UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
- - -
BRIEFING ON STATUS OF ACTIVITIES WITH
CNWRA AND HLW PROGRAM
- - -
PUBLIC MEETING

Nuclear Regulatory Commission
One White Flint North
Rockville, Maryland

Thursday, April 4, 1996

The Commission met in open session, pursuant to notice, at 2:00 p.m., Shirley A. Jackson, Chairman, presiding.

COMMISSIONERS PRESENT:
SHIRLEY A. JACKSON, Chairman of the Commission
KENNETH C. ROGERS, Commissioner
GRETA J. DICUS, Commissioner

STAFF SEATED AT THE COMMISSION TABLE:
KENNETH HART, Technical Coordinator, Office of the Secretary
WILLIAM J. OLMSTEAD, Associate General Counsel for Licensing and Regulation
PRESENTERS:
HUGH THOMPSON, Deputy EDO
CARL PAPERIELLO, Director, NMSS
MARGARET FEDERLINE, Acting Director, Division of Waste Management, NMSS
WESLEY PATRICK, President, CNWRA
BUDHI SAGAR, Technical Director, CNWRA

P R O C E E D I N G S

CHAIRMAN JACKSON: Good afternoon. The purpose of this afternoon's meeting is for the NRC staff and the Center for Nuclear Waste Regulatory Analysis to provide the Commission with a periodic briefing on the status of the NRC high-level waste program and the activities at the Center.

The Commission is pleased to welcome Dr. Wesley Patrick and the other members from our staff who will be presenting the briefing this afternoon.

I understand that this briefing will cover several factors influencing the high-level waste repository program, a revised NRC high-level waste program, and several key technical issues facing the program and the issue resolution process which, of course, you know I am always interested in.

Since the last briefing legislative initiatives and budgetary reductions have had a significant impact on the overall high-level waste program and the NRC's ability to maintain its present level of activity in this program. As a result, I understand that you have revised the NRC program objectives and focused on several key technical issues, as I mentioned earlier. We are here to listen.

Dr. Patrick, I am introducing you and Dr. Sagar publicly to Commissioner Dicus.

MR. PATRICK: Pleased to meet you.

CHAIRMAN JACKSON: Do my fellow commissioners have any additional comments?

COMMISSIONER ROGERS: Nothing, thank you.

COMMISSIONER DICUS: No, thank you.

CHAIRMAN JACKSON: You may proceed, Mr. Thompson.

MR. THOMPSON: Dr. Jackson, commissioners, this has been a year of significant changes in the high-level waste program. In particular, Congress continues to look at this area frequently. They do more looking than they do acting.

CHAIRMAN JACKSON: Let the record show that Mr. Thompson made that comment.

[Laughter.]

MR. THOMPSON: In the high-level waste program.

It is important that we continue to maintain our focus on the ultimate disposal as the focus of our program and in fact the national program. We don't want to lose sight of that.

The significant budget reductions as well as the

recognition that we have to make some modifications to the regulations themselves to make things more predictable, more reasonable, more implementable on our regulations, pose some additional challenges to the staff. That is what we are going to be touching on today.

This is kind of a unique briefing where we bring

. 5

both the Center and the staff together. We hope that this is one the Commission will find both informative as well as a useful approach, and if it is, we may be considering doing this in the future.

Margaret Federline, who is the acting director for the Division of Waste Management, will make the presentation for the staff, and Dr. Patrick, who is the president of the Center for Nuclear Waste Regulatory Analysis, will make the presentation on some of the detailed activities in the Center.

Margaret.

MS. FEDERLINE: Chairman Jackson, Commissioner Dicus, Commissioner Rogers, we appreciate the opportunity to be with you here today. I hope you will forgive me. I have my normal spring cold. I will do my best.

As Hugh indicated, there have been significant changes in the high-level waste program over the past year. Dr. Dreyfus met with you in January and discussed the perspective on DOE's program. Since then, in March, just a few weeks ago, DOE introduced some additional changes in their program in the appropriations hearing for the DOE program.

We have not had an opportunity to review those changes in detail, but in looking at them in an overview fashion, we believe that we have put a program in place that

. 6

has the flexibility at a sustained funding level to be able to address the changes in their program. So today I will be talking just briefly about the factors that influence the program and our revised program to address the revised DOE program. Dr. Patrick will address our formatting of the most important technical issues for repository performance and our approach for dealing with them.

Slide four, please.

[Slide.]

MS. FEDERLINE: As Hugh said, several legislative initiatives are under way in the Congress. On March 13 the Senate Energy and Natural Resources Committee passed amended S. 1271; the House Commerce Committee early in the year had passed H.R. 1020. Both of these pieces of legislation envision an enlarged role for NRC, particularly in the standard setting aspect as well as the licensing.

A couple of other key parameters. They do establish a basis for the waste confidence in the bills themselves and they know all the siting guidelines and the suitability process that DOE has put in place under the Nuclear Waste Policy Amendments Act.

Another significant factor has been the publication in August 1995 of National Academy of Sciences recommendations on the technical basis for a Yucca Mountain standard. These recommendations raise significant policy

. 7

questions. We are spending time doing analysis, working with EPA to interpret the National Academy report.

As you are painfully aware, our fiscal year 1996 budget was reduced from $22 million to $11 million, and DOE's budget was also reduced, from $400 million to $250 million for the repository program. Now DOE's program is about half of their fiscal year 1996 request and it is 40 percent below the 1995 percent levels. They have already

eliminated approximately 1,000 contractor positions.

I have listed on this slide the key changes that have occurred in the DOE program. Since we are focusing today on the repository program, I will touch on the bottom one.

In response to congressional direction, they have refocused their program on design and performance issues, really focusing on the core science which underlies each of these issues.

Slide five, please.

[Slide.]

MS. FEDERLINE: The next slide depicts the key milestones in DOE's program. I wanted to illustrate these milestones because for each of these milestones there is a significant responsibility for NRC. Of course we are all familiar with the licensing responsibility. Currently, under the existing program they are planning to make a

. 8

recommendation to the President in 2001, and NRC by virtue of the Nuclear Waste Policy Act would be required to comment on that.

Also, in the latest information we have received, the draft EIS, which had been previously deferred, is back on the list, and they are planning to complete that by 1999 with a final in the year 2000. We are obliged to adopt DOE's environmental impact statement to the extent that we can.

Dr. Dreyfus, when he spoke with you in January, indicated a need to revise their regulatory structure. We have since learned that they do have plans underway to revise their Part 960, which are the rules against which they would evaluate site suitability under the Nuclear Waste Policy Act. The Commission has a concurrence role in that. This was a very public process the last time we went through this.

DOE is using their total system performance assessment to focus their safety case. You can see at the bottom of this slide that they will be completing site process models and we will be seeing modules on a yearly basis of their total system performance assessment.

Also, the ESF -- I will touch on what is going on at the site in just a minute -- there are key experiments going on in thermal response and coupled processes that we

. 9

need to stay tuned into and make sure that the information is forthcoming.

Slide six, please.

[Slide.]

MS. FEDERLINE: The centerpiece of DOE's revised program strategy is the viability assessment. It is scheduled to be complete in 1998. This is not licensing and it is not suitability.

As Dr. Dreyfus has indicated in his presentations, this is intended to provide a technical basis for making decisions about continuing with the repository development. So we would expect that there would be a lot of information that would be collected after the viability assessment was completed for licensing.

Key elements of the assessment are listed here on this slide. We have emphasized continually in the past that a design of the critical elements of the repository are essential for us to be able to review DOE's program. So we were pleased to see that that was in the package.

They have also indicated that they will present a preliminary performance assessment which will predict repository behavior and will provide a basis for planning and cost estimating for licensing work.

We believe that it is critical for us to be involved in commenting on this document. We believe that

. 10

this will be the critical decision-making document by Congress. So our program is structured to identify agreements and disagreements with DOE on the most critical issues for performance as a basis for making our comments in 1998.

Slide seven, please.

[Slide.]

MS. FEDERLINE: Dr. Dreyfus gave you a perspective on where we stood with site characterization. There have been some updates that I wanted to mention.

DOE is about three miles into the mountain at this point in time. They are back in good ground as of this morning. We receive a routine morning update from DOE on

the tunneling operations.

Four test alcoves have been completed at the site and they are currently working at the bottom of the slide on alcove five, which will be used for in situ thermal testing. That is scheduled to begin in October of 1997.

The thermal testing will be particularly critical, because that will be the testing that will give us information on how the repository behaves under heat loads. We are very anxious to see that and we are very anxious to interact with DOE on the adequacy of the design of that experiment.

Site investigations have been scaled back, as I

. 11

note here on the slide. They are focused on testing the hypotheses of DOE's waste isolation strategy. This mainly focuses on bounding of hydrologic parameters in the vicinity of the repository. They are also doing some pump tests to determine the origin of the northern gradient just above the Yucca Mountain site.

I think it is important to observe at this point that no direct observations in the ESF have indicated that there are any fatal flaws with the Yucca Mountain site, but of course it is important to continue those investigations and to probe the vulnerabilities.

DOE's emphasis on testing their waste isolation strategy seems a very positive perspective to us. We have urged them for a number of years to integrate site characterization and performance assessment. We believe that that is a very positive aspect of their program.

If there were a weakness in the program that we have seen, it is that DOE is focusing on the positive aspects of performance and not testing perhaps extensively alternate concepts. That is going to make the regulator's role even more important as we try to probe the underlying vulnerabilities in the assumptions that they make.

Slide 9, please.

[Slide.]

MS. FEDERLINE: As a result of the budget

. 12

reductions, NRC and the Center have already made significant cuts in the program. There have been a total of 16 full-time equivalents reduced from the NRC program, as you can see on the slide. This involves loss of some critical skills such as materials and nuclear engineering, geology, quality assurance, and hydrology. There has also been a loss of eight FTEs, as you can see, between 1995 and 1996 at the Center.

Our program is funded at a $17 million level in fiscal year 1996. We were able to do this as a result of some previous year money that was available to us.

Our fiscal year 1997 request is at the $14 million level. There will be $3 million in previous year money available at that point. So we will be able to sustain the program, assuming that we obtain the requested amount in fiscal year 1997 through the year fiscal year 1997, but in 1998 there will be no remaining carryover funds. So we believe it will be critical to request the full amount to sustain the program at a $17 million level.

[Slide.]

MS. FEDERLINE: Let me chat for a few minutes about our concerns stemming from the budget reductions.

We believe that the program we are at now, which is the $17 million level, is the minimally acceptable regulatory program. Even prior to the fiscal year 1996

. 13

budget reductions we recognized the need to focus the program. We were getting behind in our pre-licensing work and we felt it was important to reconfigure the program to look at the issues that posed the greatest risk to the repository.

We believe that any additional reductions that are taken would result in having to cut into the core skills that deal with those key scientific issues, and if new issues are raised at the time of licensing as a result of our not being able to probe them in pre-licensing, we believe that licensing could be untimely and could be jeopardized.

We also believe one of the most important things that we are doing at this point in time is working with EPA on the development of implementable high-level waste standards. The Center analyses have been absolutely critical. As we work with EPA, we have been doing real time analyses as they formulate their strategy for the standard,

and we have been providing these analyses to EPA so that they would have some measure of whether the standards are implementable when they put them into place.

We also feel that the level of program that we are at now is essential to provide us a strong technical basis for commenting on the viability assessment. If we eliminate from consideration some of the issues which we feel to be

. 14

key at this point in time, the licensing costs and schedules that are predicted may not have input from the NRC.

I also mention on here that if the viability assessment is found to be negative, this could also trigger an early waste confidence decision which is scheduled for the year 2000. We want to avoid introducing unnecessary conservatisms in the process.

At the bottom of the slide, we believe that a sustained funding level, the $17 million level, is needed to continue the credible regulatory program and the development of implementable standards.

[Slide.]

MS. FEDERLINE: Let me turn to our program and talk for a minute about what we have done to refocus our efforts.

Of course the backbone of our program is our program objectives. As a result of budget constraints, we have been looking at these objectives and the assumptions which underlie these objectives almost on a daily basis.

The most important activity that we have going at this point in time is our cooperation with EPA in the development of the standards. We formed a formal liaison with EPA. We have a representative who deals with the EPA staff on a weekly basis. We have been conducting meetings. We have had four meetings at the management and staff level

. 15

to discuss the development of the standards. As I said, the Center has been critical in helping us to do some technical analyses which have provided support to EPA.

EPA has told us they are going to send the standard to OMB in the May-June time frame. Our plan is to prepare comments for the Commission's consideration on the proposed standard, but at the same time we want to develop a paper on what we believe a conceptual outline of our implementing regulations would be so when you are commenting on the EPA standards you have an opportunity to visualize what our standards would look like. It is quite a tall order, given the amount of time that was taken to put standards in place the last time we had a go-around. We are working very hard on this.

We have also set our program priorities on key technical issues that are most important to repository performance. We are working hard to achieve agreement with DOE on these issues. At the current time there are two issues, the volcanism issue and the seismic activity issue where there are some differences with DOE. We continue to pursue those.

Our goal is to resolve or narrow our differences with DOE so that both organizations are focusing resources on the areas of clear uncertainty and dispute.

I would just note that we have recently closed the

. 16

erosion issue. You probably recall that the National Academy of Sciences issued a report on the erosion issue. We have taken a slightly different approach. We considered all the data that was available to us, not just the data that was available from DOE. We looked at that issue and determined it would not be significant for repository performance and advised DOE that if they had adequate data in their license application that we would be able to close that issue at that time.

Slide 12, please.

[Slide.]

MS. FEDERLINE: Another of our major objectives is to provide early feedback to DOE on potentially significant flaws in the design or the performance of the repository. We think this will have the advantage of focusing our interactions. We have established a new practice in the division. We don't have any meeting without an objective. Once we complete the meeting, we review our objectives and critique it to determine if we have met our objectives. Time is so valuable to us at this point in time that we don't want to waste time if it is not clear what we are trying to achieve.

It is also important for DOE. We want to have

interaction with DOE when site data can most feasibly be collected. It won't do any good if we get to 1999 or the
. 17
year 2000 and all of a sudden raise some concern that should have been addressed as the ESF was being constructed in fiscal year 1996.

In the face of constrained resources, we are always interested in improving our program efficiency. On the next slide I will discuss a number of ways that we have attempted to streamline our program.

Of course our bottom line goal is always developing our capability for licensing, and we are dedicated to developing the methods as well as the staff capability to do that.

Slide 13, please.

[Slide.]

MS. FEDERLINE: The focus of our technical program is to independently evaluate the ten key issues which are specific for a Yucca Mountain site. These issues have been identified based on our understanding of the site. NRC has been involved in this program as long as DOE has and we have some extensive experience both on staff and at the Center.

We also are conducting our own performance analysis. We call it iterative performance assessment where we continually confirm the significance of the key technical issues. We have also done a systematic assessment of our regulation to ensure that we haven't forgotten anything.

Our key issues are consistent with DOE's waste
. 18
isolation strategy, but as a regulator we have the appropriate role of probing vulnerabilities and DOE has the role of proving the positive aspects. So there will be slight differences in the key technical issues as we go along. We believe that this will allow us to evaluate the vulnerabilities in DOE's assumptions.

In order to improve the efficiency of our program, we have recently reorganized in the Division of Waste Management and we have consolidated the high-level waste work into two branches. We feel this will have enhanced management oversight at the branch chief level as well as facilitating communications.

We have also established a management board. I participate in that board, the Center participates, and each of the branch chiefs that are involved in overseeing the activities.

We also have multidisciplinary issue teams focused on bringing all the requisite skills to the solution of each of these independent issues.

We have developed implementation plans which have laid out all the activities necessary to conduct between now and 1999. We have prioritized those activities and we are moving ahead with those activities which are most significant in the 1996 time frame. That does include specifying a path possible for resolution.
. 19
I would just note that the focus of our 1996 program is on using sensitivity analyses to independently assess the relevant importance of KTIs. We want to ensure that we are not spending our resources on some aspect of an issue which overall will not be important for repository performance.

With this as a backdrop, I would like to turn it over to Dr. Patrick, who is president of the Center for Nuclear Waste Regulatory Analysis. He will discuss the relationship between our issues and DOE's waste isolation strategy and our management approach for narrowing our differences with DOE on key issues.

Wes.

MR. PATRICK: Thank you.

Slide 15, please.

[Slide.]

MR. PATRICK: As part of its response to the budgetary and programmatic changes that have just been described, DOE has proposed a strategy for evaluating how well the repository at Yucca Mountain would contain and isolate waste. This is their waste isolation and containment strategy.

It focuses on two primary objectives. One is limiting the annual dose to the public for the period of time to be specified in the EPA standard, and second,
. 20
providing containment of the waste within the waste packages.

The strategy comprises five basic assertions or assumptions that underlie the safety case that they would intend to make in their license application, and, by implication, what they would intend to focus their activities on during the viability assessment.

You can see those five enumerated here. I would just point out a couple of key features about them.

Most importantly, and you will see this theme running throughout the remainder of this presentation and showing up in a variety of the documents that we produce over the next several years, groundwater is the principal path of release for radionuclides. With the exception of just a few radionuclides that exist in gaseous form, those are the most likely nuclides that will be the focus of uptake in future populations. Consequently, both DOE's strategy and also the key technical issues that we are examining are focused on groundwater, potential disruptions to those groundwater flow paths, and related sort of events.

Sixteen, please.

[Slide.]

MR. PATRICK: We have identified a total of ten key technical issues, or KTIs. Those span the entire range of concerns that must be addressed in testing those five

hypotheses or assumptions that comprise DOE's waste isolation and containment strategy.

In contrast to the basic strategy that DOE has proposed, several of our key technical issues go beyond the basic performance, the so-called undisturbed performance of the repository, and they explicitly identify potentially disruptive processes and events that could occur. A couple of those have already been alluded to: volcanism, which is indicated here on the top; and then part way down the chart, the structural deformation processes and related seismicity, earthquakes, and so forth.

For low probability events, our focus of attention is going to be on the consequences of those events in terms of risk to the public.

You will note down the side of chart 16 a number of priorities that are indicated. The first level of focusing of the resources that are available was to identify these ten key technical issues. As an adjunct to that, to further focus our attention, we have also assigned these priorities, as indicated here.

There is always a question as to whether we have identified the right KTIs and whether we have assigned the right priorities to those. It is always a good question and it doesn't always have a good answer. Consequently, we use the sensitivity analyses that have been alluded to earlier

and the iterative performance assessment process, those two things together with the continual acquisition of data by the Department of energy and the focused acquisition of data in a confirmatory sense and an exploratory sense from the staff side to probe whether those are indeed the issues that we need to focus our attention on and whether we have assigned them appropriate priorities and given them appropriate resources within the constraints that exist.

Slide 17.

[Slide.]

MR. PATRICK: We have identified an approach to issue resolution which comprises the four points that are indicated here. There are a number of other programmatic aspects, of course, that deal with specific aspects of interacting with the Department of Energy and other interested parties, but these four basic elements are the centerpiece of our issue resolution process.

The first two, as you can see, deal primarily with data. They include the provision for the staff to do confirmatory testing and evaluations regarding DOE's assumptions. The staff will also critically evaluate the conceptual models that DOE has proposed in that waste containment and isolation strategy. And very importantly, where appropriate, we will go beyond those conceptual models and propose alternative conceptual models where we feel that

perhaps the full range of potential models based on available data both at this site and at analog sites may not have been address.

Each of the five elements or hypotheses of DOE's strategy will be rigorously tested, as indicated in the last bullet, using independent total system performance assessment calculations and the associated sensitivity

analyses.

Slide 18, please.

[Slide.]

MR. PATRICK: This issue resolution process has associated with it a number of specific products or milestones. Outputs that we will use both to pace our progress toward resolving issues and, where we have achieved resolution at the staff level, to document that that resolution has been attained.

You will note here that one of the key areas deals with interactions with the EPA regarding the development of the Yucca Mountain standard. The staff is working very closely with EPA; NRC is interacting directly with them, and as Margaret indicated earlier, the Center is involved with your staff in performing calculations that support evaluations as to whether what is being proposed in those standards will in fact be implementable when we move down the road to developing a revised 10 CFR Part 60.

. 24

Sensitivity analyses play a key role, as we have mentioned several times. The management board has put a particular focus on these areas. Between this year and next we intend to complete sensitivity analyses in all of the areas involved, as I've indicated here. Many of those will be conducted during calendar year 1996.

Acceptance criteria and review procedures continue to be developed. When we briefed you a year or so ago the focus of those activities was in the context of a license application review plan. Since that time, with the revision of the DOE's program, the focus is now not so much on licensing in the near term but on the viability assessment.

We are examining how those review procedures should be posed and what criteria are appropriate for that first phase of evaluation, determining whether the site is indeed viable and where it should proceed with the development of a repository at Yucca Mountain through the licensing process.

One of the major changes that we have seen in the program this year is that there are relatively few DOE products that are going to be coming forward, nowhere near the number of products that we have seen in previous years where we would be involved in reviewing various study plans and scientific investigation plans, and so forth.

One of the critical documents that is becoming

. 25

more and more important as we approach viability assessment as well as the license application that will be anticipated in the future is their total system performance assessment. We have just received their TSPA, total system performance assessment '95. Staff is involved in reviewing and evaluating that.

We are going to do a two-phase review, first to do an audit review of that document to try to identify those areas that are most crucial, that need the most staff attention, and we are going to focus in on those areas and do detailed technical review, which may include selected calculations and sensitivity analyses to determine whether, number one, we understand the assertions that DOE is making, whether we can agree at this point with their conclusions, or whether we ought to be commenting back to them with respect to either the adequacy of the data, the adequacy of the conceptual models, or the mathematical formulation of those models and how they are manifest.

The last item on slide 18 is the culmination of the year's work under the new program, which will be an issue resolution report where we will document progress toward resolving the issues as we have postulated in the form of these ten key technical issues. That will be done within the context of the DOE waste isolation and containment strategy.

. 26

Having looked at the general issue resolution approach that is anticipated, beginning with slide 19 I would like to go into a specific example of the resolution process.

[Slide.]

MR. PATRICK: We have chosen here infiltration, the percolation, the movement of groundwater from precipitation down to the repository level, and then on to the water table and out to the accessible environment where future generations would be affected by the presence of radionuclides in that groundwater.

As I indicated earlier, the focus of much of the

program is indeed on every aspect of groundwater flow.

This example mirrors that of many of the others. Typically we find that there are three fundamental issues that must be addressed with each of these: the quality of the data and the sufficiency of that data; the adequacy of their models, including whether appropriate ranges of alternative conceptual models have been postulated; and finally, how they have bounded the potential future events that could occur at the site.

Those three basic areas we find have to be addressed in essentially all of the areas that we are examining and certainly with regard to this specific example of infiltration.

. 27

[Slide.]

MR. PATRICK: Slide 20 shows the starting point of this particular issue resolution, dealing with the example of infiltration. We have constructed a geological framework model using information that is available about Yucca Mountain and its vicinities, and we have drawn that data into a basic model that includes the information we need to address the two basic parts of infiltration, a shallow infiltration, the upper 30 meters or so of the area, and then the deep infiltration.

I would note that the shallow infiltration requires certain kinds of data that are a little bit different than the deep infiltration. Of most importance, and it is displayed here pictorially, are things like topography, the elevations, hydrologic properties of surface outcropping units, spatial distributions of rainfall and the like. Those are the sorts of things that we need to get a firm understanding of the shallow infiltration processes which in turn drive deeper infiltration.

The deep infiltration, on the other hand, is governed more by such matters as the stratigraphy and the structural geology.

I would note a couple of things about this figure. With regard to the structural geology, you will notice some fault zones that are indicated there in cartoon fashion, and

. 28

we have also indicated a tick that shows the general level at which the repository horizon transects this particular geological framework model.

[Slide.]

MR. PATRICK: If we were to take a slice through the top of this geological model, you will see one of the more critical factors affecting the shallow infiltration, and that is the spatial distribution of the basic rock units that exist at that site. We will get into that a little bit later, in the next slide. Here you can see the outcropping of the alluvium, the soil-like materials, the welded and fractured tuff unit, and the non-welded unit indicated there in blue.

I would also note the outline of the proposed repository is shown on this figure as well.

[Slide.]

MR. PATRICK: Slide 22 shows two basic models that we are using to examine the process of shallow infiltration.

You will notice there on the left there is one indicated in a brownish, reddish hue. That is a good model for flow through alluvial materials or through non-welded tuff units. This is a model where the mode of flow is dominated by matrix processes, flow through the matrix.

The one on the right is a little more complex model. It's a second model, a separate model that we use.

. 29

It treats the infiltration through an alluvium layer of variable thickness and then looks at the fracture dominated flow process.

This is an example of where we are treating two different conceptualizations of the geological material, one with a matrix flow process and another one with a fracture flow process.

We find that the thickness of the alluvium in that right-hand model is one of the most important characteristics that is needed to understand the infiltration of water down to the fractured area. It is one of these situations where if the alluvium is very shallow, in fact nonexistent, there is a potential for greater runoff and less infiltration. If it is very deep, there is the potential that the water will be captured long enough that much more of it will transpire back into the atmosphere. But there is a middle zone of ranges of thickness of that

alluvium which seem to be very sensitive in driving the deeper infiltration process.

The arrows up at the top of the diagram, we won't go into detail, but those are basic processes that take place at or near the surface of the earth and need to be included in the model to be able to understand the shallow infiltration process. So we show the effects of long and shortwave radiation from sunlight impinging on the surface,

. 30

precipitation, vaporization of the moisture, and so forth.

[Slide.]

MR. PATRICK: We took those two basic models and the information contained in slide 21, coupled them together and ran a series of calculations on a 30 by 30 meter grid spacing across Yucca Mountain's proposed repository area and the surrounding vicinity. From that we were able to do a calculation that indicates the range of estimates of shallow infiltration that could occur based on the information that is currently available about the Yucca Mountain site.

I just notice broadly here this color band that starts from very low infiltration rates, on the order of one centimeter per year or less, and scales up to something in the range of six to eight centimeters per year.

At most locations, it is important to note, the shallow infiltration is relatively low, but we do see critical areas where levels of infiltration much greater than the average are calculated to occur based on these models.

We integrated across this entire area and calculated some average rates of shallow infiltration.

[Slide.]

MR. PATRICK: That brings us to some of the basic conclusions that we can make even at this early stage with regard to resolving the issue related to shallow

. 31

infiltration. So far the results of our studies and comparing them with some of the work that the U.S. Geological Survey has done are very encouraging. Our independent calculations are within about a factor of 2 of what the U.S. Geological Survey has recently reported having made actual measurements in a number of boreholes in and around the proposed repository site. As far as hydrology goes, a factor of 2 is pretty good.

We feel at this point, based on internal discussions with your staff, that this aspect of the issue can probably be resolved. We can agree to an average infiltration rate of on the order of 12 to 25 millimeters per year. That seems reasonable for this particular site.

The next part of the issue, the deep infiltration, is where we begin to see some differences in the conceptualization of the problem in an area where we anticipate that considerable additional work is going to be required.

In the same document where the USGS reports these shallow infiltration results they postulate a model where they believe that because of differences in material properties the water will move very rapidly horizontally or down dip away from the repository site. In a manner of speaking, shedding the water away from and preventing or precluding much water infiltrating deeper into the mountain.

. 32

Based on our earlier comments that we have made here, that is a critical assumption. Repository performance is going to be directly and vitally affected by how much water moves into the repository both from an aspect of a transport mechanism, and before that in time, from the standpoint of how the containers come in contact with moisture and corrode as time goes on. So we have got to focus on this particular area.

[Slide.]

MR. PATRICK: We have run a few preliminary calculations that highlight the difference between the model that we are postulating and the model that the U.S. Geological Survey has noted in their particular case. Here, unlike the earlier one, I have taken a vertical slice through an area of Yucca Mountain, one which transects a fault with properties very much like the Ghost Dance fault.

We have modeled the stratigraphy, put in properties as best we know them at this point, and tried to examine what would happen as water infiltrates from those shallow models and begins to move. Well, where does it move?

In this case we show that in an example where the water can pool or pond up against that fault structure, as indicted there in the blue and green colors, and can cause

. 33

infiltration to move down deeper into the formation, where the infiltration from the shallow levels, instead of skirting off to the right of this diagram and being diverted from the repository, may in fact form what is called a trapped or perched water zone along a fault structure, causing infiltration to occur to deeper levels as time goes on.

Just to summarize, our study reveals that those contrasts in permeabilities between the stratigraphic units and the presence of faults such as the one shown here can form perched water zones and they could cause the water to move downward. That is a hypothesis or set of hypotheses, depending on how one would want to break them down, that has to be tested, because it is critical to the containment and isolation strategy that has been proposed.

If we take that a step further and try to a little more quantitatively understand why we are concerned about such matters perhaps seemingly esoteric to some about the perching of groundwater and enhanced deep infiltration, you can see that in slide 26.

[Slide.]

MR. PATRICK: Here we are showing the most recent results that NRC and CNWRA staff have developed, iterative performance assessment 2, which has been completed and recently published, and the most recent example of the TSPA

. 34

that we thoroughly reviewed and evaluated, TSPA-93. DOE does TSPAs every two years, and as I indicated earlier, we have not gotten into TSPA-95 deeply enough right now to make a comparison of this sort, but we will be in the future.

You will note that the probability distributions show quite different results. Very critically, if you look at the Sandia curve, many of the sample infiltrations for their total system model show zero deep infiltration. Another way to compare that information is that if you were to draw a vertical line upward from the 1 millimeter per year line, you will see that about 90 percent of Sandia's cases would have infiltrations driving their performance assessment of less than 1 millimeter per year.

In contrast, our model, our conceptualization of the problem would show something a little over half of all the cases would have infiltrations that low.

These higher infiltrations can lead to fracture flow and can lead to greater movement of groundwater down to the repository level.

[Slide.]

MR. PATRICK: That difference in infiltration is in turn reflected in terms of total releases that are calculated to occur from the repository, based on our performance assessment calculations, and we just show here the aqueous release models both from Sandia's performance

. 35

assessment, TSPA-93, and the staff IPA Phase 2.

You will notice there is about a three order of magnitude difference between those two sets of calculations. I would point out that there are other differences between Sandia's model and NRC's model that are being presented here, but certainly the infiltration aspect of it is a dominant player in influencing the total system performance assessment.

I have kind of come full circle now from my initial assertion of how important groundwater is to now showing calculationally that it is one of the major factors that drives the calculated releases of radioactive materials from a proposed repository area.

Using that as a little bit of a springboard, I would like to address a question that is often put to us, and that deals with iterative performance assessment in its broadest sense. Why does one need to keep iterating? What kinds of things drive this ongoing process?

[Slide.]

MR. PATRICK: One can come up with a number of lists. I happen to have a list of four here that we feel are critical areas that must be addressed and can best be addressed using total system performance assessments.

Certainly new site data continues to be collected by the Department of Energy, and we continue through

. 36

programs to get confirmatory data and also to do

investigations that provide us with insights into how to conceptualize the Yucca Mountain repository, how to develop conceptual models. Those models, those data, can affect and directly affect the output of the total system performance assessments. So as we collect data, as we get new conceptualizations, we need to fold those back into those total system performance assessments.

Conducting sensitivity studies is important not only from the technical aspect of really understanding the relative importance of the processes and conditions, but from a management perspective those same sensitivity analyses help us to identify what the key issues are and to put proper priorities and proper resources on to each of those key technical issues.

The third area. We do use performance assessment to evaluate, to test the adequacy that DOE's bounding analyses are providing to us, and most specifically, to test those five key hypotheses that they proposed in their waste containment and isolation strategy.

The fourth area, which ties in quite tightly to the first one as well, is to actually incorporate the new models and the new data into the total system performance assessment.

The first bullet deals more with getting a basic

understanding and doing what we call auxiliary analyses to understand whether this new process or whether these new data are really going to have an effect. Ultimately, in a total system performance assessment model we find that we have to do some simplifications, and that is what we come down to here in the last bullet.

I am noting there three particular areas that just in the last 12 to 15 months have been areas where we have made some changes in our total system performance assessment.

The focused infiltration, which we spoke to today.

We have looked and are continuing to look much more critically at an ash dispersion model, which is very critical to our evaluation of the relative importance of volcanism, which, as Margaret noted earlier, is one of the areas that is in discussion between us an DOE as to the importance of that particular issue.

The third one is an interesting one. Originally EPA had a release standard, and the TPA code was set up to calculate releases. When we did our iterative performance assessment 2, we had begun to get some insights into the potential move toward a dose-based model. So we introduced some dose calculation capabilities. Now, with the NAS recommendation in hand, we are moving another step, to a risk-based calculation. So the iterative performance

assessment and the total system performance assessment codes have to be revised and need to be run again to be able to incorporate those changes, both technical and regulatory, into the modeling context that is available to us.

I would like to turn the microphone back over to Margaret Federline at this point to wrap up.

[Slide.]

MS. FEDERLINE: I would just note we will have an opportunity to speak to you more in May about our performance assessment program, both high-level, low-level and SDMP.

In summary, despite the uncertainties which remain regarding the legislation and the funding and regulatory environment, we really believe that we have put in place a program that has the flexibility to respond to these changes if a sustained level of funding can be achieved.

We have focused on our issue resolution and testing of DOE's waste isolation and containment strategy assumptions. We believe that sustaining the program at $17 million is important to maintaining a credible regulatory program as a basis for our viability assessment comments.

Thank you.

CHAIRMAN JACKSON: Let me ask you a couple of questions. Let me go back to you for a second, Dr. Patrick. Perhaps this will come out more at the later briefing you

promised where you will talk about the performance assessment in more detail.

You talked about doing risk-based calculations. When I think about iteration or iterative processes, I think of updating. How do you go about doing that? Do you take some kind of a Monte Carlo type approach? How do you

actually end up doing that in real life?

MR. PATRICK: The basic approach is a Monte Carlo approach.

Let me back up a little bit further from that. The code structure that we were wrestling with in the early years of the program was to try to get something in place very quickly, to try to get some calculations in hand so we could try to scope the scale of the problem.

Beginning with iterative performance assessment phase 2, though, we took a very deliberate approach to developing a total system performance assessment code, which we call TPA, that would be modular in form, that would have a basic executive code and then a variety of modules that could be called and used as needed.

What we see happening now as time goes on, in some cases, where it is a matter of new data coming in, we will feed in a different probability distribution for those properties. For instance, permeabilities or something of that nature.

CHAIRMAN JACKSON: That's how the modularity helps?

MR. PATRICK: The data input part is we removed all hard wiring of data from the code as well.

CHAIRMAN JACKSON: I'm talking about where you use different probability distributions.

MR. PATRICK: The modularity really comes in where you have a more fundamental change in the model that is being used. For instance, some of the early calculations, the volcanism models and the structural geology models, faulting modules, were very rudimentary. They were based on rather gross assumptions, particularly with regard to disruptions of waste containers, assuming that a waste container was somehow a cantilever beam that was being shaken back and forth. Not a very good model, but to get an initial handle on how things were going we chose to do that within the resources. The modularity really comes in that now we are going to be able, with additional time, additional data available, to do a much better conceptualization of that problem.

Budhi.

MR. SAGAR: I think the main updating is relative to assumptions. I think all performance assessments, however complex they are, have underlying assumptions. The fewer you make the more confidence you have. That is what

iteration essentially does, that whatever more you have learned either of the processes that must go into models or the data, that helps you to understand the site better, or you know more about design. So long as you can update with respect to those new things, your final result, I think that is the updating we are talking about.

CHAIRMAN JACKSON: I see.

MR. SAGAR: We do use Monte Carlo, but that is primarily to take into consideration the uncertainties in parameters, in models, in whatever else.

CHAIRMAN JACKSON: If you do this kind of updating, when is enough enough?

MR. SAGAR: I think that is a very difficult question to answer. That is not only with respect to the analyses when it is enough, but also when is data sufficient. I think you have to make judgments at some point. I think you have to start saying, can I live with this amount of uncertainty that I am predicting?

Personally I don't think you can use at the time of licensing the latest state-of-the-art models, because you must have something that is proven, that exists in literature, that other people have tried. So you are always a few years behind the so-called cutting edge.

But that is a judgment call. I don't think there is a mathematical expression that we can say, if this, then

you are done. At least I don't know of any.

MR. PATRICK: But we are finding some specific areas where we are getting answers to that. For instance, generally speaking, the repository for at least the low and intermediate thermal loading conditions is relatively insensitive to rock mechanical properties, the strength of the rock, and so forth.

We have done some preliminary calculations. We have another sequence of those calculations with better models this year that we intend to run. In the second area, these models suggest that minor opening and closing of

fractures around the underground openings is relatively unimportant. They change flow properties by factors of two and three and four, whereas the natural variability in the rock is several orders of magnitude. There is an area where you can apply a judgment and say, well, if I am playing around with 30 to 50 percent or even 100 percent when my rock naturally is varying by several orders of magnitude, I probably know enough at that point.

True, it's a judgment, but I think it is one that is reasonably well substantiated, particularly if you look at a risk curve or total system performance assessment output and find that performance is relatively insensitive to changes on that order of magnitude.

CHAIRMAN JACKSON: Does that become your de facto

metric, that is, how much your total system performance assessment changes as a function of the residual uncertainties?

MR. PATRICK: I think that is probably, in my mind anyway, the key factor that comes into play in terms of how much is enough, which is your basic question, I think.

MR. PAPERIELLO: That is certainly the way I've always viewed it.

CHAIRMAN JACKSON: I noted that at the last briefing the staff made to the Commission you indicated that DOE and the NRC still didn't agree on two issues, having to do with igneous activity or volcanism and structural deformation. Where do things stand at this point?

MS. FEDERLINE: The focus of our program this year in both of those programs is volcanism. We are doing sensitivity analyses to try and understand for ourselves where additional data would really make a difference. Those analyses should be completed towards the end of the summer and we should be able to have an interaction with DOE and discuss where we believe additional data would make a difference, and narrowing those differences.

In the area of seismicity we are primarily focusing on developing an agreement on the methodology. That will be the focus of this year's activity. Once we agree on an appropriate methodology and how it will be

handled, I think that will go a long way to resolve that issue.

CHAIRMAN JACKSON: You mentioned that you would be taking an approach of developing a site-specific standard.

MS. FEDERLINE: Yes.

CHAIRMAN JACKSON: Have you done any resource estimates associated with doing that vice conforming the existing Part 60 to the EPA standard?

MS. FEDERLINE: We have done some rough estimates. We believe that the resource estimate for creating a new part is about the same as it would be for revising the old part. It's a question of looking to see what aspects of the old Part 60 need to be incorporated. The only new pieces that we would be adding would need to be added to the old standard as well. It is sort of a sum game.

CHAIRMAN JACKSON: But you think you will end up with a cleaner rule?

MS. FEDERLINE: Yes.

CHAIRMAN JACKSON: Where you take care of the implementation as part of that?

MS. FEDERLINE: Yes.

CHAIRMAN JACKSON: Let me ask one last question and then I will pass the token. I noted that you indicated that no construction-related disqualifying conditions had been noted so far during the tunneling. What kind of

disqualifying conditions might be considered during the tunneling operations?

MS. FEDERLINE: I will comment and pass it along to Wes. He can add to it.

As we understand it, the predictions that DOE has made from the surface about seismicity and faulting are holding up rather well. As I understand it, their predictions of the flow system also have been holding up.

Let me ask Wes if he has some things to add.

MR. PATRICK: Personally I think the real answers to those questions are not to come until the testing in the alcoves is fully underway. To date most of what you can do following a tunneling machine has been done, but it is very observational in nature, with the arguable exception that the ground tends to be a little more broken up than I think many people anticipated. That is something that has been

published a number of times in various press accounts.

My own view, speaking as a mining engineer and not necessarily as the president of the Center now, is that is the norm for underground. I think the only people who are surprised by that are people who have never been underground, frankly.

The Department of Energy seems to be taking a very prudent and very conservative approach with regard to the kinds of support that they are placing in the tunnel. I can

. 46

understand why they would do that.

When people do a little bit of cat kicking and say, well, gee, they have had much more category 4 ground -- that's one of the four on a scale of 1 to 5 -- than was anticipated, you have to understand that many of their decisions seem to me to be driven by programmatic concerns with regard to worker safety, which I think is a very prudent way to go.

The testing that will be done in the alcoves is going to be vital. We have briefed the Commission before; your staff has; I think the NWTRB interactions -- all of those have long pointed in the same direction, that the most important thing DOE could have done was to get underground and get underground as quickly as possible. They are doing that now.

My anticipation is within the next year or 18 months or so we are going to see some very critical data, data that is vital to understanding whether that site is viable and whether work should continue to progress. Frankly, I see that many of our questions will be answered as that work goes on. The thermal testing in alcove 5 is going to be particularly important in that regard, because so much of what is being postulated about the performance and so much about the design is driven by the thermal processes: What is the heat? What is the emplaced waste

. 47

going to do to the movement of water? What is it going to do to the rock mechanical response? And so on and so forth.

CHAIRMAN JACKSON: So you are qualifying your answer about disqualifying conditions?

MR. PATRICK: Yes. I would say it is about as close to absolutely true as one could state it to say that nothing has been seen that would disqualify the site. My qualification on that is that there are things one needs to measure before one can really make a firm substantive comment with regard to qualification of the site.

CHAIRMAN JACKSON: Is there an implementation schedule with milestones and is it tied to the alcove work?

MS. FEDERLINE: DOE's schedule?

CHAIRMAN JACKSON: Yes.

MS. FEDERLINE: Yes. As we understand it, that is the detail that we have not had an opportunity to look at yet.

CHAIRMAN JACKSON: I'm saying that would be driving the schedule and the milestones for resolution of these key technical issues.

MS. FEDERLINE: That's correct, yes.

CHAIRMAN JACKSON: Commissioner Rogers.

COMMISSIONER ROGERS: We might as well stay on this topic, because I am very interested in it. I find it puzzling to visualize how this whole thing is going to come

. 48

together. DOE says that they are going to have their viability assessment completed by the end of 1998. The kinds of data that you are talking about from the alcoves, particularly thermal data, is that going to be available in any meaningful form before then?

MS. FEDERLINE: If there was an area of concern, I think that is it. We believe we are going to have one cycle of heat data before the viability assessment. It would be desirable to have more than that data by the time of licensing.

What we are currently looking at is, with a construction authorization, the question is what determines reasonable assurance, how many confirmatory items will there be at the time of construction authorization. Clearly DOE has indicated that they plan to collect more data beyond construction authorization.

Wes.

MR. PATRICK: I would agree with that.

COMMISSIONER ROGERS: I know they have said that, but the viability assessment, if it depends in any critical way on thermal data, it is hard for me to see how you are

going to have any meaningful thermal data. You really have to have it right now to be able to wind up that viability assessment by the end of 1998, which is just around the corner.

. 49

MR. PATRICK: We have not been part of the hearings that have been going on downtown and we have not yet seen DOE's detailed information, but the last that we have available is that they were looking at one of the lower parts of the range of thermal loads as what they would come in with and do their viability assessment on. If that is true, the thermal loading question may not be as great. It is at the high end of the thermal loads where they are counting on very long dry periods that the data become most critical, at least from our perspective.

As Margaret indicates, one cycle of thermal data is about what is going to be available.

COMMISSIONER ROGERS: What is a cycle? How do you define a cycle?

MR. PAPERIELLO: A year.

MS. FEDERLINE: It is actually one heatup of the mechanical heating device, which will change the temperature of the rock surrounding the device one time.

MR. PATRICK: Again, we haven't seen the details, but typically what one does in a heater test like that is ramp up and either through guard heaters or control of a main heater get some sort of a plateau in thermal output and make a series of measurements in terms of how mechanical and hydrological and perhaps pneumatic flow pathways change or are altered during that cycle.

. 50

It is a little speculative at this point until we see the details of their plan. It's more than a little speculative.

MR. SAGAR: I think we had estimated at one point a couple of years ago that you probably needed a 10-year thermal test to get some dependable data.

COMMISSIONER ROGERS: That's what I've heard.

MR. SAGAR: Obviously by 1998 there is no way we are going to get that kind of data. So it would remain a large uncertainty in the whole analysis. I think you will have to deal with it again in making judgments whether the conclusions that are being drawn can be supported by other data.

MR. PATRICK: During this time Budhi alludes to, even then we were counting on the large block tests at Fran Ridge progressing. That would give many insights into the performance of these kinds of rocks under those conditions. That as well is not going forward. So we have lost some time there, and some data.

COMMISSIONER ROGERS: In your presentation, Ms. Federline, on slide 10, you emphasized the need for a sound technical basis for evaluating DOE's viability assessment -- it is one of the subtopics under the second bullet -- which could trigger early Commission waste confidence review.

. 51

What did you have in mind there that would trigger an NRC waste confidence review other than abandonment of the high-level waste program?

MS. FEDERLINE: If a negative viability assessment is found at that point, if DOE goes back to Congress and there is a conclusion that it is not feasible, licensing costs are too great, there is too much information that needs to be obtained, that could cause a triggering of the waste confidence.

COMMISSIONER ROGERS: You seem to imply here that we needed a sound technical basis for our evaluating their assessment, and that assessment might not be a negative assessment.

MS. FEDERLINE: I guess my point there is that without an adequate technical basis we would have to make perhaps unnecessary conservatisms, which would drive our comments to say far greater time frames or costs would be involved.

COMMISSIONER ROGERS: I see.

Dr. Patrick, in your key technical issues priorities list you listed the repository design and thermo-mechanical effects as priority 3 and total system performance assessment as priority 1. How do you do a total system performance assessment if you don't have a repository design fairly well in hand? They are coupled together,

. 52

aren't they?

MR. PATRICK: They are indeed. An even stranger one at first glance perhaps is the radionuclide transport one being priority 3. The reason it is priority 3 is that our sense from the calculations we have done is that the performance of the repository is relatively insensitive to the details of the design.

COMMISSIONER ROGERS: I see.

MR. PATRICK: So we need to have a good ACD, advanced conceptual design, for the repository to be able to conduct a total system performance assessment, but we give it a priority 3 because performance is relatively insensitive to it, and number two, we believe that DOE is on track. We spent a lot of time with them and commenting on their design process in the last couple of years or so and believe that that process is on track now. We anticipate getting a good design, so consequently we can downplay that priority.

MS. FEDERLINE: This sort of reinforces the point I was making. We are really down to the meat of the program. We believe priority 1 through 3 are important, but we had to do some relative prioritization.

COMMISSIONER ROGERS: I understand what you are saying now. That helped me very much.

That's all I have.

CHAIRMAN JACKSON: Commissioner Dicus.

COMMISSIONER DICUS: I don't have any questions.

CHAIRMAN JACKSON: Let me ask you this question, because I want to be sure I understand. DOE does this total system performance assessment and the approach you are taking is what you are calling an iterative performance assessment. You are saying that there is enough in the linkage between the two that you end up coming to concurrence and convergence on what would be the key technical considerations, such as waste package design and its relative significance, et cetera.

Is that a true statement?

MR. PATRICK: That is correct. I would put one qualification in there. The implication of part of what you said is that our models are similar enough.

CHAIRMAN JACKSON: No. There was no implication implied.

MR. PATRICK: That would be the only thing I would clarify. Many people believe that one strengthens the case if by taking a somewhat or maybe even quite different approach one comes to the same basic understanding.

CHAIRMAN JACKSON: That is what I am asking you. You were saying something about being comfortable with DOE's results, and I am saying, so DOE has its way of doing its total system performance assessment. You, on the other

hand, do your iterative performance assessment. I guess the reason I asked the question is, in order for you to have that comfort, that implies that there is some convergence or concurrence via your different methodologies on what the relative importance of these various issues and factors are.

MR. PATRICK: Yes.

MR. SAGAR: I might note that DOE also does iterative performance assessment. Their TSPA-95 is another iteration on what they did in 1993.

CHAIRMAN JACKSON: Whatever you call it, PA, performance assessment, whatever letters you want to put on it, my point is the reason you have the comfort, so to speak, in what the DOE is doing is that out of the two approaches you nonetheless have similar results in terms of relative importance of the different factors. You are saying you continue to iterate until your uncertainties don't affect the overall performance assessment.

MR. PATRICK: From the example you can see a case where the flip side is true, where their assumptions lead them to three orders of magnitude less release calculated than what ours did, and that immediately highlights in our minds the importance of that.

We and DOE agree. Right now we don't agree with the different models we are using, but we do both agree now that performance is so sensitive to that matter of

infiltration that both organizations need to put concerted effort into understanding it better. That is really what I think it is all about, to focus the resources of both organizations so that we can understand where the problem areas and uncertainty areas are so that we can resolve those

issues.

CHAIRMAN JACKSON: I would like to thank Dr. Patrick, Dr. Sagar, and the NRC staff for an informative briefing. This always enhances our perspective on the NRC high-level waste management program and the challenges that it faces. You keep us mindful of the various constraints that resource constraints place on that.

I commend both the staff and the Center representatives for working through these issues and for developing in the face of exigency maintaining a credible program. Your presentation will, of course, be useful. We expect you to keep us informed of the progress and look forward to future briefings on these important issues.

Unless fellow commissioners have any comments, we are adjourned.

[Whereupon at 3:20 p.m. the meeting was adjourned.]