repository alternative design features. We considered during the ESF study alternatives to those type of design features for the repository to make sure that we could answer the 10 CFR 60.21 question.

So, let me show you in terms of a couple of viewgraphs what we didn't address yet which will be addressed in the future. The first one of those is, in fact, the elevation of the repository horizon. Okay. That's what's in your book. I guess, let's get fancy. I was able to talk the Sandia people into giving me a real nice version. So, we'll use that one. Basically, this is the repository concept (indicating) and you can see the Topopah Spring TSw1 and TSw2 unit and the units above that. And, below it, the Calico Hills unit, the Bullfrog, and so forth, and the tram going on down. Now, the question that was asked during the break was how did one arrive at the elevation of the repository horizon for the conceptual design? And, basically, there were a number of features that were considered. First of all, the units in that part of the world are, in fact, dipping about five or six degrees, if I remember correctly, and basically we are bounded within that block by rock on the lower portion which is the vitrophyre, glassy, it's not considered to be the best rock we could put a repository in and bounded above it by--still within the Topopah Spring--by a rock which has a high lithophysal content. It has cavities which are remnants of the deposition process. And so, basically, the repository horizon that was used for the SCP/CDR was basically fit into that. It was on the south part of the block. It was above the vitrophyre on the north part of the block. It was below the lithophysal contact and it was made as flat as it could be within that stratigraphic horizon and basically that's where that came from.

Now, with respect to the outcome of the ESF Alternative Study, we do know that we would, in fact, like to raise that repository horizon above the water table. There are a couple of ways you can address that and I think I can show you in a moment, but let me basically show you the easiest one. And, I apologize for this drawing. We were unable to fix it in time. This is obviously the old exploratory shaft facility. Basically, geologists have re-looked at the strat-igraphic pick of the hole in this part of the block and have concluded that, in fact, that there probably was--probably could have done a better job picking the contact when they looked at it previously and believe now that the lithophysal zone TSw1/TSw2 contact is about 140, I believe, feet higher in this part of the block. And so, one obvious thing to do considering the results of the ESF Alternative Study, which said a block being higher above the water table is probably a better performer than your base case, would be to raise this up that 140 feet. And, in fact, there is activity going on right now to look at the possibility of doing that. So, that's why I drew that that way. I think I summarized it in the next viewgraph.

Okay. The potential increase in that unit contact may allow us to reduce the grade by changing the inclination of the repository plane. It also may allow an increase in the primary area that I showed you before which is the thing that's--the turtle shell on its side or those expansion areas that I showed you because now those are to a large degree predicated upon the location of that lithophysal zone contact. So, we may have even larger areas. Our preliminary indication yesterday is it doesn't make much of a difference on the scale we're looking at maps. The dips are five degrees of the rock mass out there. So, coming up 140 feet doesn't move something laterally very far in a relatively shallow dipping horizon.

Okay. However, being able to raise that horizon may better facilitate some of those alternative concepts we looked at; for example, the step design. I want to emphasize, however, that those design studies have not yet been performed and, as I indicated earlier, some of those are Title II trade studies and some of them, in fact, would be related to repository design studies.

All right. I wanted to point out before I get to the conclusion of this a couple of other attributes or considerations from the old SCP/CDR/ESF design that are still relevant today that we--I think we have either already improved upon these or, in fact, can still look at improving upon these. These are--

DR. DEERE: Mike?

MR. VOEGELE: Yes, sir?

DR. DEERE: Excuse me, I wonder if before we get into that because I see the next three or four are very detailed ones, back on the potential repository horizon alternative, these were based on new picks of the lithophysal zone which they picked higher up, is that correct?

MR. VOEGELE: Correct.

DR. DEERE: Now, was that on one side or the other of the Ghost Dance Fault or was it farther to the south or farther to the north? How good was the control of the new picks?

MR. VOEGELE: If Russ Dyer is in the room or somebody who has been paying more attention to that, following that, do you want to answer that question, Russ?

DR. ALLEN: Russ, would you come forward?

DR. DYER: I'm Russ Dyer of the Project Office. I think it was a pick on the core out of G-4.

MR VOEGELE: I think it was G-4. I was just about to--

MR. DYER: Which Mike is going to show you where it is right here.

MR. VOEGELE: Yeah. I'm sure it's G-4 which was what was originally a pilot hole for the original exploratory shaft. So, actually, relative to the Ghost Dance, it's quite close. But, there was only one hole where they re-evaluated --where they wanted to change the pick. Is that correct, Russ, a single hole?

MR. DYER: Yes.

MR. VOEGELE: Yes, I think it was--and, the hole was G-4.

DR. DEERE: Yes, but that's where you don't expect--or you don't seem to have found very much offset anyway on the Ghost Dance Fault.

MR. VOEGELE: Right, right.

DR. DEERE: So, isn't that a rather large extrapolation you're making as you go over the entire block or has a relative offset been taken into account?

MR. VOEGELE: I think the true answer to your question is we do not have good control where you would like to see it to make sure that we understand what the offset is across the Ghost Dance Fault where there is offset on the Ghost Dance Fault.

DR. DEERE: Um-hum.

MR. VOEGELE: Okay? We do not have control in this area. I believe the--let's see, this is--we have a hole here, here, here, and here (indicating). I do not believe we have a deep hole in this region yet (indicating).

DR. DEERE: Well, in the present drilling program that's laid out and you had a map there that showed some of the new holes and where the old holes are. How soon are we going to get a couple holes in the area farther to the south where we have greater offset to see whether or not this is a valid option?

MR. VOEGELE: Okay. I think Dave Dobson better answer that question.

MR. DOBSON: This is Dave Dobson of the Project Office. We do have plans in fiscal '92, next year, to drill some holes to help us with the stratigraphic controls for the design effort and I can't tell you exactly where the holes are going to be drilled yet because we're planning them now. But, there is some stratigraphic control down there, Mike. We don't have a lot of good core holes down there, but there's some WT holes in the southern end and so it's not that we are without information. The only place, the only significant place, where the stratigraphic horizon pick was changed was in the effort and it was in primarily G-4, but-- let's see, is Hemi in here? We did look at more than G-4, right? They looked at several holes when we went back out there to re-evaluate the horizon and we have basically a group, including the Sandia people, Los Alamos people, GS people, and DOE, and SAIC people, a couple of months ago that did this re-evaluation and laid out the core from a whole bunch of holes. And, basically, the conclusion was that it would appear that we can move at the north end the repository horizon up 140 feet and have no problem with rock quality.

DR. DEERE: Does that control also allow you to pick the offset in different positions along the Ghost Dance?

MR. DOBSON: Well, as you're aware, we can measure the offset from the Ghost Dance at the north end on the surface. It's about three meters. From G-4, you go up the hill about 100 or 150 meters and the offset on the Ghost Dance there is about three meters. It gradually increases to the south to a maximum of approximately 30 meters, maybe two kilometers south of there. And, there's a borehole--and I think it's one of the WT holes--I can't quite remember--right next to where the maximum offset in the Ghost Dance is. So, we do have some stratigraphic control there, but I don't think we have core in that hole. But, the offset at the north end is not large and so I don't think we've got any significant problems with respect to raising the repository horizon. There's not an offset problem with the Ghost Dance there.

DR. DEERE: Because I'd had the original feeling from our discussions of the past that we really needed the exploratory holes, the new holes, before we got down with our ramps because we needed that stratigraphic control to know where we're going. And, some arguments have developed or some questions have developed amongst various people in the last month or so, well, maybe we should go underground and scrap a lot of the stratigraphic control now and get underground with the ramp. But, my feeling was that you just can't get too far away from the new control. And, it seems to me from what you have said and what Dave has said that you really do need the control.

MR. VOEGELE: I think Dave and I would both tell you that basically if you want to go down without control, we'd better go back to the shaft.

MR. DOBSON: Yeah, the shafts have a lot more flexibility if you're going to just kind of take off and go. But, we have plans that are in the program and a study plan that's just about finalized right now called soils and rock properties which includes boreholes to aid in establishing the stratigraphic controls for locating the ramps and we plan to start that drilling program in 1992, next year.

DR. DEERE: Thank you. I think we certainly would agree.

MR. GERTZ: Don, if you recall my opening presentation, one of the bars near the bottom was called soil and rock properties, two to four boreholes, 250 feet to 1200 feet deep. And, that's the holes we're talking about in order to help our designers and that's what they're for.

DR. DEERE: Excellent.

MR. VOEGELE: Okay. In the context, once again, of major design features or attributes of the ESF and the repository that are relevant to repository performance and thus to things like 10 CFR 60.21(c)(1)(ii)(D), we had a number of features of the exploratory shaft and its interface with the repository that we had identified in the past as contributing to the performance of the repository system and those were ESF tests and the facility itself were separated from the potential emplacement drifts--okay, and I won't scoop myself again--in particular, to control the drainage direction. I pointed that out to you this morning that the drainage direc- tion within the ESF was separate from the drainage. It was separated from the drainage within the repository. We believed that we had, in fact, placed the surface accesses at the time in a region of low flood potential. We believed that we would be able to coordinate the number of exploratory boreholes with the ESF and repository in such a way that we would not compromise the repository's performance. Test location, we were going to control water use. We were going to limit blast damage within the ESF drifts. Counting on water being removed by the ventilation system. We were counting on seals to help us. We were avoiding surface water impoundments, control blasting in the repository itself, and the ability to remove the shaft liner to facilitate and enhance the sealing at the time when necessary.

Now, I told you that some of these things are no longer issues. In fact, we've probably done better on some of them than we had before. I think we probably still have the system separate from the repository. We'll be able to control the drainage direction. We've probably done better on flood potential. Boreholes is still the same. Water use, limiting blast damage, control blasting, I think we're doing better on that now in the design than we were in the previous design. Water removal by ventilation system, surface water impoundment is about the same, control blasting--obviously, we're looking at mechanical excavation now. We're still looking at less water. So, we're still looking at features that contribute to the repository performance. And, the point I need to make is whatever we do in the ESF design, we need to have an eye towards that repository performance, as well.

And, there's another aspect of that that's likewise true of the ground support system where we were looking at the SCP ground support system and features again with respect to the repository system performance, and I think that pro- bably anything we've done in the ESF alternative study has probably made it easier to support the system than we would have thought it was in the past. So, we probably have less potential for overbreak, we probably have round openings where we had different shaped openings before. So, we pro- bably have enhanced the support question, as well.

Okay. It's getting near the end. My voice has got about four more viewgraphs left. Okay. The last thing I wanted to talk about was the repository design reference case changes that we need to do and I think we probably can tie this viewgraph back into many of the things you heard yesterday and some of the things you might have inferred from my talk this morning and some of the things Ted said this morning. We definitely recognize that we need to update our current reference configuration which, by the way, is a controlled document. Chapter 6 of the SCP is a controlled document. Let me show you a couple of other diagrams on the side here while we're doing this.

This is the site characterization plan or organization, basically (indicating). Let me just highlight a couple of things for you in light of the document I'm about to show you. The first five chapters of the SCP were essentially a data base and they describe what we knew about the site. Chapter 6 of the SCP is essentially a repository design. Chapter 7 is the waste package. Chapter 8 is the program of plan testing.

Now, let me show you the technical document hierarchy that's in place in the program today. I'm sure many of you saw this Monday and I did bring copies for the Board if you're not familiar with this. There are copies of this diagram. The headquarters program level documents go down through something called WMSR or a waste management system requirements type document dealing with the MGDS. And, they flow down into some project specific type documents having to do with the Yucca Mountain mined geologic disposal system and it has a system description document with it. There is a set of requirements documents for the waste package, the repos- itory, and the site characterization plan itself. This is our site characterization planning basis. This is what happened to Chapter 8 of the SCP. Those documents that had to do with test planning now exist as a controlled document which is called our site characterization planning basis. And, so we do maintain that document and we manage control to that document. You can envision Chapters 1 through 5 as description documents that correspond to those planning documents. Likewise, there are repository design require- ments documents and there needs to be a description document for that, as well, and you can envision Chapter 6 of the repository as our current description document for the repos- itory. So, when we talk about requirements and description documents, there are control documents in place today for that. So, when we talk about changes to update the configur- ation, we're talking about changing the controlled descrip- tion of our repository which is where Chapter 6 evolved to from the SCP.

Okay. So, we do know we need to make changes with respect to the repository access numbers, locations, and characteristics, construction methods, the MTL configuration, the surface and subsurface interfaces, the repository horizon characteristics, and as a consequence to that, as well, with what we've learned, requirements documents also need to be updated.

So, we know we're at that point in time today. We also know that the Title II interface definition is going to probably require some supporting repository design studies. We will probably need to look at repository ventilation concerns with respect to the exploratory shaft facility, thermal considerations, development in sequencing of the repository construction, isolation and containment impact assessments. Those of you who are intimately familiar with the SCP will recognize that it's Chapter 8.4 of the SCP. That needs to be redone. If we're going to change the designs, we have to re-look at those impact assessments. That's 10 CFR 60.15, primarily. We need to do the site characterizations program in a manner that doesn't impact the site. We probably have to look at ramp sizing, fluid mater- ials usage, and basically the DOE required safety analysis report. So, that's just--you can't hold me to that. That's just a projection on my part of the kinds of repository interface type studies with the ESF that we might be looking at having to do during Title II design.

Okay. I think before I put up my last viewgraph I'm going to show you the other backup viewgraph I threw into the package this morning. This is also one of Ted Petrie's viewgraphs from the presentation to the NRC on Monday and I did bring copies of this for you, as well. I'm only putting it up to show that there is a recognition in this ESF Title II design process that we will get to a point where it will be necessary to modify the repository baseline and that has been factored into this Title II design process formally.

Okay. I have a conclusion viewgraph. After talking for three hours, three and a half hours maybe, it seems like you need to have a conclusion viewgraph, right? So, I struggled last night. I thought I would try to tell you what I thought were the four things I said today. Okay. I think the first thing I said was that repository considerations were important in the Exploratory Studies Facility Alternative Study. I think it's important to recognize that Title II design will address radionuclide containment and isolation both in terms of testing related impacts and alternatives to measure repository design features. I think it's important to know that we've identified some potential repository trade studies to support this ESF Title II design and that we will probably have to update our repository conceptual design to incorporate the results of that ESF Title II design.

So, I think I have enough voice left for a couple of questions.

DR. ALLEN: Don?

DR. DEERE: Yes. I think you put about six hours worth of data in in three hours. The question that I have relates to this higher elevation for the repository that has been considered based on the reinterpretation of the position of the lithophysal zone. Now, you'll be getting information during this year to allow you to know whether or not geo- logically that's a good assumption that has been made. And, would it be the intent then to probably go ahead and pursue that as the--I know you'll have to do some studies to do it, but is the intent that if it is borne out that indeed you could raise it, you would want to raise it?

MR. VOEGELE: I think that is totally consistent with the recommendations of the ESF Alternative Study, to look at raising that elevation and perhaps looking at a step block to avoid the Ghost Dance. Remember, we had those features which were not addressed--

DR. DEERE: Yes.

MR. VOEGELE: --in either--well, one of those features is. We had a number of repository design features that came out as characteristics of the highest ranked options that we either addressed them in the design study or we will address them in Title II design and I believe the repository eleva- tion is a projected trade study for Title II design right now. That is correct, okay. And then, the step block or whatever you need to do to avoid the Ghost Dance Fault is something that would be done in the trade study as part of repository design. But, to my knowledge--and I think it's just confirmed Ted and I think Carl is about to confirm it-- that is in the plans.

MR. GERTZ: Yeah, Don, to once again go back to my opening presentation is that in '92, in essence, all that we're going to be designing are roads and paths and the comprehensive design of the ramp which include a final grade and which then would include where you would want to end the ramp up, meaning where the repository would start, will be included in our '93 design activities and, therefore, will take advantage of the information we'll gain by the surface- based program in '92 when we do that design in '93.

DR. DEERE: Well, that certainly is the single advantage that I have heard.

MR. GERTZ: Yeah, that's--

(Laughter.)

DR. DEERE: But, I do think it is an advantage in being able to consider a higher position and a decreased grade on those ramps.

MR. GERTZ: I don't want you to think we weren't considering even without a budget slip. We were always thinking it was necessary to go get some information where we could start that design. It's just now both of them are deferred a little to the right.

DR. DEERE: Yeah, I appreciate that.

I will go back to a viewgraph--you won't have to look for it. It's one in the presentation before this presentation where you listed the NRC concerns that you try to work in in your alternative study and also the TRB concerns. And, I wanted to go to the last one you showed, the TRB concern. Exploration of the softer tuff units that occur above and below the repository level that are important in impeding downward flow of surface infiltration. Only to connect that a little bit to the recommendation or the statement that I made yesterday morning. That we feel we ought to be looking at some of those upper units and particularly--and this was the new thing--tying it together with the Ghost Dance Fault. And, that's what led to the--I guess, it's the fourth or the fifth point that we made yesterday and we felt that maybe we ought to take a look at going in one of the softer tuff units with a road header that take off--in the opening statement it said from the north ramp. And, looking at some of the drawings that were presented yesterday, it may well be that it's not convenient to do it from the north ramp. It would be more convenient to do it from the south ramp. So, I just wanted to tie that down a little bit.

MR. GERTZ: And, certainly, your recommendation was considered when we looked at ramps because that provided a nice opportunity to view that stratigraphic feature in a couple areas. And, now you've added to it and clarified it a little yesterday by saying let's view that area in the area of the Ghost Dance if we can and, certainly, we'll be looking at that.

DR. DEERE: Yes, and your statement there does remind me that we will be seeing that contact--and there are several, there's not just one, but there may be two or three sequences in that upper part--that have the characteristics that we want; that is a fractured welded tuff over a less fractured tuff. And, you will be seeing that at several faults; not at the Ghost Dance, but at several faults because you have to pass them. And, that's what came out of these charts that you showed us yesterday and there are a number of faults there. So, you probably will be able to see it or, if not, will be able to reach it and take a look at that particular interface. So, that would give some preliminary information that you will be able to assimilate before you drive into the Ghost Dance Fault.

DR. ALLEN: Ed, did you have a comment you wanted to make?

DR. CORDING: Yes. I just wanted to ask you a question regarding the interface between the ESF drifting at the repository level. And, if, for example, during the ESF program one finds that there's further development in the design for the repository, there's some interest in changing the elevation of the repository or changing the radius of the turns that go off the mains into the emplacement drifts, if in that process then there is some interference with the drifting that's done in the ESF, the comment kind of came up yesterday. You said, well, possibly, for example, we could do a radius turn off the main to go to the east/west drifts in the ESF program. And, that comment was, well, that might interfere with the orientation of the emplacement drifts in the repository. So, I'm sure one tries to get all that coordinated ahead of time and make sure it's compatible, but there's certainly going to be things learned in the process of the ESF and there may be developments in technology that would mean that some of the layout changes and that you end up having drifts from the ESF that are in the way of what you want to be doing with the repository. So, in terms of changes in elevation and also being in situations where you might actually be crossing old drifts of the ESF when you do the repository, I wonder how is that going to be handled and what sort of studies are being done in that regard?

MR. VOEGELE: I think that's probably about the most relevant question that's occurred to me in the past few months is, well, I think I'm very concerned about that com- mitment to the repository when you begin to go down there and go into this location. The only answer I can have is to try to basically come at it from at least two or maybe three perspectives. I think it's important that we have very good control on what the repository horizon is going to be before we go down with the TBMs. Now, that to me is a trade study that needs to be done during the ESF Title II design. I think that I can't emphasize enough from my perspective that this is not simply an exploratory facility that we're com- mitting to at this point in time. If we are going to co- locate these two facilities, we need to make sure that what we do is the correct thing to do for a repository. And, that's, I believe, my reason for the emphasis on 10 CFR 60.21 at this point in time. I think there may be some additional studies that have to be done with respect to how the reposi- tory and the ESF really do interface with additional better control on the horizon before we go down there. So, I think Carl may need to put his two cents worth on this one, but to me this is the biggest problem facing us right now, is making sure that what we do in this underground facility is the correct thing to do or something that we can live with in a repository.

Carl, do you have a comment?

MR. GERTZ: I obviously concur wholeheartedly. I guess I was just going to respond to Ed further on. We all recog-nize people that have been involved in underground construc-tion, there's changed conditions, things change. And should we get underground and need to reorient or something some-where else, we'll then have to be creative in our design to allow us to have a repository that whatever we do with the ESF wouldn't cause waste isolation to be compromised in an eventual repository design, whatever that is. Maybe, if we have to do the long radius turns, we don't use that part of the block for waste emplacement because it would be inter-secting or something.

DR. CORDING: Or maybe you--I mean, you try to design so you don't have these interferences, but some of those may occur. Perhaps, you'll end up with at least some study that says we can go through an old drift using these sorts of techniques and these sorts of offsets from our actual emplacement areas.

MR. GERTZ: Yeah. Much like one of our theories is to offset any emplacement areas from the potential Ghost Dance Fault underground. Should we find that necessary, we could offset our emplacement areas from any exploratory drifts that we had in place that weren't going to be used. So, it's those kind of things that certainly need to be considered.

DR. ALLEN: Excuse me, we're going to have to terminate this in 13 minutes because of airline schedules. And, I wonder if--Ted, you had a final statement here and I wanted to make sure that we don't cut you off here.

MR. PETRIE: Okay. I think you're done, Mike.

MR. VOEGELE: Okay.

(Laughter.)

MR. PETRIE: I just have a couple of things to say. Mainly, I want to thank the Board for their comments with regard to the work that's been going on, so far. Russ and Ed, in particular, helped us out quite a bit, I think, during the reviews we've had. We're looking forward to having equivalent kind of help over the next couple of years as we complete the design. And, again, thank you very much and really that's about all I have.

DR. ALLEN: Well, we want to thank you and also I'd like to thank the members of the audience who have participated and so forth and we still have a couple three minutes. Does anyone in the audience have some final statement or comment they would like--representing other groups here that they would like to make?

DR. DEERE: While they're thinking about it, I would like to simply restate the points that I made yesterday. I think there were five in the opening statement. In many of those, there was one point made and then followed by Point 2 and Point 3 which elaborated on a previous point. But, in reality, there are just two points or two topics that we addressed yesterday and one was to take a look at the 16, 18, or 20 foot, the smaller size TBMs, giving emphasis that this is an exploratory facility that has to be compatible with a future repository if such comes about. But, we don't have to do everything now to make a haulage way that is not going to be used for 20 years.

The second point was to concentrate on getting information early of the Ghost Dance Fault in three different localities--I mean, in three different geological settings: one in the upper tuff contact unit, hard tuff with the softer tuff; a second one in the candidate repository level; and the third down in the Calico Hills. And, proposed perhaps a simple J and I'm sure with the six or more options that you presented earlier--that we had that Derrick presented in the first statement this morning--you may well have something very similar to that in one of the six. Because after the early access to these points, why, you would just go ahead and continue the normal development.

You have said that in your coming Title II design studies you have no difficulty in accommodating these studies and will be looking at them. So, I think that we are glad we made the recommendations and we're glad that you are going to be able to take a look at them. We do have to catch some planes. I just want to mention that Russ and I are going to leave some of these softer tuffs and heading to Sweden to visit the Underground Rock Lab and a conference in their nuclear waste industry. And, although we're not--some of the questions that they're trying to answer certainly has some relation to things that you will be doing here.

Thanks again for all your cooperation.

DR. ALLEN: Ed, did I cut you off? Do you have anything further you want to say here?

DR. CORDING: I'm fine, thank you.

DR. ALLEN: Okay. Well, thanks again. We appreciate your remarks. The meeting is adjourned.

(Whereupon, at 11:45 a.m., the meeting was adjourned.)