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NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON NUCLEAR WASTE (ACNW)

144TH MEETING

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TUESDAY,

JULY 29, 2003

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ROCKVILLE, MARYLAND

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The ACNW met at the Nuclear Regulatory Commission, Two White Flint North, NRC Auditorium, 11545 Rockville Pike, at 9:30 a.m., B. John Garrick, Chairman, presiding.

COMMITTEE MEMBERS:

B. JOHN GARRICK, Chairman

GEORGE M. HORNBERGER, Member

MILTON N. LEVENSON, Member

MICHAEL T. RYAN, Member

DR. RUTH F. WEINER, Invited Expert

PANEL MEMBERS:

ROBERT BERNERO, NRC (Retired)

STEVE FRISHMAN, State of Nevada

JOHN KESSLER, EPRI

RICHARD PARIZEK, Pennsylvania State University, NWTRB

WENDELL WEART, DOE/Sandia National Laboratories

CHRIS WHIPPLE, ENVIRON

ACNW STAFF PRESENT:

JOHN T. LARKINS, Executive Director - ACRS/ACNW, Designated Federal Official

SHER BAHADUR, Associate Director - ACRS/ACNW

HOWARD J. LARSON, Special Assistant ACRS/ACNW

NEIL M. COLEMAN, ACNW Staff/Designated Government Official

RICHARD K. MAJOR, ACNW Staff

MICHAEL LEE, ACRS Staff

TINA GOSH, ACNW Staff Summer Intern/MIT

NRC STAFF PRESENT:

HANS ARLT, NMSS/DWM

JOHN BRADBURY, NMSS/DWM

RALPH CADY, DWM/NMSS

LARRY L. CAMPBELL, NMSS/HLWB

TED CARTER, NRC/DWM

NRC STAFF PRESENT: (CONT.)
KUIN CHANG, NMSS/HLWB
JIM DANNA, NMSS/HLWB
DAVE DIODERO, USNVTRB
JAMES FIRTH, NMSS/DWM
JASON FLEMMING, NRC
CHRIS GROSSMAN, NMSS/DWM
GREG HATCHETT, NMSS/DWM
LATIF HOWARD, NRC/NMSS
BAKR IBRAHIM, NMSS/HLWB
BANARD JARANNATI, NMSS/DWM
PHILIP JUSTUS, NMSS/DWM/HLWB
TIM KOBETZ, DWM/NMSI
BRET LESLIE, NMSS/RT6
TIM McCARTIN, NMSS/DWM
TOM NICHOLSON, NRC/RES/DSARE
JACOB PHILIP, NRC/RES
JEFFREY POHLE, Division of Waste Management
PHIL REED, RES/DSARE
KING STABLEIN, NMSS/DWM
CHERYL TROTTER, NRC/RES

ALSO PRESENT:

DEBORAH BARR, DOE

LES BRADSHAW, Nye County, Nevada Department of Natural Resources and Federal Facilities

DANIEL BULLEN, NWTRB

VERONICA CORNELL, Parallax

GUSTAVO A. CRAGNOLINO, CNWRA-SWRI

NICK DiNUNZIO, DOE

DOUG DUNCAN, USGS

ATEF ELZEFTAWY, Las Vegas Paiute Tribe

COLLEN GERWITZ, NYSERDA

CECIL HAULON

NORM HENDERSON, DOE/Bechtel-SAIC Company, LLC

KAREN JENNI, DOE (LLNL)/Bechtel-SAIC Company, LLC

ERNEST LINDNER, LAP/Bechtel-SAIC Company, LLC

ROD McCULLUN, NEI

AHMED M. MONIB, DOE (LLNL)/Bechtel-SAIC Company, LLC

ROBERTO NABALAN, Southwest Research Institute

TIM NIEMAN, DOE (LLNL)/Bechtel-SAIC Company, LLC

MICHAEL O'MEALIA, State of Nevada

ENGLISH PEARCY, CNWRA

JIM SHAFFIN, MTS-East

SURANNU STIVGLINSKI, Las Vegas Sun

E. J. TIESENMAUSEN, CCCP

JUDY TREICHEL, Nevada Nuclear Waste Task Force

ALSO PRESENT: (CONT.)

JOHN WALTON, University of Texas at El Paso/Nye County, Nevada Department of Natural Resources and Federal Facilities

JIM YORK, Bechtel-SAIC Company, LLP

I-N-D-E-X

P-R-O-C-E-E-D-I-N-G-S

(9:35 a.m.)

1) OPENING STATEMENT

CHAIRMAN GARRICK: Good morning. The meeting will come to order. This is the first day of the 144th meeting of the Advisory Committee on Nuclear Waste. My name is John Garrick, Chairman of the ACNW. The other members of the Committee present are: Mike Ryan, Vice-Chairman; George Hornberger; and Milton Levenson.

Dr. Ruth Weiner is with us today as an invited expert. And we also have the distinguished panel for the working group session with us that will be introduced. Let me just give their names and also the keynote speaker: Chris Whipple, Richard Parizek, John Kessler, Steve Frishman, Robert Bernero, and Wendell Weart, a very distinguished group that we are very happy to have and should get a lively session to be sure.

During today's meeting, the committee will conduct a working group on performance confirmation plans for the proposed Yucca Mountain high-level waste repository.

Neil Coleman is the designated federal official for today's initial session. This meeting is being conducted in accordance with the provisions of the Federal Advisory Committee Act.

We have received no requests for time to make oral statements from members of the public regarding today's sessions. Should anyone wish to address the Committee, please make your wishes known to one of the Committee's staff.

If you do wish to make a comment, it is requested that the speakers use one of the microphones, identify themselves, and speak with clarity and loud enough so that we can hear you.

Generally we have some announcements at this point. I am going to postpone those until Thursday morning and move directly into the activities of the next two days, the performance confirmation working group session. The Committee member that has the lead on this activity is Dr. Ryan. And he will be chairing the session from this point on.

Mike?

MEMBER RYAN: Thank you, Mr. Chairman.

<u>WORKING GROUP ON PERFORMANCE CONFIRMATION PLANS FOR THE PROPOSED YUCCA MOUNTAIN HIGH-LEVEL WASTE REPOSITORY</u>

MEMBER RYAN: Good morning, one and all. I would like to in advance thank Neil Coleman for all of his hard work in getting this session put together and the many hours of preparation it took to organize all of the participants and make it all coherent with what I think will be an interesting and productive agenda. Thanks, Neil.

The purposes of the working group are: (1) to increase ACNW's technical knowledge of plans to develop and conduct performance confirmation work for the proposed Yucca Mountain repository, (2) to understand NRC staff expectations for performance confirmation, (3) to describe examples of specific performance confirmation work being planned, (4) to identify aspects of performance confirmation that may warrant further study, and (5) to complement the previous working group session on performance assessment.

Over the next two days, the working group will include: (1) a keynote presentation to set the tone of the working group session, Dr. Chris Whipple; (2) a series of expert talks from senior participants, from the NRC and DOE, they will discuss approaches to performance confirmation; (3) talks by stakeholders presenting their views regarding performance confirmation; (4) a panel discussion -- our experts for that panel discussion have been introduced -- of issues and results presented; (5) public comments; and (6) a wrap-up session.

Without further ado, I would like to introduce Dr. Chris Whipple from ENVIRON, who will lead us off with his introductory presentation. Dr. Whipple?

DR. WHIPPLE: Thank you, Mike.

2) KEYNOTE PRESENTATION: WHAT SHOULD BE MEASURED DURING PERFORMANCE CONFIRMATION? HOW WILL THESE MEASUREMENTS ENHANCE CONFIDENCE BY CONFIRMING PREDICTED REPOSITORY BEHAVIOR?

2.1) VIEWS ON PERFORMANCE CONFIRMATION PRESENTED BY A DISTINGUISHED EXPERT

DR. WHIPPLE: Good morning. A simple mechanical question, I don't know how I can make slides go forward and backward. Ah, I wave that way. Okay. I will do that.

Well, with that, why don't we jump to the first one? It has kind of an overview of what I hope to cover this morning. You can tell we have someone in our office who is really good with PowerPoint. And I actually took some of the animation out of this presentation after he gave it back to me. So nothing dances, actually, but I do like the Yucca Mountain background as a theme for the talk.

I am going to try to cover performance confirmation in what I would take to be almost a philosophical sense. How should we think about it? What should it be? How do we decide what is in and out, what activities we do based on criteria that make sense, and what we shouldn't try to do in performance confirmation?

I must say an earlier agenda had some presentations on WIPP and a later agenda didn't. Until Wendell walked in this morning, I didn't know that someone who knew a lot about WIPP was going to be here. Nonetheless, I think there is a lot we can learn about the process that has been followed at WIPP that is a dead-on set of lessons applicable to performance confirmation at Yucca Mountain.

Then I want to talk about some specific technical arenas and just kind of discuss why they may or may not make sense as candidates for performance confirmation.

First comment. These are my own thoughts. And DOE has not seen these slides. They haven't commented on them, obviously, if they haven't seen them. I have heard from talking to somebody in the project that Karen Jenni and Jim Blink had worked up a new performance confirmation plan for the project.

Karen and I talked. And we agreed it would be better if we didn't see each other's slides in advance. This talk was not intended to be a review of a document but, rather, thoughts on what performance confirmation is. So I did want to get that disclaimer in.

The second qualifier is that a couple of years ago a group of us, of which I was one, helped John Kessler put on a workshop at EPRI on performance confirmation. I think some of the people here took part in that. And we produced the proceedings from that, and I had various notes in a talk I gave there.

I stole liberally from everyone's contributions to that workshop in thinking about this presentation. I think some of the ideas that I stole were mine originally and others weren't, but I thought that was a good workshop. And I recommend that proceedings to those of you who haven't seen it.

Next one. First is a starting point. The word "confirmation" is just a lousy word. It suggests we're certain of everything and we're going to nail it down and confirm it. I understand a licensing process is a legal process, but I am a technical person. There are always going to be uncertainties in performance and our understanding of performance. I think it's sensible as a technical person that we continue to refine our understanding, even when we believe we have crossed the threshold that says we know enough to issue a license and begin operations.

But the tone of the word "confirmation" suggests that we can't disqualify what we know. And that's really the main point of performance confirmation as I see it. You can wander off into the philosophy of science literature, and you find out that hypotheses are only falsifiable. You can't confirm them. You can only prove them wrong.

So just to try to get your mindset here, I think a major objective of performance confirmation is to look for signals that we've got it wrong and that the repository might not be appropriately safe. I think that should be the driving objective.

How do we go about that? Next slide, please. One of the things that came out of the EPRI workshop was sort of a list of desired aspects for any performance confirmation program. And a little later in the talk when I mention WIPP, you'll find that a number of these management principles have been missing from the WIPP project at high cost to that program and to the public that pays for it.

It's important to understand the need to be flexible and iterative in anything we do. We need to preserve the ability to start something in performance confirmation, get a year or two in and say, you know, "This isn't telling us anything that's useful. And we might as well pull the plug on it."

That's hard to do in a setting in which activities are undertaken by enforceable agreements, but it really is an appropriate aspect for a program that is going to involve a fair amount of learning as we go, which I think performance confirmation will.

The term "risk-informed," of course, was invented here. I shouldn't have to preach to the choir about that. But, as I'll mention in my next slide, I think Part 63 has missed the boat on performance confirmation in some aspects.

The issue for me for performance confirmation is how it connects to the high-level safety that we desire at a repository and not to verification of DOE paperwork.

Something that I think is difficult to do but essential is that part of performance confirmation is to give public confidence that if the repository starts to deviate from acceptable performance, we have a chance of identifying it and fixing it, reversing it, doing something about it. And I think the public needs to be involved in identifying what those aspects of performance confirmation are that provide increased confidence.

I mentioned iterative in my last slide. I think it's possible over an indefinite but long operating period, 30 to a couple of hundred years, to think of it in stages and to not block something in at the time a license is issued and let it run for 200 years.

The other aspect that is terribly important and I will mention as I go is you have to have priorities based on something. And that something to me is sensitivity of overall performance. That is, we have to keep our eye on the ball of "Does it matter?"

And then, finally, one of the things I think that the project deserves a lot of credit for is the ability to overcome the temptation to lock everything in ten years ago. I think there have been a lot of improvements in the design, a lot of improvements in the analysis. And I hope that exploratory mindset can be maintained over the long performance confirmation period.

In terms of our ability to analyze, model the subsurface performance, particularly unsaturated zone performance, the science there is really pretty early staged. I mean, 20 years ago what we could do compared to today was practically nonexistent. And one hopes 20 years from now will be a lot better and that the performance confirmation process will evolve accordingly.

Next slide, please. Okay. What Part 63-131 requires is a review to see if the conditions in the subsurface are consistent with those assumed in the license application and to see if the natural engineered systems are performing as anticipated.

I note the word "safety" doesn't appear here. To me, I read this to be a statement that the performance confirmation is focused on going back and retrospectively looking to see whether the license application is still up to date now that we are 10 or 20 years down the road and have more data from underground and not whether we have new insights as to whether the appropriate limits for public protection are met or not.

And I guess I would have preferred that the safety emphasis have been stronger and that what I see as perhaps a consistency of paperwork aspect was secondary to the higher level goal of protecting the public. I suspect we can talk about that over the next few days.

All right. So my second major bullet there is that question I just asked, are we there to confirm paperwork or to confirm safety? The final one is, to what extent do we want to continue to reduce uncertainties? And do we want to do that across the board or do we want to do that only for those things that are truly significant to safety?

It is not unknown in a big, complicated project like this one to have large teams of people whose careers are involved in polishing the third decimal place. And I hope we cannot do too much of that.

Next slide, please. This slide is something that came out of the EPRI workshop. And I thought it was on the money then, and I still think it is on the money. There is a temptation to deal with a lot of problems as you approach the hectic activity of assembling a license application of looking at performance confirmation as the bucket into which you put the problems you can't solve this week. All right?

And it can get you in trouble in a number of ways. First is the obvious one. You shouldn't agree to do anything that can't be done. It will come back and bite you in a big way. And it only postpones the pain of dealing with things.

Another point is -- and I will hit this one again later -- agreeing to measure things that don't matter. I just think it's a generally poor idea. It's expensive. It takes attention away from things that do matter.

Third one, I hope this is not something that someone does, but 15 minutes into monitoring, I hope no one says, "See, the repository is safe. We don't detect any radiation whatsoever in the groundwater 20 kilometers down gradient."

Well, of course not. But it doesn't prove anything about the safety of the repository. And, then again, that's something I think that we have to be very careful about, which is to monitor things that are meaningful.

Now I'll mention one of the things I mentioned earlier is if the public thinks it's important to do it, you do it. And I suspect monitoring groundwater where people are may well climb onto that list. And that's fine if that is what people think is important. But you shouldn't claim that because radiation hasn't shown up in 100 years, that that proves the safety of anything.

Another aspect -- and I'll get to this in talking about some of the WIPP stuff -- is don't agree to measure things plus or minus five percent when what you really needed is plus or minus two orders of magnitude. It changes the expense. And, again, it misstates the importance of what you are trying to do.

And the right starting point should not be, "How well can I measure this if I use the best available technical means?" It's "How much does this matter? And how well will I need to know it?"

Then, finally, back to that word "iterative," just because you agreed to do it at the time of the license doesn't mean that it is going to make sense 10, 20, or 30 years from now. And you need going in to have a process for reevaluating, reexamining, adding, and deleting performance confirmation requirements as the state of understanding changes.

Performance confirmation in my own view -- and this may be tailored by having spent a lot of time looking at TSPA -- is going to be tightly linked to TSPA. The TSPA, after all, is the core of the license application's case that compliance has been achieved. The question, then, is, what can you monitor in TSPA that is predicted in TSPA, that has a bearing on meeting the high-level safety objectives of the standard.

The other point is that to continue that 30, 40, 50 years into the future implies that you are going to maintain TSPA as a living model. That "living model" term comes out of the PRAs used in the nuclear power plants. The plants tend to keep them up to date. They tend to evolve with time. They tend to incorporate any modification to the plant or to our understanding of the plants.

I'm simply ignorant on the question of whether that will be done for Yucca Mountain in the TSPA. I know at WIPP, there is a requirement for recertification every five years. That has kept a certain amount of activity going on their performance assessment, but I must say it really seemed to me to be about a four-year dormancy period and then an "Oh, my God. We've got to get the thing recertified in a year. We had better kick this thing back to life."

I don't know what is going to happen with the Yucca Mountain TSPA, but only that if you intend to maintain a linkage between performance confirmation and your understanding of the site, the TSPA has to be kept alive.

Next slide, please. Okay. This is where I play the role of Karen Jenni and try to determine what decision criteria should be for performance confirmation. I came up with four general categories. And then I've got a slide on each of these.

The first is a simple one. It matters to safety. If we can monitor things that affect our belief about whether or not the regulatory dose limits are met, then that is an obvious one.

The second one is that some parts of TSPA are -- next slide, please. I'm sorry. Yes. The first one is it matters. The second one, there are some parts of TSPA that are oversimplified. They're bounding analyses. They're weak. We know they're weak.

Anyone who has had to read the near-field environment section of TSPA more than twice knows that there are parts of that process that we don't understand very well and we can't model very well. I don't mean just to pick on that one, but there are several of those.

If we can do some monitoring in areas where we believe that TSPA is weak, that may be useful. But to the extent that we think TSPA has at least bounded the worst case, like everything leaks immediately is I think a reasonable worst case bound, then you may not need to do it based on that first point if it doesn't matter to safety.

A third point, TSPA is loaded with any number of conceptual models. And the project team has done a lot of work to try to evaluate those conceptual models and test them against alternative conceptual models. But, again, field evidence that can have some bearing on "Do we have a basic correct understanding of this or that process?" I think could be terribly important.

And then the fourth one I mentioned before is where the work would address an issue of public concern, even if it didn't meet some threshold as being important to safety.

Next slide, please. In terms of the "important to safety," the question here is, are we on an absolute or relative scale? By that, I mean an absolute scale is, how does this affect compliance with a 10-millirem-per-year dose limit within 10,000 years? That is an absolute scale.

A relative scale says, does this matter more than ten percent to the calculated doses at future times? All right. That would say by some threshold measure, -- and I picked ten percent out of the air -- this is a relatively important factor compared to the other 189 factors in TSPA. And perhaps we should worry about it.

Either way, I think those two ways of asking the question, "important to the absolute achievement of dose limits" or "important to understanding the relative contributors to performance," are preferable to the question of saying, is this consistent with what DOE told us in their license application, whether or not it matters? I am going to keep hammering away at that theme.

Next slide. This slide has way too many words on it, but I will boil it down. There has been a great deal of work done with limited success across the whole risk analysis field in trying to deal with the problem of alternative conceptual models.

Proposals have been made to use weighted averages of different models. And that satisfies no one. It sort of simply assures that you are going to be only partially wrong, not completely wrong. And some of the related work using sensitivity studies, both of parameters and of alternative models that has been done, has been helpful in giving you understandings of the importance of relative subsystems, but you always have a little bit of a bad feeling about it because if the model is totally wrong, then you can't rely on the sensitivities either.

And there are examples you can find. At least in the TSPA/VA peer review, we found that things were not sensitive because they had simply assumed particularly strange parameter values and it took it off the page.

So I think one of the things that I hope that can be done in a thoughtful way is to worry about where TSPA is weak and can perform its confirmation, supplement our knowledge there with the condition that things matter.

Now, that final bullet on that page, again, is the qualifier it needs to matter. Confirmation activities where TSPA is non-conservative, where meaningful measurements can be made, and where an issue is important to safety may be a pretty small set when you get through running through those three filters. But, again, I think that is the kind of thing you should be worrying about and looking for.

Next one. This one relates strongly to the last one. Again, it goes after the question of, can you take measurements that can provide information about the relative credibility of competing conceptual models?

I mean, in the WIPP project over the years, there was a running fight over matrix flow versus fracture flow versus dual phase, dual media flow. In the long run, they converged on a set of models where it didn't matter a whole lot whether you went with just fracture flow or with two media flow. The water moved about as fast.

We are coming out of a history where the first simpleminded models of an underground repository, where the basis for the first EPA standard back starting in the late '70s really tended to start with a homogeneous rock assumption. And with time, we have come to understand that not only is that not even true in an salt site like WIPP, certainly not true in a hard rock site like Yucca Mountain, but it matters that there are fast flow pathways and we have to be aware of them. And getting the conceptual model for that is hard.

I am not sure that performance confirmation is going to be better than what we can do being underground already. I think that the thing that a lot of people are looking at for performance confirmation involves thermal effects. And those from the grand scheme of performance assessment tend to be relatively transient and not necessarily of high importance to safety, although that can be debated.

Next slide, please. I mentioned the notion that there needs to be a category for performance confirmation that is in there because the public worries about it. If you spent any time at all reading the risk communication literature, probably the single most important recommendation that comes out is talk to people about what it is they're worried about.

A favorite example of mine is for years polling done by the nuclear utilities showed that people worried that nuclear power plants could blow up like atomic bombs. The nuclear power industry people knew this to be impossible and, therefore, not worthy of discussion. And, therefore, neighbors of power plants went on worrying that these things were going to blow up like atomic bombs.

If people are worried about something that you think is unimportant, that is a great topic for conversation. And if they are worried about something where you don't think you can do meaningful measurements but they want them anyway, well, that is probably a price you have to pay.

And I think that the subtext on this has to be that you should not assume that DOE managers understand what the public worries about and what they would like to see done. I think that would be a serious mistake.

I am afraid a process is needed. I am not sure Steve Frishman is the right guy to ask either because he will gain it. But I think we need to find some way to find -- I am saying there is a legitimate basis for including activities in performance confirmation because they are subjects of public concern and that the action itself provide some reassurance.

It shouldn't be an excuse for some idea that couldn't meet any of the other criteria for being carried out under performance confirmation. That is, I have a pet hobbyhorse that, so far as anyone can tell, is completely unimportant to safety. So I am going to argue we should do it because the public wants it. Well, there ought to be a threshold there.

Next slide. This issue is not the first time or place for monitoring of the subsurface following an activity involving hazardous materials has happened. The U.S. has cleaned up hundreds of Superfund sites. The question of how do we worry about them in the future, knowing that these things, unlike Yucca Mountain, are on the surface, often very close to where people are and often fixed with much less expensive remedies than we have in play here.

There are processes for thinking through the continuing monitoring requirements. Yet, in the EPA world, they use an approach called the data quality objective framework. Among decision analysts, they use a term called "value of information." Both have the same key idea, which is if you are measuring something that does not affect any decision you make, then you probably shouldn't be measuring it? That is, information is used for decision.

Now, that's not to say that the question of "Has it leaked yet?" isn't a fair question to be asking. And as long as the answer is no, you might argue that no decision is being made, but, in fact, the decision is we don't have to go back in and patch. That is a decision. I think this framework could be constructively applied in the case of Yucca Mountain.

Again, the question is, where would measurements make a difference possibly, either to change in design, change in operation, to remediation of something, patching and fixing, ultimately to a decision that we've got it all wrong and we have to retrieve waste?

There is a correlated issue here, which is that the NRC needs to worry today about what happens when performance confirmation measurements fail to track with TSPA predictions. Do you say, "That's too bad"? Do you say, "Resubmit the license"? Do you say, "Do an analysis that shows that you still comply with a 10-millirem dose limit?" Those things need to be thought through.

It's likely in something as complicated as Yucca Mountain that there will be deviations. How do you determine which are significant? Is ten percent different from what I predicted in terms of the temperature profile on the rock significant or is that trivial?

All of those things need to be thought through because when you have suddenly got the data, then it is harder to develop criteria that you wish you had done objectively beforehand.

Next slide, please. A few slides here about the WIPP. When the WIPP project was at about the same place in its evolution as the Yucca Mountain project is today; that is, when the application, the certification compliance application, was being prepared for review by EPA, there were lots of cats and dogs that hadn't been put to bed, lots of niggling technical issues still out there.

If you might remember, there was a painful phase in the WIPP project where DOE proposed to run experiments of putting about 10 or 15 percent of the waste into WIPP ahead of its license just as an experiment. I guess many people, myself included, saw that as simply an excuse to get people in New Mexico used to the idea that WIPP was going to open. And I didn't think it had any technical merit.

The fact is that the WIPP project when it was being considered had a lot of requirements that had to be developed. One of the most important ones was the waste characteristic analyses to be performed.

EPA, I must say, did try to do DOE a favor. EPA in their draft regulation offered DOE several choices. It basically said, "We invite DOE to come to us with a sensible plan for waste characterization. And we will review it. And that plan might include statistical methods. It might include working backwards from performance assessments to determine what ranges of waste characteristics could affect a determination of compliance or any other method that DOE wants to propose, we will be happy to review."

Absent that, here are 97 pages that we xeroxed from the RCRA standard that say you have to measure absolutely everything about every piece of waste that you propose to put into WIPP. DOE did not submit a plan to EPA that time. This was in the late '80s. I remember being horrified by this and talking to the WIPP project manager. And I'm paraphrasing his answer, but the answer is that last bullet. I know we have to have that fight, but I want to have it on the other side of the finish line.

The view was that trying to negotiate all of those requirements while you're trying to get your license will delay getting a license. And it wasn't said at the time, but I think there was a sense that it gives EPA a lot of leverage over requiring things that are excessive compared to what we might do later when they don't have that leverage of do you want your license or not. What DOE misunderstood is how hard it was going to be to try to fix these after the fact.

Next slide, please. Again, on the EPA side, characterizing the radiological aspect of the WIPP waste is pretty straightforward. Radiation is easy to count. And they do.

Furthermore, the waste that goes into WIPP, the hazard is predominantly radioactive, predominantly being something along a long string of nines if you were going to attribute it in a percentage.

The chemical hazard that is relative to the radiological hazard is trivial. Nonetheless, the bulk of the money in waste characterization at WIPP goes into chemical waste characterization.

Part of the reason for that is that the agreed-to waste characterization requirements, which DOE proposed to New Mexico, included enormous detail. We promised to measure everything. New Mexico said, "It sounds fine to us. Let's agree on it. Here's your RCRA permit."

As DOE has tried to reevaluate those, -- next slide, please -- it has proven difficult. New Mexico sort of says, "Oh, wait a minute. We shook hands on this. You came to us and said, "Here is what we think is a reasonable set of requirements for our RCRA permit. We promise to measure the following things if you give us a permit. We shook on it."

DOE's view is "No, no, no, no. That was just to get the game started. And now that we are older and wiser and two managers down the road, we want to go back and renegotiate all of these requirements."

Right now the estimated price tag for characterizing the WIPP waste is about three billion dollars. Nobody thinks it makes sense who understands that waste.

To compound the lunacy, up at INEEL, where they have a large amount of waste bound for WIPP, they looked at the cost to characterize it. And they said, you know, "This is two to three thousand dollars a drum. For $1,000 a drum, we can treat it. We can open it up. We can compact it. We can make hockey pucks out of it. We can reduce the volume. We can give it better operating characteristics. And it will be cheaper." And that's what they're doing.

Now, it's only cheaper compared to the suboptimal over-characterization that was agreed to initially. There are 40,000 drums of waste in WIPP. And they have measured the head space gases in every one. All right?

The average concentration of those head spaces gases of 30 different chemicals do not for any of the chemicals exceed the allowable 8-hour workplace exposure limits under the OSHA standards, which is to say there's not much there. But, nonetheless, they continue to measure the head spaces gas in every single drum. All right?

Now, part of the problem there, again, my view is that DOE has not made a good case for this being unnecessary, hasn't put forth a statistical approach or any sort of approach. But it's not hard to imagine Yucca Mountain getting itself in the same predicament. It agrees to do everything under the sun in performance confirmation in order to speed the license application's process for the NRC.

And then once that happens, new management comes in at DOE and says, "We promised what? Do you know how much that costs? This is nuts." And all the other people at the table feel like they have been lied to. The time to figure it out is on this side of the finish line.

Next slide, please. Again, just to elaborate on this, I can imagine that there will be awkward KTIs and that one perhaps proposal for dealing with those awkward KTIs is to say, you know, "We don't really have to figure this out today." Well, let me urge you to be very careful about doing that.

Final point on that slide, again, -- and this is one that I see biting the WIPP folks -- is that it was not built into their -- well, I'll take it back. It is built into their process, but their permits only last for five years. What was not built into their process was any sort of expectation that the requirements should fundamentally change. And change is reviewed by New Mexico as reneging on a promise.

Okay. Next slide, please. Now I am just going to ramble on a little bit, as if I haven't been already, about some specific technical areas where it may or may not be useful to do performance confirmation. The first one here to me is a so-called no-brainer.

You obviously need to monitor for radiation leaks in the ventilation gases coming through the repository. However much you believe your TSPA and its statements that the things won't leak, the fact is if you're not looking for leaks there, where you would have a chance of finding them, then one might argue that the whole performance confirmation program is essentially meaningless.

Another aspect -- and this gets into an issue where there is slightly more technical uncertainty -- is how likely are rock falls that could impede ventilation of a drift, could potentially damage the waste package. And not only do you need to have an ability to detect where that happens, maybe by measuring probably something simple, temperature of flow rate of the air from that given drift, but do you have a plan in place for dealing with such a situation? That's not part of performance confirmation, but it's part of a reasonable set of contingency plans that NRC and DOE need to have.

Next one, please. As I mentioned, one of the things where a huge amount of modeling has been done, where we really can't do the measurements in a realistic way without loading the repository, is the thermal hydraulic performance. How far does the boiling front move out into the rock wall if you go with a hot design? Does the rock midpoint between the drifts stay acceptably below boiling, those sorts of questions?

And those are probably useful things to measure. But, again, the question I ask is some work needs to be done to define what sort of acceptable accuracy matters here. While I think that maintaining a below boiling temperature in the columns between drifts is terribly important to avoid pooling above the drifts, whether it's 50 percent of the space or 30 percent or 70 percent may not be so important.

Next slide, please. Here's another obvious one. The corrosion work that is going on largely at Livermore is, what, maybe five years old now for Alloy 22. They're testing a number of different chemical environments. They're trying to do things under accelerated conditions by making more chemically extreme conditions. But the predictions of the performance of Alloy 22 are that it behaved so well for so long a period of time that we still need to carry forward and get more data and particularly data that can address the corrosion models and to see if those models match with lab experiments.

It would be very like OMB or the congressional staff to believe that an hour after the Yucca Mountain license is granted, all supporting analytical and laboratory work is unnecessary since the NRC said this place is safe enough to operate. And, again, that gets into the difference between a legalistic and a technical mindset. I certainly would think my own view is that this is a set of experiments that really need to continue to run.

Next slide and last slide, incidentally. Another thing that is way too early to talk about, but it's something to fold into performance confirmation planning, is the question of can performance confirmation measurements tell us something about when it might be appropriate to close a repository.

Now, my take is that the decision to close a repository is going to be largely driven by political factors, not technical factors. Those political factors will have to do with whether or not nuclear power comes back to life, with the future course of the weapons program and what wastes it might produce, with the disposition of plutonium from the weapons program, and whether and how that makes its way into Yucca Mountain.

And all of those things will affect the desired timing of closure. If, in fact, Yucca Mountain is turned into a significant repository for weapons-grade plutonium, that might, in fact, argue for earlier closure than a thermal hydraulicist might say is ideal. They might say, "Gee, we would sure like to ventilate this thing for another 50 years," but there may be overriding political reasons.

Nonetheless, I think that the questions of when do we close should be viewed as both a political and a technical decision and we should look to see if the performance confirmation program and provide supporting information to that.

Thank you.

MEMBER RYAN: Thank you. I think what I'd like to for the presentations up through the panel discussion tomorrow is first take questions from committee members and then any questions that the panel members might have.

George?

2.2) DISCUSSION

MEMBER HORNBERGER: Chris, you outlined the WIPP example for DOE basically signing on to do too much and falling into one of your traps in your earlier slides. I know you have had a lot of experience with DOE. And, as you pointed out, there is lots of other experience. So if you do some kind of rough calculation in your head of things like the agreements made at Hanford and other places for cleanup, can you give us an idea of what fraction of the time you think that DOE actually got it right so that we have some sense of the probability of getting it right at Yucca Mountain?

DR. WHIPPLE: Well, gee, "getting it right" is not the right term of art, George. I'll say why. DOE in the end usually gets it right, but it took longer and more money than it might have taken if somebody were doing it who wasn't doing it with public funds.

I think the other point -- and I don't know given the size and isolarity of the DOE programs whether they learn as much from experience as they should. Certainly at the sites, there has been a lot of progress.

I mean, Hanford went from being a plutonium production facility to an environmental project in a relatively short period of time. And it didn't change the people that it had doing the work. It took a lot of time for that group of people to learn the new rules.

DOE is still slowly learning how to be externally regulated. And they're not particularly good at it. They fight like hell over trivia. They roll over and play dead on the expensive stuff. That's not how a smart private firm is regulated.

Smart private firm says, "We'll give the regulators all the cheap stuff they ask for, whether it matters or not, and we'll fall on our sword over the two things that cost all the money in the world that we think aren't really required." And I don't see DOE being good about that yet.

Now, I don't see as much of the site cleanup work as I used to. And my impression is that they are getting better at that. They do have some early closure success stories now. Particularly Rocky Flats is held up as an example of where I think the contractor has done a good job of telling DOE, "You have given us performance milestones, award fees based on achievements of the milestones. You don't get to tell us how to do the details because if we do it your way, we can't get it done."

I will repeat a funny old story. Back when Leo Duffy was running EM and this was when the budget for DOE's site cleanups went from half a billion to five billion in a short period, Leo is in his confirmation hearing for being appointed to that job at DOE. And he was coming out of running waste management services for Westinghouse.

Some member of Congress had been handed a set of tough questions by a staff. They wrote the line, "Mr. Duffy, isn't it true that when Westinghouse Electric Corporation does cleanup work for private clients, it doesn't require the full indemnification that Westinghouse requires of DOE?"

And Duffy said, "Yes, Congressman. That's exactly right."

The congressman kind of grinned. You know, I think he's thinking, "I've got him." He says, you know, "Do you think that's fair to the taxpayer?"

And Leo said, "Congressman, Westinghouse -- I'll go on record here -- would be delighted to work for DOE on the same terms we work for our private clients."

And he knew he had been had, the

congressman, at this point and had to say, "Oh? What's that?"

Leo said, "Yes. First, we charge our commercial fees. And second is we don't let the client tell us how to do our jobs."

I think that is a problem with DOE. They hire good people, but they override them at times. And, as I say, I think they're still learning how to be regulated externally.

MEMBER LEVENSON: Chris, you've been involved in this a long time and attended a lot of meetings. Anywhere along the line, has the issue of maybe confirmation as an adder-on to decisions made by other people the wrong way to do it?

For instance, just one example kind of off the top of my head is, rather than trying to monitor container failure by radioactive gas, which on very old fuel, there isn't much of anyway, you might put an inert tracer in waste containers and monitor ventilation systems for that.

The basic concept of can you improve confirmation by something you do in the active program, has that concept been anywhere in your background or experience?

DR. WHIPPLE: Not much, Milt. Back in the late '80s, we had this terrific old chemist on the WIPP committee who wanted to put a durable blue dye in the repository, that if you found it in the well, you would wonder, "What on earth is this? And how did it get there?" That no one took seriously. And I must say I don't know of anywhere where that is being done.

I do think that these materials do serve as their own tracers pretty well most of the time. But what you're asking, though, does pose the question of integrating across discrete boundaries in the project.

I just finished service on an academy panel that was terminated prematurely by DOE. It was on long-term stewardship of DOE sites. The key message from that committee -- we finished the report anyway -- was that DOE needs to think about how it is going to do stewardship of the sites long term as it plans the site closure remedy. And DOE took great offense and sort of said, "Yes, we do that, but we can't show you where we have written it down ever" over that one.

So I do think that the kind of long-term integration, including into the design, is something that has some possibilities.

MEMBER LEVENSON: For instance, a tracer

gas might give you data on waste package failure, at least a couple of decades earlier than looking for radioactive tracer looking for the radioactive?

DR. WHIPPLE: Yes, it could, particularly if you had waste package fails without fuel failure. Yes, you would pick up the container gas.

MEMBER LEVENSON: I think it is always that way because there is no mechanism for fuel failure until after waste package failure.

DR. WHIPPLE: Unless it was already sort of failed. No. You're right.

CHAIRMAN GARRICK: Yes. Chris, I think we would certainly agree that the focus for performance confirmation ought to be on those things that are important to safety. You analyze and test and monitor that.

I don't get the feeling that that is necessarily what is behind the plan that is being discussed by DOE at this time, even though in the preamble to the planning, they do say that the performance assessment will be the driving document.

My real question, though, is the dilemma that we seem to have here in that the dilemma is that, on the one hand, we keep talking about focus and using the information and the tools we have that have been explicitly designed to provide focus, such as the PA.

On the other hand, when I read the list of things that they're considering analyzing, testing, and monitoring, it's an extremely long list. And I don't get the sense that it has been mapped at the level of detail of the list to the performance assessment in any systematic and concrete way.

Then the other point that I am concerned about is you mentioned public involvement. To be sure, that has got to take place. But my question is, it should take place early, sooner, rather than later. It seems to me having it take place at the performance confirmation level is much too late to ever have any hope of achieving any kind of a program that has real focus to it.

Why shouldn't the strategy be more one of getting the public involvement in the tool or the methods that are being employed to define the program such that it is addressing issues important to safety? In other words, why wouldn't we want the public involvement up front, rather than later on, that could just create an unmanageable situation here?

DR. WHIPPLE: Well, I can see some practical difficulties. One is Nevada has by no means convinced the Yucca Mountain it is going to be licensed, built, and operated. I can well imagine they would not be eager to assist in that process. In fact, they're suing to try to prevent it.

Second, if we do the processes right, I am not sure everything has to be nailed down at the time a license application is reviewed and acted on.

We have got a decade between then and between arrival of waste. And even then, if certain parts of the performance confirmation were five years in coming, I'm not sure that that is a fatal disqualifier. I think if you did it right with a flexible and iterative process, it in some ways would be more desirable.

Back to DOE's long list of things that are in, I was sent their plan. I decided not to read it because what I did not want to do this morning was comment on it. But, again, I think part of the solution there needs to be some process within the project in which there needs to be a clear set of criteria applied to this list and then a studious, skeptical bunch of tightwads that says, "Tell me again why you think this qualifies to proponents of particular pieces of performance confirmation."

In the end, it's going to be a negotiation between DOE and NRC, but my sense from looking at past

DOE documents is I share your sense that DOE will sign up for far more than is necessary on the grounds that right now it's got a lot of issues with NRC and would like to solve as many of them as it can. This is a possible mechanism for doing that.

Maybe when we hear from Jim Blink and from Karen we will get a different perspective. I shouldn't speak for them.

MEMBER RYAN: Thanks.

Any other questions from committee members?

(No response.)

MEMBER RYAN: If not, I would invite our panelists to ask any questions and make any comments they would like to make. Yes, John? If you could help by just saying your name the first time for our recorder, that would be helpful.

MR. KESSLER: John Kessler with EPRI.

Chris, I certainly agree with your traps. You talked about don't agree to measure something that is not important, measure things that are only important. Yet, you also said, don't agree to measure things you can't measure. What, if anything, should DOE and NRC agree to do in the cases of things you cannot measure; yet, they're important?

DR. WHIPPLE: Well, I think it's unclear now whether you can make measurements of the critical metals that will confirm or refute the corrosion models, but I think it is important to keep on trying. So that may be something that you can't measure at this time.

I will give you a related example of something that might be useful to measure, though. As Joe Payer, who knows all about the corrosion stuff better than most of us, keeps saying is the uncertainty in corrosion is the uncertainty in the environment.

We know what the nettle is. Might it be possible five years into operation to go in and send the robot in to get dust swipes off the waste canisters? Might that tell you something?

It doesn't tell you about the post-closure conditions, but it tells you what the starting point and the mixture of dust is and whether it's in any way different than the normal desert dust but a little bit of ground Yucca Mountain rock thrown in. That might be something that would reduce uncertainties. That would be kind of a creative performance confirmation idea worth doing.

MEMBER RYAN: Yes?

MR. BERNERO: One more word. Chris, I agree with most of the comments that you brought up about the WIPP project. One of the things I was wondering what you might feel about is the subject of contentious scientific issues.

They may or they may not be important to performance assessment, as modeled in TSPA. The public may not really be involved in some of them, but they are legitimate scientific concerns that the technical community has debated about.

Do you think that these are a valid ground for doing performance confirmation measurements or would you rule them out simply because they may not affect long-term performance?

DR. WHIPPLE: Boy, I guess I would have to have a more specific situation to know. In some cases -- well, I'll back up and give a generalization.

I think management prematurely saying, "Okay. Knock it off. We've decided that theory A is correct and theory B is nonsense" is a pure recipe for disaster in an agency. And in general, it's best to let bad ideas die a deserved death at the hands of good science.

That is something I think each organization needs to have some freedom to deal with.

However, I also think that there are issues that have outlived their reasonable lifetimes, either on the grounds that it doesn't matter anyway or we have done this review 11 times.

In the case of Yucca Mountain, I think the stuff Jerry Zymanski was arguing was one that got reviewed to death. It's I think finally gone away, at least as far as I know.

It was long and painful, but I also think that in the end, the amount of work that was done I think helps give people confidence that this just wasn't buried by political muscle. I think that DOE's willingness to fund the most recent work at UNLV, in particular, was a very helpful step in establishing whether he was right or wrong.

MEMBER RYAN: Questions? Steve?

MR. FRISHMAN: First of all, I'm surprised at the bait that you threw out there.

DR. WHIPPLE: I gave you several pieces of bait, Steve.

MR. FRISHMAN: Well, the most obvious one. You talk in your discussion about traps, that you don't see that performance confirmation should, as you put it, be the bucket for problems that couldn't be solved earlier, but at the same time, when you talk about management principles, you are looking for an exploratory component.

It seems to me that there is a line that is necessary between characterization work that should have been done versus the exploratory component in the example that you gave, for example, is that the science of the UZ is still very early.

So how do we and especially the NRC's review staff figure out what the difference is between the exploratory element, as you call it, of performance confirmation and work that actually should have been done in order to gain enough confidence by the decision-makers in a decision on reasonable expectation?

DR. WHIPPLE: Good question and a fair one that I think the NRC is going to have to deal with.

MR. FRISHMAN: I am asking you to deal with it right now.

DR. WHIPPLE: Okay. And I will try. I think there are a couple of standards you can apply. One is how well the work that has been done to date measures up against the prevailing standards of good science in that arena.

I don't think it's reasonable in any arena to say, "Let's wait until 2050 because, undoubtedly, the science will be better then," not a fair answer.

So has the work that has been done been of credible technical content weighed against prevailing good science standards? Second, has the uncertainty analysis been done in a similar way? And what does it show?

We may not need to understand the system perfectly. In the case of UZ, I think that there are parts of it that are more important than others.

But I guess the other question I have is characterization absent an operating repository can only go so far. I mean, for me, the key questions on saturated zone performance, the interesting ones, are where does the water go when there are hot waste cans inside? And how long does it stay away? What does it look like when it comes back? And what is the flow field around the drifts and so forth?

I am not sure those are things that can be done in characterization.

MEMBER RYAN: We have time for maybe one last question. And we certainly I am sure in the next couple of days dive into these questions in more detail. Is there one last question? Yes, please, Richard?

MR. PARIZEK: Parizek with the Board.

Chris, you mentioned a lot of frustration with trying to reduce the monitoring responsibilities or how it works at WIPP. You kind of caught up with some agreements you made early.

Are there any examples of things you would add because you wanted the flexibility? And so would you add some monitoring or some observations that were not included in the responsibility based on understanding the science and engineering performance of that facility in a basic way? And that would also obviously apply to Yucca Mountain by analog.

DR. WHIPPLE: Yes. WIPP I can't think of any, actually. Waste is so thoroughly characterized that I, frankly, can't think of a property left unexamined.

MR. PARIZEK: Let me bring up an example in terms of the early discussion about gas and re-saturation. You could imagine waste, which could over-pressurize the fluids and cause movement.

So is there monitoring being done of, say, gas pressure buildup, say, in the back-filled salt or water accumulation in the salt after you've backfilled? Again, these are kind of testing ideas that were troublesome at the time.

DR. WHIPPLE: Yes. I don't think WIPP is

in a state yet where --

MEMBER LEVENSON: There is one, Chris. The previous academy committee to the one you're currently one made a recommendation. DOE had not planned to monitor effluence from oil and gas drilling in the area to get a background radiation picture before waste was put into WIPP so that you would know if you started seeing things whether or not it came from WIPP and it was an academy committee recommendation that they expand that program. So there have been adders.

DR. WHIPPLE: I guess I can think of one, Dick. And it's a replacement recommendation, which is in lieu of measuring every drum, why don't you just monitor the mine for volatile organics? It's a substitute. It's cheaper.

MR. PARIZEK: And that sort of serves the same purpose.

DR. WHIPPLE: That's right.

MR. PARIZEK: That's a little bit different than some of these other monitoring issues.

DR. WHIPPLE: Right.

MR. PARIZEK: Thank you.

MEMBER RYAN: Chris, thanks for giving us a great start. You have given us a lot of food for thought, both in terms of past forward traps to think about, accuracy and precision, and lots of detail. So, really, thank you for giving us a great start. We'll look forward to your continued participation the next couple of days.

DR. WHIPPLE: Thanks, Mike.

MEMBER RYAN: We're at a break in our schedule. We'll take a 15-minute break and promptly resume at 11:00 o'clock.

(Whereupon, the foregoing matter went off the record at 10:45 a.m. and went back on the record at 11:00 a.m.)

MEMBER RYAN: Thank you. We'll continue on. Our next speaker is Jeff Pohle from the NRC, and he's going to provide us with some introduction to performance confirmation, the NRC's expectations regarding content of PC plans in a license application.

Jeff, good morning, and thanks for being with us.

MR. POHLE: Thank you. First, let me test the microphone. Can you hear okay? Okay.

Our review process begins by requiring all our staff to take some training on Part 63. Everyone is fortunate here today in that they get to see one element of that training class, and this will be basically the third time I've gone through this set of slides. And usually the most interesting part are the questions that arise, so I rarely get to make all of the points that I've written down that I want to make, because questions usually supersede those and I end up going off in another direction.

CHAIRMAN GARRICK: Maybe you should start with the last one.

MR. POHLE: Perhaps. Basically, we'll go over the four general sections of Subpart F, and I'll end with a slide on some other requirements that are relevant to a performance confirmation program.

Next slide.

The first four slides, this slide and the following three, will deal with the general requirements of 63.131. And on the slide there are two parts to 131(a), and so there are two things that basically this ties the objectives of the program in that I want people to keep in mind.

Clearly, the second sentence shows that the overall objective of the program is linked to the post -- the barriers important to waste isolation, and this sets up the context of how the performance confirmation program should really be viewed in the context of the post-closure safety standards.

Now, it's not the objective of the performance confirmation program to set those standards. We all know those are set by EPA and required by law to adopt them in our regulations.

And also, another item to keep in mind, we have a requirement for retrievability. And that requirement exists in a rule, so as not to moot the Commission's prerogative to make a decision on whether to issue a license amendment for permanent closure.

So, clearly, during construction we're interested in any observations and what is actually found in the ground that could change the option to retrieve. So there are two things we keep in mind -- option, to maintain the retrievability options by being cognizant of what's going on, and relating the objectives of the performance confirmation to the post-closure performance standard.

One other thing I'd like to point out that there will not -- it is not an objective of the performance confirmation program, nor will it be an objective of the staff during their review of DOE's performance confirmation program, to make findings on whether the information is sufficient to make a licensing decision. That is addressed elsewhere in our Yucca Mountain Review Plan. That is not something we will get wound up with in reviewing this program. That is not the context of our review.

Basically, the activities are not intended to provide the data or information needed to make the evaluation findings for the post-closure performance objectives.

Next slide.

The program must have been started during site characterization and will continue until permanent closure. One aspect of the performance confirmation program will be to provide a baseline information on parameters, processes, whatever, that may be changed by site characterization instruction and operations.

In effect, performance confirmation began during site characterization and will continue until permanent closure. In fact, it's presumed the site characterization program was the program which obtained the information that establishes the baseline which will be incorporated into the performance confirmation program.

Also, in general, these requirements really do not specify or limit the type of tests that must continue until permanent closure. The staff realizes that area of knowledge creates an evolving understanding of the site. Performance assessments have changed over time, and we expect that to continue in the future.

So we have no expectation that any particular activity would continue until permanent closure. There are going to be a lot of activities. Some will cease, new ones will come up during a period of time, and we have the complete freedom to deal with that in a regulatory sense.

Next slide.

63.131, another general requirement -- the program must include monitoring, testing, experiments, as may be appropriate to provide the data requirement. The point I want to make here is the regulation is permissive. We tried, and it was our intent, not to either specify or limit any particular testing method that DOE may choose to apply.

In another slide, I'll reference this again, that we had no intent of specifying any particular process, parameter, or model. It's DOE's responsibility to come forward and identify those items.

Now, it's clear that the context set previously in the general objectives is that everything should relate to the barriers that are important to waste isolation. Immediately, that throws out a lot of things you don't have to be involved with, if it's not related to that.

And then, as Tim will get in tomorrow, we go into more and more detail and down to the risk importance, how you decide and prioritize, of those things related to the barriers, that you really feel should be part of the performance confirmation program. In fact, in the Federal Register we made that quite clear.

Next slide.

131 -- now, these are the last part of the general requirements. Certainly, any activities that are done on a performance confirmation should not have an adverse impact on the ability of the repository to isolate waste, similar to a requirement we had on site characterization. Site characterization activities should not adversely affect the ability of the barriers to meet the performance objectives.

And as I noted previously, incorporated into the plan would be some background information that constitutes the baseline understanding of the site. While -- well, I'll get into that tomorrow. We'll carry that forward more in terms of review of that.

And general -- the last general requirement is monitor changes from baseline parameters that could affect repository performance. Again, the burden in this case is on DOE to define what those parameters/processes would be. What's significant? What's important?

And, again, it must relate back to performance of the repository. And certainly our expectation is that the baseline presented here would be consistent with performance assessment input and assumptions.

Next slide.

This next section deals with geotechnical and design parameters, and there are three paragraphs. And a point I want to highlight here is that we really haven't prescribed any specific measurements or observations to be made. We're not really specifying the parameters and the interactions that need to be evaluated. Again, that's -- the responsibility is on DOE to present that to the NRC for our evaluation.

And certainly in the last bullet, this is where we would expect the risk insights to be factored into the program, when you start getting down to a more detailed level, whether it's from DOE's development of their plan or for our evaluation of that plan.

Next slide.

Part of DOE's program that they're going to have to deal with -- there's going to have to be some type of -- I call it an administrative structure developed around it. It's not just technical people reviewing the types of testing methodologies and instrumentation and the parameters and the models.

There will have to be some provisions, whether it's work instructions or procedures, that guide the program where results are evaluated and decisions made.

Do things need to change? Whether it's -- do we need to modify the performance assessment? Do we need to change construction methods? Do we need to change design? This may or may not happen, but our expectations were that the process must be set up that will allow for us and allow the Commission to be notified when something significant occurs.

So we have a lot of freedom in terms of what the details of that are going to be in the future. We haven't crossed that bridge yet, but we meed to be aware that that will be an aspect of our review of their program.

And we are certainly not in the best position to define what a trigger level would be on any given item. Again, there's a lot of freedom on how that will be implemented in a licensing decision. I know DOE has expressed some concern if we say "establish a range on a parameter that we feel that, you know, our licensing case assumes this range.

And if we have some observation where that parameter is out of that range, what happens? What if we needed to modify that? How -- do we have to amend the license?

I don't know what it's going to be. We have -- there's precedent in a number of directions, and I think Neil Coleman of your staff certainly has experience in the mill tailing side on performance-based licenses where we try to give as much freedom and flexibility to the licensee as we can, to allow them to make those decisions, certainly have that record available for inspection, but not necessarily have to notify the NRC on every given item to actually take a licensing action.

But that's down the road, and I can't predict what will happen on that.

MEMBER HORNBERGER: Jeff, but --

MR. POHLE: Sure.

MEMBER HORNBERGER: -- do I understand from what you've said, then, that you are looking to DOE to propose the structure and to propose something about how one would decide whether something was significant or not?

MR. POHLE: Yes. And, again, that is part of our review. That's the type of thing that could well be negotiable. As to where it ends up with, you know, I can't predict. But it's nothing new and unusual that we haven't had to deal with before in other licensing situations.

Next section on design testing, this is basically dealing with tests of engineered systems and components. Again, the context assumes that these are of importance as barriers for waste isolation. On thermal interaction, testing initiated as early as practicable, and there are some ifs basically on the placement methods for seals and backfill.

We've made -- this was changed a fair amount from the proposed rule. It generally referred to systems and components, again putting the burden on DOE to identify those things that are important to deal with rather than trying to specify things in the regulations. Design has changed so much over time that that's really the only way we could deal with it.

And then, it's also another area where we would fully expect the risk insights to be employed.

MEMBER LEVENSON: Jeff, on that last bullet, I understand a seal in connection with something like whip. But Yucca Mountain is such a porous structure that -- what's the function of the seal here?

MR. POHLE: I'm not predicting any function in this case. If it -- if there's a rationale why, one, you don't need seals, we'll make that decision. I think we have the freedom to do that.

That reminds me of a former branch chief of mine, John Austin. It was years ago in a meeting -- want to remember this -- on groundwater travel time. And he just flat said out, "Look, we're not going to do or require anything that's silly. It's just not going to happen." So we will, with that, modify, make changes as needed to deal with the facts of the situation, and common sense rules will apply.

Last slide -- next-to-the-last slide, I think monitoring and testing waste package. This is a bit different in the fact that we will require monitoring waste packages. And there are some items applied in terms of representativeness in the actual requirement for laboratory experiments on dealing with the internals, and the monitoring must continue as long as practical up until the time of permanent closure.

There's really nothing to highlight here except a reminder, again, that the performance confirmation program is not intended to provide the data that we made -- where we make a licensing decision on.

And the last slide -- there are other requirements that will relate to the performance confirmation program, certainly records and report requirements, deficiencies reports, requirements for tests. Actually, the requirements for tests would allow the NRC to go in and do their own testing program onsite. We certainly haven't thought about that.

Certainly, the programs will be subject to inspection, and certainly subject to the quality assurance requirements. All these things should be a factor when we look at the plan.

Questions?

MEMBER RYAN: Thanks very much, Jeff. Any questions from committee members? George?

MEMBER HORNBERGER: Jeff, how do you see

this negotiation that you describe with DOE going forward? It strikes me that, I mean, the performance confirmation plan has to be part of the license application. Is that not correct?

MR. POHLE: Correct.

MEMBER HORNBERGER: And is it my understanding that the negotiations have to be done prior to submittal of the LA?

MR. POHLE: No. I can only relate to my past experience, and it's been mostly in the licensing actions and mill tailings and solution lines. It was -- a license application would come in. There was an everyday communication with the applicant. On a page, I don't understand this. You know, clarify this for me. Or the applicant may change their mind after the submittal and want to submit change pages up until the time, you know, we do that.

And it's not even clear that the entire license application will be incorporated into the license by reference. How much of it? Portions of it may.

Now, my experience -- we always took the entire application and incorporated it into the license. So from thereafter, each change page would -- or pages would come in with a letter requesting an amendment to make these changes, to be reviewed, evaluated, make a decision, write a letter saying, "Yes, the license is amended to incorporate these pages."

I do not know what our management will want to do with something this expensive. I don't know what's done for nuclear powerplants. I know certainly some things get incorporated into the licenses -- tech specs and all that kind of stuff -- but that's not my area of experience. So we have a lot of freedom at that point to decide how we want to handle it.

The other question I had is you mentioned the possibility of saying, all right, we have some parameter or other, and we consider a certain range that was part of our review of the license, and we're going to make some decision on whether or not something that falls outside -- a measurement that falls outside of that range would trigger an action.

Is there any experience with similar kinds of agreements -- say, in mill tailings or --

MR. POHLE: Yes. The closest thing I would think of would be like a solution mine. And for those that aren't familiar with it, you're trying to dissolve uranium out of the geologic formation below ground in an aquifer.

So you generally do that by injecting a chemically-enhanced solution that would dissolve the uranium, inject it in a well, and have a ring of wells surrounding that that's pumping water out, where you get uranium and solution running through a chemical plant, some resins, to remove the uranium.

Now, usually in an operating facility there would be monitor wells outside that area. And during the license application review process, we would agree on what chemical constituents of the water -- it could be TDS, it could be uranium -- and an action level, that if -- and it happens it's a very active facility, and you can start injecting more water than you're withdrawing and start to getting the stuff move out of the mine zone.

So if it -- as I recall, if observations -- and I think it ultimately was changed due to experience. Maybe there had to be two or three observations sequentially before they would have to notify the NRC, at which time they would take action, which was generally to increase withdrawals or decrease the amount of injections to get the pressure back toward the well field and bring this excursion back into the mine zone.

Now, whether that was changed, we went through a process called performance-based licensing. Now, whether that approach was modified, Neil on your staff could probably fill you in later on that, whether -- to some degree, it was our policy objective to let the licensee deal with that without triggering all of these action items, but yet have sufficient documentation that during an inspection we could go out there and see what actions were taken.

And given that we were putting the responsibility on the licensee's side of it, then we would have problems, if they were not dealing with the situation based on some method they said they were going to. But that's where my experience ends, in the mid '80s, so -- but to the extent we could, there's no reason why we couldn't draw on historical approaches to dealing with these types of things.

MEMBER LEVENSON: Jeff, your slide 4 contains some sort of strong language. It says, "Program must have been started during site characterization." Does that mean that all of the confirmation things you expect to be in place, even before you get an LA?

MR. POHLE: No. My interpretation of that is merely in the broadest sense we consider site characterization part of performance confirmation. It provides the baseline information, which is referenced in the subsequent sections.

We do not assume you started with a zero slate in order to develop a performance confirmation plan. I do not see this as a significant --

MEMBER LEVENSON: You're --

MR. POHLE: -- sense.

MEMBER LEVENSON: -- extending site characterization forward into the future, then, beyond LA.

MR. POHLE: That's just semantics.

MEMBER LEVENSON: And some of these confirmation things you can't start to do until after you have wasted --

MR. POHLE: Of course.

MEMBER LEVENSON: You can't put them in what has been traditionally called --

MR. POHLE: Of course.

MEMBER LEVENSON: -- site characterization.

MR. POHLE: We have a very long-term view on that. In a sense, I'm saying the opposite, that performance confirmation encompasses everything, cradle to grave.

CHAIRMAN GARRICK: I'm thinking back of Chris' comments about the performance confirmation should be safety-based. And I'm looking at this language of the Part 63, and it seems to me that it's much more construction- and design-based than explicitly safety-based.

MR. POHLE: Well, I can only link back to the general requirements and the objectives as stated in the rule, where it ties it into the barriers. That was the idea of the language used at that time. And keeping in mind we didn't set the safety standard. So whatever the safety standard is that applies to post-closure performance, the barriers are intended to meet the standard, and that is the contextual link to the standard for safety.

CHAIRMAN GARRICK: Okay.

MEMBER RYAN: Thank you. Any questions from panel members? We'll start with Ruth.

DR. WEINER: Dr. Ruth Weiner. On your page 5, on 131(c), you say, "The program must include all of these things, as may be appropriate." And I take it from what you said that DOE decides, or you decide in negotiation with DOE, what is appropriate? And how do you keep this from becoming a get-me-another-rock situation?

MR. POHLE: Well, difficult decisions are not new to the NRC. But never forget that we put a burden on the staff -- if we feel there is some confirmatory work let's call it that we feel needs to be done, and that DOE has not captured in their proposal, we will have a lengthy technical and regulatory basis justifying that request. It will never make it through the system otherwise, and that will be available to one and all.

MR. BERNERO: Jeff, the words in 63.133(a) about tests of engineered systems and components are very general and not too specific on what that would include. I know that elsewhere the regulations include a requirement for retrievability to be maintained, that capability to be maintained for years.

And the Yucca Mountain Review Plan calls for an analytic demonstration of retrievability, even an analytic demonstration that there is surface space to store the waste, but not a demonstration, not a test of it.

Is 63.133(a) directed at tests of the very operational aspects and function of the repository and the ability to recover from mishap?

MR. POHLE: I would say no, and that's, I mean, a strong feeling of mine that I want to keep all operational things out of the performance confirmation program. There's a whole group of people that deal with the safety assessment for operations.

An item that was discussed this morning on waste characterization -- well, you know, is the waste that is received, you know, within whatever criteria are laid out in the license, again, to me that's an operational matter. It's not a performance confirmation matter.

MR. BERNERO: But I find it odd that backfill, which is an operational matter, is included as a test, to evaluate effectiveness of placement and compaction procedures.

MR. POHLE: Right.

MR. BERNERO: And I assume that is with drifts full of waste.

MR. POHLE: But in this case -- yes and no. And in this case, these are backfill, to my knowledge, and certainly seals would not have an operational function. I think their function would be primarily post-closure. It would be the justification for having either in there.

And if there is no experience base in backfilling or putting in seals that presumably would have some very long-term meaning, if it's relevant to post-closure. Then, can you meet the specifications that you are stating are required for backfills or seals, should they be used, would be the question.

So this is an unusual case where it shows up in performance confirmation space.

MEMBER RYAN: Steve?

MR. FRISHMAN: Back to 131(b), you sounded a little blase in your answer to Milt's question about performance confirmation must have started during site characterization.

I see -- in the rule, I see a real difference between performance confirmation and site characterization, and you seem to have been -- in your answer seem to have blurred that somewhat.

Let me just ask point blank, what if you discover, during your review of the license application, that there has not been a performance confirmation program up to that point? What do you do about it?

MR. POHLE: Can you repeat that one more time?

MR. FRISHMAN: What if you discover in a license application that there has not been a performance confirmation program that you can identify that took place prior to the end of site characterization? What do you do about it?

MR. POHLE: One, I can't think of anything that's more farther from being a safety-related question than that. The fact is, there is a substantive database obtained during site characterization that will form the basis of the baseline information which is used to develop the performance confirmation plan at this particular stage or phase of the process. That's where we're at, so I don't see having a negative answer in any of these --

MR. FRISHMAN: Well, what you're telling me, then, is that the language framed as a requirement doesn't matter.

MR. POHLE: What I'm saying is that the -- a baseline set of information exists, and that is the baseline information that is required under Subpart F, and it's also the baseline information you need to further develop the details of the performance confirmation for --

MR. FRISHMAN: Okay. Well --

MR. POHLE: -- define activities to be done in the future.

MR. FRISHMAN: Well, we had -- last December we had a technical exchange between the NRC staff and Department of Energy on performance confirmation. And it was recognized in that meeting that was some number of months after site characterization legally ended under the Act -- it was recognized that at least at that point there was no particular program of work or even individual items of work that the Department could identify as specifically being performance confirmation. That was one of the results of that technical exchange.

MR. POHLE: I recall your statement and your closing remarks. There were no comments on that statement, and I recall DOE said they would get back to you. I have no further information on where that went, but there was no comment from anyone at the meeting.

MEMBER RYAN: Perhaps we could take another question. John?

MR. KESSLER: I'm not sure it's a question as much as an observation. You repeatedly said that NRC has a lot of freedom on this, and I think that's a good thing. It certainly gets to one of the things Chris talked about about the need to be flexible.

What concerns me is the lack -- that some of the options haven't been explored, it seems. My impression is the options have not been explored internally to NRC, let alone whatever it is DOE may send NRC's way.

For example, in this EPRI performance confirmation panel that was done a couple of years ago, there were a couple of people with licensing experience on there and they suggested that the tech spec approach would be a good one. And I'm just suggesting that NRC staff should become maybe more familiar with that tech spec approach, understanding how it could be applied.

I guess what my bottom line concern is is that running to a license amendment every time there's a little change is the best way to kill flexibility that it seems both NRC and others are after here. And a good understanding of what all of the licensing options are and how to make them work seems pretty important here.

MR. POHLE: I agree.

MEMBER RYAN: Yes, Chris.

MR. WHIPPLE: Jeff, you mentioned that NRC intends to get a detailed performance confirmation plan from DOE and review it. Is it conceivable that in your review you might identify elements of that plan which you believe to be unnecessary and largely uninformative, and that you would tell DOE that? Or would you decide that's DOE's business, to identify and filter out such things?

MR. POHLE: Yes, that's a difficult question. Generally, our focus would be, is there something that needs to be done that isn't being done? And not to make those decisions for DOE otherwise. I will do as I am directed.

MEMBER RYAN: Other questions? Richard, yes, please.

MR. PARIZEK: Parizek, the Board. It seems like you give a lot of flexibility to DOE, and you say a need for administrative structure or procedures to evaluate and allow modifications in construction, and so on.

So that really allows the program to kind of address surprises as they occur from time to time. It's not clear what NRC's role would be. I mean, would you go and inspect underground conditions to say, "Well, I don't think this is normal, or this is average"?

Because, you know, you get working on the five-thousandth package, and it's sort of routine. And, you know, another two miles of tunnel, and what's new, and you get used to it, or you take a lot of this for granted. What sort of outside inspections are required that draw attention to the fact that maybe there are some deviations? Is that a review function of outside independent people? Or is it DOE should discover this for themselves?

I think of people, you know, working around a pig farm, and all of the farmers say, "I don't smell pigs," when anybody who comes from the outside smells pigs, you know, or paper factories, and so on. So how do you discover differences and anomalies?

MR. POHLE: Well, they both have responsibilities. DOE, as the licensee, has a responsibility to be aware, and all NRC regulations have a requirement when you learn something of significance, important in terms of some standard you have to meet, you have, what, two days to notify the NRC.

And it's certainly the responsibility of NRC. We will be doing inspections, I'm sure -- we do that at all license facilities -- where some staff are just starting -- they put a group together to flush out the inspection part of the program, given where we're at today.

I can envision decisions being made on what to inspect, given limited resources, be based on risk. Some risk guidance from the staff would be in the process on when and what to inspect in part of that. And I also can envision continued interaction with DOE from my technical staff here. I would expect us to maintain a capability.

I would expect our own performance assessment to evolve over time as new data are coming in. And then maybe the NRC may determine some information should be collected sometime down the road, whether it's collected by DOE or we have the option of going onsite and doing some tests of our own. Whether we have the budget or decide to do that, I have no idea. I mean, I'll probably be long gone by then.

So, yes, there will be a continued active oversight program. That will probably consist both of inspections and technical staff interactions, perhaps not too dissimilar to them having in the past.

MEMBER RYAN: Jeff, it seems to me you've outlined really three major components to your vision of performance confirmation as a topic. One is to have a technical plan of what I'm going to measure and why, and how all of that technically lines up somehow with the safety questions of the safety case or the safety requirements. And I use those safety terms in the broadest sense.

The second is an administrative plan for how DOE wants to manage this program over time -- time being a long time, decades rather than months or that kind of thing.

And then, third is how that will translate into the NRC's oversight role through its inspection and evaluation of that plan. Have I got the three parts that are in your mind right in kind of a general way?

MR. POHLE: That sounds reasonable to me. And, in fact, I never -- until we started doing the Yucca Mountain Review Plan, this management, administrative aspects, I started remembering my experiences from other facilities. Whoa, whoa, whoa. You know, the regulation really doesn't specifically deal with that, but that's a fact of life. A program has to be managed, and generally we want licensees to do things are inspectable, and we're going to have to get into that. And DOE has certainly come to that realization later in time.

As the time approaches, a lot of areas of the license application -- whether it's operations -- you can imagine the types of procedures and operational-type inspections that will be done in terms of just real-time worker safety. And in that safety assessment there's a whole world of management and administrative aspects that will have to be developed and incorporated into the license application.

MEMBER RYAN: You know, I think it's helpful to think about John Kessler's comment, in that if you do that well, of thinking about the technical aspects, the management aspects, and how they lead into an inspection and oversight aspect, you can, you know, not create a huge burden, but you can also think about it as being tremendously prescriptive and burdensome. And I guess the art will be to have an effective and useful program that doesn't create an inordinate amount of weight to go with it.

Thanks.

Any other comments from the panel members?

MR. POHLE: Can I make one closing --

MEMBER RYAN: Yes, please.

MR. POHLE: -- comment?

MEMBER RYAN: Absolutely.

MR. POHLE: Post-closure monitoring -- there is a requirement -- I think it's in 6322 -- DOE will have to have some post-closure monitoring plan in the license application. And that means after permanent closure, and we do not consider that part of performance confirmation.

So you are correct, performance confirmation ends at permanent closure. There's a bit of a question mark as to what post-closure monitoring will be, but it's not addressed under Subpart F.

MEMBER RYAN: Thanks very much, Jeff. Appreciate it.

We'll move right to our next talk, which is by Deborah Barr from the Office of License Application Strategy, U.S. Department of Energy.

I'm going to ask everybody's indulgence and that we break promptly at 12:10. The committee has another meeting scheduled in its lunch hour. So if we could do that, we'll stop our question discussion at 12:10 precisely, so we can get on to that other activity.

Thank you very much.

Debbie, good morning. Welcome.

MS. BARR: Thank you. I'm Debbie Barr, and I am the DOE technical lead on the performance confirmation --

MEMBER RYAN: Maybe you could pull the microphone a bit close.

MS. BARR: Sorry.

MEMBER RYAN: There you go.

MS. BARR: Thank you. Okay. I'm the DOE technical lead on performance confirmation, and we're happy to be here to talk with you about this today.

Overview, yes.

Actually, while I'm waiting here, I should probably mention, for those of you who picked up the black and white copies that were out in the -- outside the doors, they are missing half the pages. We had done them double-sided. We were trying to save a few trees. But instead we lost half of the information, so -- okay. All right. So if you got it first thing this morning, then you probably got one of the reduced copies.

Okay. So, basically, what we're going to hear about today, what you're going to hear about today, is I'm going to start off by talking about our vision for the performance confirmation program, and I'm going to talk about what our focus was in developing Revision 2 of the performance confirmation plan.

After I talk with you this morning, then you'll hear from Karen Jenni, who will then go on to discuss the decision analysis process that we used in developing the list of activities that would be a part of our program. Following her in the afternoon will be Jim Blink, and he is actually going to walk through those activities, give you a description of them, and, you know, describe those key components of the program.

And then, at the end of the day, you'll hear from me again, and what I'm going to do is tell you where we're going from here, what our next steps are, what you can expect to see in the future.

Next slide.

So first off, I'd like to set it in context of the bigger picture. Performance confirmation is not the only testing and monitoring program that will be taking place now and in the future. There are a number of other programs, and this slide actually just represents probably not anywhere near as many as there will be.

The ones that are in that nasty yellow color are the ones that are culled out in the regulation, in 10 CFR 63. And, of course, the middle one on the bottom is the NRC-specified test, and the reason why there is the arrows pointing at all of the other ones is because they, of course, can specify -- the NRC can specify any test in any of those regulatory-required programs.

There is also the science and technology program, and I'm not sure if he's here now, but I heard that Bob Budnitz might be wandering in and out today. And if he is, if you have any questions about that particular program, then he could answer them for you.

And so what we're here to talk about today is one of these programs, and that is the performance confirmation program.

Okay. So what is the difference between this program and any of the other testing and monitoring programs which might take place? The performance confirmation program has certain goals, and it has a specific focus.

And those are laid out fairly clearly in 10 CFR 63, and those are things like the activities in that program will be specifically designed to confirm what we have laid out in our license application. This program also will be testing the functionalities of the total system as well as the barrier performance.

Other testing and monitoring programs will have a number of other goals, and those may be things like increasing confidence or meeting other regulatory requirements. Now, this is not to say that performance confirmation activities themselves will not increase confidence. In fact, they probably will to some extent. However, that is not the sole purpose of those activities.

The performance confirmation program has a specific role, and there are requirements of it. And they are, as I mentioned before, laid out in 10 CFR 63, and they were described by Jeff Pohle earlier.

Basically, to paraphrase, the NRC requires that our PC plan will be a part of the license application, and also that this program will demonstrate that the total system and the subsystem components are behaving as expected.

We have actually been working on developing the performance confirmation program for quite a number of years, and we've gone through several iterations of the plan in the past. We have had various different methods that we were using to develop the program. And over time, in the past we have also had a small number of interactions with other organizations.

As a matter of fact, I think there may have been a presentation before the ACNW in the past on this as well. And then, there was also the EPRI workshop that took place in 2001.

In the interactions that we've had, we gained a lot of valuable feedback from other organizations, other agencies, and we're hoping that in this program we've done a good job of incorporating the things that we've learned from those other interactions. And so approximately a year ago we decided that we needed to reassess the program that we had in place, that we needed to revise it and update it.

And so with that in mind, there were a number of reasons why we chose to do that at that time. First off was that there was a finalized 10 CFR 63 that was then available, and then there was also the expectations that were laid out in the Yucca Mountain Review Plan.

The previous performance confirmation plan focused on principal factors, and now we wanted to update it to reflect the barriers that were important to waste isolation. We wanted to take a risk-informed approach and determine a program that would confirm each barrier's performance as well as the total system.

And then, we also wanted to ensure that the program we had in place was consistent and compatible with repository operations.

So what was our vision? What was our plan for developing this program? The first thing, of course, that we considered was that it had to be based on 10 CFR 63 requirements, and also what we could read into the expectations in the Yucca Mountain Review Plan.

Now, keeping in mind that the purpose, the existence of this program is because it is called for in the regulations, the goals and the requirements are clearly laid out there. However, we did not just stop there. We didn't confine ourselves to meeting the wording of the regulations, or do a checklist against the phrases within the regulation and say, "Okay, we need this test to meet this one, and this test to meet this one."

If we had done that, we would have ended up with a program that lacked depth and an understanding of the critical aspects of what makes the repository function as a whole, as well as the individual barriers.

And so that brings us to the second point, which was that we wanted to look at those things that are truly important to the performance of the repository. And so we believed that we were meeting not only the specific requirements of the regulation but the intent as well.

Not all activities are equal in value. And so in our vision of the performance confirmation program, we needed to look at how we could determine how complex an activity needed to be, to what extent we needed to do it, how many activities were appropriate to do.

We needed a way of prioritizing the kinds of activities that we might do and assessing them for their importance to telling us what was really significant.

We also needed to -- as part of our vision, we needed something that was not going to drive the design requirements, but was actually going to be complementary to it.

And lastly, the performance confirmation program should support a license amendment for closure. It should provide us with the information we need to be able to close.

So what you're going to hear about in the next talk from Karen Jenni is how we used a multi-attribute utility analysis to develop our list of activities. This is a combination -- this was a method that was used to combine technical judgments about activities as well as management value judgments when you've got varying degrees of importance of different goals.

And so this is the method that we used to combine all of those together in determining the value of each added activity to the program.

Now, while in the past we took a top-down approach to developing the program, this one is actually more of a bottoms-up approach. But that does not in any way suggest that we did not incorporate TSPA or the insights gained from that in the development of the program. That was very much a factor in the process that we used.

The performance assessment uses barriers and scenarios as a basis for decision analysis. And also, there were performance assessment technical staff that provided their input as far as the technical insights that went into the decision analysis process. Performance assessment managers provided management value judgments.

And when we talk about performance assessment here, we're talking about process extraction as well as total system.

So where are we going from here? I'm going to talk more about this in the afternoon at the end of the day. But I did want to briefly cover it here, because I'm hoping to make you aware of what information we have to share today versus what has yet to be developed.

And so as you consider the information that you hear about today, if you can set it in the context of what we have yet to do, hopefully that will help you understand what information there is available right now versus what we may have to defer to some later point in time.

And so at this point in time, Revision 2 of the performance confirmation plan is currently in Department of Energy review. This plan, Revision 2, basically will capture everything that you hear about today, and that is the decision analysis process, the development of a program.

And basically, this revision of the plan sets the context for why we believe we have the right program, what the rationale was that went into it.

Then, Revision 3 of the performance confirmation plan is scheduled for spring of 2004, and that's where we talk about how we then implement the program described in Revision 2. It will include such activities as further definition of the activities in the program. What you're going to hear about today is a fairly high-level description. There's not a lot of detail in it, and that detail will be developed further in Revision 3 of the plan.

There will be a crosswalk to current and previous testing. We'll establish the expected baseline for all of the activities in the performance confirmation program, and we will also establish the bounds and tolerances for the parameters in the program.

There will be more discussion of the management and administration issues, and then we will also identify the needed test plans and define the process for which we report to the NRC on any variances, significant variances, in the values that we -- in the activities that we perform. And we'll also describe the corrective action steps that may be appropriate given those variances.

And then, of course, lastly, contingent upon a successful license application, we would then implement the program that's described in the performance confirmation plan. And, of course, that would be to monitor, test, and collect data, analyze it, and report to the NRC on any significant variances, take the appropriate corrective action steps.

So that's all I had for this morning. Can I answer any questions?

MEMBER RYAN: Debbie, thanks very much. I guess we'll hear over the next several presentations some of the details, and I'm sure everybody has questions about what those are going to be. So are there any questions on the general approach and what we're going to hear over the next several presentations?

CHAIRMAN GARRICK: I only have one, and it's back to this question of the performance confirmation activities that are taking place during site characterization. Are there any activities going on right now that you would anticipate would carry over into performance confirmation? And except for the near field, isn't now a very good time to really start performance confirmation where you have good access and freedom from other operations that are going on, and so forth?

MS. BARR: Right. Well, as we get to Jim Blink's talk, he's going to talk about the specific activities. And I think that you'll see quite clearly that some of those activities seem very, very closely related, if not the same, as some activities that are currently going on.

I think the concern that was expressed by Steve here was that, organizationally, we do not have anything formally labeled as performance confirmation. However, we look at it from the standpoint of information flow. And the information that's flowing from the activities that are currently going on now are what feed into performance confirmation.

They are setting the baseline for what will carry forward as a part of the plan. They are providing us with the information that we needed in order to assess whether they truly were important to be included in the performance confirmation program.

And so in Revision 3, we will make that crosswalk. And yet I think that you'll see undoubtedly that some of the activities that Jim will talk about later do appear to be things that are currently going on now and will continue to go on in the future.

MEMBER RYAN: Debbie, just one quick question. And if we're going to cover it later, that'll be fine. You mentioned performance assessment and manager-provided, management value judgment. I'm curious what management value judgments means.

MS. BARR: Well, I think Karen is probably going to be going into quite a bit of detail on that, but very generally --

MEMBER RYAN: Okay.

MS. BARR: -- what I would say is that when you have technical people looking at the various different areas -- for instance, you have -- we have technical people looking at waste form. You know, we have technical people looking at using above the repository. We did it barrier by barrier, and we had the appropriate technical people involved in the assessment of those particular areas.

And yet when you then look at it from a higher level, and you say, "Okay. Are these two barriers of equal value?" Or, you know, from a bigger picture perspective, what are the kind of judgment calls that you need to make --

MEMBER RYAN: So the basis for this value judgment, the value is in its appropriate -- or its relationship to the safety question? Is that where the value comes in? I mean, the real focus to me is, what are they valuing? You know, is it an important safety question, or is it a technical question that would take a lot of money to do experiments to resolve it, or both, or, you know, that kind of thing.

MS. BARR: No. We're --

MEMBER RYAN: Is there a hierarchy there?

MS. BARR: Yes, we're not talking about management judgment, you know, values as far as like, oh, this costs too much, and that doesn't. You know, it wasn't that kind of judgment.

So I think -- tell you what, if you haven't gotten a satisfactory --

MEMBER RYAN: I'll come back to it.

MS. BARR: -- answer to your question after Karen's talk --

MEMBER RYAN: It's a great start. Thanks.

MS. BARR: -- you can readdress it.

MEMBER RYAN: George?

MEMBER HORNBERGER: Debbie, your -- the very last bullet there -- again, I recognize that I'm not asking a detailed question here, but just in general. So if we get to this implement performance confirmation plan, we say, "Take corrective action should significant variances arise."

So have you had the discussions to go in the direction of how you decide whether something is significant? And I'm thinking in particular, you are going to be doing -- a lot of this performance confirmation is going to be laboratory tests. Have you thought a lot about what the term "significant variance" means in this case?

MS. BARR: Well, I think in this case probably by "significant variance" what we mean is when it reaches that threshold of when it's reportable to the NRC. Now, clearly, that doesn't mean that we don't do anything until it reaches that stage. We, of course, will be doing our own internal data analysis and forecasting of the information available.

And so, clearly, it wouldn't get to the point where, you know, we would have to report it to the NRC, and we'd just say, "Well, you know, we don't know what it means. We haven't looked at it."

So corrective action steps here I believe mean what happens after it becomes reportable to the NRC. And that, you know -- again, I'll address this a little bit more at the end of the day, but that can be anywhere from modifying our models all the way up to retrieval. So there are a number of possibilities there, and they're not all necessarily extreme.

MEMBER LEVENSON: I'm not sure this is a basic part of performance confirmation, but it's an important similar kind of thing. Is there currently a program for determining the background, the radiation, and the exhaust gas from the tunnels and drifts and its variation with barometric pumping, so that you have a background against which to know what you're seeing when you get to performance confirmation?

MS. BARR: Well, for those activities that we have information on now, that information that has been collected to date will serve as the basis for developing that baseline. However, there are a number of activities, as was stated earlier, that won't even start until we begin construction on a repository or even after emplacement. And for those periods of time, we would need to develop baseline information for those activities.

MEMBER LEVENSON: So you're not determining baseline -- things like radon due to barometric pumping from the mountain, which can be done now, is not being done.

MS. BARR: No. If it can be done now, that -- the work that is currently ongoing is what will be providing the basis for that baseline.

MEMBER RYAN: Questions from panel members? Oh, yes, John. Sorry.

MR. KESSLER: A follow-up on this very last point. I guess to me it's related to Jeff's talk in terms of talking about all of this freedom of approach, which I think is a good thing. So it seems as if NRC has given DOE the rope. Will we hear about how the licensing approach -- anything about the licensing approach? You know, the tech specs versus license amendments versus -- you know, how is it that DOE might propose that this -- all of the aspects of performance confirmation get taken care of in a formal licensing approach?

MS. BARR: I'm not sure I understood the question. Could you --

MR. KESSLER: In Jeff's talk, you know, there were questions about, well, it could be license amendments, could be tech spec changes, could be something else. In terms of when you take corrective actions and you talk about triggering NRC, you know, notification, when DOE puts this in the license application, what is the licensing mechanisms that they intend to use, saying, okay, if it gets without such-and-such range, we'll come back for a license amendment after we do XYZ, or we plan to develop a set of tech specs that -- to live under.

You know, what are those conditions of operation that DOE is proposing that NRC is clearly asking for DOE to take the lead on? Will we hear about those?

MS. BARR: I believe that's part of what's encompassed in Revision 3, in that we would develop the correction action steps that we would follow. And then, of course, it's up to the NRC whether they would accept what we propose or not.

MR. KESSLER: Is this going to be something that might be the subject of a future tech exchange before you actually commit to something?

MS. BARR: I think it probably would be appropriate for that. There is certainly nothing definitely planned right now, but that's certainly an appropriate thing to do before we submit a license application.

And, actually, I should probably -- you know, you pointed out that, you know, NRC has given us the rope to, you know -- I would like to point out in response to some of the comments earlier, we are not taking the approach of, you know, what's the minimum necessary that we can get by with? And we're not taking the approach of, what's the maximum so we can get a license application, and the negotiate later.

That is certainly not the approach that we're taking. And I think we've put a lot of hard work into this, and I think we've come up with a program that really meets the intent of the regulation. It really does.

MEMBER RYAN: Is there one last question?

Hearing none, thank you for introducing what will be an interesting afternoon I think, Debbie. Thanks very much.

We'll resume promptly at 1:15. Thank you very much.

I turn it back to you, Mr. Chairman.

CHAIRMAN GARRICK: Done.

(Whereupon, at 12:05 p.m., the proceedings in the foregoing matter went off the record for a lunch break.)

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

1:17 p.m.

MEMBER RYAN: Our next speaker is nearby. Oh there you are. I didn't see you sitting over there.

Karen, welcome, and thanks for being with us this afternoon. Your presentation is entitled "Decision Analysis Process, Views to Develop a Performance Confirmation Program." You have our undivided attention. Thanks for being here.

MS. JENNI: Thank you very much. I'm going to talk about the process that we used to develop the performance confirmation program. I'm going to talk in quite a lot of detail about some things that I heard interesting this morning, so hopefully, I'll be able to capture your attention.

I'm not going to talk about the specific activities that are included on the program. I'm going to get you right up to that point and then a little bit later this afternoon, Jim Blink is going to talk about the activities that are in the program.

First, let me give you just a little bit of brief background about the methodology and the approach and then I'm going to walk through each of the three phases of this process in some detail and

I'm going to give you some examples. There are, I think, one or two that you saw in earlier presentation on this before I had examples. I know John Kessler did and now I've added some detail in terms of specific examples of activities that were evaluated and how they were evaluated.

A key distinction that we made early on is a distinction between individual parameters or activities and a set of activities or what we call a portfolio. We separated the evaluation of parameters or activities from the evaluation of portfolios. A key point is the best set of activities, the best performance confirmation program or portfolio, doesn't necessarily result from just ranking all of the potential activities in order of benefit or cost benefit and so I think from the top down. There are other things that may come into play that are important in creating the correct set of activities.

There are a lot of activities as you'll see, close to 300 activities that were evaluated. Well, there are almost infinite number of combinations of activities or portfolios. It was not feasible to evaluate every possible portfolio, so we started by evaluating activities and we created portfolios later.

Slide, please?

(Slide change.)

MS. JENNI: We had a technical exchange at the end of February where we got a little bit wrapped up around terminology, so this time I put all the definitions up front and I'll try to stick with this. It's kind of a crib sheet for me and for you.

Parameters are things that can be measured or observed. They can be related to performance assessment models. They can be model inputs. They can be model outputs. They can be intermediate results. It's something that the program could potentially measure or observe.

A data acquisition method is a means to measure that parameter. There are a couple of examples here of parameters and data acquisition methods. This combination of a parameter and a data acquisition method we call performance confirmation activity or candidate performance confirmation activity.

In some cases, I think you'll see later on, there are several different approaches proposed to measure the same parameter, so those are different activities, same parameter, different data acquisition methods leads to several different activities.

Portfolio then is a collection of

activities that could form the basis for the performance confirmation program and the program itself is the selected set of performance confirmation activities. So I'm going to keep my crib sheet out, because sometimes I slip up.

The approach we used here is decisional analysis approach. Why did we go with an approach like this? Well, it's logical and proven and tested. It provides a consistent basis for evaluating and comparing activities. It addresses the fact that trade offs between different objectives and goals might be necessary and probably the key point for us is that it allows us to take advantage of the appropriate expertise at the appropriate point in the process.

So technical judgments that go into this which are the potential impacts of including an activity on the objectives of the program, there are also management value judgments which I'll talk about in some detail in about 10 more slides. But they are basically judgments about what's important for the program and how important are those objectives relative to each other.

The combination of those technical judgments, what are the impacts of this activity and the value judgments, how important are those impacts, combine to give us a figure of merit or what we call a utility of each activity.

Next slide, please.

(Slide change.)

MS. JENNI: I'm just going to breeze through this slide, but for those who are interested in the mathematics, the basis here, as Debbie mentioned, is multi-attribute utility analysis which is that aspect of decision analysis that focuses on value modeling, on quantifying impact on multiple objectives.

There's a five step process here which you'll see that we implemented in Phase 1 which is our next slide. The overall approach had three phases. In Phase 1, we went through and we evaluated activities in terms of how they met certain criteria. In Phase 2, we took those activity evaluations and we developed a set of alternative portfolios and then in Phase 3, we selected a base portfolio and modified that based on management judgments.

The steps in Phase 1 are shown on this slide. And they map to the five steps in the MUA process on the previous slide. The first step is a management judgment about what's important. What are we trying to accomplish with the performance confirmation activity? How do we measure the value of an activity?

The second step on the -- I can't do this, on my left, your right, are technical judgments, so we went to technical investigators and asked them to define candidate activities in light of the objectives that are important and then evaluate how all those activities meet the objectives of the program.

Simultaneously, on the management value judgment side, the performance assessment managers assigned basically weights, relative values to the different objectives and then again that combination gives you the overall value in Phase 1 of an activity. I'm going to go through, each of these boxes has one or possibly two slides associated with it.

The first step was to define the criteria. We've got three. Chris had four, but they're pretty similar. We formed our workshop that involved technical investigators in the different model areas, performance assessment, analysts, DOE staff. It was a pretty big group. And we spent a day talking about performance confirmation activities and how do you judge the value of a performance confirmation activity.

And what came out of that workshop was three or four, depending on how you parse that first bullet, criteria that were judged to reflect the value of an activity. It was the sensitivity of barrier capability and/or system performance to that parameter, the confidence we have in the current representation of that parameter, and then the accuracy with which you can measure that parameter, so I think the direction of preference here is pretty clear. If you've got a parameter to which system performance is very sensitive, you have less confidence in its current representation and you can measure it very accurately. That's something that's a pretty good candidate for performance confirmation.

On the other hand, if you've got something to which performance barrier or system performance is insensitive, you're very confident in your current representation and you can't measure it very accurately anyway. It's one of those things that you can't measure. Well, that's not a very good thing to include in your performance confirmation activity.

Next slide, please.

(Slide change.)

MS. JENNI: The next step was to say conceptually how do these three or four criteria roll up to form, how do we take inputs on those criteria and estimate the value of the activity? This slide will kind of slowly walk you through the process. What we're looking for is an overall measure of benefit. We said that's a function of the value of "perfect information" which I put in quotes because that's not ever available. You never know anything with certainty. And the accuracy with which the proposed activity measures that.

So how valuable is it if you could know it? And then how well can you know it?

The value of "perfect information" then is a function of those three -- drawn from the three criteria we mentioned. It says will this hypothetical perfect information change your estimate of system performance, of barrier performance or change your conceptual models?

If you go down just a couple more --

(Slide change.)

MS. JENNI: Those things then tie specifically to the criteria on the previous page and they tie to questions that we asked of the technical investigators. On the other side, accuracy, how accurately does this activity or data acquisition method measure the parameter. We define three aspects to accuracy. How accurately does it capture temporal changes in the parameter? How accurately does it capture spatial variability in the parameter? And then how directly do you measure that? Is it something that's a direct measurement of what you care about or is it something that several steps removed where you have to make a number of inferences to get from your measurement to the parameter that you care about.

Next slide, please.

(Slide change.)

MS. JENNI: Those blue boxes at the bottom of the slide, for those of you that have color copies, the ones at the bottom for those of you who don't, all tie to specific judgments that we could ask technical experts to estimate for an activity. What we did was, rather than just give them this list and say how does your proposed activity compare against these criteria, we developed a pretty detailed set of questions. Developed a questionnaire where for each of those criteria there was a set of questions.

Yes?

MEMBER RYAN: I was just going to ask on that point, how is it different from doing sort of a numerical sensitivity analysis where you don't have to rely on a judgment or a value here, you can calculate it?

MS. JENNI: Some of the activities did not tie really tightly to TSPA models. Some of them did and in those cases we went to the technical investigators who were most familiar with the model and asked them to use their judgment and you'll see the detail in the questions in just a minute. They tie pretty closely to PA. But there were also aspects and we wanted to allow for activities that didn't tie directly to a PA model input or a PA model output.

We used a questionnaire just to make sure that everyone was answering the same questions. You say you're highly confident in this parameter. If I say it and you say it, it might mean different things, but if we write down exactly what it means, then we at least know we're saying the same thing when we say highly confident.

So next slide, please.

(Slide change.)

MS. JENNI: The way we got the first set of technical judgments is we held a series of workshops where we met with the technical investigators and the performance assessment modelers, so with each model area, roughly equivalent to the barriers. We gave them the questionnaire. We talked about the process, about the criteria and we sat with them while they developed an initial candidate list of performance confirmation activities. So we said in light of these objectives of the program or criteria, what's the set of activities that you might propose? And we really encourage them here to be comprehensive. Anything they thought would be valuable on any of those criteria, propose it, initially, and then we went through an example. We went though with them this questionnaire. Let's evaluate it against the criteria. Now you know how to evaluate it and then the modelers went off, the technical experts went off and in their own workshops went through the evaluation for all of their parameters.

Next slide, please.

(Slide change.)

MS. JENNI: In addition to having evaluations from the technical experts, we had a small group of two dedicated individuals who evaluated every activity. There were more general technical experts than really deep in a particular model area. And the goal there was just to provide another consistency check. You get some consistency by using a detailed questionnaire. You get that sort of within a model area, but to ensure consistency between model areas that the people were familiar with an aspect of the natural system are interpreting questions the same way that people who are familiar with say the waste package barrier.

We had these two people who evaluated all the activities and then they met with each of the groups to kind of reconcile differences. The whole purpose of this little exercise was to ensure consistent interpretation of the questions across the different groups.

Once that was achieved, those evaluations went away and we stuck for the rest of the analysis with the evaluations that came from the technical experts in each area.

Next slide, please.

(Slide change.)

MS. JENNI: Now this slide, for those who are trying to follow along in their printed copies, this differs a little bit. The next two slides in your printed copies capture the information that we'll go through here.

This is the conceptual framework that we went through for how criteria rolled up to values. I want to go through at least a couple of these in detail.

Next slide, please.

(Slide change.)

MS. JENNI: Here's an example of one of the questions that the technical experts were asked about their proposed activities. This was the question that has to do with system performance and they were asked to assume that the parameter lies outside of its currently modeled range and then estimate how much that would change the estimate of total system performance.

To answer this question they had available to them all of their knowledge in the technical area. They also had sensitivity analyses for the TSPA, sensitivity analyses for the particular model components and they were asked to incorporate all of that knowledge into an answer to this question.

Next slide, please.

(Slide change.)

MS. JENNI: Again.

(Slide change.)

MS. JENNI: That was combined with a question about confidence. This was the one confidence question. It basically asked how confident are they in the range of this parameter. Could be an input. Could be an output. How confident are you that that model range won't be exceeded in the 10,000 year performance period.

Next slide, please.

(Slide change.)

MS. JENNI: And one more.

(Slide change.)

MS. JENNI: The answers to those two questions combined to give you an answer to this question about how likely is perfect information to impact system performance. I think you've got all the questions on one of your slides and maybe we can just page down until we get -- keep going until I stay stop.

(Slide changes.)

MS. JENNI: Right there. The questions from the questionnaire at the bottom tie directly up to this value of hypothetical perfect information and that's the first place where another set of management value judgments come in. We have these three aspects to value of information. Will that information change estimate and system performance, barrier performance or of the conceptual models? Those three impacts combine to capture the value of information based on how important management thinks it is to capture changes in system performance, barrier performance or conceptual models.

So we'll talk later about those rating judgments in there. Those are the Ws on your slides.

Next slide.

(Slide change.)

MS. JENNI: There are also a set of similar questions related to the accuracy components. Here we asked how confident are you that information collected in the activity accurately represents temporal changes. And in this case we just had a constructed scale going from highly confident to not at all confident or in this case it's not even trying to capture temporal changes. That would be some of the least accurate if you're not even trying to highly confident that you've captured temporal changes.

Next slide.

(Slide change.)

MS. JENNI: Just page down again.

(Slide change.)

MS. JENNI: Again.

(Slide change.)

MS. JENNI: Go down until we get the top equation.

(Slide changes.)

MS. JENNI: One more.

(Slide change.)

MS. JENNI: Thank you. And we can come back to any of these questions, but the basic concept here is now the blue boxes across the bottom with the questions are questions that were asked of technical experts most familiar with each model area and those were combined using management value judgments about the relative importance, the Ws on that chart to capture those two aspects that we care about. How valuable is the information if you could collect it? How accurately can you collect it and then those are combined to give this overall utility value.

Next slide.

(Slide change.)

MS. JENNI: One more.

(Slide change.)

MS. JENNI: Now I want to talk a little bit about the management value judgments. There were two types of judgments that were necessary. They were the weights that we talked about and there were also some within criteria judgments that construct a scale that we talked about that I showed you with the confidence. Those need to be tied to value judgments and I have an example of that on the next slide. But let me talk about this process.

We met with -- on that bottom bullet, we had a group of about eight managers from the performance assessment project. They went through an exercise where they first reconfirmed that we had the right criteria, so they endorsed these are the right criteria. They looked at the questionnaire and at the metrics and then they answered a series of trade off questions designed around exactly the same scales and metrics used in the technical questionnaire to develop the value judgments.

Next slide, please.

(Slide change.)

MS. JENNI: Here's an example of one of the metrics. This is the scale that the technical experts use to evaluate how well this activity capture spatial variability in the parameter assuming that it was a parameter that did vary spatially.

The managers looked at this same scale and then assigned relative values in terms of accuracy to each of these aspects of the scale and that's on the next slide.

(Slide change.)

MS. JENNI: On the right is the summary of those judgments. There were eight managers involved in the assessment. They talked about the scale. They did individual assessments. They talked about differences in opinion and they reevaluated and the details are shown in the bar chart on the left. The one thing I want you to get here is that the judgments of the different managers were highly consistent in terms of how accurate or how valuable in terms of accuracy are measurements that you are highly confident captures the spatial variability, moderately confident and so forth.

So this function on the left was used to scale the responses, the technical responses to the spatial accuracy question into value responses.

Next slide, please.

(Slide change.)

MS. JENNI: There's another type, the second type of value judgment which I pointed out on the slides are the weights, the relative weights of the different criteria. We said there are three aspects to accuracy, capturing temporal changes, capturing spatial changes and the directness of the measurement. These are the weights assigned by the managers to the importance to overall accuracy of capturing temporal changes, spatial variability and directness. So what they said was the most important thing in terms of accuracy is capturing temporal changes in the parameter. The next most is capturing spatial changes and the last one is how direct the measurement is.

You're ahead of me.

(Slide change.)

MS. JENNI: The final set of value judgments were the judgments related to barrier capability, so there's a criteria how sensitive is barrier performance to this parameter. We also -- management also said well something that a barrier that is less important to performance compared to a barrier that's more important to performance probably shouldn't get the same value in the system. So they provided a set of weights for the barrier capabilities, for barriers themselves, I'm sorry.

They used management judgment. They used the TSPA analyses. They used the sensitivity analyses, a risk prioritization report. They used a series of one-on analyses that are similar to some of the analyses that EPRI has done. And they also had fairly lengthy discussions about the different barriers and how to weight them in performance confirmation.

You'll see these are -- they're pretty

clearly tied to system performance.

Next slide, please.

(Slide change.)

MS. JENNI: We also did a rough estimate of the costs of each activity. I think understanding both the costs and benefits is important to the decision making process. You don't want to just include -- well, there's a possibility if you just look at the most important, most beneficial activities you'll end up with a very cost ineffective program if you ignore the cost component. If you include activities based only on minimizing costs, you might leave out things that are very valuable. So we wanted to capture both sides.

Costs came into play in developing the portfolios. I'll talk a little bit about that when we talk about Phase 2.

Next slide, please.

(Slide change.)

MS. JENNI: This is just a little summary of where we started and where we ended up. We started with about 360 different activities. This is when we met in the workshops and we asked the technical investigators to think broadly and develop a list of everything you think should be considered. During the evaluation, some of those fell out, some of them were duplicated among different groups and so forth. We ended up with 287 activities for which we had an activity, an estimated value and an estimated cost. We then went back one more time to the technical experts and we showed them the results of the evaluations of their proposed activities. They had provided us with completed questionnaires, a list of activities, completed questionnaires. We combined them with the management value judgments and we wanted to take them back to them and do a kind of reality check. Does this make sense to you? If not, why not? And we spent another day with them talking through what the evaluation came up with, what their reaction to that was and we noted where they had exceptions.

MEMBER RYAN: That's an interesting point in that you spent a lot of time with the process trying to elicit their opinions and deal with them well. What was the -- can you give us some insight there as to why they didn't agree that their opinions had been reflected?

MS. JENNI: For the vast majority of activities, they did feel, yes, that matches what we think it should match. There were probably fewer than a dozen cases where they said that really doesn't make sense to me. I think that activity is more valuable. We went back and we looked at their answers to the questionnaire. We could trace why it evaluated poorly and they thought it was important. But what we did was it's just a tool, so we wanted to make sure we carried the relevant information forward to the decision makers. Where they disagreed, we flagged that in the documentation.

MEMBER RYAN: Out of how many portfolios?

MS. JENNI: No, they didn't have input to the portfolios. Where they disagreed with where the activities ranked -- we just within groups. So we met with say the saturated zone modelers and we said here are the 15 activities that you proposed. Here's how they rank in terms of benefit. What's your reaction? For the most part, they said that matches my intuition. Sometimes they had questions, well, why is that one down there? And then we would go back and explain the calculation, what input they gave us, how it was rated by management, so why it ended up where it did.

Most of the time that satisfied them and sometimes it didn't and they said I still think it's more valuable. In that case, we just flagged that and said we'll carry that forward in the portfolio development.

MEMBER RYAN: So with the exception of those flags, they did agree that the results reflected their opinion?

MS. JENNI: Yes.

MEMBER RYAN: You might want to change that bullet.

(Laughter.)

MS. JENNI: Okay. Thank you.

MEMBER RYAN: Thank you.

MS. JENNI: Next slide, please.

(Slide change.)

MS. JENNI: This is an example of two activities, real activities that were proposed and how we carried them through the evaluation, so I want to walk through this. The numbers here refer to just codes that we used to code the activities. When you see the performance confirmation plan it will tag to exactly to these numbers.

One activity was hydraulic testing of fault zone characteristics. Another was on-site testing of invert materials.

The technical judgments, just in words, are listed there. Next slide.

(Slide change.)

MS. JENNI: Next slide.

(Slide change.)

MS. JENNI: One more.

(Slide change.)

MS. JENNI: I want to walk through the comparison, how we took those general technical judgments on the previous slide, and codified them to get utility values. So it just went through the questionnaire and we'll just page through this fairly quickly and see where there are differences. So in this case the two parameters were both sensitive, system performance was insensitive to both of these parameters.

Next slide.

(Slide change.)

MS. JENNI: Next slide.

(Slide change.)

MS. JENNI: And they were moderately confident in both cases in the power representations of those parameters.

Next slide.

(Slide change.)

MS. JENNI: One more.

(Slide change.)

MS. JENNI: One more.

(Slide change.)

MEMBER HORNBERGER: Karen, your formula, you're multiplying by answers to these questions. I don't get a number if I multiply something by C.

MS. JENNI: The questions that are in terms of probability, we just used the probability. So this answer C says 75 percent, so the value used in that equation is 75 percent. So in all cases where the scale is probability, the number that was used in the equation is the probability.

In the other cases where the scale is not in terms of probability, the value function, the first one that we saw where we saw how the managers translated answers to the spatial variability question to value, that's the value that was used in the equation.

Here's the first place where the assessments differed. In this case for the activity 159, they said barrier performance was highly sensitive for that parameter and for the invert materials barrier performance was somewhat sensitive to that parameter.

Page down.

(Slide change.)

MS. JENNI: Again.

(Slide change.)

MEMBER RYAN: Karen, we had one question on that.

MR. KESSLER: We had one quick question on that. I just want to understand what you're saying in that you can back up, oh boy -- there we go.

For example, this is getting back to something that was in Chris' talk originally, where he was talking about in some cases there are parameters that may be used to a conservative range such that it was a very broad range. And so what you're saying is in those cases where you maybe went in with this broad range that you feel is conservative, you're going to wind up with a bunch of F categories, meaning that the real measurement is likely to be just a small fraction of that range you put in PA. Is that what would be happening in those cases where you're putting in conservative values?

MS. JENNI: I think you'd capture that in a different place.

MR. KESSLER: Okay.

MS. JENNI: Right here it's saying what is the model range, whatever it is and how sensitive is barrier capability to the full range of that parameter value. So this is a true sensitivity question. If we page down --

(Slide change.)

MS. JENNI: We missed it. Let's try to get it. Page back up.

(Slide change.)

MS. JENNI: Again.

(Slide change.)

MS. JENNI: Two more.

(Slide change.)

MS. JENNI: That's -- it's the confidence question where you would get the impact of a very conservative, range. So if you put in a highly conservative range, so you're really confident you're not going to find anything outside of that range, then you would score a D on this. It says we're really confident in the curve range. We captured the bounds of physical reality, so here you would say you're confident that that range won't be exceeded.

MEMBER RYAN: Fair enough, but what that means is if you have a wide range, you're only likely to sample from a small portion of the range in any realistic test?

MS. JENNI: Correct.

MEMBER RYAN: But that wasn't considered in that weighting that I was asking about?

MS. JENNI: I'm getting -- can we come back to that question? I'm not quite sure I get it, but --

page down.

(Slide change.)

DR. WEINER: Could I ask a question before you get away from that slide?

MS. JENNI: Yes.

DR. WEINER: Go back to that one.

(Slide change.)

DR. WEINER: You said when you had a probability you just multiplied, used the probability as your number. What do you use in this case?

MS. JENNI: Midpoint for the ones in the -- for B and C and 5 percent and 95 percent for the others. Just as a target.

DR. WEINER: Thank you.

MS. JENNI: Page down.

(Slide change.)

MS. JENNI: I'm afraid we hung up the presentation by going back and forth too many times.

Now if you can just continue to page down until we get all the numbers back on there. So you can see the places and in your printed copy you just have the answers to the questions and how it flowed up in the calculation, so you can see where the evaluation of the two activities differed and how that translated into a pretty big difference in utilities score.

You can keep going. Thank you.

(Slide change.)

MS. JENNI: Back one.

(Slide change.)

MS. JENNI: Back one more.

(Slide change.)

MS. JENNI: So here, now is when I wish I had a pointer. You can see the places just like you could in the text where the evaluation of the two activities differed. It differed in terms of estimated sensitivity of barrier capability and in terms of both of the key accuracy measures.

This difference flows up to a difference in the value of information. These two differences flow up to a really big difference in estimated accuracy of the two activities and that translates to a very big difference in the benefit of the two activities.

So this difference comes from the difference in the sensitivity of the barrier capability and the difference in the weights assigned to those two barriers. Not only is the capability of the invert less sensitive to this parameter, it's also weighted quite a bit lower than the other one.

On the accuracy side, these were the two most highly rated parameters and these values were very low. So we do a very poor job with this measurement of capturing temporal changes or spatial variability. It translates to a relatively low accuracy value.

Next slide.

(Slide change.)

MS. JENNI: The last piece was to estimate the operating costs. We had information from the technical experts as to how long the tests would take, how long an individual test would take, how long a total testing program would take and those were translated into a rough estimate of the operator.

MEMBER RYAN: Karen, if I could maybe you up to that previous slide, I'd like to ask you a question about how to interpret the numbers.

159A has a numerical value of 510 roughly, 250 times greater than 28A parameter. And those are numerical comparisons, but is it really fair to say one is 250 times more important than another? Is that relative numerical ranking hold up or is that just a translation of what are, in fact, subjective assessments?

MS. JENNI: These are a translation of what -- our subjective assessments. It's a numerical comparison. It has some meaning in that larger differences indicate more difference than small ones, but I wouldn't say 250 times, but I would say the difference between more than 100 is different than the difference between 1 and 500.

So it's not meant to say the decimal point matters or the difference between a 1.7 and a 1.8 is important. This was meant to give you one summary number of all of both the technical judgments and the value judgments and to provide input to the decision makers who really come into play in the next couple of phases.

MEMBER RYAN: So you'd let me round those off to one significant digit?

MS. JENNI: I would let you round those off in one significant digit.

MEMBER RYAN: And I think it's important to give us a sense of what -- like you just aid, I mean the difference between 1 and 10 probably means they're about the same. The difference between 1 and 100 is there's a difference. The difference between

1 and a 1000 is there's a big difference. Am I on the right track with that?

MS. JENNI: You're on the right track. The total range, I'm going to get this number wrong, but it's close to right. I think the least -- there were a number of activities that evaluated pretty darn close to zero and the most valuable activity probably had a numerical score of around 1500, so that's kind of the range of what we saw from and that obviously would translate straight down.

MEMBER RYAN: And part of that numerical range is just an artifact of where you set midpoints and how you broke up ranges and all of that, so that's really helpful to hear about that.

MEMBER HORNBERGER: Since Mike interrupted you. Let me get my question in too.

At least to the nonpractitioner, this has a flavor of a kind of a carnival game where you're free to assign weights and you're free to decide whether it's 90 percent or 50 percent or anything. And again to the nonpractitioner, it looks like you could get any answer you wanted. Now I'm sure that you don't believe that, so can you give me some sense of how robust this is to the assumptions that you make as you go along?

MS. JENNI: I'm connecting the first part of your question to the second part. I definitely hear your first part and it's something that Debbie has talked about that when I go through the details of these steps it just feels like you're just talking about math here and it's disconnected from the activities. So on one of those slides showing this example, I wanted to show you the real judgments, kind of in words, that people were making.

This was a tool to translate those judgments to make sure that they're consistent, first, so that when I say it's highly sensitive and you say it's highly sensitive, we mean the same thing. Then to translate all of those judgments into a metric, assume a metric as a shorthand for all the details.

It is remarkably hard to make it say whatever you want, even though it seems arbitrary when you -- or it seems like maybe you can just play games until you get the right answer, whatever you personally think the right answer is. It's very hard for the technical investigators, the people providing these inputs to game the system because they don't know what the relative values are. They don't know what the rates are. It's hard for managers to game the system when they assign the weights because they don't know what the technical judgments are. So they give us their true value assessments as to how important these different things are. This group gives us hopefully their true assessment of sensitivity, confirmed by some consistency checks and then the combination happens without either one knowing what the other input is.

Now they do look at it at the end. As I mentioned, we went back and said here's how it rolled up, how does that feel? Is that about right? But it's pretty -- impervious is too strong a word, but I can't think of a softer one, to gaming that way because nobody sees -- no one who is providing input sees the equation or sees the inputs until we have all of the inputs and then they can look at it and it's especially important, you'll see in Phase 2, we never went back after this phase, excuse me, we never went back and said well, if that were more sensitive, then it would be more valuable and it should be in this portfolio. In that case we just said this is a tool, it gave you an input, management is free to make adjustments as they see fit.

So I think you could, I could, given the spreadsheet and this model to go back and create an activity that scored well, but the process kind of prevented that from happening.

DR. WEINER: I want to compliment you on the explanation you just gave because that's very correct, but I have a question. Your calculation of the utility was linear. You just multiplied the numbers together and then added it up. You didn't try any kind of nonlinear manipulation.

MS. JENNI: That's correct.

CHAIRMAN GARRICK: Yes, I just wanted to understand this a little better. When you had a situation where you had a difference in judgments on the same question, on something that you considered important, case studies of that kind of situation have indicated that one way to get a test of the robustness of the two answers would be to look at the supporting evidence for that judgment.

I heard you say earlier that what you did do was just flag it and move on, more or less. Have you in any of those judgments that you considered real important, did you take that extra step? Did you seek to find what the supporting evidence was for that judgment?

MS. JENNI: There were a couple of cases where we had differences in opinion. We had some differences in opinion in the technical judgments, so the actual evaluation of the activity using the questionnaire, between -- ended up with one set of judgments from the technical experts and one set from this small core team that evaluated all of the activities.

In those cases, what we did to resolve the differences, we got the two groups together and we had them talk as a group about the rationale for their evaluation and they came to consensus on what the appropriate score was. So we didn't go back to the models, but we went back to the individuals providing the input.

We did exactly the same thing on the management value side. If managers disagreed on the relative importance of the different criteria, they talked about what their rationale was for weighting one thing high and another thing low and eventually came to consensus on that.

The last piece where we got differences in sort of the overall ranking, those we did just flag along with an explanation why it evaluated the way it did and why the technical experts thought it should evaluate differently. That's what we did. We went back to the inputs to this system which were the technical and management value judgments. We didn't go back further than that and look at the TSPA model results, for example, to see whose judgment would be correct, if there was one correct answer.

CHAIRMAN GARRICK: Thank you.

MEMBER RYAN: Thank you for letting us interrupt you with all those questions, but it really is helpful to hear the details.

MS. JENNI: Sure.

MEMBER RYAN: One more.

MS. JENNI: It may make me a little bit late.

MR. KESSLER: Karen, I want to talk about the barrier weight.

MS. JENNI: Yes.

MR. KESSLER: One of the things Chris talked about in his presentation and was also in Jeff's was the parts of part 63 that basically say you know it's not so much on the relative safety which was the point that Chris was making as much as it may be does everything perform the way you'd expect? And if it was the latter that was all that one wanted to design a performance confirmation for, why wouldn't all the weights be one, all the same?

This gets right to Chris' point which is you chose to weight them based on what you considered safety based on your performance assessments. And I'm just wondering whether you had any feedback from NRC so far on those relative weightings. I know this also came up in the recent technical exchange on a risk-based prioritization and all of that and well, the response back from NRC, I interpret subjectively is is that barriers are a little more important than we'd like barriers to be, individual barriers to be a little bit more important. Beyond that, I'm not sure I understand what NRC said, but all I'm saying is that to me, the relative weights could be an area that maybe require discussion with NRC to get to the really, the fundamental basis of what they believe, the relative importance of safety versus testing every single barrier is.

MS. JENNI: The barrier weights, as you saw, tie pretty closely to system performance which would slant, if you will, a program based just on the Phase 1 numerical results, heavily towards those barriers that are most important to performance.

There are other aspects to the regulation, for example, specifically required to test the performance of all the barriers. Those factors then roll in in Phase 2. And the real, however most tangible impact of the barrier weights is that it affects to a great deal the scope of the activities addressing each of the barriers. There are activities that address the performance of each of the barriers. But the scope of those activities is significantly greater for important barriers and for less important barriers.

Should we go to the next slide, please?

(Slide change.)

MS. JENNI: One more.

(Slide change.)

MS. JENNI: Now I'm going to talk about Phase 2. Page down.

(Slide change.)

MS. JENNI: Phase 2 is where we took the results of Phase 1, which were 287 activities, the technical judgments, the measurement value judgements, summarized in a utility score and operating costs. And in Phase 2 we used those results to create a set of candidate portfolios. What are some of the ways that we can combine these activities into a comprehensive performance confirmation portfolio. And then we evaluated each of those portfolios. Next slide.

(Slide change.)

MS. JENNI: I talked about this briefly

early on. But why did we go to this extra step? You've got 287 activities, we have them evaluated in terms of utility and in terms of cost. Why don't you just rank them and fund either all the ones that are highly beneficial, all the ones that have a high benefit to cost ratio? That's not necessarily the result in the best portfolio. We recognized that early on.

There are some regulatory requirements that aren't captured by the technical judgements and management judgements. And there are some that aren't, some requirements that aren't related to the value of the specific activities included. For example, someone asked a question about it during Jeff's talk, that there's a requirement that multiple methods be used. That doesn't relate to the specific activities that are included, but it relates to the full set. So you can't present us a performance confirmation plan that has only lab activities. It has to have multiple methods. So that is what we would call a portfolio level criteria. You can't capture it just by ranking activities and funding until you get to, funding down until you get to where the benefit is marginal.

Another factor is a cost factor. There

are some costs that can't be assigned to individual activities because they support a whole bunch of activities. For example, an observation drift or a remotely operated vehicle. But portfolios can be evaluated for these criteria. Next slide, please.

(Slide change.)

MS. JENNI: I also mentioned earlier that if there are 287 activities, you can imagine a real large number of possible portfolios. We couldn't evaluate every possible portfolio. But we could create kind of a candidate set of portfolios designed around different philosophies. The first obviously most important thing is that any portfolio considered needed to address the performance requirements of the regulation.

Beyond that, there are some reasons why you might want to include other activities. You may have a minimal set, a maximal set, and in fact on the next slide we'll see that that's how we started.

We said, well what is kind of the bounding set of what we would consider. The most comprehensive portfolio included every activity that was proposed by a technical expert and evaluated as having benefit. We ignored costs and we included everything, all 287 activities. We said that's it -- that's the most you would consider doing. And then on the other end we said well, what's the least that we would consider a viable or potential performance confirmation plan? And here we defined it around a minimum cost threshold. We looked at the least said cost of activities that addresses the Subpart F of the regulation.

In this case, the degree of activity is quite small. Because the focus was minimum cost. These two were just to span the space. This is sort of the range of what you would consider. And then we developed portfolios that are bigger than the smallest one and smaller than the biggest one. Next slide.

(Slide change.)

MS. JENNI: We developed these around different philosophies. One of the philosophies was well, let's design the performance confirmation around a cost effectiveness argument. To do this we ranked all of the activities that were evaluated in terms of utility to cost. We plotted them on a plot like that, and we just picked three points near where the marginal cost benefit starts to fall off.

These are examples of portfolios that you would develop using a benefit cost threshold or a cost effectiveness threshold. Those three portfolios were defined, and in two of those we ended up evaluating in some detail later on. Next slide.

(Slide change.)

MS. JENNI: This is a completely different perspective or philosophy on how to develop a portfolio. Here we kind of ignored, put aside for the moment the utility calculation results and focused on something that Chris mentioned early on about the meaning of the word confirmation. We kind of focused this on disconfirmation. We said let's think about this in terms of hypothesis testing. What activities could we do that would disprove specific hypotheses about how the barriers work and how the total system works?

We defined a set of performance hypotheses at the barrier level and the system level. Then we flagged every activity as either directly testing one of those hypotheses, indirectly testing, or not related to one of the hypotheses.

Then we developed two portfolios. We took one that is just a direct test of the hypothesis and then we created another portfolio that were both direct and indirect tests of the hypotheses, and we evaluated both of those in some detail. Next slide.

(Slide change.)

MS. JENNI: Then there was a set of kind of three portfolios defined around nonvalue related concepts, I call them. There was one defined around making maximum use of a thermally accelerated drift. If we're going to have a thermally accelerated drift, let's do as much with it as we can. That was this philosophy.

Another one of these philosophies had to do with let's maximize use of testing off footprint. Keep workers' risks as low as possible, minimize any possibility of interference with activities in the repository. And a final one was to maximize the use of existing data. So take everything we've got and use as much as that as possible.

These were all interesting portfolios to develop. When we looked at them as a whole, they didn't provide any significant benefit over the other general philosophies. They were kind of things to have in our back pocket, so if management asked hey what about more off footprint activities, we could pull those in and say well, here's the list of what they are. Here is what that portfolio would look like. Next slide, please.

(Slide change.)

MS. JENNI: We took those activities,

those portfolios, excuse me, candidate portfolios and evaluated them in terms of things that were easy to count first; how many activities are in each portfolio, what is the total utility of all the activities that are in that portfolio, what are the costs?

We also mapped each activity to all of the requirements of said Part F of the regulation. And we did an analysis, a purely subjective assessment of how well each portfolio met each of those requirements. I'm going to show you the examples. Page down.

(Slide change.)

MS. JENNI: This is the code that will help you interpret the remaining graphs. There were six portfolios that we evaluated in detail. The spanning portfolios, the minimum cost, and the all-inclusive, two of the cost effective portfolios, and both of the hypothesis testing portfolios. Page down.

(Slide change.)

MS. JENNI: This was the first comparison. Again, just the things that were real easy to do. Counted up the number of activities in each portfolio and then added up the utility of all the activities in each portfolio. These are both pretty crude measures of the overall benefit of a portfolio, but there were things that were obvious to ask and obvious to do.

So this compares the portfolios and again this is the minimum cost, this is the one that includes everything. These two were defined around cost effectiveness thresholds, and these two were defined based on the hypothesis testing philosophy.

This slide I hesitated to include because I thought it would be phenomenonly difficult to explain, but I'm going to give it a shot anyway. On the right are all the paragraphs of Subpart F of 10 CFR 63. All the specific requirements in the regulation. Across the bottom are the six portfolios, and on this side is a purely subjective scale on how robustly each portfolio meets that specific criteria.

These judgements were provided by a small team of individuals who were involved in analysis from day one all the way through the end. They looked at this cross-walk that we developed between activities and the regulation and looked at how many activities addressed each paragraph and what those specific activities were and just gave their best judgement from does it address it adequately to addresses it very robustly for each paragraph. Which one do you think wins?

(Laughter.)

MEMBER RYAN: The right. I'm guessing because of the higher number, the higher robust weight.

MS. JENNI: Well, that would be the one that is most robust. Let's go to the next slide.

(Slide change.)

MS. JENNI: There is, of course, a downside to Portfolio K. That includes everything. The whole kitchen sink. This plot has normalized cost, this is the most expensive portfolio, least costly, and this is in this case the average of all those robustness scores. Again, a pretty crude measure. That would say every aspect of the regulation is equally weighted. But just a general overall assessment of how as how costs go up, the average robustness score goes up. The pink one is the robustness score and the blue one is the overall utility again, the sum of the utilities of all the included activities.

Those were, that I just showed you, were the three graphs and all the bases for them that were presented to Senior Management as here's the information that is available to you from this analysis plus anything else you ask us for, for selecting a performance calculation program.

MEMBER RYAN: I'm sorry. I wouldn't ascribe much meaning to any of those breaks in the curve. It goes from low to high and is that a fair assessment?

You know, if you look, back up two slides. I still see a downward trend. The fact that it is 175, 137, and 176 on the number, and then it looks to be some kind of a gross correspondence perhaps with the utility. It just is going from high to low. You're showing individual points in those graphs, but there are probably pretty big error bars on them, I would guess is my point. How do I read that?

MS. JENNI: You might say, for example, all three of those are about the same?

MEMBER RYAN: I'd say if you look at K going down to A, there's a general trend downward and that is about it.

Can you read more into it than I can?

MEMBER HORNBERGER: I don't think you can see a trend, can you? I could just flip F and E. There's no rational decision as to where those are.

MEMBER RYAN: Yeah, I'll accept that. I'm just saying we've got an analytical graph here and we're just talking about a quantitative assessment. I'm just trying to understand how I link those two.

MS. JENNI: There's one thing in here that is indisputably quantitative which is the number of activities in each work folder.

MEMBER RYAN: Right. Okay.

MS. JENNI: This is normalized, the sum of the utilities in each program. So it gets back to your same question about is there a difference between a 1 and a 10? Is there a difference between a 1 and a 500?

MEMBER RYAN: Yes.

MS. JENNI: Yes, there is a difference. This difference is probably negligible. This difference, again, if we looked at the absolute scores, this would a pretty significant difference. Least utility, highest utility. These are probably in the noise, that might even be in the noise. But that difference is --

MEMBER RYAN: And I don't disagree with what you said. It would be interesting to try and figure out a way to graphically display that.

MEMBER LEVENSON: If you plotted those instead of an A, B, C, if you plot them by the number and you don't get the breaks, they all disappear. If you rearrange these points, they go 25, 101, 137, 175, 176, 281, you have a nice smooth curve.

MEMBER RYAN: What you got is three analytical guys struggling to understand qualitative assessment. So it is not critical, it is just we're reaching to understand.

MS. JENNI: Well, it was pointed out to me after the fact that these should be bar charts because they are just numbers. They're just numbers that summarize what is in Portfolio A. Twenty-five activities with a normalized utility of 14.

MEMBER RYAN: That's a big step forward in helping me.

MS. JENNI: What is in here? Two hundred eighty-one activities with a normalized utility of 100. So if you think of this as a bar chart rather than trying to reflect the trend, perhaps that helps.

MEMBER RYAN: That's a nice friendly amendment to how that is presented.

Chris, you had a question.

MR. WHIPPLE: Yes, I do. Karen, I took your comment a few slides ago about what was the basis for portfolios to say that there is a requirement that each barrier be looked at in performance confirmation. So I took that to mean that the most important contribution from each barrier was at a minimum in each portfolio. And my concern with that is that it seems to me that the intellectual shift from part 60 to part 63 was to get away from trying to define a large number of subsystem requirements and to get to an overall performance base, kind of a more freestyle standard.

And I think that the literal reading of some of these requirements, it appears you're interpreting much more strongly than Jeff did when he presented them this morning. For example, I noticed you got a line running across here where you were all able to interpret what was amended about seals. But when Milt asked about seals, answer was we don't know, we're waiting for DOE to tell us. And my concern is you're reinventing subsystem requirements by this rather strong interpretation of what is meant by the standard. And that concern is amplified by the fact that two case studies you used to illustrate, you could have left out dose and impact on conceptual models from the value of information half of the formulation and it wouldn't have changed a thing.

Those were both the trivial numbers compared to relative weight towards the one barrier assessment. And my hunch is that for most of these things it is the barrier contribution more than the dose or conceptual model that drives the overall utility when you're done. And I guess that puts you firmly in the realm of subdividing across all the barriers and then putting yourself in a relative rather than an absolute sense with respect to compliance with the safety standards.

I'm not sure that's where you would necessarily want to be.

MS. JENNI: I think you're correct that the barrier weight is a strong driver in this overall utility number, and that if we created a portfolio that was just a benefit ranking and funded until we got down to some activity that everyone agreed the benefit was negligibly small, we'd end up very heavily weighted towards activities addressing those barriers most important to performance.

You're also correct in saying that we interpreted the regulation to require testing of every barrier. So there are activities in the program that Jim will go over that address each of the barriers. It turns out that the scope of activities addressing the less important barriers is quite small compared to the scope of activities addressing the more important barriers.

MR. WHIPPLE: Does that imply then that it is hard to pick which one of those portfolios does the best job of performance confirmation with regard to say meeting dose requirements, those kinds of things?

MS. JENNI: It is hard from looking at this graph, but you can go back and prioritize based only on -- you could go back and prioritize based on any one of the criteria. You could go back and say all I care about is system performance.

MR. WHIPPLE: Are you going to go through that process as you go from 1.2 to 3 or --

MS. JENNI: I don't believe that activity is planned.

MR. WHIPPLE: Okay.

MS. JENNI: Let me go on and put the final piece of the puzzle together. Page down.

(Slide change.)

MS. JENNI: We'll go back to our two activities from Phase 1. Just a reminder of what they are and I just want to show you which portfolios they ended up in. This one, vibrate testing, ended up in a lot of portfolios, not in the minimum cost one, but in all of the ones based on cost effectiveness, one of the hypothesis testing ones and of course they're both in the all inclusive one. This one, as you recall, had a pretty low utility. It ended up in one of the cost effectiveness portfolios. That with the lowest threshold for making the cut.

It didn't end up, it did not either directly or indirectly address the hypothesis about invert performance. So it wasn't in those. We'll come back to this one more time and see how this played a role in Phase 3, which is the next slide. One more.

(Slide change.)

MS. JENNI: Phase 3 was the management exercise where they took the input from this decision aid, Phase 1 and Phase 2 results and created a final portfolio. What they did was use one of the portfolios from Phase 2 as a starting basis, make some modifications to that, re-evaluate, look at the that portfolio as a whole, make some modifications to that. We'll talk a little bit about what those are and then, of course, documented the program. Next slide.

(Slide change.)

MS. JENNI: This was the portfolio that was selected as the starting basis, something designed around cost effectiveness but with some very specific changes. So the BSC manager said start here, but there's some things we really liked about the other portfolios. Go back and look at places where you judge that portfolio to be weak with respect to some of the regulations and add some activities drawing from the hypothesis testing portfolios. And then map all of those activities back to the regulation and bring it back to me as the starting basis.

So the answer was none of this exact six that were presented, but it was kind of a combination of portfolio C, bringing in activities from some of the other philosophies.

And it really ended up, I would say, being driven by that kind of a discussion. We liked the idea of doing this cost effectively, when we look at those comparisons, that seems like a pretty robust portfolio, but it is missing some aspects. And you've captured those and some of the other concepts so good, pull those in. So that was the starting basis. Next slide.

(Slide change.)

MS. JENNI: Then the process was really based on management judgement. They took that portfolio that had something like 99 activities, they looked at it. They looked at the regulatory comparison, the regulatory crosswalk, and they talked through the manager projects and advisors, talked through each of those activities and made a few more changes. Quite a number of activities were removed because they were either being done elsewhere or they were judged to be more appropriate to other parts of the program. So they said these are good ideas, they shouldn't be performance confirmation, they should be done by the scientific testing and evaluation program or they should be done by the engineering program.

Or in a couple cases, they should be referred to the science and technology program. Going to interesting sciences was one of Wendell's comments early. But they're not really performance confirmation.

Worth doing, not worth doing in this program. So a number of activities were referred to other programs. Some were combined where it just made more sense. These were evaluated as two activities but really they should be done together. Some were retained, but modified in scope, either increased or decreased, and two new activities were added. In your backup, you have a description of the activities that were deleted, modified, and added. I didn't want to go through those in detail. You might want to come back to that after Jim's talk where he talks through what is actually in the program. One more slide.

(Slide change.)

MS. JENNI: This is the end of the two

activities. We started with Portfolio C, so this activity was in the initial basis. This activity was not in, it was in neither of the hypothesis testing. So it wouldn't come in initially. We talked about each activity, said that if you added this activity it would increase the robustness of the program with respect to one of the requirements. But that was already judged to be robust to that requirement. There was another activity that addressed the performance of the invert. And the judgement was that that was sufficiently robust.

In the management discussions, the scope of this activity was increased, expanded to include both transport testing as well as load testing. So that's where those two activities ended up. And I think that was my last slide.

MEMBER RYAN: You didn't do too bad. We only ate up 15 minutes of questions asking questions. John?

CHAIRMAN GARRICK: I just wanted to clarify one point on this, the point that was raised about part 60 and part 63 and the difference being the elimination of subsystem requirements. I think it is very important that we realize that what we're talking about there is a requirement. Not that we shouldn't know what the individual barrier's performance capability is. I wasn't sure that was really clear, because this Committee has pushed very hard that the capability exists in the performance assessment to evaluate the contribution of individual barriers.

What we did not support in Part 60 was that there should be specifications on what each of those barriers should do. Just wanted to clarify that.

MEMBER LEVENSON: Yes. As a large staff, NRC has -- it's basically responsible for compliance. This Committee tends to focus on the technical aspects rather than the compliance. Fairly important part in trying to evaluate the overall picture is everything that is being done.

Is there anywhere single place where the testing other than what you're calling confirmation testing can be located so one can find out everything that's being done that contributes to the safety of the facility as opposed to just contributing through compliance?

MS. JENNI: I'm going to refer that question if I can back to either Debbie or Jim. You heard the question?

MS. BARR: Debbie Barr, DOE. I think what you're asking is when I showed that one chart that had all of the other testing programs and things like that, you're asking for maybe some definition of what is in them? Is that --

MEMBER LEVENSON: In putting together the selection here, it was pointed out that some of the tests were agreed were important, but they were defined as something other than confirmation, so they're going to be done somewhere else.

The question is is there a single place where one can find out from a customer safety standpoint, I don't care what you call it. The question is what is being done.

MS. BARR: Right. I understand what your question is. Unfortunately, we're not really able to answer the details of other programs here at this time. We work with the performance confirmation program and there are better qualified individuals who can really address those other questions.

MEMBER LEVENSON: I really didn't want an answer right now. My question is does such a source exist?

MS. BARR: Yes, and it is being developed even further.

MEMBER RYAN: Questions from the Panel?

Bob?

MR. BERNERO: Karen, I'm not sure I'm understanding the structure. You had a slide, six portfolios were evaluated in detail, the one with the code. And as I understand it, portfolio C and E were developed on the basis of cost effectiveness. That is an underpinning of the evaluation.

MS. JENNI: That's correct.

MR. BERNERO: Then when I look at those two slides of curves or whatever you want to call them, slide 33 and slide 35. It appears to me that those, one is a plot of number of activities and utility as a function of portfolio, and the other is robustness and cost. It seems to me that is just feeding back cost effectiveness. And I'm not surprised that there's an apparent plateau in those that includes portfolios C and E. But it also includes portfolio F, hypothesis testing. And I don't really understand how that portfolio was evaluated, because one of the things I was looking for is in the total system performance assessment, or in the individual barrier assessments, there is an idealized model of a closed repository. You know, it is there. Everything is in place.

And my question is where can one find

testing the effectiveness of construction. Did it come out with the drip shields in place properly, not spaced with too large a gap or with gaps right over containers or whatever? I'm groping for how this hypothesis testing, it is really two portfolios, F and G. How is that developed and evaluated? I just don't understand it.

MS. JENNI: Your first point is exactly right. Activity C and E were defined around cost effectiveness. The two graphs you referred to are the cost effectiveness framework, so you're seeing exactly what you'd expect to see in those two portfolios.

Portfolios F and G were constructed from a list of activities and a list of hypotheses and then a tie. Does this test the hypothesis directly or indirectly? It is then evaluated using the same metrics, which really puts them in kind of a cost effectiveness framework.

So they were constructed around the hypothesis testing philosophy and evaluated in a cost effectiveness framework. So they were evaluated in terms of what's the utility of the activities that are included going back to the activity evaluations, although they weren't constructed from those evaluations.

Now where you find specific activities, I think you'll get to some of that in Jim's talk this afternoon. Where is this activity? Is it in the program or not? Jim is going to walk through those activities.

MEMBER RYAN: Ruth?

DR. WEINER: Karen, what would have happened if you had used eight different managers for your manager value judgement? Do you have any idea?

MS. JENNI: I think if we used eight different managers who were familiar with the performance assessment models and the sensitivity analyses, I think we would have gotten pretty similar results because of the process which is everybody looked at the same set of information and everybody discussed, they kind of did an initial first pass. This is what I would do if I were assigning the weights. Put them all up on the board and let's talk about where we differ.

The process is designed to get some consensus among the managers about what is important.

DR. WEINER: So what you're really using as managerial values is collective DOE managerial thoughts. Is that a fair statement?

MS. JENNI: The managers that we used were

BSC, not DOE. So DOE was invited to participate. They preferred to review the results of the program than to provide the rating inputs that I would say were using the consensus value judgements of the performance assessment managers at BSC.

MEMBER RYAN: Yes.

MR. WEART: We did a similar kind of exercise, but for a different purpose on WIPP, which you may have heard of system prioritization. And there the thrust was to reduce the number of programs to just those necessary to give us a high confidence of obtaining the permit from PPA. And the rest of the programs weren't thrust off into some other activity, but were eliminated.

Would it be your expectation that as a result of this exercise, there will be programs eliminated from the overall project?

MS. JENNI: For this exercise, I don't believe that it would reflect programs that are on-going. There is that list of the 287 activities that were proposed. What this has done is select those that will go forward, and the others, well, some you saw in Phase 3 were referred to other programs and some would not go forward. So it is a little different than eliminating something that is ongoing but it is used to narrow down the scope of what will be done.

MR. WEART: Thank you.

MEMBER RYAN: Jeff, you had a question?

MR. POHLE: I just had a point of clarification from a statement during a presentation. I'll make sure it is not misinterpreted when you were discussing it, a specific requirement for laboratory tests on waste package. Some of your wordings sounded like there was a generic requirement in Subpart F, were multiple data acquisition methods for all parameters or activities. And that is not quite correct.

MS. JENNI: That is not what I meant to imply. I'm sorry if I did. I did mean to imply that you wouldn't want, not only for the regulation but because it makes sense, you wouldn't want a performance confirmation plan that existed of only one type of activity. So, and we didn't interpret it to imply multiple methods for a single parameter were necessary. But overall, the program should include things that are lab testing and some that are field testing.

MEMBER RYAN: John, first you and then Richard.

MR. KESSLER: I'd like to follow up on Wendell's question. You have portfolio A defined as a minimum portfolio. I presume then that minimum means that it was BSC's estimation that that did meet the part 63 requirements for performance confirmation, yes?

MS. JENNI: Yes, with minimal scope.

MR. KESSLER: Okay, so everything that goes beyond Portfolio A could be considered extra stuff.

MS. JENNI: Yes. And what we did when we developed the minimum program was to focus on minimum cost. Another guy talked early on about why you might not want a minimum cost portfolio. It is the minimum cost portfolio that meets the letter of the requirement.

MR. KESSLER: That seems like a good use of taxpayer money then to stick with Portfolio A. So again, if the other portfolios one can almost -- what I'm concerned about is DOE is doing NRC's thinking for them. DOE is saying well, NRC is going to ask us for this, that or the other thing, so we better put it in there. If DOE feels that Portfolio A meets the requirements, and it is an effective use of the money, then I guess I'm just saying philosophically, why go beyond portfolio A. Maybe I'm misinterpreting what I heard Wendell say, but it sounds like sort of the same thing.

MEMBER RYAN: Richard.

MR. PARIZEK: Richard Parizek. In a discussion of a value judgement method, you don't give any references to this and I guess it would be helpful to dig into this, the reference so we would know where to go. Or maybe it is so commonplace and I just missed it.

MS. JENNI: Oh, I can provide you a reference.

MR. PARIZEK: And then how does this differ from say maybe, I mean you get the judgements in the individuals it is going through expert elicitation process, which is quite formal. NRC has a very specific listing of how you do this. Is it this formal, the process you went through that would be similar to the expert elicitation process. Say, what geomatrix for instance would have subjected these groups through or individuals through?

MS. JENNI: This is quite a bit different from a formal expert elicitation. It has some of the same tools, some of the same facilitated discussion aspects. But other than that, it is not the type of rigor that you see in a formal expert elicitation.

MR. PARIZEK: So there might be a little bit more room for bias as a result based on people's own individual areas of interest, or if you have more say ground water modelers than you might have had biosphere people with a weight, maybe ground water issues more so than biosphere issues, just some evenness of people involved?

MS. JENNI: I think what you would have gotten in that circumstance is a lot more activities proposed in the area where you had higher representation. But probably not significantly different number of activities accepted, if they're evaluated appropriately following the process with the consistency checks and so forth.

MR. PARIZEK: I think you indicated that they used the TSPA results, one-on analyses, one-off analyses. They had a benefit of all of those sorts of analyses, then you could make judgements on a basis of that.

MS. JENNI: Exactly.

MR. PARIZEK: Given that, I guess it helps narrow down those issues which are important, or more important, right? Compared to what it might have been like when you had the KPI list originally and tried to guess at which ones would drive performance. This is a much more advanced analysis stage that you're at.

MS. JENNI: Yes, and the need is you're right, very much driven by the PA results in terms of that informs the experts' input.

MR. PARIZEK: Now to the extent that the TSPA process still has uncertainties in different model areas and data or modeling and so on, you still then could be misled as to things that drop out that when does imply that disappear from the face of the earth, just because it got a low score. But maybe it deserves elevation because you don't understand the process that well, and it may really be important. So if you're going to throw it in the waste basket, you have to be very careful not to throw away important items here.

MEMBER RYAN: Steve?

MR. FRISHMAN: I'm curious about what makes up sort of the base case for this whole exercise. And the reason, and how sensitive this result is to, you know, where everybody started. And the reason I am is because I see a curiosity in the backup material, with the two added items. And that they were added I guess just sort of out of the blue relative to the process that brought all the rest of them forward.

And the reason that I'm curious about them is because they're both sort of a reflection of some of the latest thinking and concern about the repository from a design and analysis standpoint, where the latest change in underground design is the lower lithoposal becomes very important because it represents about 80 percent of the emplacement area.

And if you look at the geodetic monitoring, that becomes more and more important as the importance of potential vulcanism rises in the view of the program. If this were to all start over again today given the current evolution of the TSPA and the current evolution of design thinking, would this turn out to be different again? It looks to me like just from these two examples and they're important enough to where I don't think, I don't think it is just skewing my own thinking. I think there's something there.

Where do you draw a line and say everything all fits together, because the license application is where everything by definition had better all fit together.

MS. JENNI: I think I can address part of that question. Where we started, and you're right, it's an important point. It ties to Dr. Parizek's question. If we didn't have anybody involved in the process that knew anything about say, one of the barriers, they wouldn't have proposed an activity. You could have ended up with under representation, because if you don't ask, nobody proposed an activity. Obviously, it didn't get evaluated.

So the best that we can do is go to the modeling experts in each of the barrier areas, each of the barriers or modeling areas, and ask them to propose performance confirmation activities, given a set of objectives. If they didn't propose it, it didn't get evaluated. We went to the people who knew the most about those areas to get the most comprehensive list that we could to begin with.

Now, I'm going to ask for help to address your second question, because I think you're asking when does this stop? Will we add more activities prior to the LA? I think the answer to that question is we may make changes in Revision 3.

If new things come to light that we weren't aware of, that no one was aware of when we developed this plan, it is not written in stone. Look for help back there and make sure I didn't speak out of turn. I'm getting nods.

MEMBER RYAN: I was just going to make the comment, I think I heard Jeff say this morning that he felt, correct me if I'm wrong, Jeff, but that this could evolve as well over time. If new things were identified, there was the flexibility aspect of it that he talked about. I guess that seems to be an aspect that addresses your question. There's nothing preventing you from adding things to the performance confirmation program or frankly taking them away as time goes on.

MR. FRISHMAN: Well, I think the place where something showed up in your answer. You went to the people that knew the most. Well, I'm suspecting that the way this thing is evolving, is not necessarily the people who know the most that influence this. It is the people that know the latest. And I'm not sure that tells you what a performance confirmation program ought to be. Because the latest is only the latest. Tomorrow, it can be something new again.

So I guess my point is, before you can define a program through a process like this, you better at least know where the basic perimeters are, and everybody ought to be using the same basic parameters to say what is most important and what is not most important. And the reason that I picked on these two additions is because they are of very late importance. And it isn't that somebody knew the most and said we have to add that in. It is just they knew the latest thinking.

MEMBER RYAN: Any other questions? We had a question over there on the side.

MS. JENNI: I think Debbie has a comment.

MEMBER RYAN: I'm sorry.

MS. BARR: If I could make a comment here. In relationship to your comments here, you're absolutely right. As our understanding of the system changes, it would change what our program would look like. However, the time frame of the development of this program is such that the latest information that is available for license application, has pretty much been developed at the point that these people have their input. And so they were working from the things that are supporting our license application.

Again, we view this as a growing and living program and we look at any new information that we gain between now and closure would, of course, influence what the program would look like, and it would potentially change the kinds of things we would do.

Just as we view the developments of the work that will be done by the science and technology group as something that we can learn from. If it fundamentally changes our understanding of the way any behavior or any particular barrier or the total system responds, we would then need to make a change in our program to address that. Some things we may find ultimately don't make as much difference as we originally thought. Other things may turn out to be more important and we need to add things to the program. So yes, we will be evolving over time. But this is not already outdated as far as license application is concerned.

MEMBER RYAN: Milt, you had a comment and then we had a question on the side.

MEMBER LEVENSON: Yes. Ten or more items have been removed from Portfolio C with a transfer to the science and technology program. Does the science and technology program have a budget that does this fit with theirs? Or is this just a way of getting it out of the system? How coordinated is this?

MS. JENNI: Well, Bob is here. But what we did with those activities was not say the science and technology program is going to fund them. That is not within the purview of performance confirmation.

But what we did was send those activities, recommend them to the science and technology program to be compared with the other activities that they're funding. So this is something that might be useful. It might be appropriate for science and technology. Let's have them compare it with everything else that they have on the table.

MEMBER LEVENSON: That's a different definition. What you said before was that one of the primary reason for removing many of these things was that they would be done elsewhere. Now would be done elsewhere is a little different than saying it is a candidate for them to consider. So it must have also included that these are relatively unimportant. Did it matter if they didn't get funded?

MS. JENNI: There were some activities that were being done elsewhere. But not very many of those. Those were kind of weeded out early if we identified hey, this is an activity that is already being done in a different program. These activities that were removed in Phase 3 from the portfolio were deemed in the judgement of the managers to be more appropriate for other programs and referred to those program managers for consideration. So at this point in time, I don't believe we know each of those activities were funded or not funded. But they will be tracked.

MEMBER RYAN: We're at the end of our time. I would like maybe to have one more question?

MS. GOSH: I had a couple of questions.

MEMBER RYAN: We're running very low on time. Maybe we can take them after the break?

MR. WEART: I'll be very quick. If you went back to your PA managers and ask them if they were surprised by any of the activities that dropped out or surprised by any of them that came to the top, what kind of answer would you get?

MS. JENNI: I'd like to do that.

MR. WEART: You did that in WIPP, and it was surprising that people that knew the most found that there was very little difference in this process from their professional judgement. However, the value of the process was that it was documented, rigorous, structured, and so you had something to support those judgements. But there wasn't very much difference. In fact, what a knowledgeable person would have done.

MEMBER RYAN: Let's go ahead with these two questions please.

MS. GOSH: Yes, just really quickly. When you listed your values of perfect information, you decomposed the repository weight by barrier and parameters within each barrier. And I was wondering how you accounted for synergistic effects among parameters that go, that affect multiple barriers.

MS. JENNI: Parameters or activities that were proposed that affected multiple barriers.

MS. GOSH: Right, which may not come across in your one-off or one-on sensitivity analysis we looked at.

MS. JENNI: I guess it is a two part answer to that question. If it affected say, two barriers, it was evaluated in terms of the sensitivity of each of those barriers to the parameter. And the value of perfect information number included the sum of both. So that part was captured if it addressed two barriers. If it addressed two barriers where it was more sensitive together than the sum of the pieces, that piece is not captured in that number value. So the sum of the sensitivities of the two barriers is captured. But if it is more than additive, that piece would not be captured in here. We did tag each activity with the barriers that it affects. So activities that affect multiple barriers, we carried that information along. And that became a consideration in the Phase 2 and the Phase 3 piece, where if you can measure this, if you had a choice, for example, between two parameters that would give you information on the waste package.

And one of them also gives the information on other barriers. That's something that would come into play in terms of the Phase 2 and Phase 3 piece.

MS. GOSH: And just one last quick question. I know this is an on-going program, but have you considered issues that are of public concern that maybe not pop up just in terms of a risk concern in your formal decision framework?

MS. JENNI: You can probably tell from looking at the list of criteria and the experts involved that we did not include public concerns specifically in the analytic piece. They may have been taken into account at some level in the Phase 3 and Phase 2. But to come back to Chris' point, that would be the manager's judgement about what was of public concern.

MEMBER RYAN: Thank you. We are a little bit behind time. Let's take our break and assemble back at 3:10, please. We'll start promptly at 3:10.

(Whereupon, the foregoing matter went off the record at 2:56 p.m. and went back on the record at 3:12 p.m.)

MR. RYAN: Thank you. Already at the podium is James Blink who's going to give a presentation on the elements of a performance confirmation program, a presentation of DOE's selected program and its components. Thank you, sir. Welcome.

MR. BLINK: Yes. I have five items that I wrote down while the other speakers were speaking that I needed to clarify or follow up that were either referred to me or need a little more information.

The first one is Chris Whipple said that Karen Jenni and I went and reinvented the PC program, and that was done by a very large group of people. Our core team was a half dozen to ten people, it varied from time to time. We involved the DOE staff in getting the overall criteria, the three criteria that Karen talked about. We touched the technical staff in every part of PA to get the technical judgments and involved the eight senior and middle managers in the performance assessment program.

MR. WHIPPLE: No, I was speaking of intellectual leadership.

MR. BLINK: Okay. I appreciate it. I just want to make sure that -- you know, this was a group effort, and a lot of people contributed.

The second thing is the program that I'm going to show you here in a minute is missing one big part that you may have caught on to from some of the earlier questions, and that's design verification. The Performance Confirmation Program begins with the assumption that engineered system that's installed on the Mountain is installed as designed. So we assume that the waste packages will be made out of the right material that meets the material specs, that it has the right dimensions, that the heat treatments were proper, that the invert was installed the way it was designed, that the drifts were surveyed in when they were constructed. All of that is part of design verification. If it weren't, it would be part of performance confirmation, but design verification is an important part of the overall program, and a large part of what I think Milt Levenson was asking for he might find in that. In Debbie's chart, she called that engineering test and evaluation.

There's another part of our program that responds to the regulatory requirement of confidence in the performance assessment models. Performance confirmation activities tend to increase confidence, but not all confidence building activities should be considered performance confirmation. And some of those activities, not very many, actually, were referred back to the process model departments within PA to consider for their programs if they needed additional confidence building between now and LA or afterward as the level of required confidence increases as we go through the stages. Those are candidates for them that we've referred back to them.

But my next point is why didn't we pick Portfolio A and go home? Portfolio A was the lowest cost portfolio with the fewest activities, and we did that -- we tried to make the broadest interpretation of the regulatory requirements that we could when we developed that. So there is some risk if we go that soft. If we decided to go that way, we likely would have a longer licensing process as we go back and forth with the regulator. So we started off with C, which was the second least costly portfolio, and then we added to it until our Management believed that we had a regulatorily robust program.

Last point is the two adders. One of the adders really wasn't an adder of a totally new activity. What it was is a change in timing. We had couple thermal testing in the lower lithophysal unit after placement of waste and accelerated drifts. And what we added was an activity to do that earlier. Now, we already have in the work that's ongoing testing in the middle non-lithophysal unit, and the activity that we added was between the construction -- or between the license application and the amendment for receiving in place to get additional information on the lower lithophysal unit. We thought that we had the capability to go and do that early, and we decided to add that activity. But the objectives of that activity are no different than the objectives of the thermally accelerated drift.

The other one that we added was a bit of ongoing work that's being done, funded by the project, and for some reason we just didn't catch it as we went through. So we nominated about 300 activities. That was one that everybody just missed, and we caught it in the review of the document. One of the reviewers said, "What about this? This is ongoing work, shouldn't it be in the program?" We carried that back to Senior Management and decided, yes, it should be. So that one was an oversight. It wasn't latest information; it was work that we've been doing for a number of years that we decided to continue. So with that said, first slide.

MR. LEVENSON: I've got a quick question before you start your presentation. Of the 26 items that were removed from Portfolio C, were any of them in Portfolio A?

MR. BLINK: Karen, can you check that while I speak, because I don't know the answer off the top of my head? We'll come back to it at the end, Milt.

Okay. The purpose of this presentation is to describe the program that the BSC has proposed to DOE and DOE is currently considering. Some changes may occur during that acceptance process, and, as was said by another speaker, this is a living program. It's expected to evolve as we learn, so it's probably going to evolve some between now and the license application, and it's possible it could evolve as we go further.

Mel Knapp asked me to go back and read the NRC document that the secretarial position that talked about the differences between the terms, "risk-based," "performance-based," "risk-informed." And I did that and I tried to place in context with that the phases in this decision analysis. Phase 1 of the decision analysis relied heavily on performance assessment results. We used the direct numbers, we gave those direct numbers from the one-on and one-off calculations to the technical experts in each one of those groups so that they could be informed, not only by their knowledge of the process level, but how it played out in the total system. We elicited the management value judgments, and then we put it all together a mathematical formula and got a number where we could rank the candidate activities. We called that risk-based in that it was directly based on mathematical calculations of risk.

MR. RYAN: Let me stop you there and ask because this is the part that I think folks get stuck on. You're assigning a mathematical value to an opinion or a qualitative assessment or a qualitative judgment. That doesn't make it analytic. I mean it's analytical in the sense that you've converted it to a number system, but at its root it's still a value judgment; is that right?

MR. BLINK: It was base on the numerical calculations of risk for the total system and for the total system as it's decomposed one piece at a time, removed one piece at a time and also as it's built up one piece at a time, the so-called one-off and one-on analyses.

MR. RYAN: Oh, so it is the numerical values --

MR. BLINK: Yes.

MR. RYAN: -- of calculated dose or

whatever it is that drives it.

MR. BLINK: Right.

MR. RYAN: Okay. All right. I'm sorry.

MR. BLINK: So Karen's questions, a lot of them were related to those results, and we made sure that the technical experts not only had their knowledge of how water flows through the unsaturated zone but how that reflects on the dose.

Phase 1 was also performance-based because the performance of the repository is the measure of that risk, the probability weighted performance. Phases 2 and 3 were risk-informed. They used that risk-based result of Phase 1 and incorporated in it management judgment, judgment of the synergies between activities, both in cost space and in value space. So we say that the resulting program is risk-informed and performance-based. That's what we mean by that. John?

MR. KESSLER: I'll try to keep it a real quick clarification question. The second one, the performance-based, you say it's considering performance of the individual variables and the total system, so I'm a little confused. Because I was reading risk-based as total system risk-based and performance-based as subsystem performance-based, but you're saying that's not quite right, that somehow you're mixing up total system and individual barrier performance in that second bullet?

MR. BLINK: It's risk-informed because we took into account the subsystems as well as the total system. But the -- so we're looking at the performance --

MR. KESSLER: Even if some subsystems are less important to overall risk than other subsystems.

MR. BLINK: And they receive less weight because of that.

There were several ways we could put this presentation together. Next slide, please. The way that I show the content of the program to the people in the project who would have to execute it is by grouping the activities by the time and the location that they're done. Activities that are done in emplacement drifts that no human can go into, activities that are done in emplacement drifts before we load them, activities that are done in the laboratory and so forth. Another way to do this -- and that was shown in Section 5 of the Performance Confirmation Plan that's currently under DOE review.

Another way that one can do this is to link the activities directly to the regulatory requirements, to each of the paragraphs in Subpart F and to the paragraphs in the YMRP, and we've also shown that in the Performance Confirmation Plan. That presentation tends to have a lot of repetition because many activities address multiple paragraphs in the regulation.

A third way to do it, and it actually was the way that we built the program, was to go through it barrier by barrier. We actually did it process model area by process model area but that has a linkage to the barriers. And what I've chosen to do in this one is to try to do it from the most important aspects of the program to the least important. So it's a risk-informed method. Next slide.

So the YMRP says that the PC program should be risk-informed and focused on the parameters and natural and engineered barriers important to waste isolation. And we indeed focused the decision analysis on that. So that's the way that we structured this, and we'll go from highest to lowest. Next slide.

This is a little bit of apples and oranges, because we have scenario classes and we have barriers, and then we have something that's in between. First, we looked at the scenario classes.

The igneous activity scenario class is the one that dominates the risk from the repository. Most of the probability weighted dose comes from that scenario class. And so that's the one I'll discuss first.

The next highest scenario class for risk is the seismic activity scenario class which was screened out in the site recommendation but will very likely be screened in the license application. Biosphere-related activities are downstream of the nine barriers important to waste isolation, and they tend to play, although differently, in each of the scenario classes, the two disruptive scenario classes and the nominal scenario class.

Now, getting to the nominal scenario class, I've grouped the barriers, or in some cases the cross-cutting processes that cut across multiple barriers, into groups and listed them in the sequence of most important to least important. What's interesting about this is the most important group of barriers is engineered but so is the least important group of barriers. There are natural barriers near the top and natural barriers near the bottom. The same with the engineered. It shows a little bit of balance.

So now let me go ahead and walk through

those bullets one at a time. The igneous activity scenario class is the largest contributor to probability weighted annual dose, and, consequently, we've included in the Performance Confirmation Program activities to confirm the assumptions, the data and the analyses of those igneous events. Next slide.

I divided those activities into three categories. The first one is the category having to do with the probability of occurrence of the igneous event. Activity 180a -- and these are activities in Karen's decision analysis spreadsheet. We just kept the same numbers so we wouldn't get lost. It had to do with drilling the aeromagnetic anomalies that have been mapped. That will improve the data set and allow us to update our expert elicitation activity 181 to incorporate the improved data set.

Consequence of the igneous events we have several activities. The first one has to do with the number of waste packages that are hit by magma, and that will be calculations and also analog studies. A group of activities has to do with the behavior of contaminated ash. These activities have to do with ash loading, resuspension, redistribution, stabilization and weathering of the ash. And then of radionuclide partition, sorption and dissolution and migration. These activities will be addressed by a combination of modeling and analogs and some laboratory testing. The result of all that will be incorporated in an updated expert elicitation that will include the updated data set.

One additional activity, and this is one of the two that were added during the final review, was this ongoing activity of satellite monitoring of GPS stations on the ground that look at the regional deformation of the surface of this part of the basin and range. That's Brian Wernicke's work out of Cal Tech.

The next scenario class is the seismic activity scenario class, also expected to be a significant contributor to the probability weighted dose and hence has a representation in the PC Program. Next.

Start with measuring the dynamic properties of rock and soil at higher strains than we have in the past. These are the higher strains that are associated with major seismic events. And that will extend our existing data set. We'll measure regional seismic activity, this is an ongoing activity, and also the strong ground motions in the near field assuming that during this of the order of a century monitoring period we'll see events with some strong motions.

Finally, if we do see those kinds of events, we will inspect. We will inspect the underground, both in the emplacement drifts and in the drifts where we have human access.

The next group of activities has to do with the biosphere, and biosphere factors are potentially multipliers on the dose, whereas the other nine barriers many of them back each other up. So they tend to -- if you have a change in one barrier or neutralize it, you may not see a difference in the dose because another barrier picks up. The unsaturated zone below the repository and the saturated zone are good examples. The only way you can really see how well they perform is to neutralize them together. Neutralizing them one at a time doesn't give you a lot of insight.

The biosphere activities fall into groups also. One is an ongoing activity which is a periodic survey of the reasonably, maximally exposed individual, the characteristics of that person and also occupational dust levels, which goes to that. The next area has to do with the movement of radionuclides that are added to the soil and their migration back to the water table where they can be pumped back to the surface. This is something that can play from irrigation water but it also can play from radionuclides that are deposited in ash in an igneous event. The last two groups of activities have to do with the biospheres pathways to humans either through plants or through animals, and these both also play in nominal and disruptive scenario classes.

The waste package and drip shield are the barriers that have the largest impact on the dose in the nominal scenario class. The waste package is expected to isolate radionuclides from the reasonably, maximally exposed individual by preventing water from reaching the radionuclides. This is the waste package operating in the environment that's created by the natural system. The drip shield backs up the waste package by protecting it from rock fall and also by preventing advective transport if there are any breached waste packages.

I have three slides worth of activities on these two important barriers. The first slide has to do with activities that support both barriers; that is, we have samples of Alloy 22 and titanium in the test matrix for these activities. The first group of them are activities that go towards the mechanistic details of the failure modes, potential failure modes of these two components. These have to do with general corrosion, phase stability localized corrosion, microbial corrosion. All of these are ongoing activities, and they will strengthen our extrapolation out to 10,000 years of performance. There's one correction to this Slide 73a, phase stability only applies to the waste package, which will probably be on the next slide.

The second activity type has to do with the stresses on these components if we have a mechanical failure in the drift, a failure of the ground support and a rock fall perhaps. In the pre-closure period, that would directly impact the waste packages. In the post-closure period, that would impact the drip shields. And we're going to do laboratory tests on mock-ups to quantify the stresses that these kinds of events could place on those engineered components.

The third category of activities that touches both of these barriers has to do with the environments on those barriers. There's a series of activities listed here. They're grouped -- we have two thermal-accelerated drifts which I'll speak to in a minutes, and those drifts will have instruments mounted at the ends of those drifts. Also, we'll have samples that are emplaced in the drifts and then removed and taken to the laboratory. And we'll use the remotely operated vehicle to service these samples and also to take data within the drifts.

The types of things that we'll measure are temperature, humidity, the composition of the dust, the composition of the gas, the pressure, the radiolysis effects, the change in the composition of the gas, the chemistry of condensate in the cooler regions of the drift, microbe characterization and then in a companion laboratory activity, the chemistry of thin films. We can try to do that on samples that we collect, but we also can try to create those conditions in the laboratory and look at how those films evolve. In all of the emplacement drifts, not just the two thermal-accelerated drifts, we'll be measuring the temperature, humidity and dust. The other measurements are confined to the thermal-accelerated drifts.

The next slide, the waste package has two activities that are directly to the overall waste performance. The first one is monitoring radionuclides in the exhaust air, and probably the sensor module at the end of each drift that measures the temperature and the humidity will also be able to sniff for radionuclides. That's an ephemeral signal, just as if we put in a tracer in the waste package it would be an ephemeral signal. It would quickly dissipate, so we'd have to catch it on the fly, and we'd have to be able to convince the NRC that over 100 years we'd be able to not miss such a signal. That's a valuable activity, but it may not be sufficient. So we added one more --

MR. LEVENSON: Excuse me, why this 100-year thing? I mean if it's not leaking anything measurable, why is it a worry? Why over 100 years?

MR. BLINK: Well, that's the nominal duration of the pre-closure period.

MR. LEVENSON: Well, yes, but the dilution isn't over the 100 years. You're monitoring continuously.

MR. BLINK: But you would only see these gases in a fairly short pulse after the waste package initially fails.

MR. LEVENSON: Yes, yes, yes. But you could detect every failure, so I don't understand the timing portion.

MR. BLINK: If you are accurately able to do it, but it's not a repeatable -- if you saw a signal and you questioned whether you had an instrument failure at the end of the drift or whether one of the 100 packages in the drift had failed, you'd have trouble going back. You'd have to remove all 100 packages and look at them.

MR. LEVENSON: But that's true whether it's one year or 100 years. I'm not sure I understand the significance of the 100 years.

MR. BLINK: There is no significance other than the signal that you would be looking at is a short one, and you would have to be watching for it during the whole entire period. So the signal is a very short fraction of the monitoring period for any given waste package.

The second activity is one that's complementary to the first, and that's an ability to come into the drift at any point in time and verify that the waste package has not leaked. When you fill the waste package and do its final seal, it's got an internal temperature depending on the processes in the surface facility. When you carry the waste package underground, it's temperature initially goes down and then goes back up. But at almost every point in time during the pre-closure period the internal pressure of the waste package that was set by the density of the gas in it at the moment that it was closed is different than the external pressure in the drift.

So if we have a sensor in the waste package that's sensitive to that initial pressure compared to the external pressure, if that's sensor can change its configuration if the waste package vents and assumes the ambient pressure and you can sense that from the outside, either by shadowing in its own radiation field or by an inductive sensor, which has been developed in the low-level waste program, then you can come back at any time and verify that the waste package is still hermetically sealed. So the two activities are complementary. One tries to catch it as it happens, and the other is a way that you can verify in situ without removing the packages. Both of those activities are a direct measure of the performance.

MR. LEVENSON: Is that second one existing technology or is that a wish?

MR. BLINK: Hanford has a bordon tube sensor that they've deployed within waste package drums. We're looking at --

MR. LEVENSON: But that's a different hunk of metal with completely different properties than what you're talking about here.

MR. BLINK: Yes. We're evaluating the feasibility of that one right now. We haven't verified whether they're working.

MR. LEVENSON: Okay. Let me just go back to our introductory speaker who said don't put something on your list that can't be done.

MR. BLINK: I agree, and also don't put -- don't leave something off your list because you haven't checked to see if it could be done. This is one we think has a reasonable chance of success and so we're pursuing it. If it doesn't pan out, we'll drop it and do something else.

MR. KESSLER: Jim, maybe you've answered the question I was about to ask, because I've got that very same thing about one of Chris' traps on Number 1. Have you done a calculation to determine that you have detectors that are sensitive enough. Assuming you had some pinhole leak and it was diffusing out through a pinhole, could you actually measure what you would expect given that maybe only one percent or less of your cladding has failed? Have you gone through the calculation to determine you could actually measure it?

MR. BLINK: Both of those activities, the pressure sensor and the detection of low levels of gas, are subject of our scope of work for Revision 3.

MR. KESSLER: Meaning, no, you haven't done it yet.

MR. BLINK: We haven't done the calculation yet, although we have identified people who can do the calculation and are accessing places where those kinds of calculations are already done.

MR. KESSLER: Okay. Thanks.

MR. BLINK: Okay. Moving on to the drip shield, for the drip shield we're looking at rock fall detection, and we're going to try to do this using acoustic or seismic tomography. We already have one program in our grant program that's demonstrated this in the exploratory studies facility where if you have a large mechanical event, in their case, say, drop a weight off of an elevated platform underground, you can detect that with sensors that are mounted on the surface and in the accessible access drips and ramps.

Using that, we will be able to detect whether we've had any kind of large mechanical event, be that a failure of a piece of the ground support or a weld that fails in a waste package pallet perhaps, something of that nature. We don't have to watch all 100 miles of drift continuously. We can listen with just a few stations and then send the remotely operated vehicle in to check the place that we've identified.

The two thermal-accelerated drifts, one of them will have drip shields installed in it after about five years when we terminate its ventilation. So in that situation, we'll be able to inspect that drift for the conditions under the drip shield as well as above the drip shield. All of the other drifts are perturbed by ventilation and don't have the drip shield installed until just before closure.

Finally, the drift shape monitoring, there are a number of means of doing this, some of them as simple as stretched wires; others, bouncing lasers off embedded mirrors or fiber optics, one stretched and one not, doing interferometry that are there in the literature so that we can measure how the drift changes its shape from a round drift to an oval drift due to the thermal stresses that are imposed on it by the waste.

Moving on to the preemplacement environment. That environment, the hydrological, mechanical and chemical environment in the drifts depends on the properties of the host rock. And we have an opportunity to see that host rock for a short period of time after we excavate it and before we install the ground support. If later we have a mechanical event or a hydrologic event, rock fall or a seepage event, we'd like to know what that rock looked like before we put the waste in to see if we can untangle the reasons for it.

So we plan -- on the next slide, we plan to map these drifts as we excavate them. We're planning a three-pass system where we go through with the Tunneling Boring Machine, putting in light ground support, following with the mapping activities after the TBM is disassembled and removed and moves on to the next drift. And then that will be followed by the final pass that installs the heavy ground support, which right now is a pure straight liner and the inverts. So we will have a full map of the drifts. That map will include large fractures, faults, stratigraphic contacts and lithophysal, exposed lithophysal characteristics.

In addition, if we see something in that mapping that looks like it's a significant fracture or fault and we need to investigate it, we'll be able to do that with the proviso that we don't want to drill bore holes directly above where a waste package would sit. So if we do drill a bore hole to further investigate that hydrology, we'd want to do that off to the side, either in a small alcove or off the rib or leave a space in the waste packages, ultimately.

Finally, we'll be collecting water as we have in the ESF, and we'll use chloride mass balance and isotope chemistry that characterize that water to try to understand its age and its chemistry.

Moving on now to the surface barrier and the unsaturated zone barriers above and below the repository horizon. First, the surface barrier and the unsaturated zone above limit the release of solubility-related radionuclides, examples being plutonium and neptunium. They do this by reducing the rate and volume of water that reaches the engineered barriers and also be controlling the chemistry of the water that reaches the engineered barriers.

In contrast, the unsaturated zone barrier below the repository horizon reduces the annual dose in the event that those engineered barriers are breached, for example, by an igneous event. And this barrier primarily plays for the short-life radionuclides such as cesium and strontium that can decay away during the time that they're held up in the barrier or for solubility-limited radionuclides like plutonium and neptunium that are retarded.

Activities for these barriers, first for the surface and the unsaturated zone above, we have a number of seepage activities. We're going to have some alcoves that are between the emplacement drifts in the pillars where it's cooler that we will bulkhead to reduce the effects of ventilation. So these will be areas that are not susceptible to heavy influence by ventilation or heat, and we'll look for seepage in those much in the way that we've done the seepage tests in the ESF.

This situation is most typical of the service period of the repository, and we'll locate those alcoves to look at the likely potential areas where one might expect most -- where seepage would be most likely, looking at the infiltration map and the types of rock.

Less likely but still possible is thermal seepage into an unventilated drift. We're going to have a thermally accelerated drift where the ventilation is turned off at five years, and we will try to detect any seepage into that. The first way that we'll try to detect seepage is by watching the humidity of the exhaust air from the ventilated drifts, and we'll have 100 drifts with air flowing through them. The humidity of the exhaust will go up and down statistically depending on the input humidity, and if you have seepage in one of those drifts, we think we can statistically detect that out of the ensemble.

For the single drift, however, we don't have strong ventilation flowing through it; we have slow flow. But calculations by a number of investigators indicate that even in the absence of forced ventilation we have adequate flow through a drift that we should be able to -- that there will be movement and we can see the change in humidity.

Finally, the least likely situation for seeing seepage is into the emplacement drifts themselves. The ventilation and the heat both mitigate against seepage, but we will be able to detect it from the -- at some level from the humidity measurements and the remotely operated vehicle will be able to go and visit those drifts and look directly.

If we have seepage, we need to be able to put it into context what drove that seepage. Was it a thermally driven event, was it a fast pathway from the surface caused by a very intense storm? Because of that need, we've got precipitation monitoring, and we have a pre-placed test to look at the infiltration in the event of a very large storm. So preinstalled lysimeters and near surface bore holes.

Finally, the regulation calls for us to look at seal performance, and seals are a way that we prevent bore holes from being a hydrologic short circuit of that unsaturated zone above barrier. And we plan to look at seals and confirm that they will seal the bore hole to the extent that it's no more permeable than the host rock, and we plan to do that before the receive and possess. That would be done in the laboratory.

Moving on to the unsaturated zone below the repository, we'll look for radionuclides in deep bore holes near the footprint, which is dominated by the unsaturated zone. This will confirm unsaturated zone barrier performance if we've also detected an engineered barrier failure. But we don't expect to see any radionuclides. The travel time is too long. This is one of those public confidence building activities that although it may not be directly required for regulatory compliance, if you don't look for a failure, you'll never see it. So by looking and not seeing it, it gives some confidence to the public that the whole entire system doesn't have some inherent flaw that we haven't thought about.

The other test in the unsaturated zone below is we'd like to look at the transport and sorption properties of the unsaturated zone and we'll likely field a test somewhere in one of the excavated drifts before we load it to measure that.

Moving on to the coupled thermal processes, somebody talked earlier about the near field environment. I guess it was you, Chris. Heat added to the underground facilities by the radionuclide decay will elevate the temperatures for long periods, and those will drive coupled processes, thermal, hydrologic, mechanical, chemical processes, in the drift and near field rock. We're going to look at those.

In the lower lithophysal drift scale test, we want to look at these prior to emplacement. We already have a drift scale test in road header excavated middle non-lithophysal rock. The drift scale test, which is in the middle of its cooling phase, it had a four-year heating phase. We would like to do a similar test in the lower lith and we think we can do such a test in the cross drift, in the ECRB cross drift, which was TBM excavated in the lower lith, already exists there, and we would only have to drill a small alcove and some bore holes. We could move the heaters from the drift scale test in the middle non-lith and refurbish them. So this is a test that we ought to be able to field fairly quickly, and we're going through the timeline to do that now, but it looks like we would be able to field that test and get that data before the receive and possess license amendment would be granted along the baseline schedule of the project, which would give more confidence both to DOE as a licensee and to the NRC as a regulator that we understand the processes. There is no risk until we put waste in the Mountain, so doing this test before we put the waste in the Mountain adds a lot of confidence compared to doing it afterwards. And that's the reason why Management moved this test up from being a thermally accelerated drift to doing this ahead of time. It was a risk mitigation -- a programmatic risk mitigation measure.

I've talked about the two thermal-accelerated drifts now, alluded to them. This is the slide that tells you what they are. Drift Number 3, the third drift to be filled in Panel 1, will be thermally accelerated by ventilation control. So it will have the same kind of waste package layout as a regular drift, but we will run the ventilation rate up and down in order to run the temperature of the packages in that drift up and down to look like an accelerated post-closure temperature peak. So we'll go up to the post-closure peak above boiling, not be limited to the below boiling of the other ventilated drifts.

This drift will have a near field focus and we will use instruments that are fielded from an observation drift to probe that near field, rather than bore holes that are in the drift itself, which can't be accessed for maintenance very easily. We'll look at fracture permeability, rock saturation, temperature, water chemistry, quite similar to what we've done with the drift scale test.

Drift Number 4 will be thermally accelerated by tailoring the waste packages, either by spacing or aging or derating, putting fewer than the capacity of spent nuclear fuel assemblies in them. This drift will have an engineered barrier environment focus because we will turn off the ventilation at five years or thereabouts and install the drip shields. So this will look like a regular drift after closure going through its peak temperature cycle and back down into the region around boiling. It will rely heavily on the remotely operated vehicle, and it has a number of activities, although two of the activities on that list, 53a and 57a, probably shouldn't have been listed. They're listed in square brackets because

I've listed them before for other sections of this talk. Fifty-three(a) is an emplacement drift activity, and 57a is a laboratory activity.

Moving onto the saturated zone, the saturated zone has very similar function to the unsaturated zone below for the short live radionuclides and the solubility radionuclides in the event that those engineered barriers are breached. The activities we have in the saturated zone are monitoring again for radionuclides in the deep bore holes, and this would confirm the combination of the unsaturated zone below and saturated zone are performing if the engineered barriers have been shown to fail. Again, this is one that's a public confidence building activity.

We have the water wells, and we will measure the chemistry in the water wells and also their water levels. The chemistry affects the retardation of radionuclides, and the water levels are diagnostic of the flow pass and rates through the regional saturated zone. We'll also collect colloids from this water and do laboratory studies on them. Colloid transport is an area that we would like to confirm.

Finally, we want to look at the hydrology across the fault zones that the saturated zone is exposed to, and so we will have some wells that are on either side of the bore hole of the faults, at least three wells for each so that we can look at anisotropy, and the results of that will help us firm up the general flow through the saturated zone.

The last set of barriers are the cladding, the waste form and the invert, three engineered barriers. These are barriers that are important to waste isolation, but they contribute to defense-in-depth. They're less directly important to annual dose than the other barriers I've discussed so far. Consequently, we've placed less emphasis on confirmation of those barriers. We're going to look at them but not to nearly the degree of activity that we had in the other barriers. Next slide.

For the waste form, we're going to look at the radionuclide inventory. We're simply going to monitor what goes in the repository to make sure that it's within the envelope that's included in our performance assessment calculations, and we'll do that from the waste acceptance documents. We also want to look at the waste form colloids. Colloids that are generated directly from the waste form can be an important pathway for radionuclides and failed waste packages, so we will continue to do laboratory tests in that area.

For the cladding, we're taking credit for the cladding but we don't intend to try to confirm the mechanistic details of its performance in the way that we have for the waste package. Instead what we'll do is monitor work that's going on in dry storage facilities and in academic and industrial research and take advantage of that information, but we don't intend to do direct measurements of cladding underground or in the laboratory.

Finally, for the invert, the invert has iron beams with a tough gravel ballast, gravel that's created from the rock we excavate from the drifts and sized to a design spec. And we have a pretty good understanding of how radionuclides sorb on tough -- in cores and in blocks and in situ, but we haven't done those kinds of measurements for gravel, engineered gravel. So we'll extend those measurements to that geometric situation.

The next slide, which is the last slide in the regular presentation, tries to summarize all this. I've listed those areas that I've just walked through, and I've just listed a count of the activities, both in number and in the length of that histogram on the side, with the most important barriers, the barriers that -- or scenario classes that are most well represented in the program being in blue, and the ones that are least represented and least important being in that kind of ugly orange color. A caveat on this is each of those 72 activities has a large degree of variability in how hard it is to do it, we've had some discussion about a few of those, and how much it costs. So just a count of the activities is not a very fair comparison, but it was an easy one to write down. And where there's an asterisk, where there's two numbers in the parentheses, the second number is an activity that was previously counted for one of the lines above it. It was just that code.

To make this easy for you to think about, the next four slides, which I'm not going to walk through, are simply a listing of the titles of each of the 72 activities that are in the program that I've mentioned before in that other grouping. And then the next five slides after that are a listing of each of the paragraphs in Subpart F, quote from it, and which activities we think support compliance with that paragraph. So with that, I'm open for questions.

MR. RYAN: Thank you very much. Let me take care of a couple of housekeeping items before we press on. We're scheduled for another break but with everybody's concurrence what I'd like to do is dispense with that. We have one more talk and then a period for public comment, and we got a request to make comments, so we'll move right to the rest of the agenda if that suits everybody.

Second, I want to highlight day two of this workshop. We've had a lot of great presentations from the DOE team on their views of performance confirmation. We had Jeff Pohle this morning kind of open the NRC view. We have some, I think, excellent presentations planned by the NRC staff tomorrow to also hear the second part. We could be here till nine o'clock tonight if we wanted to get it all in one day, but I think we've got a great day planned tomorrow with the NRC staff giving some additional presentations, and we'll look forward to that. So that's upcoming, so come back for the free popcorn and coffee and doughnuts in the morning and all that; we'll start again.

But with that, James, let me just ask you one question that was on my mind. It was actually on my mind from the previous talk. How many individual data points are you going to generate in a month or a week or a year? Have you tallied it up yet?

MR. BLINK: I have not tallied that up, but it's a pretty large number.

MR. RYAN: It's huge. It speaks to me that one additional task on that list should be data analysis coordination and interpretation as its own effort, because somewhere along the line there will need to be some integration or evaluation that's pretty formally thought through as you figure out, well, we're going to have 100,000 data points a month. Oh, that was the microphone; I thought it was Milt.

(Laughter.)

MR. BLINK: That is something that's very important to us. In the Performance Confirmation Plan, we have an eight-step process. This was Step 1 of the eight of defining what the program is. The step you talked about is either 6 or 7. I'd have to go back and look.

MR. RYAN: Having spent a lot of time in data analysis, I would urge you to make sure that doesn't fall off the end of the truck.

MR. BLINK: Right.

MR. LEVENSON: In the experience from WIPP, one of the national academy committees criticized was that a significant fraction of the data was not being used by anybody. It just went into storage and if nobody is going to -- we have that same problem nationally with satellite data. Awful lot of it and there's so much coming that most of it is not even looked at. To spend money collecting data that nobody is going to look at is not exactly fair to the taxpayer.

MR. RYAN: Well, there's also another aspect to it, Milt, that I think is important, and that is that the technology used to collect data today will be obsolete in five years. So all those wonderful disks, whether they're laser disks or zip drives, which were the best thing since buttered toast ten years ago, are gone. So the media and all the technology you use to manage this data needs to migrate forward with the technology. There's lots of detail there. Just something to think about. George?

MR. HORNERGER: James, actually, I just have a comment. There's a lot of detail here and I'm sure we could get into questions at any level of detail. But at any rate, my comment is that this morning Chris pointed out that one of the things that he advised against was making claims that were not right, and he in fact used the example of the deep bore holes. And even though in your words you said this was for public confidence, when I read your slide it says that this is to confirm unsaturated and saturated barrier performance. And that's simply a nonsense, right?

MR. BLINK: One can make a hypothesis that there are fast paths and that radionuclides can move down a fast path. We've been confident before that radionuclides can't move very far. I'm sure Steve Frishman can give you a list of --

MR. HORNERGER: So if you get a positive, then that's correct, but if you don't get a positive, it doesn't confirm anything.

MR. BLINK: That's right. Exactly right. So it's very likely that it will be an investment that won't give us any useful information, but there's a small chance that it will detect something that we just don't think will happen.

MR. HORNERGER: Well, that generic area, while we don't like to use the word, "rationing," since nobody has unlimited resources, everything gets rationed, and whenever -- I think you have to be very careful about spending money on things that you're pretty sure are not going to happen at the expense of monitoring things more likely to happen, and that would be a serious issue.

MR. BLINK: Our intent here is not to

drill a whole new fleet of wells. We have a significant number of deep wells around or near the footprint, and we have another set that Nye County has drilled using grant money, and we intend to use those wells where at all possible. We work in them as necessary.

MR. HORNERGER: And those wells have been incredibly important. My point wasn't that that was a waste of money. My point is just that it's not really a confirmation. We're getting a lot of information that was really needed for performance analysis, I don't doubt that at all. And I don't doubt that these wells should continue to be monitored for public confidence, but I would just -- I think that you might want to at least give some thought to whether you want to present it as a confirmation of saturated and unsaturated zone performance.

MR. BLINK: Yes. We debated this one pretty heavily internally before we put those in there.

MR. RYAN: George, that's another example, I'll just point out, I don't mean it to be a criticism, but just be careful with language. On Page 24, it says, "The saturated zone reduces the annual dose in the event the drip shield and waste package barriers are breached by an igneous event." I mean ascribing that kind of skill to the saturated zone you've got to be careful that way you say it. If radioactivity is transported in the saturated zone, it will be less than if it's not transported in the saturated zone. So I guess what it leads me to think about is that you really need to align very carefully the goal of the measurement and the measurement that you're making.

It gets back to what Chris, I think, said at the beginning. I always view that a measurement, whether it's in a bore hole or radioactivity measurement, really serves two functions. In some way, it gives you information to evaluate conformance with the safety case. I don't want to say meeting regulations because it's more than that. There's one opportunity, conformance with the safety case. Second is increasing my knowledge base of system behavior. The simple analogy is if you put in a ground water well, you can monitor to see that the concentration meets requirements, and you can also measure water level and do other things that help you understand over time geohydrologic behavior, perhaps.

So whenever I think about an environment measurement, I always ask myself those two questions:

What does it give me in terms of enhancing my ability to demonstrate conformance with the safety case, and what does it give me in terms of information and helps my understanding of the environment a bit? And if you ask those two questions for every measurement in your list and really examine that carefully, I think you can really enhance what you're doing. It might be a good addition. I'd invite anybody to offer additional comment on that point. John?

CHAIRMAN GARRICK: You have a footnote on Slide -- the last one I guess you showed that says, "The 72 activities have varying degrees of scope, complexity and cost." And they also have varying degrees of development and reliability. How much of a handle do you have on that part?

MR. BLINK: In some cases, these are activities that we've done in site characterization or are doing now. We have a good handle on those. In other cases, these are activities that take advantage of technologies that are being used by other programs, other projects around the country and around the world, so we're adapting technology to a different mission, perhaps. In a few cases, we're not quite sure yet, and we're working those cases the hardest.

CHAIRMAN GARRICK: It seems to me that

that -- it gets pretty important, especially against each one of them to ask the two questions that Mike just articulated. I suspect that some of the activities are extremely in their early development, and they have to be measured how much information we really are going to get from them and therefore is it worth it.

I'm curious, this program that you have presented is based on what you call a risk-informed, performance-based background. If you had done it just on a risk-based basis, I guess that the scope would be quite different. Would you -- and much less.

MR. BLINK: I would agree there would be quite a few barriers that might not have had any activities because of the defense-in-depth capabilities of these combined barriers.

CHAIRMAN GARRICK: Yes. And so when it comes to really a decision analysis at that level as to what you're going to get out of some of these things because of the lack of information that you have by taking a risk-informed approach as opposed to, say, a risk-based approach, it would be very interesting what kind of -- how these two programs would compare and also maybe begin to give you a baseline for the worth of some of these activities.

MR. BLINK: One of the things that we considered as we went into this was whether we should do just that. And the thing that led us down the path that we went was 131(a)(2), confirming that the barriers are performing as intended and anticipated. And we thought in reading that if we declare a barrier to be important to waste isolation, whether it be as a backup barrier or barrier that directly influences dose when it's neutralized, that we had to touch it in the Performance Confirmation Program because of that paragraph. So that's what led us in the decision analysis to make sure that each barrier was in some degree included in the Performance Confirmation Program but that the weight of the resources went to the ones that we thought were the most important to total system risk.

CHAIRMAN GARRICK: I know we're in the safety business here but do you have a first order approximation of what the cost would be for running this particular program on some sort of a --

MR. BLINK: We do have the number. We calculated it for the program, and we compared it to this aspect of the total system life cycle cost that's been published. And it dropped between 15 and 20 percent from the previous scoped program.

CHAIRMAN GARRICK: I see. Okay. Thank you.

MR. LEVENSON: The wording in 10 CFR 63.134(a) says, "Program must be established at the repository operations area for monitoring the condition of the waste packages. Waste Packages chosen for the program must be representative of those to be emplaced in the underground facility." And that's 83(a), but in the detail it says you're going to do 100 percent. That's a pretty expensive extrapolation from the requirement, a humongous extrapolation.

MR. BLINK: The performance assessment calculations for early failure of waste packages, failures that would occur during the pre-closure period for the site recommendation, was one-fourth of a waste package for realization. That is, we had a 25 percent chance that one waste package would fail. It's really difficult in a sampling program to monitor a small fraction of 11,000 waste packages and have confidence that the prediction of less than one waste package having failed is correct or incorrect. And that's what led us to looking for a low unit cost method of being able to detect waste package failure, and we came up with the two that we discussed.

MR. LEVENSON: I understand what you just said, but what confuses me is I thought that this program was designed to demonstrate compliance and all the compliance requirement is that it be representative, in fact, it doesn't even have to be underground because it says, "Those chosen for the program must be representative of those to be emplaced underground." You've gone from that to doing 100 percent of those in the ground. Is anybody looking at this from how realistic or how far you're going beyond? We're using the experience of WIPP for the last years. DOE's had some pretty serious criticism from a number of academy committees on issues just like this.

What's the justification for going way beyond the -- well, let me back it up another way. There's several reasons for doing things. One is for compliance and that certainly should not be the limit. You need to do things for compliance, you need to do things for legal reasons, and you need to do things for safety reasons, and I'm not sure that going from a sample to 100 percent is a requirement of either compliance or legal or safety.

MR. BLINK: The sampling program was to remove several waste packages from the underground, take them to surface and destructively examine them repackaging their contents.

MR. LEVENSON: That's your program, that's not what's in 10 CFR 63.

MR. BLINK: That was what the prior interpretation of a sampling program was, and we're not planning to remove any waste packages for destructive examination.

MR. LEVENSON: But there's no requirement in the regulations that you do that. That's just another case of your doing something.

MR. BLINK: So is the third alternative that you're throwing on the table is monitoring a subset of the 11,000 packages for hermetic seal?

MR. LEVENSON: That's all the requirement is, unless you've got a legal or safety reason for doing more. There are three reasons for doing things and spending money: Conformance to compliance, for safety and for legal reasons. And I'm the first one to point out that I think that compliance is not necessarily enough for safety. There's lots of places you want to go beyond the minimum. NRC sets minimum. If you can't identify a safety, legal or compliance reason, then why are you doing it? I'd suggest that you really need an assessment of everything you're proposing and identify why it's being done -- being done for compliance, being done for safety or being done for legal reasons.

MR. BERNERO: Jim, on Slide 27, this is cladding, waste form and invert questions continued, I'm having trouble with some of these things as to whether they are a part of the performance confirmation program or are more properly in some other administrative part of the program. For instance, radionuclide inventory, 199(a), which is done from waste acceptance documents, strikes me as part of the program that would be establishing, controlling and modifying when necessary the waste acceptance criteria and only indirectly if there is some massive change coming to performance confirmation space to say you don't have ten trillion curries there, we've only got ten million curries or the other way around.

Sorption coefficients for waste form colloids, laboratory tests that would speak to establishing waste acceptance criteria, and I don't see how that's performance assessment's or performance confirmation's job to do that. That would be a technical judgment within the program on how to establish these waste acceptance criteria or modify them when necessary.

Monitor cladding studies, this 1(a) has the flavor of virtually all of the fuel has in-tact cladding and we're trying to keep track of that very small fraction that might not be in tact, and yet in the industry today you even have certified storage and transport casks for failed fuel and for debris, substantial quantities of that.

And once again, that gets to the waste acceptance criteria. I don't see it as the sort of parameter monitoring associated with performance confirmation looking for some threshold that would say, you know, 12 years into we've got a different picture of cladding failure or modeling. It just doesn't seem like it belongs in performance confirmation and that it is more properly in the mainstream of the program, not a retrospective monitoring.

MR. BLINK: I think those are good points. The radionuclide inventory is similar to the design verification aspects that we talked about. What we're confirming is that what we're putting in the ground is within the limits of what we said. For the sorption, for the waste form colloids, the waste form colloids don't exist until the waste degrades, so it's not characterizing the waste for what's already there but for how the waste deteriorates upon contact with water.

The cladding, it's similar to the radionuclide inventory. We have within the performance assessment a fraction of initially failed cladding and a range that we sampled. We need to be sure that if the cladding performance changes over time that we know about it so that we can update the performance assessment.

Those are difficult ones to categorize, and somebody earlier said it's not so much I want to know what's the performance confirmation, I want to know what you're doing, not the semantics of how you bend it. And to some extent that's what we're talking about here, but your points are well taken.

MR. RYAN: James, I think as you think about moving from Rev 2 to Rev 3 these are good questions to think about. Let me expand on the radionuclide inventory. It's clear that you'll want to have receipt records from what's shipped to you; two, there will obviously be critically control on other issues in the process building for anything that goes in there, be it spent fuel or other material. And then obviously there will be detailed loading plans. It seems to me that there's three different times that inventory is checked, rechecked, added up and looked at. I wonder if there really isn't an overlap here with that particular issue and maybe should be off the plate.

It really gets back to, I think, the questions that I raised and the question Milt's asked to once you get through this level of detail is to circle it again and say why am I doing this measurement and ask those critical questions: Is it cost effective, is the technology right and does it add to the safety case, does it give me any kind of system performance information and really be critical of your own thinking there, because I think if you do that, you'll end up with a program that fleshes out good things. Either you'll take some things away that might be duplicative or not necessary and you'll really focus on those things that could be helpful. And I'm only guessing but my guess is if you go through that exercise in a successful way, it will make your conversations ultimately with the NRC a little bit clearer and more focused on what's going to work and do a good job in this area of requirements. So it's something to think about. Any other comments or questions? Yes, John?

MR. KESSLER: I'd like to get back to a question I asked earlier about whether or not you had done the calculation to determine whether you could measure some canister that might leak early in terms of radionuclide release. You said that that calculation hadn't been done yet. So getting back to Karen's presentation, how on Earth in that particular case did you determine the accuracy with which the proposed activity captures the parameter value if you haven't done the calculation to determine that yet? Just as an example. I'm sure that there's probably others now if you haven't done that for --

MR. BLINK: That's one that took an opinion by the people who were looking at it, and it's not a very informed opinion.

MR. KESSLER: Okay. So people just guessed that they could measure this.

MR. BLINK: It's more than guess because in other programs people are measuring very low concentrations of radioactive sources for a number of reasons, and so there was knowledge of those programs by some of the people who were participating.

MR. RYAN: Yes?

MR. PARIZEK: Parizek, Board. I was happy to see this process get to this stage. There's a long list of things to chew on here. Like on Page 8 you have analog studies would be used to look at the way in which waste packages might be hit by magma. I wasn't sure how the analog approach would work here. Could you elaborate on that?

MR. BLINK: That one I'm going to have to get back to you on, Dr. Parizek. I've got to confer with the volcanologists.

MR. PARIZEK: My mind goes right away to car hulls in Hawaii or something, a lava flow or something like this, but we'll just be advised later.

GPS stations using Brian Wernicke's approach, does it look to see if you have disruptive events that then require an underground inspection or is this sort of stress fields that are building up? How is this going to work?

MR. BLINK: What he's looking for are precursors to disruptive events.

MR. PARIZEK: Okay. So you could all of a sudden see a change and that you would clue you in that you need to be looking underground?

MR. BLINK: Right. And it's -- the measurements are good measurements but the interpretation of those measurements is subject to a lot of expert judgment.

MR. PARIZEK: Right. And then the analogs for a migration in soil, this would be from fallout or from sites where radioactive waste materials now occur? Just want to see how that's released through soil into ground water? That was on Page 12.

MR. BLINK: Again, I'll have to get back to you on that. We have people pursuing each of these candidate activities and fleshing them out for Revision 3, but I'm not sure of that.

MR. PARIZEK: There's a drip shield on Page 13, protection of breached waste packages. That almost implies that the waste packages might corrode under a drip shield rather than having the drip shield knocked out of a line by rock falls, then allowing exposure of the waste package. So this is implying that a protected waste package by a drip shield could still maybe corrode and breach prematurely.

MR. BLINK: The drip shield has that potential function. We're not intending to say that we're predicting that the waste packages are going to fail under it within 10,000 years.

MR. PARIZEK: Then just one other comment: There's a lot of work to be done here on instrumentation and methodology. A lot of this is not going to be off-the-shelf items that you can go buy.

You have to develop the technology. A lot of international programs spend a lot of time demonstrating that you can retrieve and you can place a buffer around waste packages. So a lot of this development and work needs to be done. How far does this have to be in time for LA or is this sort of after LA you develop these technologies?

MR. BLINK: For the LA we'll have defined the locations and redundancy of the various activities. We'll have defined the instrument package to some degree, although probably not down to individual sensor locations.

MR. PARIZEK: So there may still be developmental work required to get the right instrumentation.

MR. BLINK: So the detailed design of the activity in some cases may not be done, but there will be enough to show that it's feasible.

MR. PARIZEK: All right. Thank you.

MR. RYAN: Comments? Thank you very much, James; we appreciate it. Sorry. Go ahead.

MR. FRISHMAN: Looking at your table on Page 28, I don't know how fair this question is but if you look at igneous activity and waste package and drip shield, that's half of the program, of the

Performance Confirmation Program. These are your two most critical pieces of your safety case, one being that waste packages and drip shield don't fail, the other being that the only other failure mode in 10,000 years is igneous activity. So it looks to me as if you have the two critical aspects of the case for Yucca Mountain being those that require the most performance confirmation. Is it possible that you have gotten into the situation that I made reference to earlier and that's that you haven't sufficiently characterized these two features and performance confirmation is, as Chris put it, the bucket that it fell into because you couldn't get the answers?

MR. BLINK: I don't think so. These are ongoing activities that have a substantial body of information. We've said in the site recommendation and backed up with our documents that we have confidence that we understand how the waste package barrier performs. And in our estimates of probability and consequence of igneous events, that it doesn't mean that we shouldn't continue to do work to confirm that what we said is true. That's the purpose of performance confirmation.

MR. RYAN: Well, I guess maybe one other point is a measure of fraction of the program. I don't see that exactly. I mean there may be small activities or big activities in one of the other areas. It could be a lot of work and a lot of money, and I just don't know if that's a good measure.

MR. FRISHMAN: Well, I'm just beginning to wonder whether this is -- whether we have a pretty high jolt on risk-informed here, and the most -- the things to which the whole repository concept for Yucca Mountain are based -- are in this case very evidently the highest risk. And so I'm just wondering it's back to the question of what's the license application going to tell us, and is it going to be sufficient without a Performance Confirmation Program? And I'll talk a little bit about that tomorrow, but I just wanted to sort of plant that question in the framework of if you were really done with site characterization, would you have all these -- the necessity for this Performance Confirmation Program that at least in number of exercises represents half of the program.

CHAIRMAN GARRICK: But another thing that could change this picture dramatically, Steve, would be if you had uncertainties on the parameters associated with these measurements. That may make it an entirely different picture. For example, igneous activity, if you were able to reduce some of the uncertainties associated with that, it would disappear completely on the basis of the regulations. So I don't think that -- that's why this activity concept and number counting concept can be extremely misrepresenting what the situation is. As a couple of us have already pointed out, the state of the art of some of these tests, measurements and instruments is not in this accountability issue. The uncertainties --

MR. FRISHMAN: Well, the reason the igneous activity number is so high is because there's a whole bunch of new work out there that is proposed to be done. It's not confirming something that has already been done to say that, yes, our case in licensing was correct. It's a whole bunch of new that's being proposed.

CHAIRMAN GARRICK: Yes. I just don't think that the microscope has been turned up in all of the areas an adequate amount to really see what this picture needs.

MR. KESSLER: Yes. There's new work that's being done. I guess all I want to do is try to reiterate, I think, something that Jim just said, which is the assumption about performance confirmation is just like has been said earlier, the assumption is you have enough now or you'll have enough at the time of LA for NRC to reach a reasonable expectation that compliance will be met, okay, and that all of this is simply to confirm that performance. I've heard Jim say that. My understanding is that they're there.

Whatever they do with volcanism, as an example here, has got to be such that NRC with the current amount of information or the amount of information at the time of LA is going to have reasonable expectation that compliance will be met. That means that if there's uncertainties about probability of igneous or consequences of igneous activity, that those have to be set wide now, such that if you add these 13 igneous activity issues, chances are you'll wind up with improved behavior, at least that's what everybody should be expecting if reasonable expectation in the near term is met.

I would argue that there's probably work that's being done now that already goes past what is needed to establish reasonable expectation. A lot of what have been rated by now both DOE and NRC as low-risk KTI agreement issues might fall very well into that class of work that doesn't really need to be done now but could easily be pushed into performance confirmation if it's needed at all. It's just a case, though, that as these get scrubbed, one always needs to ask, as certainly NRC will ask, do we have enough -- do we know enough now that we have reasonable expectation to proceed with construction of this repository? And that all of this should just go beyond that, just additional confirmation that performance is okay. They've got to have reasonable expectation with what they have at the time of LA.

MR. RYAN: As Steve said, I'm sure we'll hear more about that tomorrow, and also from the NRC we'll hopefully hear some additional input from their points of view. Thank you all. I'd like to thank you again, Jim, for your presentation. I'd like to now ask Debbie to rejoin us for her documentation and further development discussion and look ahead.

MS. BARR: Actually, I'll just take a moment now to do like Jim did and clarify one point that I've been hearing discussed during the breaks and all. Cost effective doesn't mean cheap, cheaper and cheapest and we chose one of the above. Cost effective means that we are trying to get the most value for a reasonable expenditure, and that's that we need to be good stewards of the finances that are being devoted to this project. And so cost effective is really getting at getting the best value for what we can do and not throwing away resources on something that provides little or no value. So I did want to make that clear before I go on and start my presentation. Okay. Next slide, please.

All right. So where are we going from here? I'm going to go into a little bit more detail than what I talked about earlier today. And as I mentioned before, Revision 2 of the Performance Confirmation Plan is currently in DOE review. As was mentioned earlier, we have had extensive DOE involvement in the development of this program, and so this isn't something that's just coming out of the blue that hasn't had any insights and involvement by DOE.

The DOE review is expected to be completed in August, and based upon the substantiveness of the comments that are made, I -- optimistically, it could conceivably be done as early as September with the changes in using -- in making the changes that DOE provides to BSC on the document.

Revision 3 of the Performance Confirmation Plan is scheduled for spring of 2004, and this is the same list that I showed you earlier about the differences in the documents. These are the things that are going to be developed in the next revision that are not currently available in this revision. As I talked about before, Revision 2 is making the case for why we have the right program, why we have the right list of activities, what was the basis that went into developing that list? Revision 3 will then go on to how we implement that program. And so I'm going to go into detail on each of these bullets here in the next few slides.

First of all, the activities will be defined further. You've seen a high-level description of those activities, and they will be developed further as ar as the details of the programs. This will also include, as I mentioned earlier, a crosswalk to the current and previous testing showing how the information flows from site characterization into performance confirmation. Revision 3 will also specify the spatial range over which the data's collected as well as the temporal, meaning not all tests will be running from now until closure. There will be some that will be shorter, others will be longer. They'll have different time durations, and those will be described to some extent in Revision 3.

There will also be details of how the data will be collected. For instance, will it need a remote operated vehicle, is it something that occurs in a laboratory setting and so forth. There is some brief level of description of that in Revision 2, but this will be expanded on in Revision 3. And then also there will be things like the type of power and communication instrumentation needed and so forth, all of those logistical sort of things will be described in Revision 3.

We also talked about how we're going to establish the expected baseline for the activities in the plan, and not only the baseline but also the bounds and tolerances for the parameters. And by this what I mean is you may conceivably have for a particular activity some nominal value that you expect to measure, and there may be a range, an expected range around that nominal value which is something that you can realistically expect the value to stay within. At the opposite end, on the line on the bottom, is component capability range. That is a wider band, a range, in which if it exceeds that range or stays at the outside of that range for a particular period of time, you're looking at the possibility of that component no longer contributing to the overall performance.

And so somewhere between those two, between the expected range and the component capability range would be the compliance range, and that's the one where we talk about where if it exceeds that, then we would report to the NRC and there would be certain corrective action steps which would be initiated there.

In Revision 3, we'll also have various management and administration topics described there. There will be identification of general test procedures, there will be organizational structure described there, and it will also talk about the needed test plans. Because not all of the detail is going to make its way up into the Performance Confirmation Plan. Obviously, the level of detail needed to implement the test occurs down in the test plan area and so that's where some of the detail will be, because it's too low of a level of detail for the Performance Confirmation Plan. The test plans will also talk about establishing testing commissioning processes and so forth.

All right. And another thing that will be in the Revision 3 is defining the process for reporting variances and also describing the appropriate corrective action steps. Within this we have -- there's the requirement for regular routine reporting of all tests, and then there's also what we talked about earlier, the variance analysis -- well, okay, I'm sorry, we didn't talk about this bullet, but there would be variance analysis where basically if we looked at data trends and forecasts, we would see that potentially something is headed in the direction of exceeding the bounds, and so we would describe the process for looking at this. Then the third one is reporting of actual data outside of regulatory limits. So if it did exceed those regulatory limits, we would then report to the NRC and start the process of working with the NRC on that. And that, of course, involves corrective actions which can be something along the lines of potentially model improvements, it could be test modifications, it might involve something as extensive as a change in the repository design or construction, and then the extreme case would be removal of the waste packages and retrieval. And all of this, of course, would occur in conjunction with the NRC and the stakeholder.

Okay. In Revision 3, we will also develop further design requirements and provide further details that would be needed for the development of, for instance, the accelerated drift test. Those are the ones that Jim talked about. There's the two accelerated drifts and then the one thermal test in the lower lithophysal. There would also be further details on various monitoring and collection systems, such as the ones that I show on the slide here. And then, of course, contingent upon the successful license application, we would then implement what's in the Performance Confirmation Plan, and that would involve monitoring, testing, collecting of information, analyzing it and evaluating it, and if there are significant variances, taking the appropriate corrective action steps.

Now, I almost hate to talk about this slide because it was a touchy subject earlier, but as Jim pointed out earlier, there are some areas where we are looking to technological advances to be able to optimize various aspects of the program. And so in some areas we're looking at what level of technology will be available to support the Performance Confirmation Program.

This doesn't mean in any way, though, that we cannot proceed if those advances or our expectations are not met. In most cases, there is some alternative that can take its place, in some cases, it's just an alteration of what we had previously planned. And so some of these areas would be, for instance, a remote operated vehicle. We know the technology is out there now to have a remote operated vehicle. We are looking for something that gives us reduced dependence on infrastructure, and so we are looking to benefit from things that would develop in time for our needs.

Jim talked about radionuclide sensors, for instance, in the exhaust means. I should probably preface all of this by saying that when these were included in the program, this wasn't some wild idea that people just threw in saying, "Wouldn't it be neat if this technology were available?" In most cases, it was that there was some basis for believing that that was either already available or soon would be available. And so, for instance, in the case of radionuclide sensors, there's a lot of nonproliferation technology out there. We believe that if it's not already available, it is something that soon could be available.

As Jim mentioned, seepage detection via humidity spikes, that's an area that needs to be looked into a little bit to see if it's something that we can benefit from. A rock fall or engineered barrier system collapse by acoustic and seismic tomography, this is an area that we already used to some extent. Whether it's something that can give us the sensitivity we need is something that we're looking into.

And Jim talked about the hermetic seals within the waste packages, some sort of non-electronic, internal pressure sensor. Fast, effective mapping, of course there's always the tried and true method of mapping, so there's no doubt that this is something we can accomplish, but there are possibilities for improved efficiencies in that area that we could take advantage of. And also some sort of automated monitoring of drift deformation. Clearly, measuring drift deformation is not a new art, and so it's something that we're just looking at benefitting from the advances in. All of these areas are ones in which the Performance Confirmation team is currently researching to see what's available, what is soon to be available and what we can benefit from.

And, lastly, again the Performance Confirmation Plan Revision 3 is due next spring, tentatively March of '04. And this is the document that will support the license application. Chapter 4 of the Safety Analysis report is the chapter on performance confirmation, and that is scheduled in our baseline now for December of 2004. And that's it.

MR. RYAN: Thank you very much. That was

a great presentation and great day, and I appreciate you and your team's effort to put all of that together. It really has been very informative and helpful.

I'm reminded on your technology slide that the Russians solved the problem that the U.S. had in space, they couldn't get a pen to work in zero gravity so you know how they solved a problem?

MS. BARR: No.

MR. RYAN: They used pencils.

MS. BARR: Oh, okay.

CHAIRMAN GARRICK: We solved it. We spent a million dollars.

MR. RYAN: Yes. I offer example to think sometimes the simple way to go is perhaps the best. Sometimes the gadgets may not be all they're cracked up to be. That's from somebody that uses a lot of gadgets, so take it in the spirit it's offered. I enjoy the gadgets too. Any last questions?

MR. LEVENSON: Again, it's kind of a system question. There are going to have be remotely operated vehicles to emplace the waste and at least the concept to retrieve waste if it has to be. Is the remotely operated vehicle that's in your technology development area completely independent of that program?

MS. BARR: Yes, it is. In a previous iteration of the Performance Confirmation Program, we had planned on basically using the same process. We would use the gantries that would be used for emplacement to then patrol the drifts and so on and so forth and take the measurements that we would use a remote operated vehicle for.

However, we wanted to be independent of that, because, for instance, you could potentially have even some minor amount of rock fall which could block the tracks and cause a problem with your ability to move your remote operated vehicle. It's tied to a rail system throughout the repository. And so because of that, we've been looking at ones that are independent of a rail system. And so, for example, we've had a few meetings with some of the people in DARPA and they've shown us some of their robotics technology that's been very interesting. We know that there's possibility out there. We already know the technology exists for something that's not tied to a rail.

MR. RYAN: Questions? Comments?

MR. HORNERGER: Yes. Deborah, just a clarification. I'm just trying to figure out how some of these things fit into your path forward. And on your Slide 5 you point out that you're going to establish expected baseline for performance, and you talk about establishing the bounds and the tolerance and you have expected range in compliance and so forth. And when I look at your list of some of your things, for example, precipitation monitoring and analysis of precipitation confirmation, does that fit into this scheme? Are you going to establish a nominal value for precipitation and an expected range?

MS. BARR: Yes. It's my understanding that for all performance confirmation activities there will be baselines and ranges established.

MR. HORNERGER: So you basically are going to -- if the monsoon weakens or strengthens, then that's a variance and you'd have to -- okay. Measurements of moisture content and potential in surficial soil after significant rainfall events. Again, the same thing, you would establish range and a component capability range?

MS. BARR: Yes.

MR. HORNERGER: It's hard to --

MS. BARR: And keeping in mind that some of these could be time-dependent. I mean it doesn't necessarily mean it's going to stay within some set bounds for the entire time period.

MR. HORNERGER: Well, it won't.

MS. BARR: Like, for instance, temperature could --

MR. HORNERGER: Yes. Yes, clearly, it will.

MS. BARR: Yes.

MR. HORNERGER: When you look things like precipitation and we look at the statistics of precipitation we know that these distributions have long tails.

MS. BARR: Yes. And, actually, that's why when we talk about a compliance range falling somewhere between a barrier is no longer providing performance and an expected range, that's the area where we're going to have to work with the NRC on deciding where in that range the compliance range should be. Because, clearly, we don't want it so close to the expected range that we would be reporting things that are not meaningful, and yet we also understand that the NRC would want to have plenty of advance notice if we were headed in the direction.

MR. WHIPPLE: Can I ask just for clarification are you suggesting that there is a compliant and a non-compliant range with rate rainfall at the site? And what's the NRC going to do if the rainfall is out of spec?

MS. BARR: Well, okay, but rather than thinking of just the activity as an isolated thing, think of it in terms of the barrier to which that activity contributes to.

MR. WHIPPLE: I understand, but as George says, rainfall's been studied for many thousands of years, any place on the planet you pick gets a 1,000-year flood every 1,000 years, roughly, on average, sometimes more.

(Laughter.)

MR. WHIPPLE: You know, if that's not folded into TSPA, well, you better go back and fold it into TSPA. But I can't for the life of me imagine how this becomes performance confirmation.

MR. RYAN: Chris, this is kind of a long point I was trying to make this morning, that you really need to circle back and say why am I measuring it?

MR. WHIPPLE: Yes.

MR. RYAN: Now, rainfall is one of why am I measuring it. Well, I can make a connection that some fraction of rain will potentially infiltrate and it becomes part of the subsurface system so that's important, but that's completely buffered by the soils to some extent.

You might have a range of, say, in the East where I live, 30 to 60 inches of rain in a year. You're still going to have 15 inches infiltration because most of it's going to run off. So, again, I don't criticize that particularly, although I understand George and Chris' point about, but I think it's incumbent upon you to circle back now that you've got this portfolio and really ask why are we doing this?

MS. BARR: Okay.

MR. RYAN: Why are we measuring it and what is it tell us that we really need to know? And rainfall is something you might want to monitor for the geohydrologic water balance, that's fine, but making it a compliance issue as part of your PC may not -- I mean that may be something where the compliance is actually you're measuring it as you said you would. Whatever it is we don't care. You know what I mean? So there's a different way to think about required measurements. The requirement is that you're doing it. Whether you get zero inches of rain or 100 inches of rain doesn't matter.

MS. BARR: Jim?

MR. BLINK: If I could take just a quick try at that.

MR. RYAN: Sure.

MR. BLINK: One is if we consistently see year after year precipitation that's considerably higher than what's in our climate model that feeds into the TSPA, we might react to that, quote, "non-compliance," by modifying the PA model. We probably wouldn't change anything other than that, but we would bring ourselves up to date. What it would mean is that the climate change is coming a little sooner, perhaps, or some effect like anthropogenic effects have changed things that's not included in the model.

The other side of the precipitation is if we see a big seepage event, we would like to know whether that's collated in time with a big rainfall and infiltration event. Unlikely that it is, the delay between the two is probably much longer, but the statistical correlation between those things tells us a lot about those two barriers that are above us, above the repository horizon. And to look at only one side and not the other --

MR. RYAN: No. All that's great. I don't disagree with you at all, but the point is turning it into something where you have a compliance issue isn't really helpful and is kind of off point. So I mean if you say I'm going to measure all these things having to do with the water cycle and you make that a self-imposed requirement, then the fact you're measuring them becomes the issue, not what the values are necessarily.

MR. BLINK: Yes, I understand.

MR. RYAN: So I think, again, defining very, very carefully why it is you're doing something and whether you're going to get compliance or a conformance with the safety case information or improving your understanding of the environment information or both is something you really need to think through for each and every one of those measurements.

CHAIRMAN GARRICK: Jim, am I to take from what you just said that the PA is going to be a living document through the pre-closure period?

MR. BLINK: Yes, sir.

MS. BARR: Yes. Actually, that's one of the potential corrective action steps or something that would even precede a corrective action step. If we see something that's deviating from what we expect, even before it gets to the point where we would need to report to the NRC, we might ourselves initiate doing another TSPA to see what the impacts are.

MR. RYAN: Any other questions, comments? We had one request for time to speak from a member of the audience. Ms. Treichel, good evening -- good afternoon, welcome.

MS. TREICHEL: Thank you. Judy Treichel, Nevada Nuclear Waste Task Force. One of the things that would provide some public comment would be to know that we could get the presentations with not just the odd-numbered pages, because I like to write on them and I don't like getting them later, and I still want to get one of the Debbie's last ones, because that was never out there. So that's just a little QA problem that pops up from time to time.

I think the whole discussion has been really strange. I was part of or attended and made a comment at the December meeting that was mentioned here about performance confirmation, and the fact that as we've been hearing all through these presentations that there should be -- or there has to be a performance confirmation must have been started during site characterization, and obviously if the Department is now in the process of coming up with one, it wasn't there during site characterization. There was something there.

If we're working on Rev 2, there had to be a Rev 0 and a Rev 1, and I never got those, and I was supposed to be getting them, and I suppose there will be something on there that happened already so they could say that they had something, but this really looks like something that's in its infancy.

And it lends itself to comments like Chris Whipple made when he said that the word, "confirmation," could indicate an overconfidence or could send the wrong message. Well, what we were told as the public, the ones that are supposed to be getting all of this new confidence, was that if there was too much uncertainty, if you weren't really confidence, if the thing really wasn't shown to be doing what it had to do, it wouldn't happen. So I'm not sure that a Performance Confirmation Program's going to give us what should have already been there. I doubt that it would. But we seem to be in the very first steps of something.

And then once you get to this point where you're just putting it together, we're real nervous about things that have to happen in the future, like the $8 billion worth of titanium that has to get thrown in there but it's promised now but has to be paid for later. And a lot of this program is going to have to be paid for later. So is there going to be some sort of a financial bond that goes with this, some kind of a promise where you've got the money in the bank and you know that it's going to happen because it doesn't always happen.

And as Debbie said, some activities could be deleted or replaced. Well, I'm sure they could. When we came up with the KTIs, each one of those at the time that it was put down as an action item or as an issue, it had to be resolved, and it was important. And now we're seeing some of them becoming a little less important or being able to be shuffled off or something. But this does appear to be a collection of things that would be much handier to be able to do later if there's money, if there's time. And if it had already been done during site characterization, which I believe and a lot of Nevadans believe it should have been done, we wouldn't be worried about whether or not there would be money to do it.

And I'd also like to know if there's any possibility that things could stop if in fact this laundry list of new scientific marvels like the remotely operated vehicles and so forth don't come through or if when they do it's a problem to get them to work with all that heat or under a radioactive situation or something. Is any of this stuff going to be shown and going to be shown working? The word, "retrievability," is always thrown around, and I don't think that that would ever be demonstrated in any way that it should be. But even these things that are now going to be part of a program that's required really need to sort of be proven that they can happen and that they will be paid for. Thank you.

MR. RYAN: Any other comments from members of the audience? Mr. Chairman, that brings us to the end of our agenda for the day, so I turn the gavel back over to you, sir. Yes, I'm sorry? Please.

MR. BLINK: Revision Zero of the Performance Confirmation Plan was issued in September of 1997 in support of the viability assessment, so we've had a documented program that a lot of the issue with this discussion about it starting in site characterization is a semantics discussion, and I think Debbie covered it well in her first talk. The information flow from the data collected during site characterization is in the system and the Performance Confirmation Plan states that it will be used in constructing the baseline for the future performance confirmation activities.

So I don't see any issue with whether we had one earlier or not. We have had a data collection program that was covered under site characterization and that program is evolving to something that's called performance confirmation in 10 CFR 63 which didn't exist at the time that we were doing the site characterization. So a lot of that could be semantics.

On the financial bond question, that's an interesting one, and it seems to me that we already have a Nuclear Waste Fund, which the Congress apportions, and if a condition of license is that a Performance Confirmation Program that has been included in the license continues, then it would be more difficult for the people who control the purse strings of doing the work to change the scope of that work, because then we would be afoul of an issued license. We could get a stop work from the NRC if we didn't collect the data that we had promised in the license application, assuming that that was made a condition of the license in some way.

MR. RYAN: Any other comments? Questions? Clarifications? Mr. Chairman?

CHAIRMAN GARRICK: I think this is probably the end of the day. I will ask the Committee members if there's any business matters they would like to take up at this point. We could certainly do that, but otherwise I would like to adjourn for the evening and pick up tomorrow morning at, what is it, 8:30? All right. With that, we are adjourned.

(Whereupon, at 5:02 p.m., the ACNW meeting was recessed until Wednesday, July 30, 2003, at 8:30 a.m.)

CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of:

Name of Proceeding: Advisory Committee on Nuclear Waste 144th Meeting

Docket Number: n/a

Location: Rockville, MD

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission taken by me and, thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings.

Debra Wilensky

Debra Wilensky
Official Reporter
Neal R. Gross & Co., Inc.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, D.C. 20555-0001

July 14, 2003

AGENDA
144th ACNW MEETING
July 29-31, 2003

TUESDAY, JULY 29, 2003, NRC AUDITORIUM, TWO WHITE FLINT NORTH, ROCKVILLE, MARYLAND

1) 9:30 - 9:40 A.M. Opening Statement (Open) (BJG/MTR/NMC)
The Chairman will open the meeting and turn it over to the Working Group chairman who will state the Workshop objectives and provide a session overview.

WORKING GROUP ON PERFORMANCE CONFIRMATION PLANS FOR THE PROPOSED YUCCA MOUNTAIN HIGH-LEVEL WASTE REPOSITORY (OPEN)

The purposes of the working group are (1) to increase ACNW's technical knowledge of plans to develop and conduct performance confirmation (PC) work for the proposed Yucca Mountain repository, (2) to understand NRC staff expectations for performance confirmation, (3) to review examples of performance confirmation work being planned, (4) to identify aspects of performance confirmation that may warrant further study, and (5) to complement the previous working group session on performance assessment.

2) 9:40 - 10:20 A.M. Keynote Presentation: What Should Be Measured During Performance Confirmation? How Will These Measurements Enhance Confidence by Confirming Predicted Repository Behavior? (Open)
2.1) Views on performance confirmation will be presented by a distinguished expert.
10:20 - 10:40 A.M. 2.2) Discussion

10:40 - 10:55 A.M. *** BREAK ***

3) 10:55 - 11:25 A.M. Introduction to Performance Confirmation (NRC's Expectations Regarding Content of PC Plans in a License Application) (Open)
3.1) Presentation by a representative of NRC's Office of Nuclear Material Safety and Safeguards (NMSS), Division of Waste Management (DWM)
11:25 - 11:45 A.M. 3.2) Discussion

4) 11:45 - 12:00 P.M. Introduction to Performance Confirmation (Open)
4.1) Presentation by a representative from DOE
12:00 - 12:15 P.M. 4.2) Discussion

12:15 - 1:15 P.M. *** LUNCH ***

5) 1:15 - 2:15 P.M. Decision Analysis Process Used to Develop a Performance Confirmation Program (Open)
5.1) Presentation by a representative from DOE
2:15 - 2:45 P.M. 5.2) Discussion

2:45 - 3:00 P.M. * BREAK *****

6) 3:00 - 4:15 P.M. Elements of a Performance Confirmation Program - a Presentation of DOE's Selected Program and Its Components (Open)
6.1) Presentation by a representative from DOE
4:15 - 4:40 P.M. 6.2) Discussion

4:40 - 4:55 P.M. * BREAK *****

7) 4:55 - 5:15 P.M. Documentation and Further Development of the Performance Confirmation Program - A Presentation on Possible Changes in the Next Revision of DOE's PC Plan (Open)
7.1) Presentation by a representative from DOE
5:15 - 5:30 P.M. 7.2) Discussion

8) 5:30 - 6:00 P.M. Public Comments

WEDNESDAY, JULY 30, 2003, NRC AUDITORIUM, TWO WHITE FLINT NORTH, ROCKVILLE, MARYLAND

WORKING GROUP ON PERFORMANCE CONFIRMATION PLANS FOR THE PROPOSED YUCCA MOUNTAIN HIGH-LEVEL WASTE REPOSITORY (OPEN) (CONTINUED)

9) 8:30 - 8:35 A.M. Opening Statement (BJG/MTR/NMC/HJL) (Open)
The Chairman will make opening remarks regarding the conduct of today's sessions.

10) 8:35 - 9:05 A.M. NRC's Risk Insights Initiative and its Impact on Review of Performance Confirmation Plans (Open)
10.1) Presentation by a representative from NRC's NMSS/DWM
9:05 - 9:30 A.M. 10.2) Discussion

11) 9:30 - 9:45 A.M. NRC's Acceptance Criteria in the Yucca Mountain Review Plan, for Review of Performance Confirmation (Open)
11.1) Presentation by a representative from NRC's NMSS/DWM
9:45 - 10:00 A.M. 11.2) Discussion

10:00 - 10:15 A.M. ***BREAK***

12) 10:15 - 12:15 P.M. Presentations by Representatives of the State of Nevada, several affected Counties, the Las Vegas Paiutes, and the Electric Power Research Institute (Open)

12:15 - 1:15 P.M. * LUNCH *****

13) 1:15 -1:45 P.M. Research Perspective on Long-Term Testing for Performance Confirmation - Development of an Integrated Ground-Water Monitoring Strategy (Open)
13.1) Presentation by a representative from NRC's Office of Nuclear Regulatory Research
1:45 - 2:00 P.M. 13.2) Discussion

14) 2:00 - 3:15 P.M. Working Group Roundtable Panel Discussion on Performance Confirmation (Open)

3:15 - 3:30 P.M. * BREAK *****

15) 3:30 - 4:15 P.M. Panel and Committee Summary Discussion (Continued)

16) 4:15 - 4:45 P.M. Public Comments

17) 4:45 - 4:55 P.M. Closing Comments by Working Group Chairman

18) 4:55 - 6:15 P.M. Preparation of ACNW Report (Open)
Discussion of principal points in a proposed ACNW report on the Performance Confirmation Working Group.

THURSDAY, JULY 31, 2003, CONFERENCE ROOM 2B3, TWO WHITE FLINT NORTH, ROCKVILLE, MARYLAND

19) 8:30 - 8:35 A.M. Opening Statement (Open) (BJG/JTL)
The Chairman will make opening remarks regarding the conduct of today's sessions.

20) 8:35 - 9:30 A.M. Risk-Informed Regulation for NMSS: Status Report and Plan for Future Work (Open) (MTR/HJL)
Briefing by and discussions with representatives of the NRC NMSS Risk Task Group regarding the current status of risk-informed regulation for NMSS and the plan for future work.

21) 9:30 - 10:00 A.M. Summer Intern Project (Open) (STG)
The ACNW summer intern will update the Committee on the status of her project titled "Assessing Model Uncertainty in Performance Assessment".

10:00 - 11:00 A.M. ***BREAK***

22) 11:00 - 11:45 A.M. ACNW September Retreat (Open) (BJG/MPL)
Members will finalize plans for the Committee's September retreat which is scheduled during the 145th meeting (September 16-18, 2003).

23) 11:45 - 12:15 P.M. Committee Visit to Yucca Mountain (Open) (BJG/MPL)
The Committee will finalize plans for the Yucca Mountain Site visit scheduled for the 147th meeting (November 18-20, 2003).

12:15 - 1:15 P.M. ***LUNCH***

24) 1:15 - 2:30 P.M. Preparation for Meeting with the NRC Commissioners (Open) (BJG/JTL)
The Committee will discuss proposed topics for the ACNW meeting with the NRC Commissioners which is scheduled for Thursday, October 23, 2003, between10:00 a.m. and 12:00 Noon.

25) 2:30 - 5:45 P.M. Preparation of ACNW Reports (Open)
Discussion of the proposed ACNW reports on:

25.1) Performance Confirmation Working Group (MTR/NMC)
25.2) 2003-04 ACNW Research Report (MTR/RPS)
25.3) Briefing on the HLW Risk Insights Initiative and the Risk-Informed Issue Resolution Process (BJG/NMC)
25.4) Role of ACNW in Yucca Mountain License Application (BJG/MPL)
25.5) Risk-Informed Regulation for NMSS (BJG/HJL)

26) 5:45 - 6:00 P.M. Miscellaneous (Open)
The Committee will discuss matters related to the conduct of Committee activities and matters and specific issues that were not completed during previous meetings, as time and availability of information permit.

6:00 P.M. Adjourn 144th Meeting

NOTE:

- Presentation time should not exceed 50 percent of the total time allocated for a specific item. The remaining 50 percent of the time is reserved for discussion.

- Thirty-Five (35) copies of the presentation materials should be provided to the ACNW.

- ACNW meeting schedules are subject to change. Presentations may be canceled or rescheduled to another day. If such a change would result in significantinconvenience or hardship, be sure to verify the schedule with Mr. Howard Larson at 301-415-6805 between 8:00 a.m. and 4:00 p.m. prior to the meeting.

Performance Confirmation for Yucca Mountain

Presented to the Advisory Committee on Nuclear Waste

Rockville, MD
July 29, 2003

Chris Whipple

ENVIRON

Overview

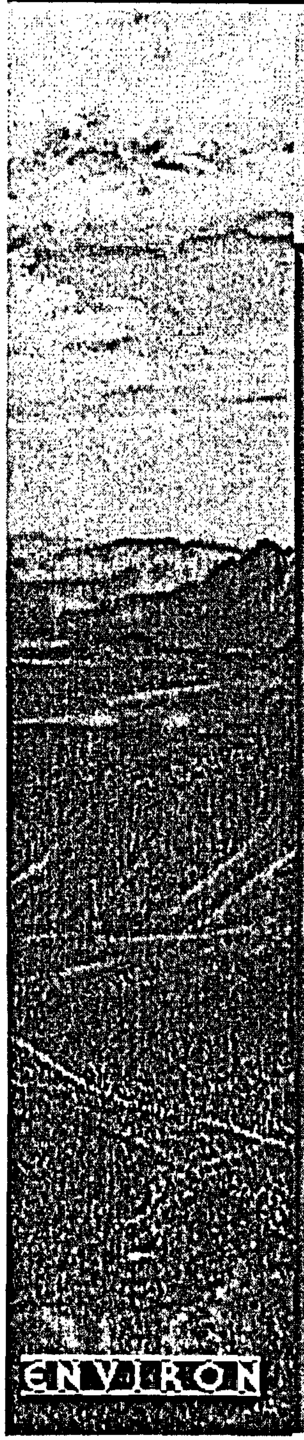
- Disclaimers/qualifiers
- General thoughts on performance confirmation
- Criteria by which one decides what to do or not to do
- Lessons from WIPP and their application to Yucca Mountain
- Specific thoughts about what performance confirmation might usefully include

ENVIRON

Qualifiers

- This presentation reflects my views on Performance Confirmation, and should not be taken to represent the viewpoint of anyone else or of any organization, including DOE. It has not been reviewed by DOE.
- Some of the material in this presentation comes from an EPRI workshop on Performance Confirmation and draws from the efforts and thinking of those who organized and participated in that event.

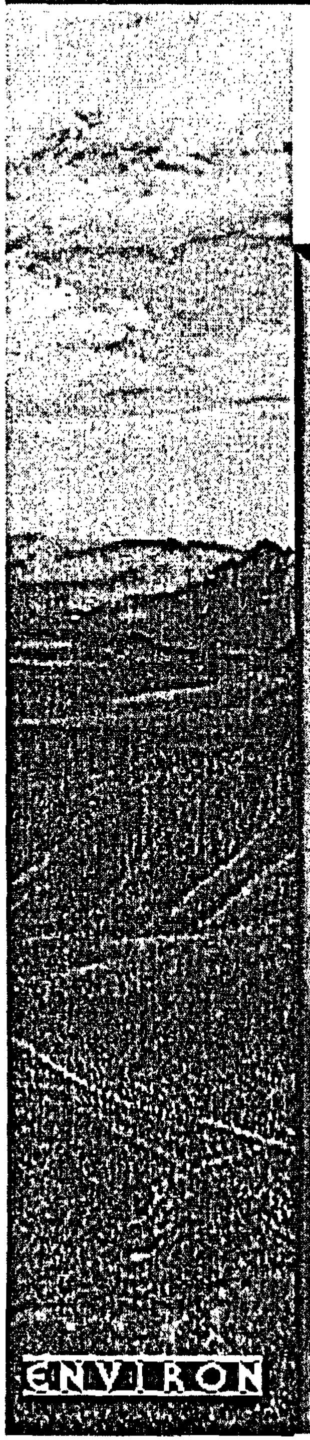
ENVIRON



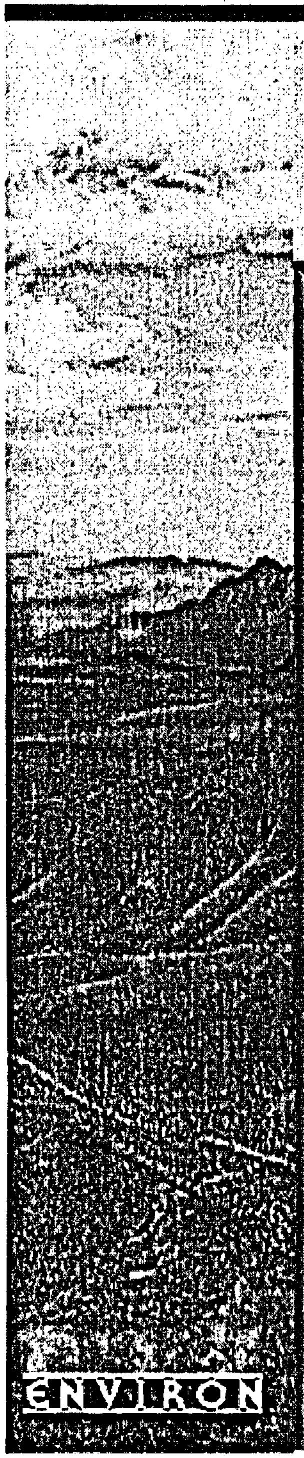
Does "Confirmation" convey the right idea?

- May indicate overconfidence
- Inconsistent with idea that hypotheses are tested by falsification
- Suggests that deviations from predictions are failures
- Deviations can indicate that the system is not as well understood as one would like, but in such cases, it is important to know whether differences reflect misspecified systems or conservative analyses

Management Principles



- flexible
- iterative
- risk-informed
- connected to high-level performance goals
- involves the public
- increases confidence at each stage
- can be prioritized
- has exploratory component



Goals for performance confirmation studies

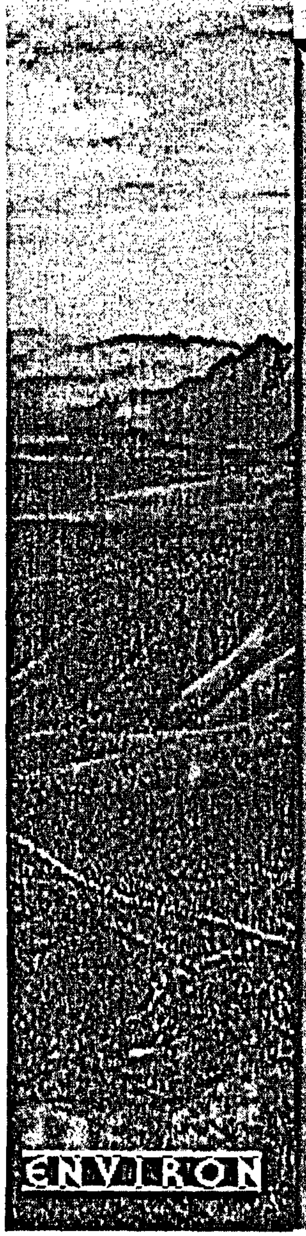
- Part 63.131 requires performance confirmation data to assess whether
  - Actual subsurface conditions ... are within the limits assumed in the licensing review; and
  - Natural and engineered systems ... are functioning as intended and anticipated
- To what extent is such evaluation required when such conditions and systems do not bear on compliance?
- Does performance confirmation seek to reduce uncertainties in the degree of margin of performance against standards?

Traps

- Agreeing to do things that can't be done
- Agreeing to measure things that don't affect performance
- Claiming safety based on monitoring of too limited duration or extent
- Requiring unnecessary accuracy or precision in measurements
- Failing to establish and apply a system for periodic reconsideration of performance confirmation requirements

ENVIRON

Performance Confirmation and TSPA



- Given that TSPA is the basis for licensing of Yucca Mountain, it is logical that it will also be used to determine what to monitor during the performance confirmation period.
- Will TSPA become a living model, evolving in response to performance confirmation information?
- Are periodic revisions and updates planned?
- What post-licensing level of effort, relative to current activities, is planned?

Criteria for Selecting Performance Confirmation Activities

- Threshold of importance based on TSPA results and sensitivity studies
- Potentially important processes or events not treated realistically in TSPA
- Can contribute to assessing the validity of an important TSPA conceptual model
- Addresses an issue of public concern, even if deemed unimportant by TSPA

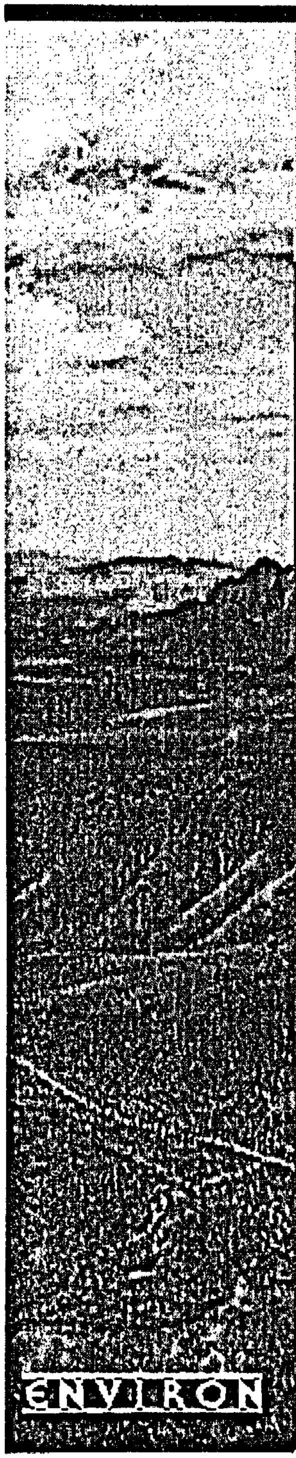
Threshold of importance based on TSPA results and sensitivity studies

Absolute or relative scale?

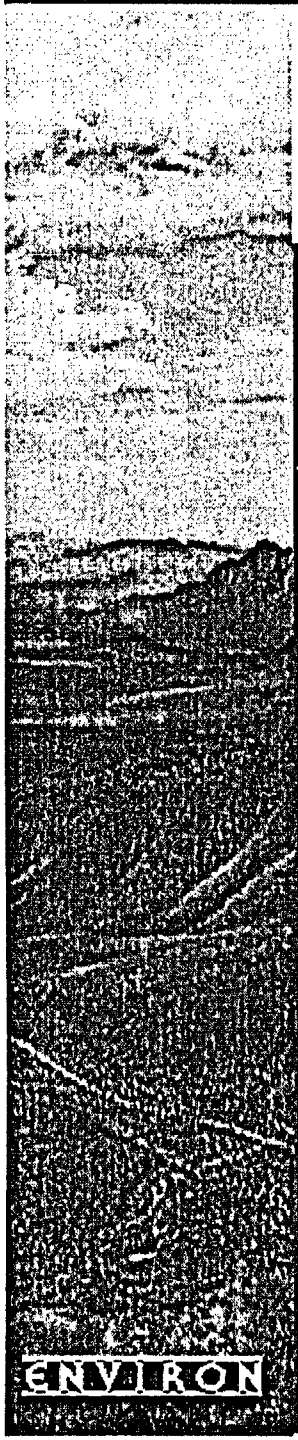
- Should the threshold for undertaking a confirmation activity be that noncompliance is possible?
- Is it sufficient to require confirmation measurements for parameters or processes that are important to safety in a relative sense, but where noncompliance is not feasible?

ENVIRON

Potentially important but not treated realistically in TSPA



- There are process that TSPA treats via simplified bounding analyses, or doesn't address where the failure to do so is in the conservative direction (e.g., effect of spent fuel alteration products on radionuclide mobility).
  - Not clear where such processes can be monitored with the expectation of learning anything within the performance confirmation period
  - Not clear that it is the role of performance confirmation to make TSPA more realistic where it is conservative
  - Confirmation actions appropriate where TSPA is non-conservative AND where meaningful measurements could be made AND where the issue meets an important-to-safety threshold (may be moot given that non-conservative TSPA is probably unacceptable)



Can contribute to assessing the validity of an important TSPA conceptual model

- TSPA sensitivity analyses have been made to assess the relative importance of parameters, assuming that the overall framework is conceptually valid
- Some analyses of alternative conceptual models has also been done
- Conceptual model uncertainty is typically more difficult to address in an analysis than parameter uncertainty
- Opportunities to evaluate conceptual model uncertainties outside of the TSPA framework may be available

Address issues of public concern, even if deemed unimportant in TSPA

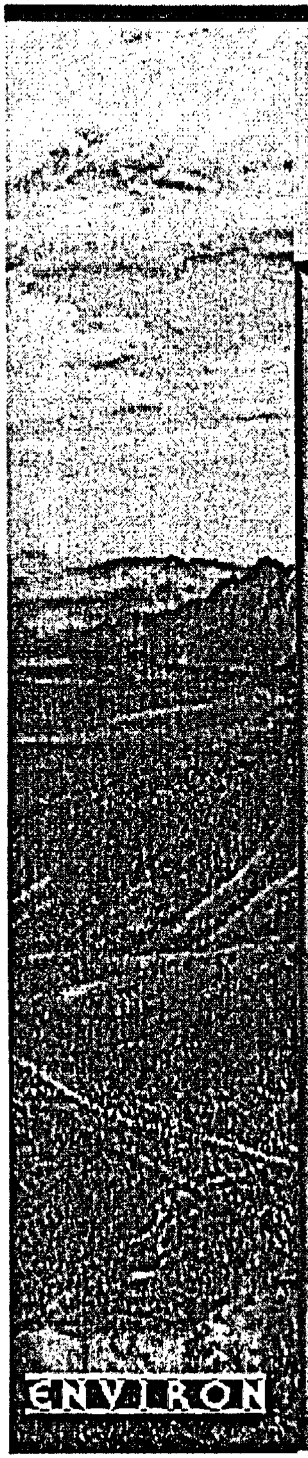
- Key risk communication recommendation is to take the public's concerns seriously and to address these concerns even if they are not seen as valid by technical experts
- Should not be used as an excuse for doing otherwise low-valued work

ENVIRON

Use a value of information or data quality objective framework

- Under such a framework, data are only collected where they could affect some action or decision
- Concurrent with performance confirmation measurements, has NRC/DOE tried to define criteria that would trigger modifications to the repository or its operation? That is, how do performance confirmation data matter?

ENVIRON



Learn from WIPP

- To speed EPA certification of WIPP's compliance, DOE deferred resolution of several key technical issues in waste characterization until after certification was granted.
- The plan was to get some waste underground, and to reopen discussion regarding characterization requirements later.
- "I know we have to have that fight, but I want to have it on the other side of the finish line."

Learn from WIPP, cont.

- Characterization of WIPP waste for radiological properties is managed by EPA. These requirements are straightforward; radiation is easy to measure.
- Characterization to identify hazardous chemicals is conducted under a RCRA permit granted by the New Mexico Environment Department (NMED).
- These requirements largely reflect methods proposed by DOE in its permit application. The requirements are excessive, given the comparatively minor chemical hazard of the waste.

ENVIRON

Learn from WIPP, cont.

- NMED views the agreed-to permit requirements as something that DOE and New Mexico shook hands on, not as a temporary set of requirements to be renegotiated at the first opportunity.
- When WIPP opened, the budget for analysis was cut to essentially nothing. The view at OMB and among Congressional staff was that if EPA had certified WIPP as safe to operate, no significant technical uncertainties remained. Needed analyses to support reduced waste characterization have not been performed.

ENVIRON

Applying lessons to Yucca Mountain

- Do not use performance confirmation as a way to put off dealing with awkward KTIs, except when it makes sense, i.e., when informative measurements can be made AND where the issue is important to safety/ compliance.
- It is normal for technical people to think their issue is the most important issue, and that it deserves a prominent place in performance confirmation – they all can't be right about this. Also need to beware of rice bowls.
- Plan for the periodic review of requirements with the expectation that they should change as data become available.

ENVIRON

Monitoring to address conditions during the confirmation period

- Is monitoring of ventilation gases for radionuclides sufficient to detect early waste package failures? Other environmental monitoring, e.g., of ground water, is likely to be useless, but may provide public confidence.
- Rockfalls, while not anticipated in the confirmation period, could affect ventilation and thermal conditions beyond those analyzed in TSPA. Would monitoring of ventilation flow rates be sufficient to identify if rockfalls have occurred?

Thermal hydrologic predictions could be tested

- It should be possible to monitor and compare temperature and moisture conditions with model predictions.
- Below-boiling temperature in pillars between drifts is important to allow drainage, but peak temperatures are not reached until after closure.
- Compliance and long-term performance are insensitive to such factors in TSPA. It isn't clear how this information would be used or whether it would be informative with respect to safety.

Corrosion modeling is based on limited experimental evidence

- Value in continuing corrosion experiments in a way that addresses both models and parameters
- The chemical environment on waste package surfaces will change after repository closure. It may not be possible to make measurements during the operating period that provide useful information with respect to these environments

ENVIRON

When to close the repository?

- Are there confirmation measurements that can help inform this decision?
- Some decision factors will likely involve the future course of nuclear power and the weapons program; these are not connected to confirmation.
- Current NRC requirements do not envision a post-closure confirmation program. Can useful post-closure measurements be made? Post-closure monitoring assumed for hazardous surface facilities.

PERFORMANCE CONFIRMATION PROGRAM
SUBPART F OF 10 CFR PART 63

144th Meeting of
Advisory Committee on Nuclear Waste
July 29-31, 2003

Jeffrey Pohle 301-415-6703 jap2@nrc.gov
Division of Waste Management
U.S. Nuclear Regulatory Commission

Discussion Topics

- General Requirements for Performance Confirmation
- Confirmation of Geotechnical and Design Parameters
- Design Testing
- Monitoring and Testing Waste Packages
- Other Relevant Requirements

General Requirements Objective

§ 63.131(a)

Provide data, where practicable, to:

- Indicate whether actual subsurface conditions are within limits assumed in licensing review, and
- Indicate whether natural and engineered barriers are functioning as intended and anticipated

General Requirements
Program Duration

§ 63.131(b)

Program must have been started during site characterization, and it will continue until permanent closure.

General Requirements Testing

§ 63.131(c)

Program must include in situ monitoring, laboratory and field testing, and in situ experiments, as may be appropriate to provide the data required.

General Requirements Implementation

§ 63.131(d)

- Does not adversely affect the ability of the geologic and engineered elements of the repository to meet performance objectives
- Provides baseline information on those parameters and processes pertaining to geologic setting that may be changed by characterization, construction and operation
- Monitors changes from baseline of parameters that could affect repository performance

Confirmation of Geotechnical and Design Parameters

§ 63.132(a), (b), and (c)

- During construction and operation, continuing program of activities to confirm geotechnical and design parameters and ensure the Commission is informed if design changes needed to accommodate conditions found.
- Monitor subsurface conditions against design assumptions
- DOE identifies specific parameters and interactions between natural and engineered systems and components in Performance Confirmation Plan

Confirmation of Geotechnical and Design Parameters

§ 63.132(d) & (e)

- Data compared with design bases and assumptions. If significant differences, DOE determines need to modify design or construction methods and reports any changes to NRC
- In situ monitoring of thermomechanical response conducted until permanent closure

Design Testing

§ 63.133(a), (b), (c), and (d)

- Tests of engineered systems and components, as well as the thermal interaction effects of the engineered systems and components, rock, and water, must be conducted.
- Testing initiated as early as practicable
- If backfill included, must test to evaluate effectiveness of placement and compaction procedures before permanent placement begun
- Must test to evaluate effectiveness of seals before full-scale sealing operation begins.

Monitoring and Testing Waste Packages

§ 63.134(a), (b), (c), and (d)

- A program must be established at the GROA for monitoring the condition of the waste packages. Waste packages representative of those to be emplaced.
- Consistent with safe operations, testing environment representative of emplacement environment.
- Program must include laboratory experiments that focus on internal condition of waste packages. To extent practical, duplicate emplacement environment in lab.
- Monitoring must continue as long as practical up to the time of permanent closure.

Other Relevant Requirements

DOE's Performance Confirmation Program is subject to:

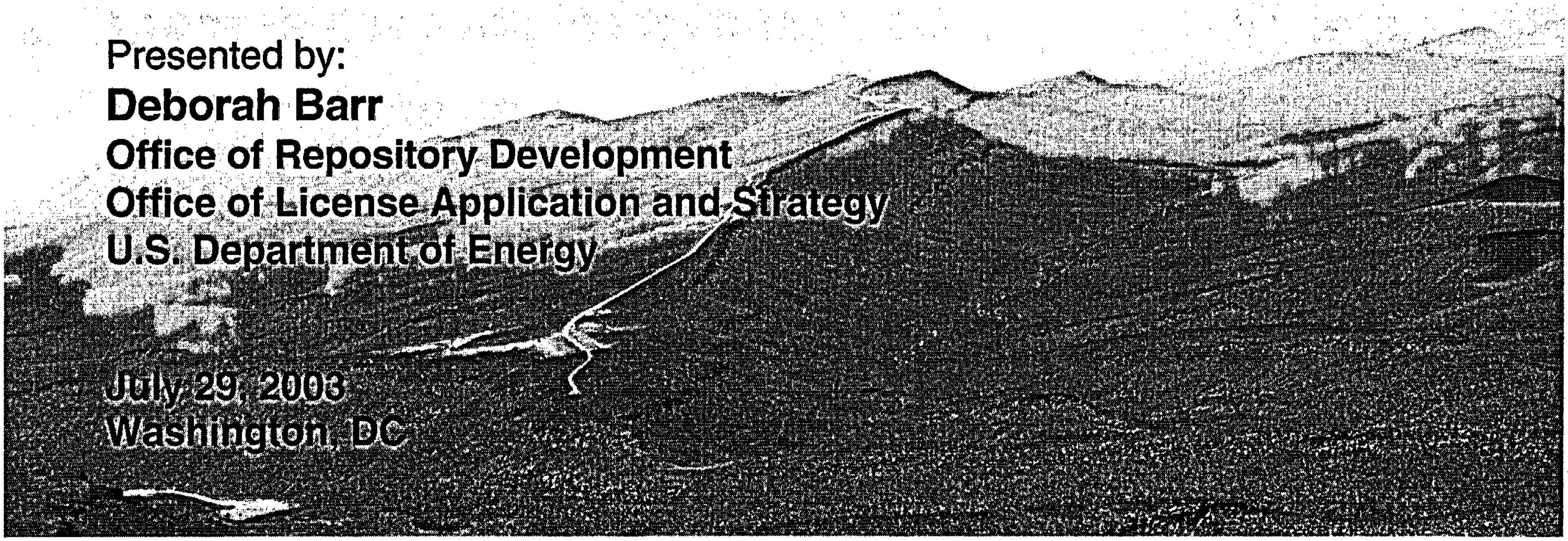
- Requirements for records and reports (§ 63.71)
- Requirements for reports of deficiencies (§ 63.73)
- Requirements for tests (§ 63.74)
- Inspection after the LA for CA is submitted (§ 63.75)
- Quality Assurance (Part 63, Subpart G)

Overview of Performance Confirmation

Presented to:
Advisory Committee on Nuclear Waste

Presented by:
Deborah Barr
Office of Repository Development
Office of License Application and Strategy
U.S. Department of Energy

July 29, 2003
Washington, DC



Outline of Talks

- Vision of the Program
- Focus of the *Performance Confirmation Plan* Revision 02

} D. Barr

- Process used to select activities for inclusion into the program

} K. Jenni

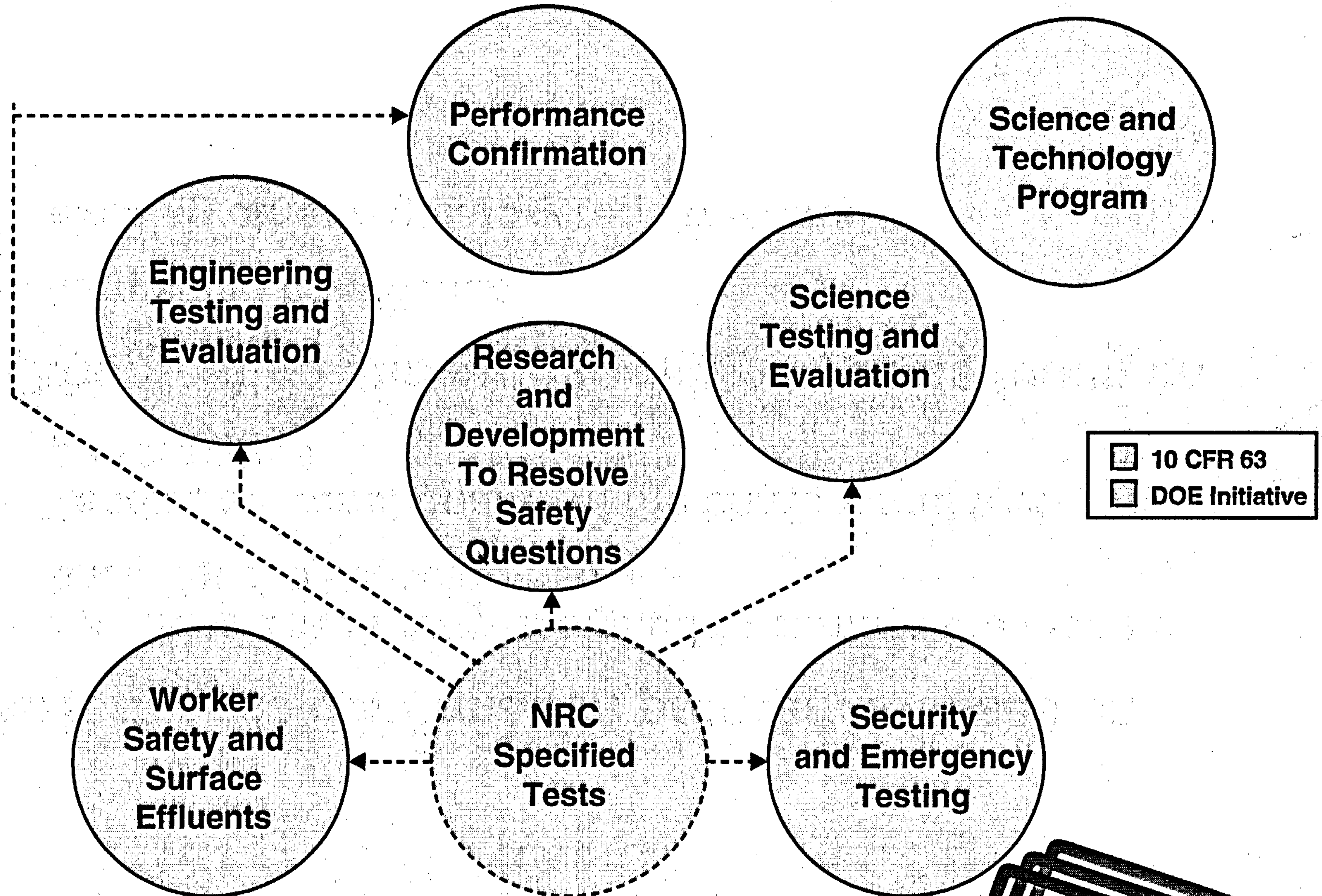
- Brief description of the selected program and its key components

} J. Blink

- Further development of the performance confirmation program

} D. Barr

Testing and Monitoring Categories



Performance Confirmation versus Other Testing and Monitoring Programs

- Performance confirmation program focuses on
  - Activities specifically designed to confirm the technical basis for the licensing decision
  - Testing the functionality of the barriers and total system performance
- Other testing and monitoring programs focus on
  - Increasing confidence
  - Meeting other regulatory requirements

Role and Requirements for Performance Confirmation

- **The NRC requires a performance confirmation plan as part of a License Application for the Yucca Mountain repository**
  - "Performance confirmation means the program of tests, experiments, and analyses that is conducted to evaluate the adequacy of the information used to demonstrate compliance with the performance objectives ..." (10 CFR 63.2)
- **Performance confirmation program should demonstrate that the system and the sub-system components (i.e., barriers) are operating as predicted**
  - "The performance confirmation program must provide data that indicate, where practicable, whether natural and engineered systems and components required for repository operation, and that are designed or assumed to operate as barriers after permanent closure, are functioning as intended and anticipated" (10 CFR 63.131(a)(2))

Motivation to Update the Performance Confirmation Plan

- **Address requirements in the finalized 10 CFR 63**
  - **Also address expectations laid out in the *Yucca Mountain Review Plan***
- **Reflect the barriers important to waste isolation**
  - **Previous *Performance Confirmation Plan* based on principal factors**
- **Use a risk-informed performance-based process to determine how to confirm each barrier's performance**
- **Ensure performance confirmation program is consistent and compatible with repository operations**

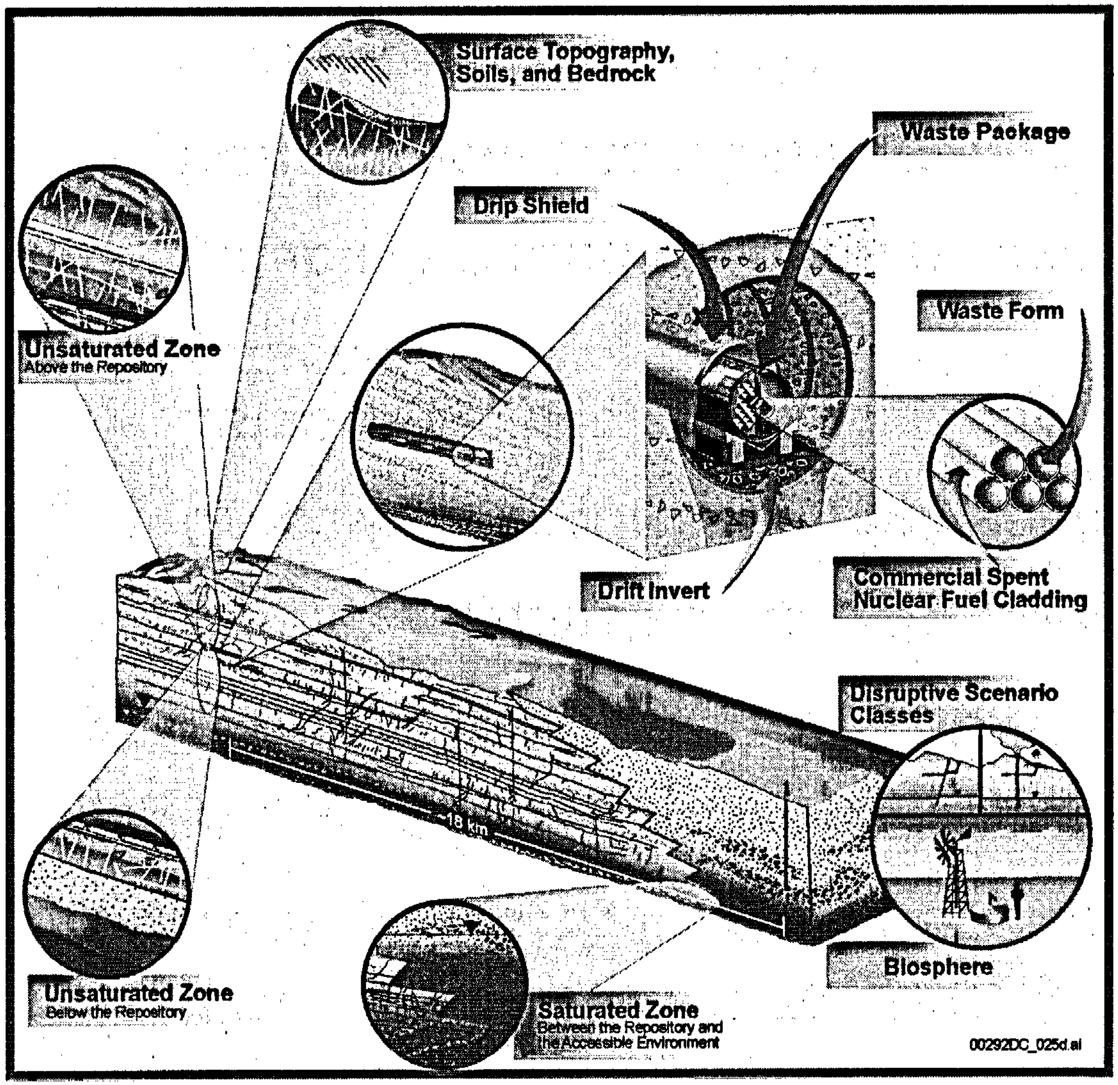
Elements of a Performance Confirmation Vision

- Based on 10 CFR 63 requirements and *Yucca Mountain Review Plan* expectations
- Provides a comprehensive and thorough look at critical aspects of the overall system and the barriers
- Uses a risk-informed performance-based approach to determine the complexity, extent, and number of activities to include for testing a parameter's effect on total system performance or a particular barrier functionality
- Confirms operations rather than imposing substantial design requirements (i.e., does not drive facility design)
- Supports a License Amendment for closure

Performance Confirmation Activity Selection Process

- **Implemented a risk-informed performance based approach using a formal multi-attribute utility analysis of the value of including each activity**
- **Multi-attribute utility analysis is a decision analysis tool: used here to combine technical judgments about activities with management value judgments on the importance of different goals**

Decision Analysis Based on Performance Assessment



- Performance assessment barriers and scenario classes were the basis of the decision analysis
- Performance assessment technical staff provided technical judgments
- Performance assessment manager provided management value judgments
- Performance assessment includes process abstraction and total system model

Path Forward

- Revision 2 of the *Performance Confirmation Plan* is currently in U.S. Department of Energy review
- Revision 3 of the *Performance Confirmation Plan* is scheduled for spring of 2004
  - Define activities (what, when, where, and how)
  - Crosswalk to current and previous testing
  - Establish expected baseline for performance confirmation activities
  - Establish bounds and tolerances for key parameters
  - Management and administration
  - Identify needed test plans
  - Define the process for reporting variances and describe the appropriate corrective actions steps

Path Forward
(Continued)

- Implement *Performance Confirmation Plan*
  - Monitor, test, and collect data
  - Analyze and evaluate data
  - Take corrective actions should significant variances arise

U.S. Department of Energy
Office of Civilian Radioactive Waste Management

YUCCA MOUNTAIN PROJECT

Decision Analysis Process Used to Develop a Performance Confirmation Program

Presented to:
Advisory Committee on Nuclear Waste

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Washington, D.C.

The Decision Analysis Approach Separates Parameter from Portfolio Evaluation

- The performance confirmation program consists of a "portfolio" of activities
  - A set of specific activities designed to monitor or test performance confirmation parameters
- The best portfolio does not necessarily result from simply including the top ranked activities
  - There may be objectives or goals for a performance confirmation program that are unrelated to the specific activities included
  - There can be interactions among activities that make it more or less desirable to include two specific activities together
- However, the value of the portfolio depends at least in part on the value of the specific components of that portfolio
- Evaluating the individual activities is a prerequisite to evaluation of portfolios

Decision Analysis Approach

- Provides a consistent, logical, defensible basis for evaluating and comparing activities considered for inclusion in the performance confirmation program
- Explicitly acknowledges that tradeoffs among different objectives and goals may be necessary
- Bases the evaluation on:
  - The potential impacts of including the parameter on the key objectives of the program ("technical judgments")
  - The relative importance and value of achieving those objectives ("management value judgments")
  - Combining technical judgments and management value judgments yields a "utility," or overall estimate of the value of including the potential activity
- Facilitates documentation of the technical and management basis for the selected portfolio of activities

The Technical Basis for the Approach is Formal Multi-Attribute Utility Analysis

- A technically sound mathematical approach for evaluating alternatives where more than one objective is important
- Has been used by DOE, other federal agencies, and private companies since the late 1970s to evaluate complex decision problems
- The five-step process for implementing multi-attribute utility analysis:
  - Define the objectives of the decision-maker(s), and develop metrics to measure performance against those objectives
  - Evaluate how each alternative performs against each objective
  - Assess tradeoffs: value functions and weights
  - Combine value functions and technical evaluation to estimate the overall value of each alternative
  - Use the combined evaluation results to support decision making (consider the appropriate decision rule, the quality of information, the comprehensiveness of the analysis, etc)

Approach

Phase 1: Activity evaluation → **Phase 2: Portfolio development and evaluation** → **Phase 3: Portfolio selection and refinement**

Management value judgments

Technical judgments

Define activity evaluation criteria

Define and describe candidate performance confirmation activities

Assign management value judgments to criteria

Evaluate activities (technical judgments using evaluation criteria)

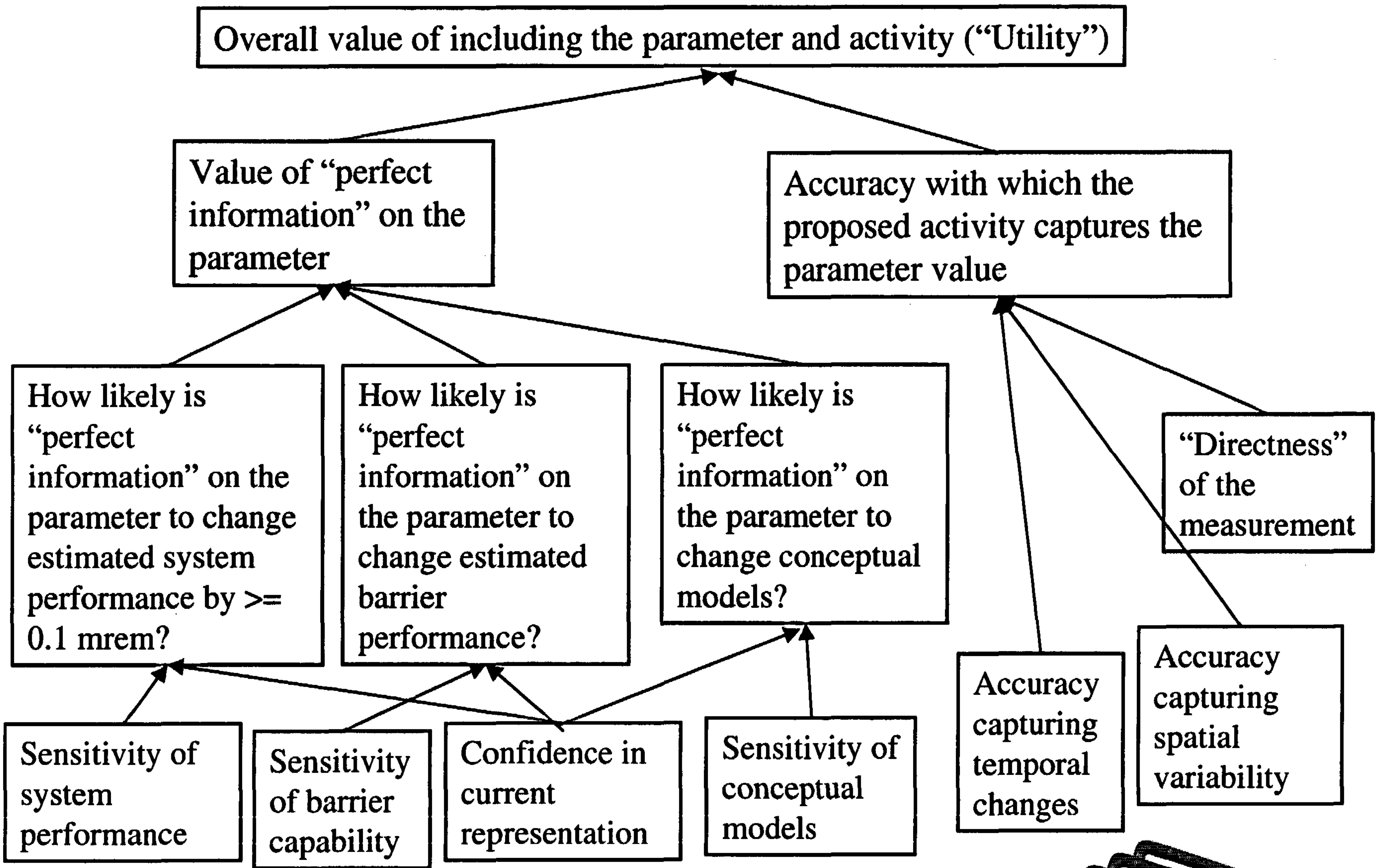
Combine technical activity evaluation and management value judgments to get overall utility for each candidate activity

In each phase all scenario classes and barriers were explicitly considered

Activity Evaluation Criteria

- At an initial workshop (August 26, 2002), three criteria were defined, to be used in estimating the potential impact of a performance confirmation activity on the performance confirmation program:
  - Barrier capability and system performance sensitivity to the parameter
  - Confidence in the current representation of the parameter
  - Accuracy with which the proposed activity measures or estimates the parameter
- Workshop participants included:
  - Technical investigators with various areas of expertise
  - Performance assessment analysts and managers
  - DOE staff

Estimating the Utility of a Specific Activity



A Detailed Set of Questions was Developed Around Each Criterion

- The goal of the questionnaire was to elicit technical input on how well proposed parameters and activities meet the three criteria
  - Detailed questions and “scales” are also necessary to allow managerial value judgments to be applied consistently to the technical judgments
- The goal of the questionnaire was to improve consistency across model areas
  - Technical judgments about sensitivity, confidence, and accuracy must be made by the relevant technical experts most familiar with the model areas
  - Unaided or ad hoc evaluation of parameters by different individuals typically results in vastly different interpretations of the criteria
  - A single consistent set of questions reduces inter-individual variations in interpretation

Workshops were Held to Develop Candidate Activities and Distribute the Questionnaire

Technical judgments

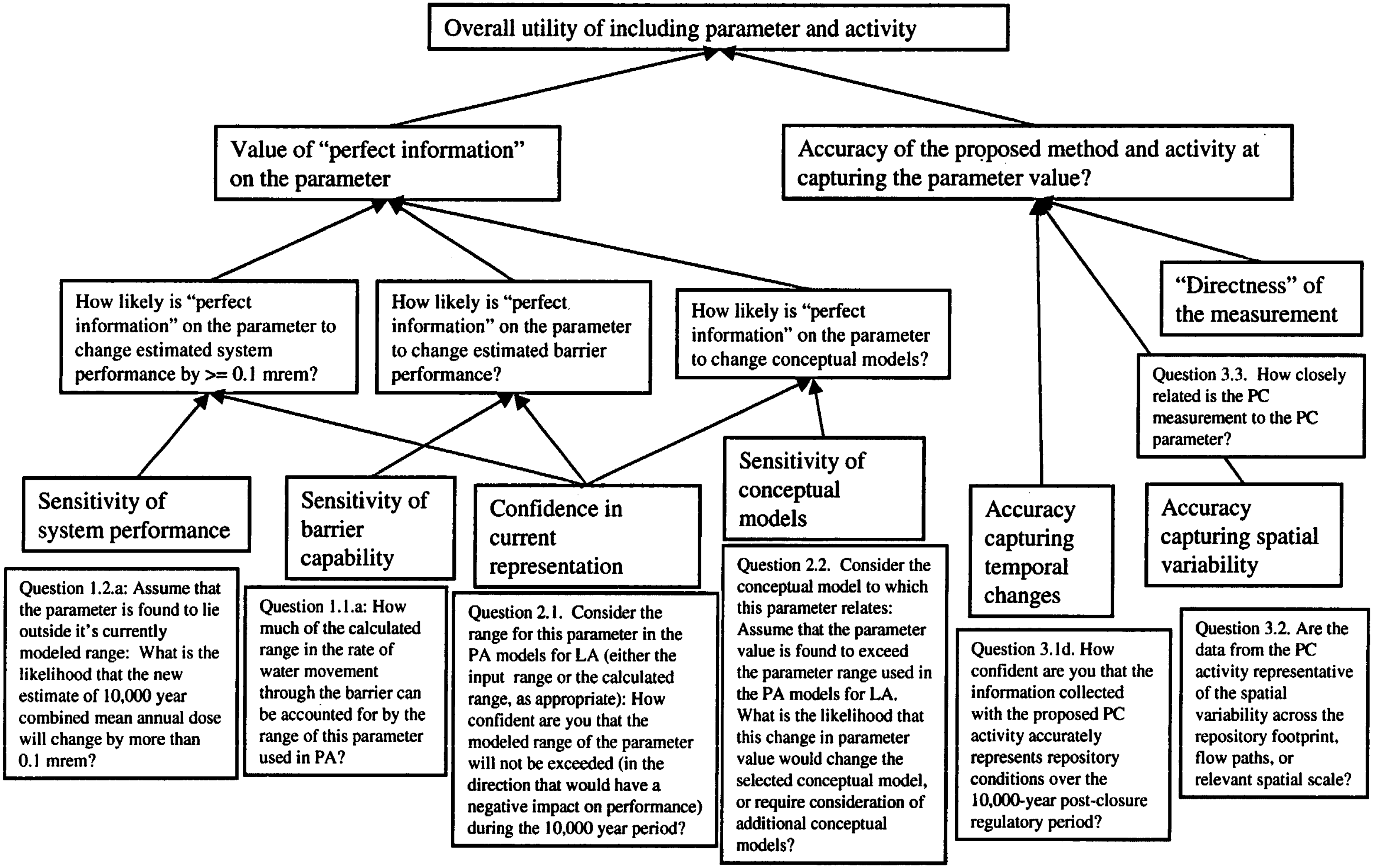
- **Workshops were held in September 2002 with each group of technical experts**
  - Technical investigators and Total System Performance Assessment modelers familiar with each barrier, with total system evaluations, and with disruptive events analyses
- **During the workshops**
  - Each group developed a comprehensive list of parameters to be considered
  - For each parameter identified, the group defined one or more data acquisition methods that could be implemented to provide information on that parameter
  - Several activities were evaluated in each workshop by the group, using the questionnaire

Parameters were Evaluated in Small Group Meetings

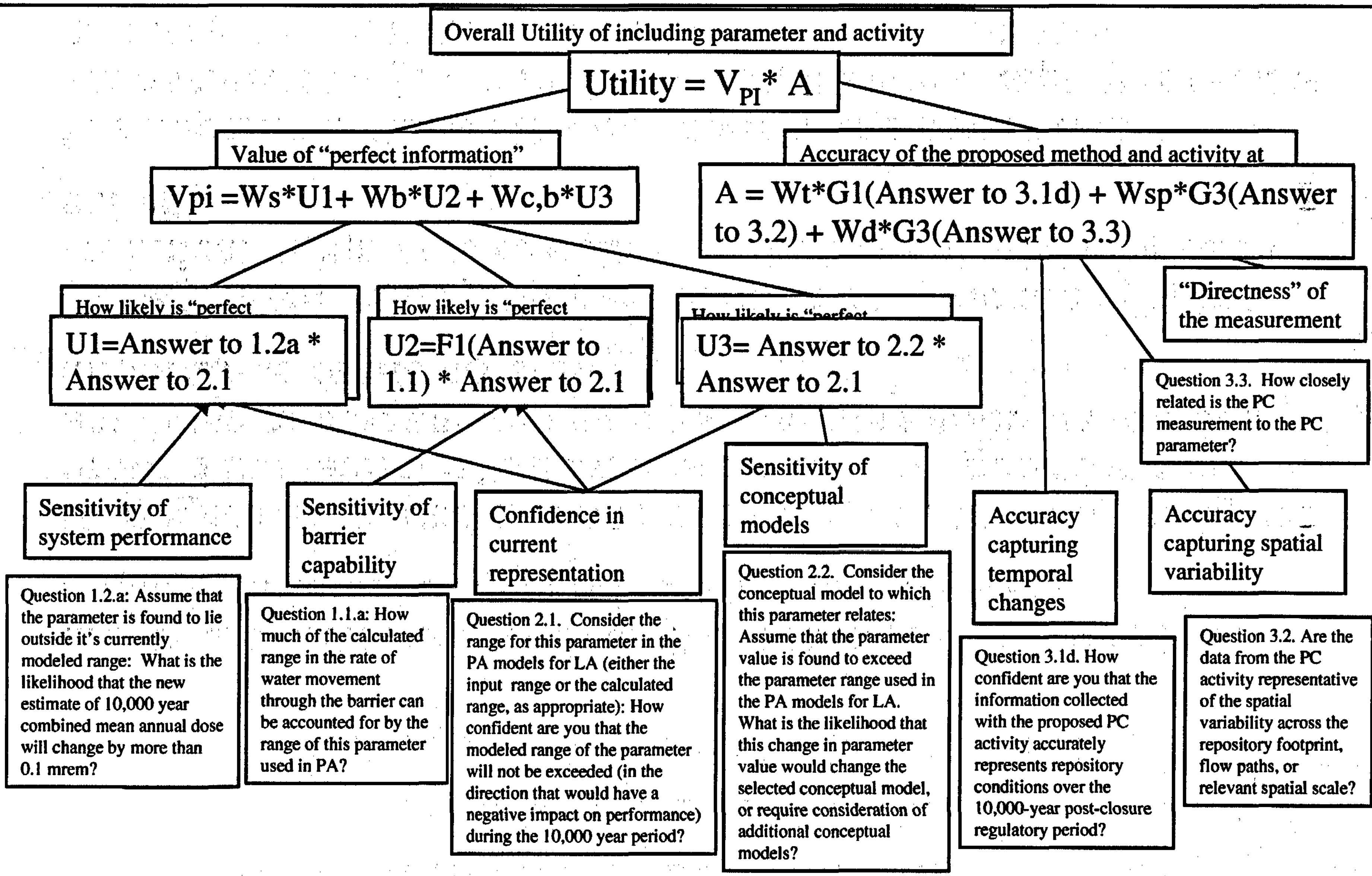
Technical judgments

- **After the workshops (October-December 2002)**
  - The technical experts used the questionnaire to specify their technical judgments on each activity within their area of expertise
  - A subset of the core team specified their technical judgments on each proposed activity across all model areas, to provide a consistency check
- **Differences in the technical judgments by the two groups were identified and then reconciled**
  - When differences in "utility scores" calculated from the evaluations differed significantly, individual scores were discussed and reconciled until the differences in the evaluations were relatively small
    - "Significant" differences in utility were defined as differences larger than 10 percent of the difference in score between the highest and the lowest scored activities
  - The few differences which could not be resolved during discussions were reviewed and resolved by a knowledgeable senior manager

Technical Judgments
Use of the Questionnaire



F1 extrapolates answer to question 1.1 to estimate the likelihood that information a parameter value outside the currently modeled range would impact barrier capability
W's are management weights, Ws is the weight for total system impact, Wb for barrier, Wc,b for conceptual model impact (barrier specific), Wt for temporal changes, Wsp for spatial representativeness, and Wd for directness of measurement
G1, G2, and G3 are management value functions, translating the answers to questions 3.1, 3.2, and 3.3 to values
Vpi = the value of "perfect information, A = accuracy



Performance Assessment Managers Provided the Necessary Management Value Judgments

Management value judgments

- Managers reviewed the overall process and endorsed the specific criteria being used to evaluate activities
- Managers answered a series of tradeoff questions, designed around the technical questions used in the questionnaire, to establish management value judgments about the relative importance of the criteria
- Management value judgment used in conjunction with the technical judgments to establish the overall utility for each activity
- Participants included the manager of the performance assessment project and the manager and/or deputy for related subprojects: natural systems, engineered systems, performance assessment strategy and scope, and the performance confirmation manager

Example Management Value Judgment for the Technical Judgment Question on Spatial Variability (1 of 2)

Management value judgments

- **Participants reviewed the descriptions of the degree of confidence technical investigators may have that the measurements capture the spatial variability of the parameter - that is, the choices available for "technical judgment" of this question**

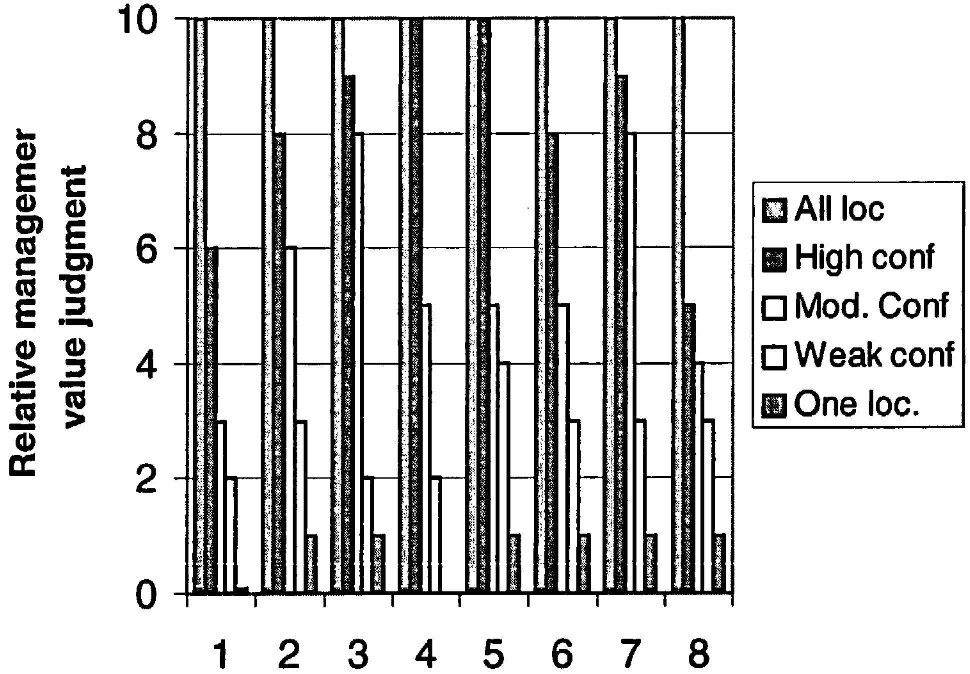
3.2.a. Are the data from the PC activity representative of the spatial variability across the repository footprint, flow paths, or relevant spatial scale?

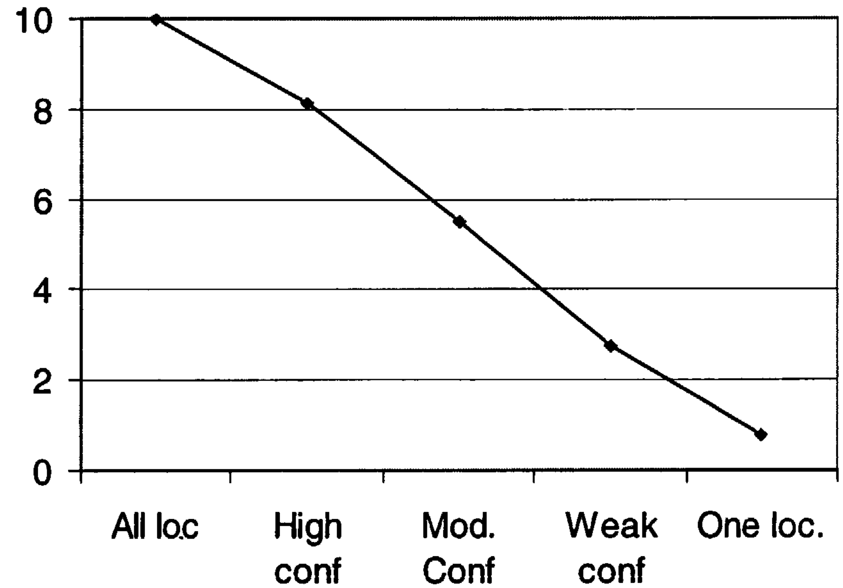
A	The data measures a parameter over all locations across the relevant spatial scale.
B	The data measures a parameter over representative locations we are *highly confident* represent the spatial variability across the relevant spatial scale.
C	The data measures a parameter over representative locations we are *moderately confident* represent the spatial variability across the relevant spatial scale.
D	The data measures a parameter over representative locations we are *weakly confident* represent the spatial variability across the relevant spatial scale.
E	The measurement gives no information on the known spatial variability of the parameter across the relevant spatial scale and only measures a single (or non-representative few) location(s).

Example Management Value Judgment for the Technical Judgment Question on Spatial Variability
(2 of 2)

Management value judgments

- Participants discussed the scale and assigned each of the five levels a weight indicative of relative accuracy of the measurement
- 8 participants
- Rankings highly consistent
- Average of the relative weights of the 8 participants used

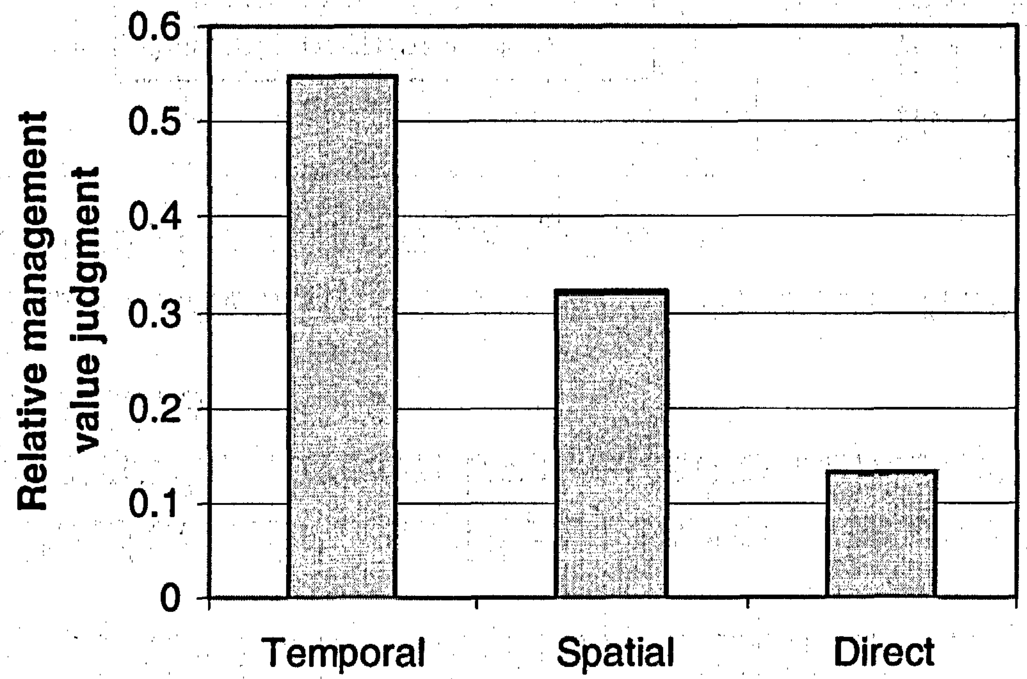




Example Management Value Judgment Accuracy

Management value judgments

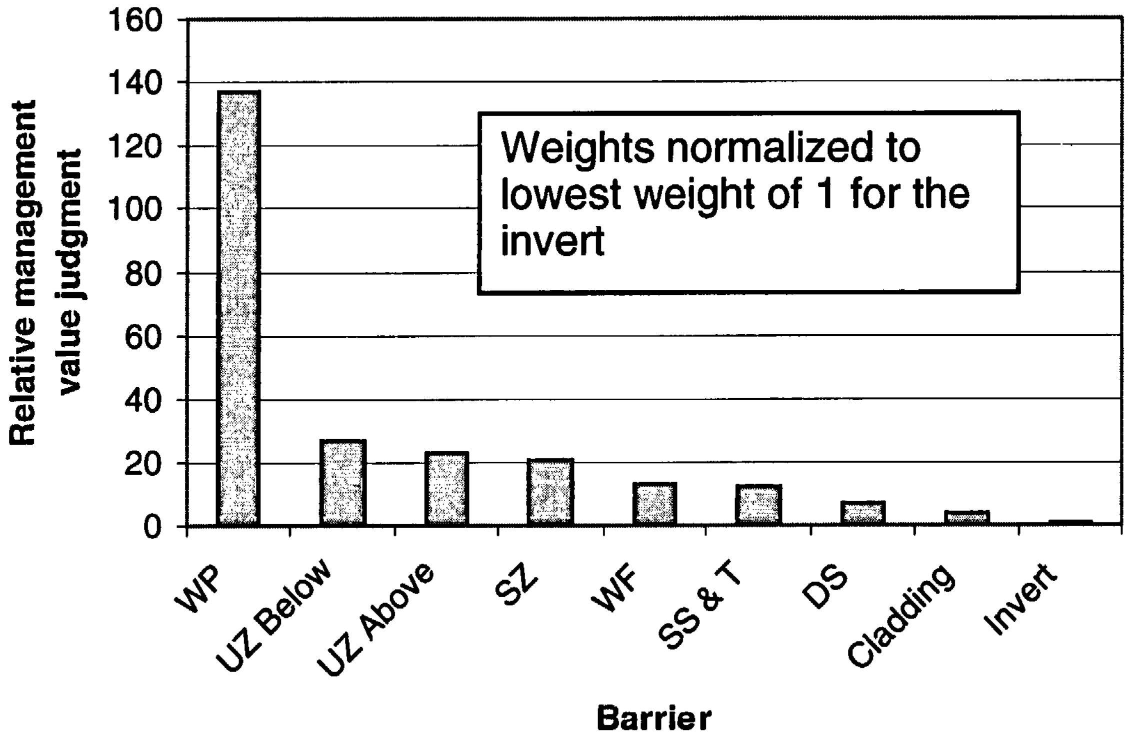
- "Value of perfect information" on a parameter was scaled by the estimated accuracy of the activity
- The three technical judgment aspects of accuracy were weighted by the management value judgments shown below:



Management Value Judgments Related to Barrier Capability

Management value judgments

- The contribution of "sensitivity to barrier capability" to total utility depends in part on the relative value assigned to each of the nine barriers
- Performance assessment managers assigned weights to each of the barriers, based on judgment:



  - Informed by the risk prioritization report and the "one on" analyses
  - Informed by discussions of barrier capability

Costs for Each Activity

Cost estimation

- **Understanding both the benefits and the costs of a candidate activity is an essential component of the decision making process**
  - Including activities based solely on maximizing "benefit" may result in a highly cost-ineffective program
  - Including activities based solely on minimizing costs may leave highly valuable activities out
- **Costs are a consideration in developing portfolios, for example:**
  - Cost synergies may make combinations of activities more attractive
  - Costs can be a factor in deciding between otherwise equal activities

Phase 1 Summary

- 237 parameters and a total of 360 activities initially identified
- After discussion, evaluation, and consolidation, 204 parameters and 287 total activities remained
- A review meeting was held with representatives of the technical experts who provided input
- Technical experts indicated where they thought the results did not reflect their technical opinions, and comments were carried forward to the portfolio development phase

"A Tale of Two Activities" Phase 1, Activity Definition

- Activity 159a: Hydraulic testing of fault zone hydrologic characteristics, including anisotropy, in the saturated zone
- Technical judgments:
  - Saturated zone performance is highly sensitive to the parameter
  - Total system performance is very insensitive to the parameter
  - The conceptual model of the saturated zone flow is sensitive to changes in the parameter
  - Moderate to high confidence in the currently modeled range of the parameter
  - Parameter is not expected to vary temporally
  - High confidence that measurement captures the spatial variability in the parameter
  - Measurement is closely related to the parameter of interest

- Activity 28a: On-site testing of the hydrology, permeability, imbibition rate, and unsaturated hydraulic parameters of the invert materials
- Technical judgments:
  - Invert performance is moderately sensitive to the parameter
  - Total system performance is very insensitive to the parameter
  - The conceptual model of the invert flow is sensitive to changes in the parameter
  - Moderate to high confidence in the currently modeled range of the parameter
  - Parameter is expected to vary both during the pre- and the post-closure periods; measurements will not capture temporal changes
  - Low confidence that measurement captures the spatial variability in the parameter
  - Measurement is closely related to the parameter of interest

"A Tale of Two Activities" Phase 1, Evaluation of Activities

159a
28a

Overall Utility of including parameter and activity

Utility = 510
1.7

Value of "perfect information"

Vpi = 5.85 (Saturated Zone barrier weight = 21)
0.18 (Invert barrier weight = 1)

Ws = 180

Wb = [1 – 137]

Wc = 0.25*Wb

How likely is "perfect

U1= 1.5e-6
1.5e-6

How likely is "perfect

U2= 0.27
0.17

How likely is "perfect

U3= 0.045
0.045

Sensitivity of system performance

159a: F
28a: F

Sensitivity of barrier capability

159a: B
28a: C

Confidence in current representation

159a: C
28a: C

Sensitivity of conceptual models

159a: B
28a: B

Accuracy of the proposed method and activity at capturing th

A = 87.1
9.5

Wd = 0.13

"Directness" of the measurement

159a: C
28a: C

Wt = 0.55

Accuracy capturing temporal changes

159a: NA
28a: No. D

Wsp = 0.32

Accuracy capturing spatial variability

159a: B
28a: E

"A Tale of Two Activities" Phase 1 – Operating Costs

Activity 159a

- Each test estimated to take 6 months to 1 year, total testing time 1 to 3 years
- Testing can be done using automated equipment in a shirtsleeve environment
- Estimated operating costs: $750,000

Activity 28a

- Testing estimated to take 6 months to 1 year
- Testing can be done using automated equipment in a shirtsleeve environment
- Estimated operating costs: $300,000

Approach

Phase 1: Activity evaluation → **Phase 2: Portfolio development and evaluation** → **Phase 3: Portfolio selection and refinement**

Define portfolio philosophies

→ **Develop candidate portfolios**

→ **Evaluate robustness and costs of portfolios**

Rationale for Portfolios

- Each candidate activity contributes to demonstrating compliance with one or more regulatory requirements
- The best portfolio does not necessarily result from ranking activities by utility, cost, or the ratio of utility to cost
  - Some regulatory requirements are not captured by the technical judgments and management value judgments input to the utility
  - Activity evaluations do not account for potential synergies
- Some costs cannot be assigned to individual activities (e.g., observation drift construction and remotely operated vehicle development)
- Portfolios of performance confirmation activities can be evaluated for regulatory compliance and for total cost

Philosophy for Portfolio Development

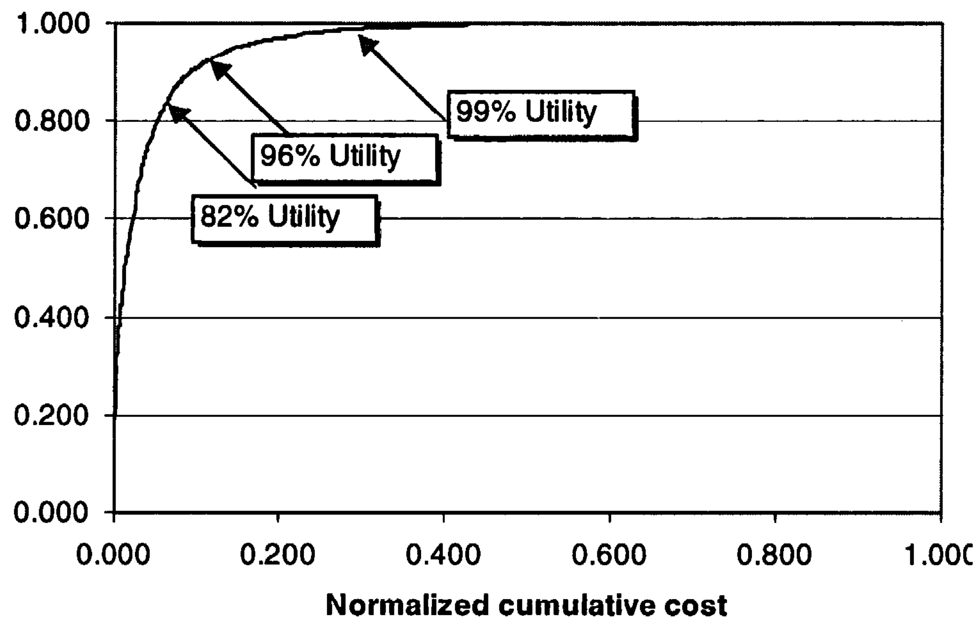
- **Each portfolio addresses the performance confirmation requirements of 10 CFR 63**
- **Eleven portfolios were developed**
  - Spanned a range of scope, costs, and robustness
  - Included portfolios that emphasized cost-benefit and hypothesis testing philosophies
  - Included portfolios that emphasized off-site work or on-site work
- **Six of these portfolios were evaluated in detail**
  - Scope, costs, robustness

Two Bounding Portfolios Were Developed

- All inclusive portfolio (K)
  - Includes all activities identified by the technical experts and evaluated as having positive benefit (ignoring costs)
- Minimum cost portfolio (A)
  - Least-cost set of activities that addresses the performance confirmation requirements of 10 CFR 63
  - The degree of activity for each 10 CFR 63 requirement is small, to achieve minimum cost
- These bounding portfolios were evaluated in detail
- A reduced version of the "all-inclusive" portfolio was developed, consisting of every parameter identified, but including only the most valuable activity associated with measuring that parameter (B)
  - This portfolio was not evaluated in detail

Cost Effectiveness Portfolios

- Three portfolios were developed
  - All activities were ranked by utility-to-cost ratio
  - "Threshold" utility-to-cost ratios were set for alternative portfolios (C, D, E)
  - Activities that met the threshold were included in the portfolio
  - Reviewed for cost synergies among activities
- Portfolios capturing 99 Percent and 82 percent of the total potential utility were evaluated in detail



Hypothesis Testing Portfolios

- Two portfolios were defined around the notion of "hypothesis testing"
  - A set of performance "hypotheses" was developed at the barrier and total system level
  - Activities were identified as
    - Providing a direct test of an hypothesis
    - Providing an indirect test of an hypothesis (e.g., testing "inputs" to the hypothesis)
  - Example:
    - The surficial barrier will limit infiltration to less than nn percent of precipitation, averaged over the footprint and one year
- One hypothesis testing portfolio included only direct tests of the hypotheses (F)
- A second hypothesis testing portfolio included both direct and indirect tests of the hypotheses (G)
- Both portfolios were evaluated in detail

Type or Location Portfolios

- Three portfolios were developed that focus on either the type or the location of performance confirmation activities
  - Maximize use of a thermally accelerated emplacement drift (H)
    - Assumes a thermally accelerated drift will be included in the program; includes primarily activities making use of that drift
  - Maximize use of off-footprint testing (I)
    - Designed to keep worker risks as low as possible, and minimize interference of the program with activities in the Geologic Repository Operations Area
  - Maximize use of existing data, activities in existing facilities, and pre-emplacement activities (J)
    - Using data already collected or being collected in the Cross Drift Thermal Test and the Drift Scale Test
- These portfolios were not evaluated in detail
  - Did not provide significant additional benefit over other portfolios

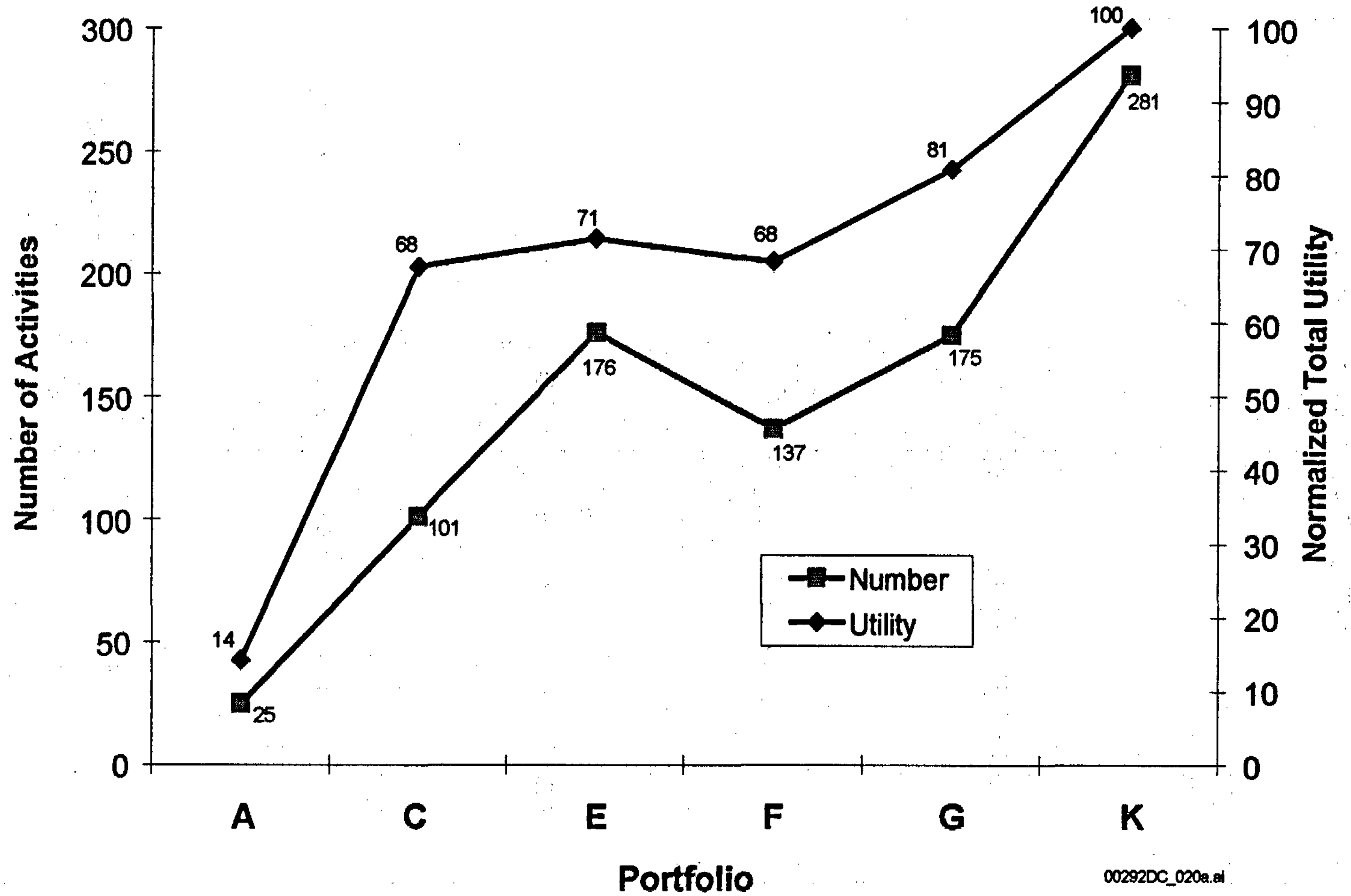
Portfolio Evaluation Criteria

- **Activities were mapped to the regulatory requirements in 10 CFR 63 Subpart F**
  - Some activities support multiple requirements
- **Attributes were totaled across the activities in each portfolio**
  - Activity count
  - Total utility
  - Total operating plus capital cost
- **Activity utilities were summed for each regulatory requirement in 10 CFR 63 Subpart F, within each portfolio**
- **A subjective assessment was made against each regulatory requirement in 10 CFR 63 Subpart F, for each portfolio**
  - This added "coverage" as a subjective subcriterion

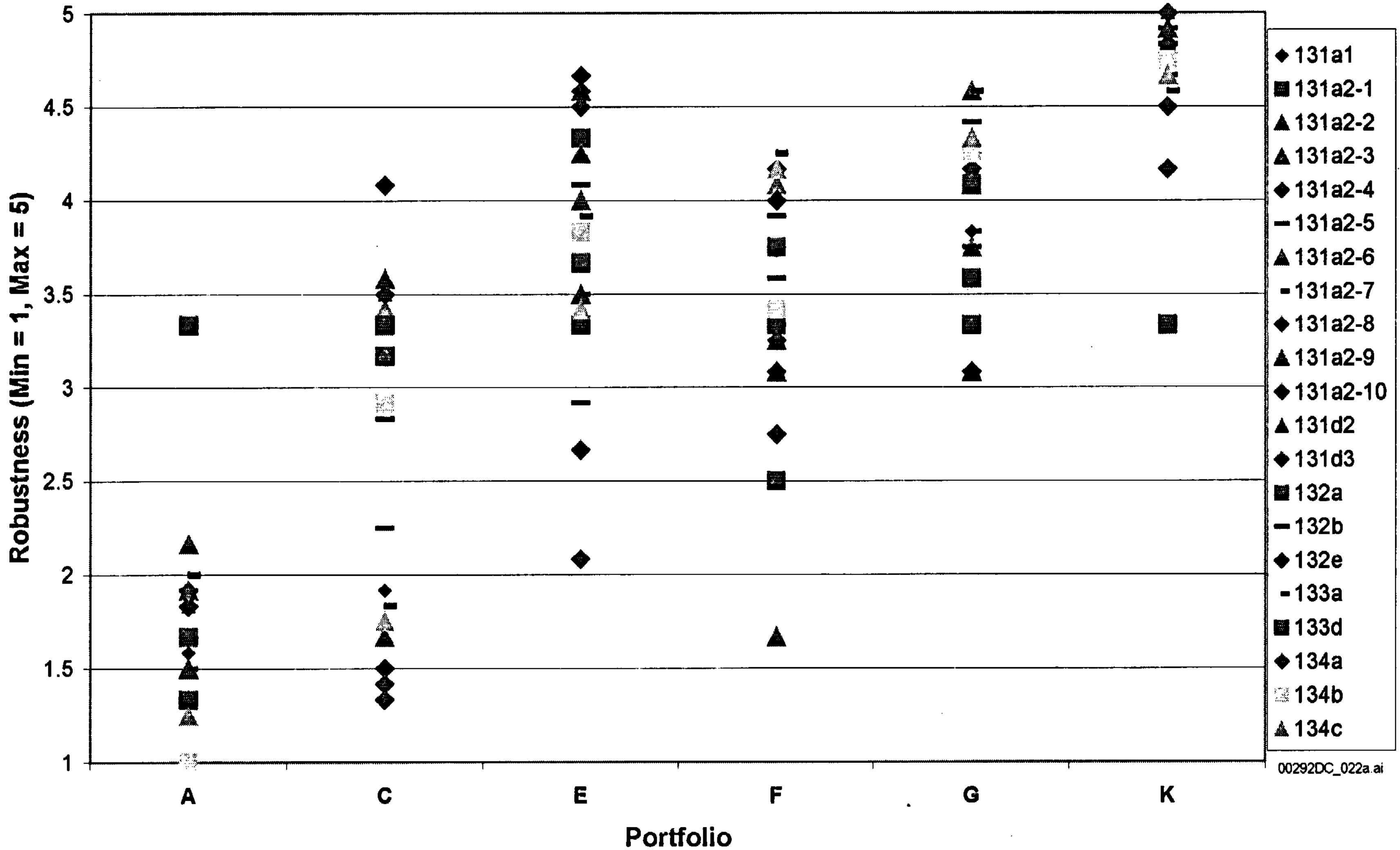
Six Portfolios Were Evaluated in Detail

- Minimum cost (Portfolio A)
- Cost effective - 82 percent total utility (Portfolio C)
- Cost effective - 99 percent total utility (Portfolio E)
- Hypothesis testing – Direct (Portfolio F)
- Hypothesis testing - Direct and indirect (Portfolio G)
- All inclusive (Portfolio K)

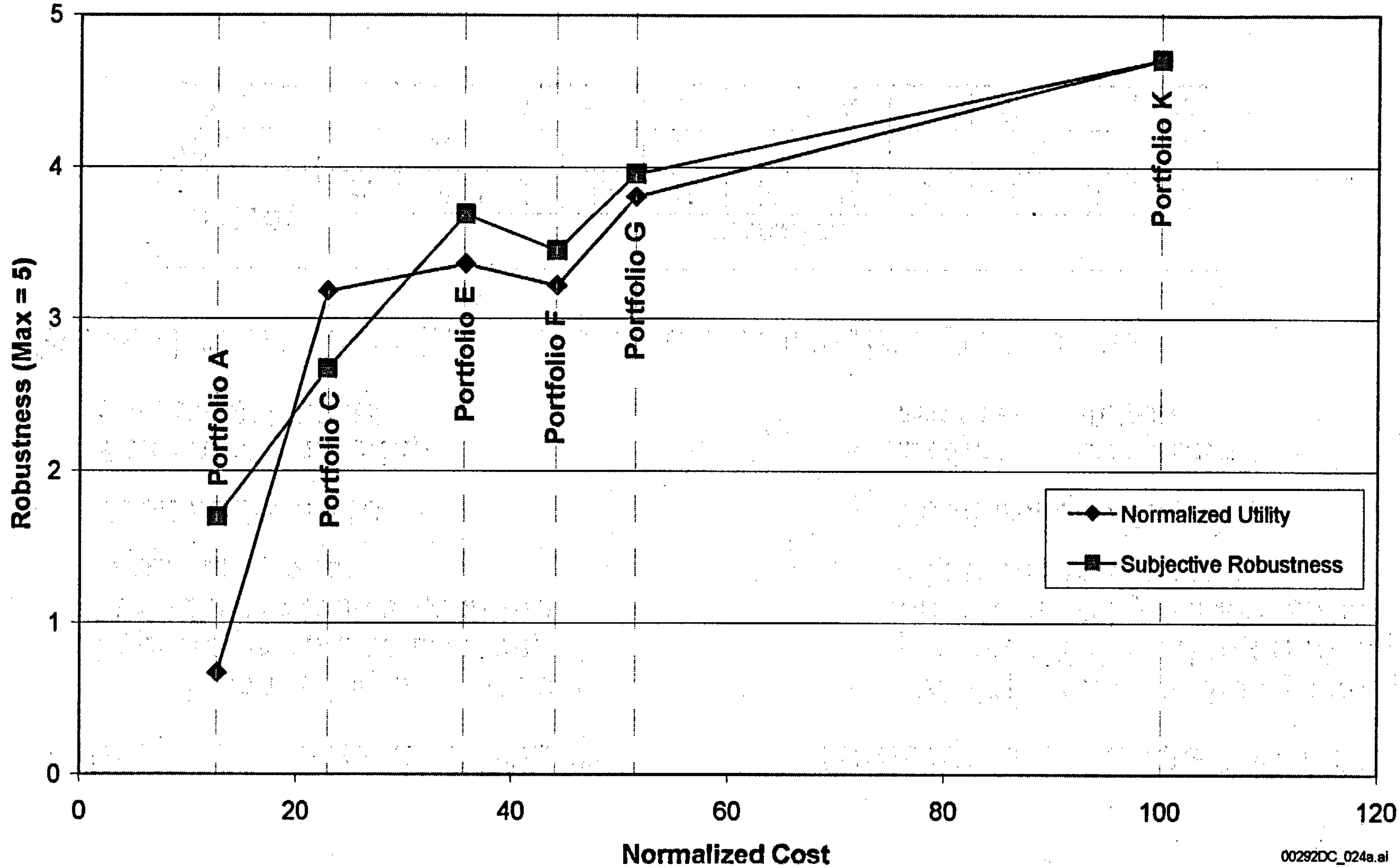
Portfolio Comparison
Activity Count and Summed Utility



Portfolio Comparison
Subjective Assessment of Robustness



Portfolio Comparison
Relative Costs and Subjective Robustness



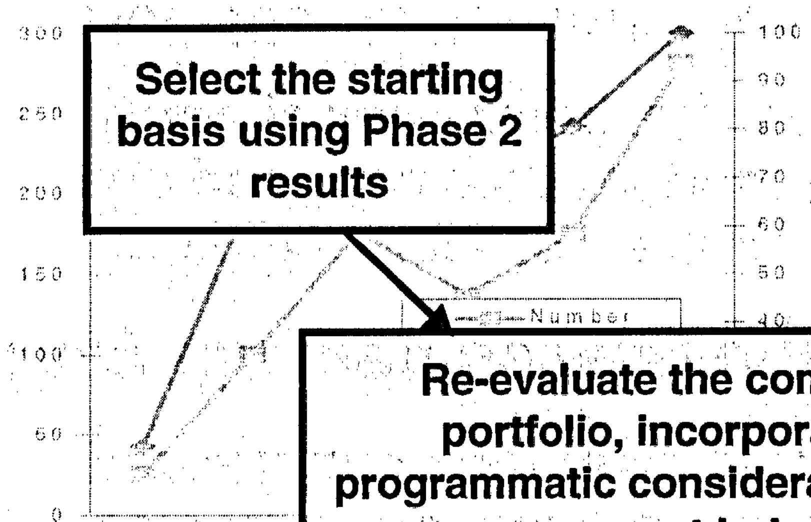
"A Tale of Two Activities" Phase 2, Portfolio Development

- **Activity 159a Phase 1 Recap**
  - Hydraulic testing of fault zone hydrologic characteristics, including anisotropy, in the saturated zone
  - Total utility = 510
  - Estimated operating costs = $750,000
- **Activity 28a Phase 1 Recap**
  - On-site testing of the hydrology, permeability, imbibition rate, and unsaturated hydraulic parameters of the invert materials
  - Total utility = 1.7
  - Estimated operating costs = $300,000
- **The activities were included in the following portfolios:**

Activity	Portfolios										
	A	B	C	D	E	F	G	H	I	J	K
28a		X			X						X
159a		X	X	X	X		X		X		X

Approach

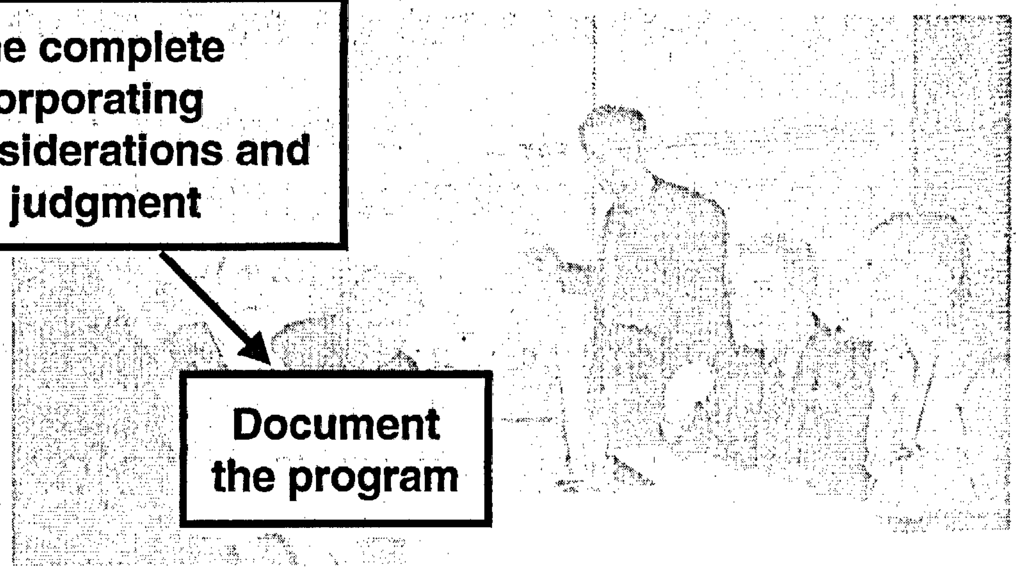
Phase 1: Activity evaluation → Phase 2: Portfolio development and evaluation → Phase 3: Portfolio selection and refinement



Select the starting basis using Phase 2 results

Re-evaluate the complete portfolio, incorporating programmatic considerations and management judgment

Document the program



Starting Basis

- The BSC Manager of Projects and senior advisors
  - Reviewed all eleven portfolios, and the detailed evaluation of six
  - Selected "Portfolio C" as the starting basis for the performance confirmation program
- They directed several changes to that basis
  - Activities were to be added to increase the robustness of the portfolio with respect to aspects of the regulation where it was judged relatively weaker than some other portfolios
  - Activities in the portfolio were described in terms of their relationship to the specific paragraphs of the regulatory requirement (10 CFR 63, Subpart F)

Portfolio Refinement

- In a series of meetings, BSC senior management reviewed every activity in the modified basis portfolio, and made adjustments to the portfolio based on management judgment and programmatic considerations
- Of the initial 99 activities:
  - 26 were removed from the portfolio because they were more logical candidates for other testing programs
  - 3 were combined with other activities in the program based on the judgment that the combined activities were a more logical unit to consider
  - 3 activities were retained in principle but modified in scope
  - 2 new activities were added

** The Performance Confirmation Plan, Rev. 02 includes a description of the rationale for changes to the portfolio made during management discussions*

"A Tale of Two Activities"
Phase 3, Portfolio Selection and Refinement

- **Phase 2 recap**

Activity	Portfolios											
	A	B	C	D	E	F	G	H	I	J	K	Performance confirmation program
28a: On-site testing of the hydrology, permeability, imbibition rate, and unsaturated hydraulic parameters of the invert materials		X			X						X	
159a: Hydraulic testing of fault zone hydrologic characteristics, including anisotropy, in the saturated zone		X	X	X	X		X		X		X	X (modified)

- **Portfolio C was selected as the starting basis for the performance confirmation program**
- **Adding Activity 28a would have increased the robustness with which one aspect of the regulation is met: confirming the performance of the invert barrier, but**
  - **Portfolio C was already judged to be robust to that requirement**
- **The scope of Activity 159a was increased during management discussions**
  - **Expanded to include transport testing as well as flow testing**

Backup

Backup: Modifications Made to Portfolio During Phase 3 (1 of 4)

#	Activities	Barrier	Rationale for Addition, Modification, or Removal
Modified Activities			
96b	Moisture content/potential in soil—In situ measurements with tensiometers, TDR and neutron probes, continuous monitoring	1	Modified: to be done only after significant rainfall events
159a	Fault zone hydrologic and transport characteristics (incl. anisotropy)—Fault hydraulic testing at 2 sites	4	Modified: expanded to include transport testing
185a	Number of waste packages hit in Zone 1—Modeling, analog studies	10	Modified: originally propose for Zones 1 and 2, reduced to apply to Zone 1 only
Added Items			
220a	Drift scale test in the lower lithophysal unit	2,3	Added to provide a test prior to construction authorization. Test not yet fully defined
221a	Geodetic monitoring of extensional tectonics in the Yucca Mountain Region	10	Added to provide additional indicator of igneous activity
Removed Items			
62a	Flow splitting and/or flow paths on all engineered barrier system surfaces—preemplacement test in drift with heat	5,6,9	More appropriate for the Scientific Testing and Evaluation Program
63a	Crack plugging—Laboratory Testing under controlled environment	5,6	More appropriate for the Scientific Testing and Evaluation Program
64a	Pit plugging—Laboratory Testing under controlled environment	5,6	More appropriate for the Scientific Testing and Evaluation Program
65b	Water flow rate through breaches in the engineered barrier system components—Laboratory test with heat	5,6	More appropriate for the Scientific Testing and Evaluation Program
78a	Flaws (including manufacturing flaws, and size, orientation, number)—Laboratory testing under controlled environment of specimens from manufacturing mockups and laboratory-prepared specimens	6	More appropriate for the Engineering Test and Evaluation Program

Backup: Modifications Made to Portfolio During Phase 3 (2 of 4)

#	Activities	Barrier	Rationale for Addition, Modification, or Removal
Removed Items (continued)			
81b	Critical stress (K1SCC and stress threshold)—Laboratory testing under controlled environment of laboratory-prepared specimens and specimens from manufacturing mockups	6	More appropriate for either the Scientific Testing and Evaluation Program or the Engineering Test and Evaluation Program
95a	Physical/hydrological properties of soil—Core samples for measuring density, porosity and permeability	1	More appropriate for the Scientific Testing and Evaluation Program
98a	Matrix/fracture/bulk physical/hydro properties—Core samples for measuring density, porosity and permeability	1	More appropriate for the Scientific Testing and Evaluation Program
114b	Hydrologic and mineralogical properties of the PTn—Evaluation in alcoves from the shafts (Mapping, core samples, laboratory testing)	2	Appropriate as candidate for OCRWM's Science and Technology Program
135b	Hydrologic conditions beneath drift (drift shadow)—Analog studies, natural caves, old mines	3	Appropriate as candidate for OCRWM's Science and Technology Program
138a	Field Hydrologic properties of the CHn (and interface with TSw 3)	3	Appropriate as candidate for OCRWM's Science and Technology Program
139a	Hydrologic conditions CHn	3	Appropriate as candidate for OCRWM's Science and Technology Program
140a	Field sorptive characteristics of the CHn (including K_d)	3	Appropriate as candidate for OCRWM's Science and Technology Program
152a	K_d—Laboratory testing of rock matrix samples and alluvium samples	4	Appropriate as candidate for OCRWM's Science and Technology Program
154a	Recharge rates: regional model domain—Modeling and new field work (USGS regional model)	4	Appropriate as candidate for OCRWM's Science and Technology Program

Backup: Modifications Made to Portfolio During Phase 3 (3 of 4)

#	Activities	Barrier	Rationale for Addition, Modification, or Removal
	Removed Items (continued)		
156a	Flux at Site-Scale Model Boundaries—Use the coupled site/regional models to evaluate measured fluxes across boundaries—borehole dilution tests (concentration as a function of depth in the borehole, monitored over time)	4	Appropriate as candidate for OCRWM's Science and Technology Program
175b	EBS behavior under ground motion—Offsite shake table	5,6	More appropriate for either the Scientific Testing and Evaluation Program or the Engineering Test and Evaluation Program
176a	Alloy 22 failure criterion—Perform laboratory experiments on specimens of Alloy 22 with a range of residual stresses due to cold working/surficial damage	6	More appropriate for either the Scientific Testing and Evaluation Program or the Engineering Test and Evaluation Program
177a	Titanium grade 7 failure criterion—Perform laboratory experiments on specimens of Titanium grade 7 with a range of residual stresses due to cold working/surficial damage	5	More appropriate for either the Scientific Testing and Evaluation Program or the Engineering Test and Evaluation Program
183a	Dike system geometry—Analogs: mapping of exposed dike geometries, some drilling of dikes	10	Appropriate as candidate for OCRWM's Science and Technology Program
184a	Conduit system geometry—Field measurements, analog studies	10	Appropriate as candidate for OCRWM's Science and Technology Program
186a	Update modeling and laboratory experiments of damage to waste package from igneous event	6	Not needed – performance models treat waste package hit with magma as destroyed
188a	Ashplume: Incorporation ratio—Models and analogs, field studies	10	More appropriate for the Scientific Testing and Evaluation Program
189a	Ashplume: Waste particle size—Models and analogs	10	More appropriate for the Scientific Testing and Evaluation Program
195a	Proportion of eruptive styles—Models and analogs, field and laboratory measurements	10	Rolled into activity definition in 196a

Backup: Modifications Made to Portfolio During Phase 3 (4 of 4)

#	Activities	Barrier	Rationale for Addition, Modification, or Removal
Removed Items (continued)			
196a	Distribution of magma type downdrift—Models and analogs	10	Appropriate as candidate for OCRWM's Science and Technology Program
197a	Distance magma travels downdrift—Models and analogs	10	Appropriate as candidate for OCRWM's Science and Technology Program
198a	Distribution of physical environment downdrift—Models and analogs	10	Appropriate as candidate for OCRWM's Science and Technology Program
213a	Dust Levels by Occupational Activity	10	Combined with activity 162a

U.S. Department of Energy
Office of Civilian Radioactive Waste Management

YUCCA MOUNTAIN PROJECT

Elements of the Yucca Mountain Performance Confirmation Program

Presented to:
Advisory Committee on Nuclear Waste

Presented by:
James A. Blink
Bechtel SAIC Company, LLC
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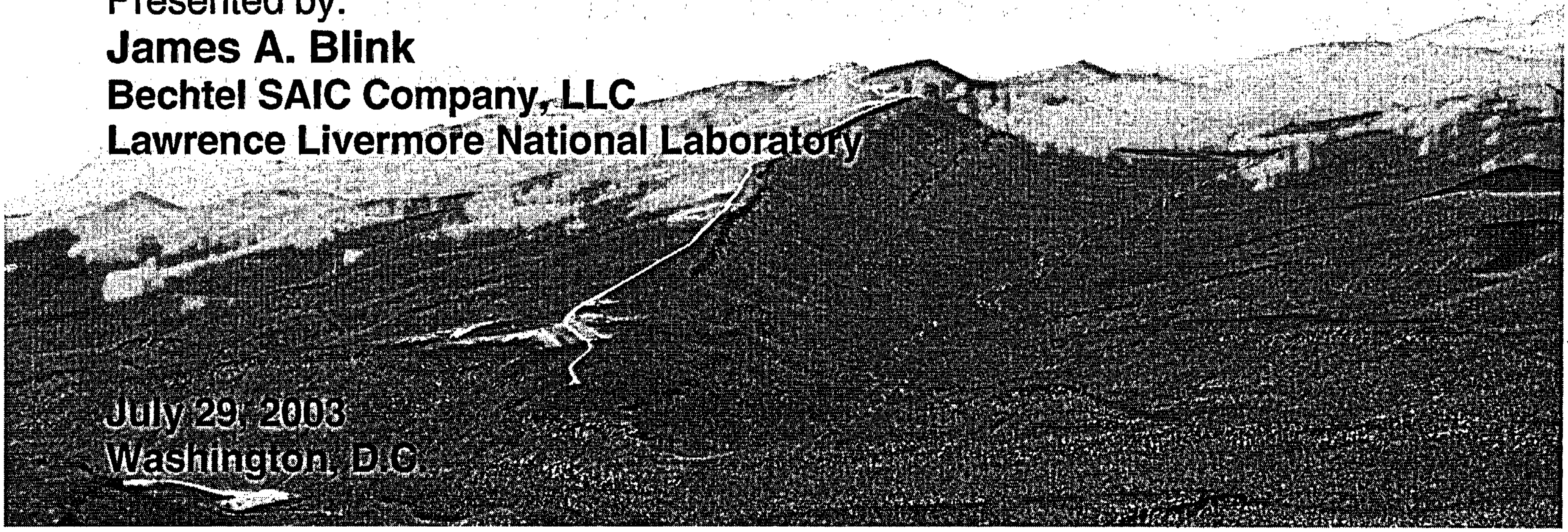


July 29, 2003
Washington, D.C.

Purpose of This Presentation

- **Describe the performance confirmation program proposed by BSC to DOE**
  - **Some changes may occur in the DOE acceptance process**
  - **Some evolution may occur as the activities are developed in preparation for the license application**

Risk-Informed Perspective on the Performance Confirmation Program

- Phase 1 of the decision analysis to scope the program was risk-based
  - Relied on performance assessment calculations
- Phase 1 of the decision analysis to scope the program was performance-based
  - Considered performance of the individual barriers and the total system
- Phases 2 and 3 of the decision analysis were risk-informed
  - Included consideration of factors such as synergy among activities, feasibility, operability, and cost; in addition to the risk-based results of Phase 1
- The resulting performance confirmation program is risk-informed, performance-based

Risk-Informed Perspective on the Performance Confirmation Program
(Continued)

- **The performance confirmation program can be described from several viewpoints**
  - **Time and location of implementation (Section 5, *Performance Confirmation Plan*, Rev 02)**
  - **Response to regulatory requirements of 10 CFR 63, Subpart F, and the *Yucca Mountain Review Plan* Section 2.4 (Section 4, *Performance Confirmation Plan*, Rev 02)**
  - **Association with repository barriers (Section 3 and Appendix B, *Performance Confirmation Plan*, Rev 02)**
  - **Risk-informed, performance-based terms, with respect to relationships to scenario classes, repository barriers, or processes**
    - ***This presentation is structured to reflect the risk-informed, performance-based program***
    - **Risk is defined as the mean annual dose to the *reasonably maximally exposed individual*, calculated in total system performance assessment considering the probabilities of each scenario class**

Organization of This Presentation

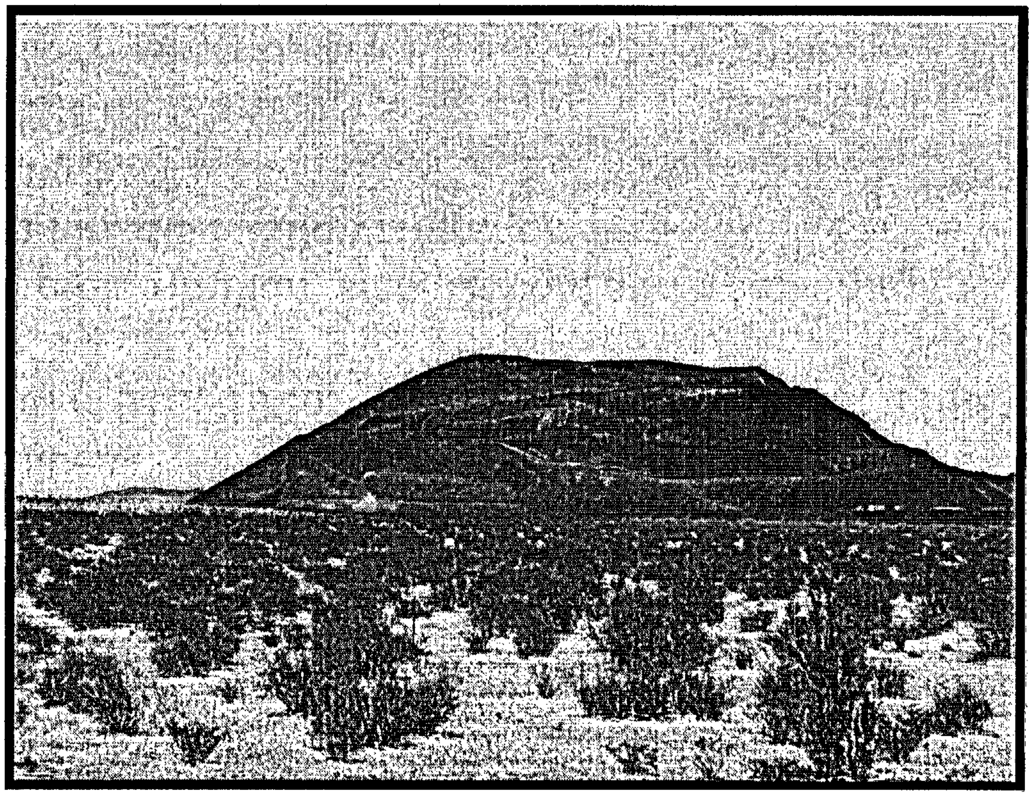
- The *Yucca Mountain Review Plan* Section 2.4.1 states the performance confirmation program should be "risk informed" and "focused on parameters and natural and engineered barriers important to waste isolation"
- The decision analysis focused the performance confirmation activities on the highest risk areas
- This presentation groups the activities into risk-informed categories
  - For convenience of discussion and to minimize repetition of activities
  - The groups are by total system performance assessment scenario class, barrier, and cross-cutting processes that affect a number of barriers
- The groups are sequenced with highest risk groups first and lowest risk groups last
  - Activities categorized in more than one group are described in detail in the group that best describes their primary performance confirmation role, and summarized in other groups

Activity Group Sequence

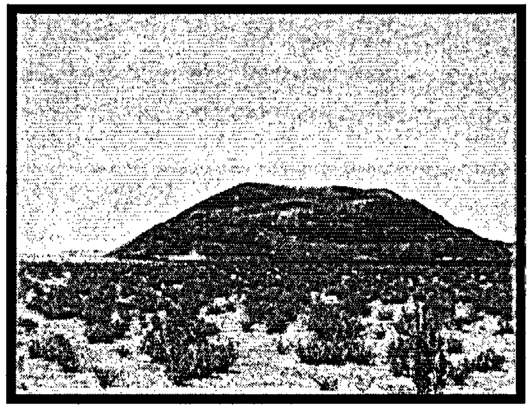
- Activities related to disruptive scenario classes (with highest risk scenario class first)
  - Igneous activity scenario class
  - Seismic activity scenario class
- Biosphere-related activities "downstream" of the nine barriers
  - These may apply to multiple scenario classes
- Nominal scenario class (which is lower risk than the disruptive scenario classes)
  - Waste package and drip shield
  - Preemplacement environment
  - Surface topography, soils, and bedrock; and the unsaturated zone (both above and below the repository)
  - Coupled thermal processes
  - Saturated zone
  - Cladding, waste form, and invert

Igneous Activity Scenario Class

- Igneous activity is the largest single contributor to the probability-weighted annual dose to the reasonably maximally exposed individual
- Consequently, performance confirmation activities confirm assumptions, data, and analyses of igneous events



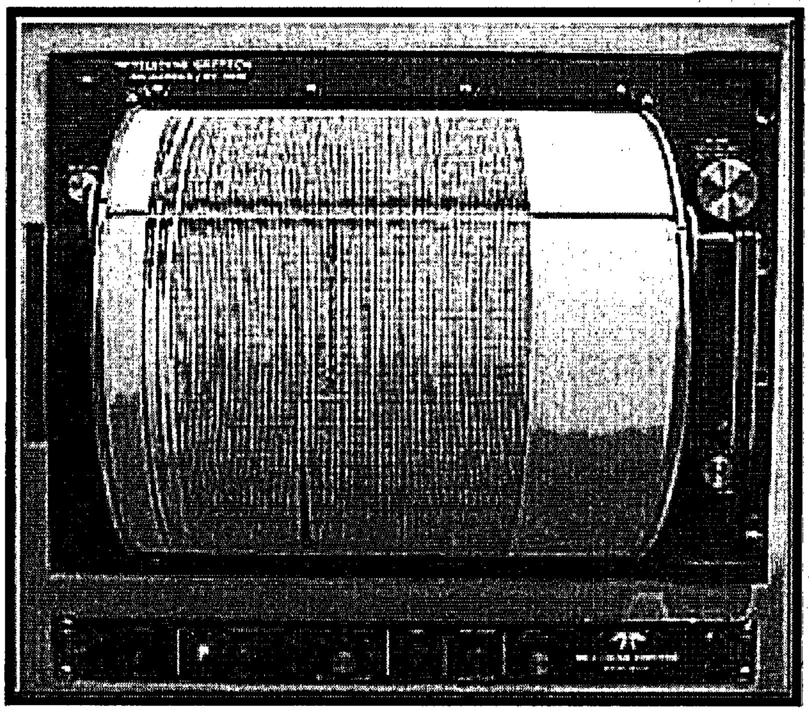
Igneous Activity Scenario Class
(Continued)



- Probability of occurrence of igneous events
  - Drilling of aeromagnetic anomalies (180a)
    - Improved data set
  - Updated expert elicitation (181a)
    - Incorporate improved data set
- Consequences of igneous events
  - Number of waste packages hit by magma (185a)
    - Calculations and analog studies
  - Behavior of contaminated ash (191a, 192a, 193a, 207a, 214a, 215a, 216a, 217a)
    - Ash loading, resuspension, redistribution, stabilization, and weathering
    - Radionuclide partition, sorption, dissolution/migration
    - Modeling, analogs, lab testing
  - Updated expert elicitation (182a)
    - Incorporate improved data set
- Precursor conditions
  - Satellite monitoring of regional extensional tectonics (221a)
    - Ongoing activity

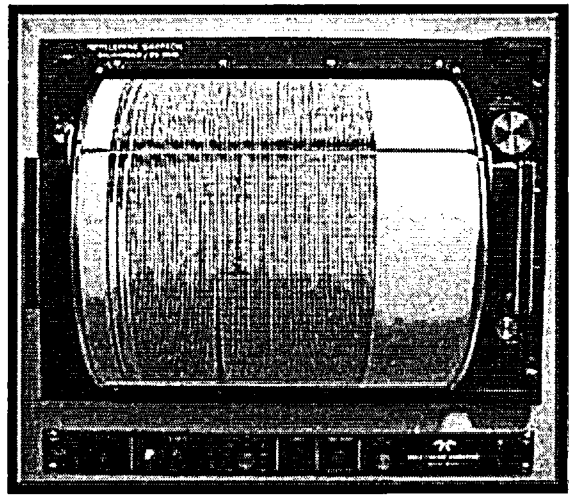
Seismic Activity Scenario Class

- Seismic activity is expected to be a significant contributor to the probability-weighted annual dose to the reasonably maximally exposed individual
- Consequently, performance confirmation activities confirm assumptions, data, and analyses of seismic events

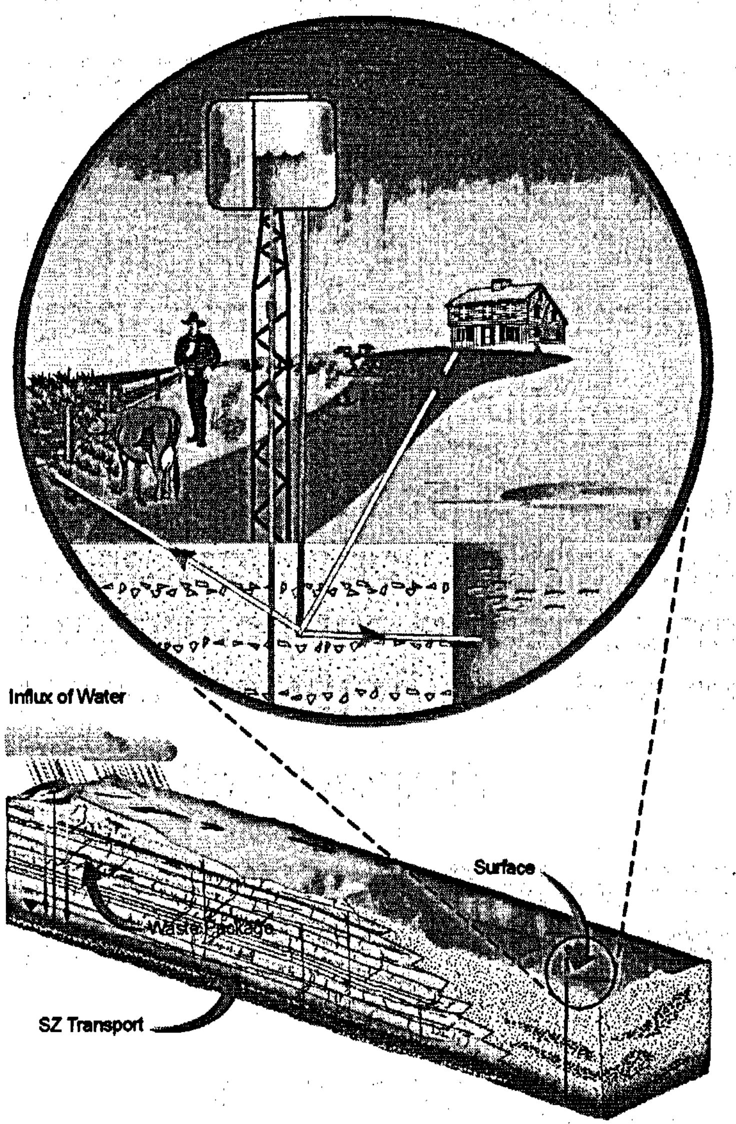


Seismic Activity Scenario Class
(Continued)

- **Rock and soil dynamic properties at higher strains associated with major seismic events (173a)**
  - Extend existing lower strain data set
- **Regional seismic activity and near-field strong ground motions (167a)**
  - Monitor for seismic activity and its consequences
  - Ongoing activity
- **Inspection of surface and underground fault displacement in drifts if strong ground motion occurs (170a)**
  - Contingency activity, using remotely operated vehicle



Biosphere-Related Activities "Downstream" of the Nine Barriers

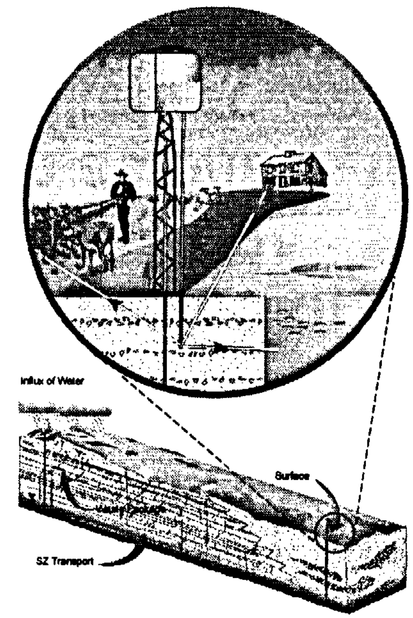


- Biosphere factors are potential multipliers on dose, without defense-in-depth mitigation
- During the long period of time prior to repository closure, human activities in the region are likely to change
- Consequently, performance confirmation activities confirm important biosphere factors

Biosphere-Related Activities "Downstream" of the Nine Barriers

(Continued)

- **Periodic survey of *reasonably maximally exposed individual* characteristics and of occupational dust levels (162a)**
  - Ongoing activity
- **Natural analog study of the movement of radionuclides added to soil and their migration back to the water table, where they may be pumped back to the surface (166b)**
  - Nominal and disruptive scenario classes



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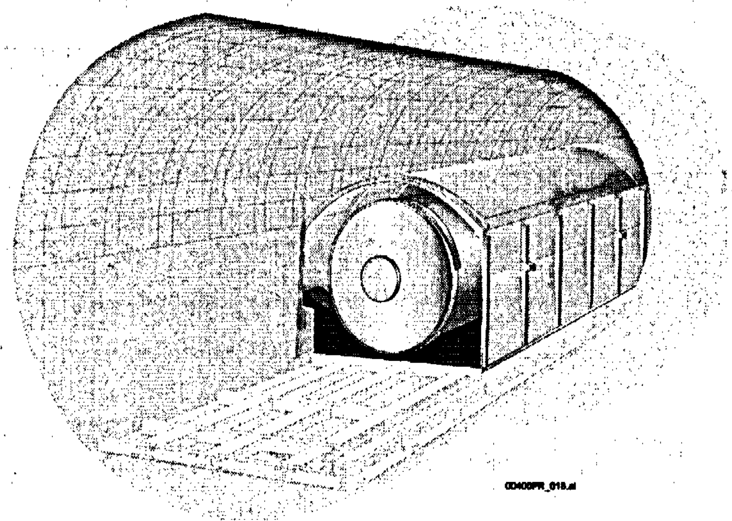
- **Radionuclide movement to humans via plants (204a, 205a, 206a)**
  - Nominal and disruptive scenario classes
- **Radionuclide movement to humans through soil ingestion (direct or via animals) (208a)**
  - Nominal and disruptive scenario classes

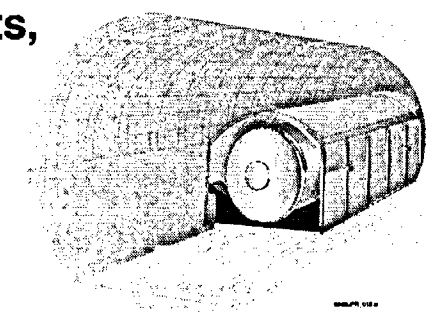
Waste Package and Drip Shield

- The waste package, in the environment created by the natural system, is expected to isolate radionuclides from the reasonably maximally exposed individual by preventing water from reaching the radionuclides
- The drip shield protects the waste package from rockfall and prevents advective transport from breached waste packages
  - Only the slower diffusive transport can operate under an intact drip shield
- Consequently, performance confirmation activities confirm assumptions, data, and analyses of waste package and drip shield performance



Waste Package and Drip Shield
Combined Activities

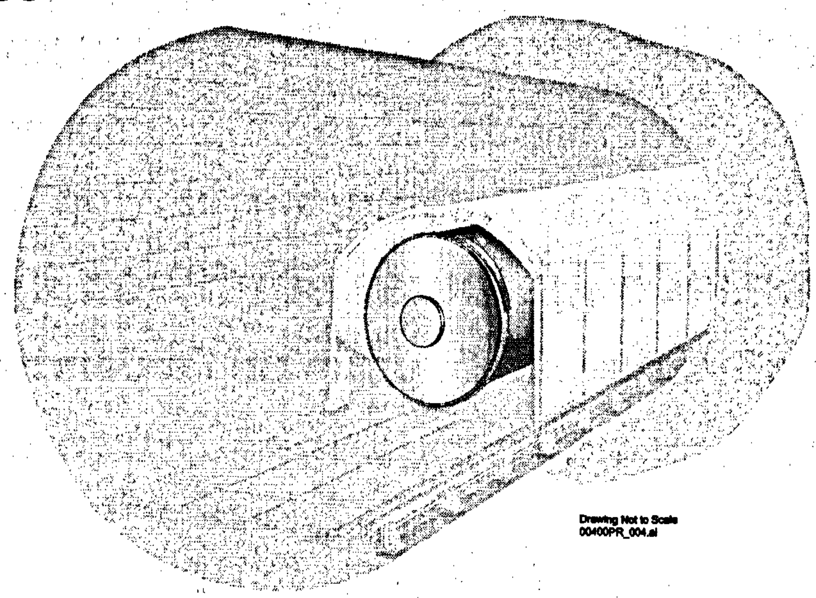
- Mechanistic details of waste package and drip shield corrosion (68a, 69a, 70a, 71a, 72a, 73a, 74a, 75a, 76a)
  - General corrosion, phase stability, localized corrosion, microbial corrosion
  - Ongoing activities
  - Strengthen extrapolation to 10,000 years
- Laboratory tests on mock-ups to confirm stress sources on the waste package and drip shield (79a)
  - Consequence of rockfall and seismic activity
- Waste package and drip shield environments (51a, 52a, 53a, 54e, 56e, 57a, 58e)
  - In thermally accelerated drifts, using drift-end instruments, in-drift samples, and the remotely operated vehicle
  - Includes temperature, humidity, dust composition, gas composition, pressure, radiolysis effects, condensate chemistry, thin film chemistry, and microbes
  - Temperature, humidity, and dust measurements include all emplacement drifts



Waste Package

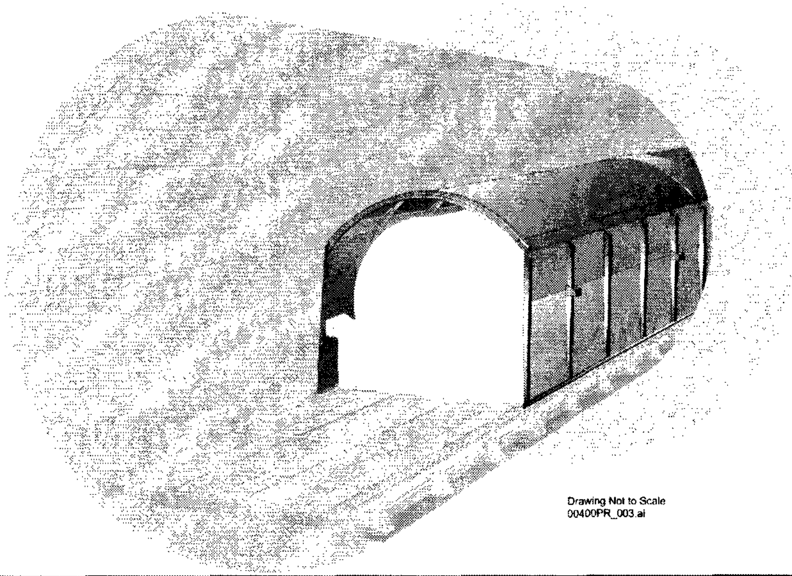
- **Monitoring radionuclides in exhaust air (251a)**
  - Measure at the end of each drift in a sensor module that also measures temperature and humidity
- **Pressure seal of all waste packages (83a)**
  - Measure with the remotely operated vehicle, imaging internal mechanical sensors that respond to equilibration of internal and external pressures

Both activities provide direct measures of overall waste package performance



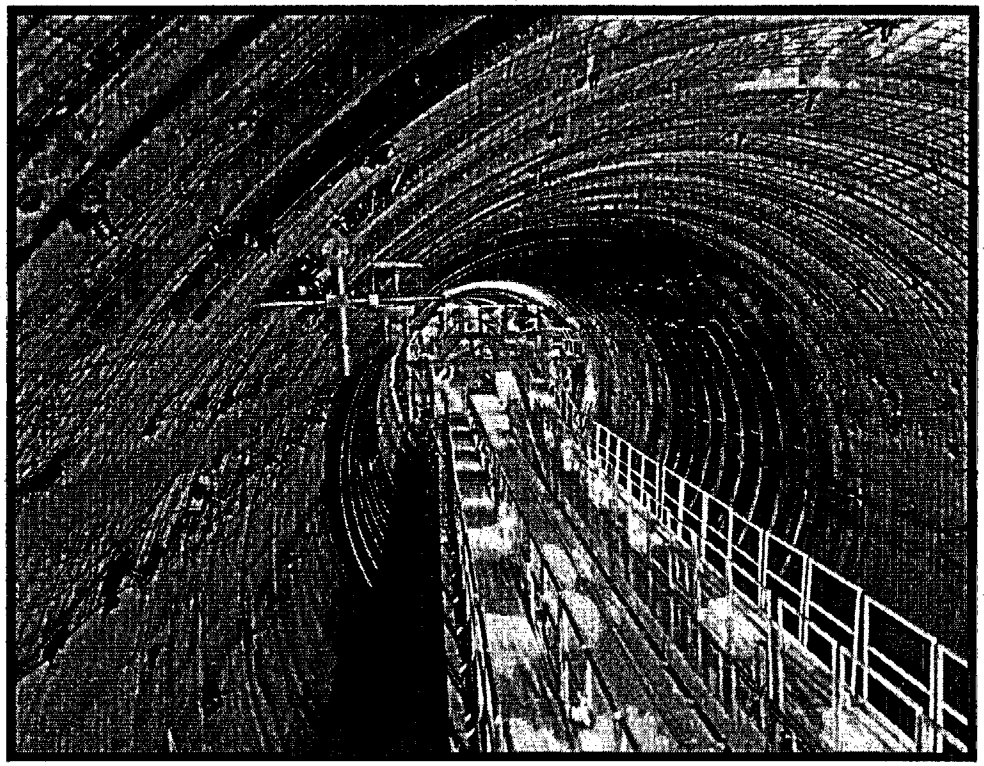
Drip Shield

- **Rockfall detection using acoustic/seismic tomography (59a1)**
  - Concept demonstrated by an existing university grant program
- **Inspection of drifts using the remotely operated vehicle (59a2)**
  - Drift 4 will include drip shields after about 5 years
  - Other drifts will be inspected for ground support integrity
- **Drift shape monitoring using the remotely operated vehicle in the thermally accelerated drifts (60b)**
  - Several concepts being considered



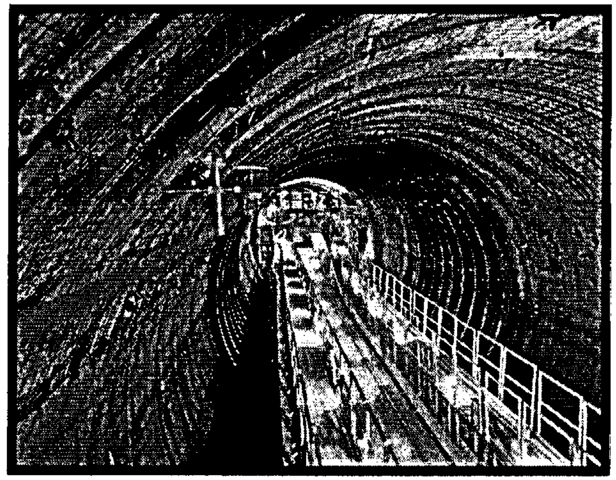
Preemplacement Environment

- The mechanical, hydrologic, and chemical environment in the emplacement drifts depends on the properties of the host rock in which the drifts are excavated
- Consequently, performance confirmation activities during construction of all emplacement drifts confirm host rock assumptions, data, and analyses



Preemplacement Environment
(Continued)

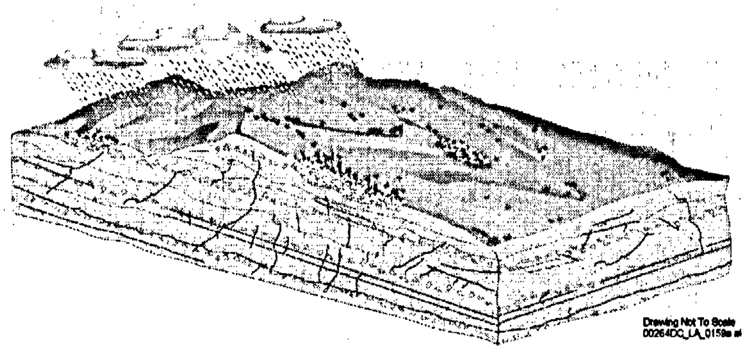
- Mapping of fractures, faults, stratigraphic contacts, and lithophysal characteristics (105a, 106a, 107a, 108a)
  - Three-pass construction
    - Excavate with light ground support
    - Remove Tunnel Boring Machine and map
    - Install permanent ground support

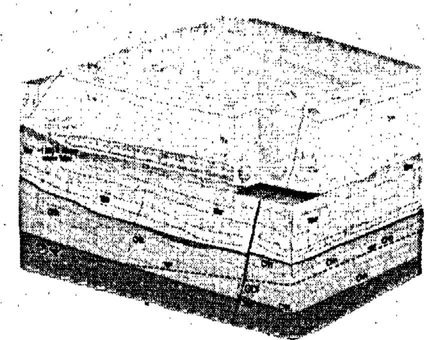


- Hydrologic properties of significant fractures and faults (109a, 111b)
  - No characterization boreholes will be located over emplaced waste packages (gaps will be used, or characterization will use alcoves)
- Chemistry and age of pore water, using chloride mass balance and isotope chemistry (119a, 120a)

The Surface Barrier and the Unsaturated Zone Above and Below the Repository

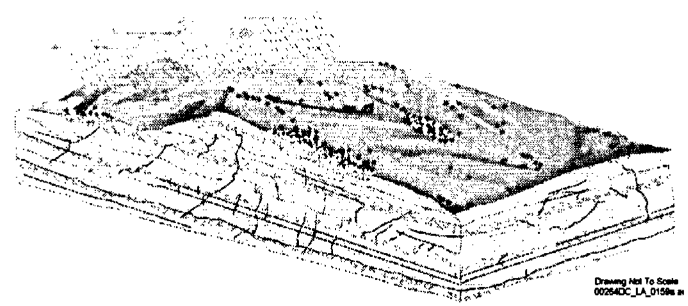
- The surface topography, soils, and bedrock and the unsaturated zone above the repository limit the release of solubility-limited radionuclides (Pu and Np)
  - By reducing the rate and volume of water reaching the engineered barriers
  - By controlling the chemistry of water that reaches the engineered barriers
- The unsaturated zone below the repository reduces the annual dose in the event the drip shield and waste package barriers are breached (i.e., by an igneous event)
  - For short-lived radionuclides (such as Cs and Sr)
  - For solubility-limited radionuclides (such as Pu and Np)





The Surface and the Unsaturated Zone Above the Repository

- **Seepage into bulkheaded, low temperature alcoves (133b)**
  - The situation most typical of the 10,000-year postclosure period
- **Thermal seepage into an unventilated, thermally accelerated drift (51a, 133c1)**
  - Detected by humidity change in the nearly stagnant, but slowly moving, air. Investigated using the remotely operated vehicle
  - Plausible because of the absence of ventilation, but unlikely due to elevated temperature
- **Thermal seepage into ventilated heated drifts (51a, 133c2)**
  - Detected by ventilation humidity change and investigated by the remotely operated vehicle
  - Unlikely due to ventilation and thermal effects
- **Precipitation monitoring (84b)**
  - To place seepage data in context
- **Infiltration from rare high-intensity and long-duration storms (96b)**
  - To place seepage data in context
- **Seal performance (200a)**
  - Seals prevent hydrologic short circuits

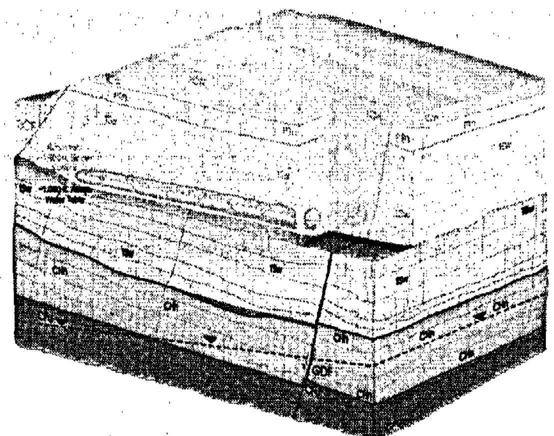


YUCCA MOUNTAIN PROJECT

Note: Activities in [square brackets] are listed on a prior slide

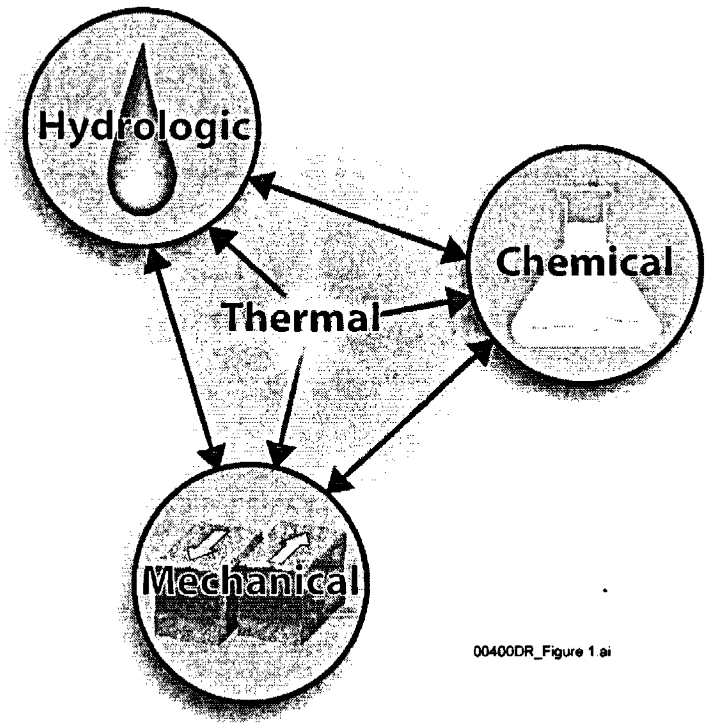
The Unsaturated Zone Below the Repository

- Monitoring for radionuclides in deep boreholes near the footprint (151a)
  - Confirms unsaturated zone barrier performance if engineered barriers fail
- In situ test of transport and sorption properties of the unsaturated zone (137a)
  - In a drift, prior to emplacement



Coupled Thermal Processes

- **Heat added to the underground facilities by radionuclide decay will elevate temperatures for long periods**
  - **Elevated temperatures drive thermal-hydrologic-mechanical-chemical processes in the drift and near-field rock**
- **Consequently, performance confirmation activities confirm the assumptions, data, and analyses of coupled thermal processes**



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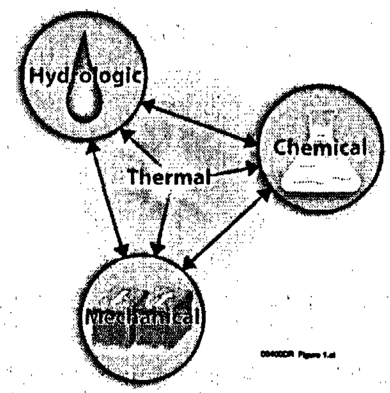
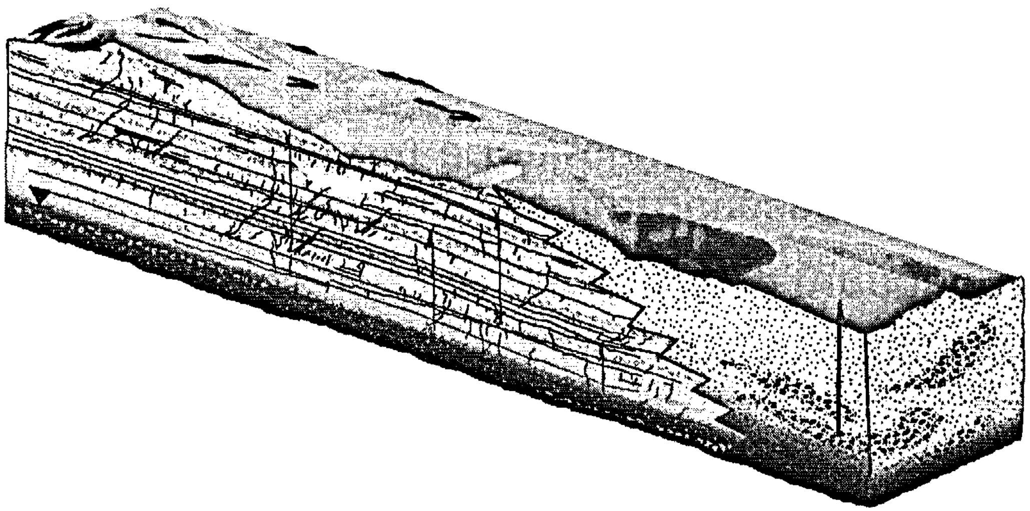
Coupled Thermal Processes
(Continued)

- **Lower lithophysal drift scale test prior to emplacement (220a)**
  - In the cross drift that was excavated by a tunnel boring machine
  - Thermal and thermal-mechanical processes are primary objectives; thermal-hydrologic and thermal-chemical processes are secondary objectives
- **Drift 3, thermally accelerated by ventilation control (125a, 128a, 129b, 131a)**
  - Near-field focus, uses an observation drift rather than in-drift boreholes
  - Fracture permeability, rock saturation, temperature, and water chemistry
- **Drift 4, thermally accelerated by waste package aging and derating (51a, 52a, 53a, 54e, 56e, 57a, 58e)**
  - Engineered barrier environment focus using the remotely operated vehicle
  - Includes drip shields and termination of ventilation at 5 years



Saturated Zone

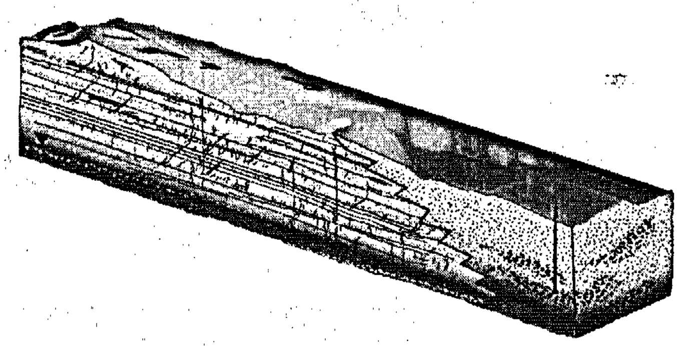
- **The saturated zone reduces the annual dose in the event the drip shield and waste package barriers are breached (i.e., by an igneous event)**
  - For short-lived radionuclides (such as Cs and Sr)
  - For solubility-limited radionuclides (such as Pu and Np)
- **Consequently, performance confirmation activities confirm the assumptions, data, and analyses of the saturated zone**



Saturated Zone

(Continued)

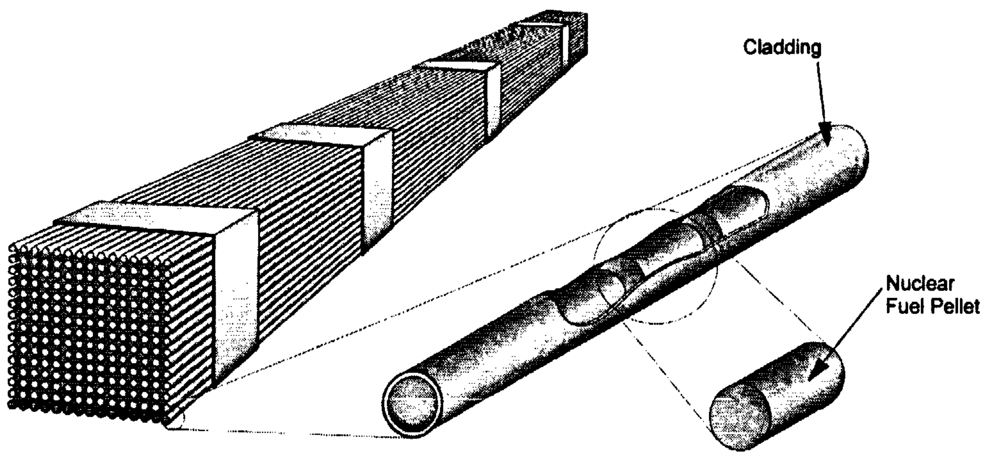
- Monitoring for radionuclides in deep boreholes downstream from the footprint (151a)
  - Confirms unsaturated and saturated zone barrier performance if engineered barriers fail
- Saturated zone chemistry and water levels (150a)
  - Chemistry affects retardation
  - Water levels are diagnostic of flow paths and rates
- Saturated zone colloids (153a)
  - Laboratory studies using field samples

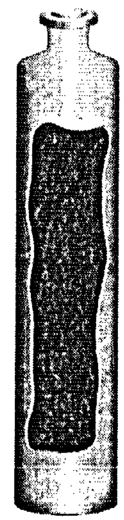


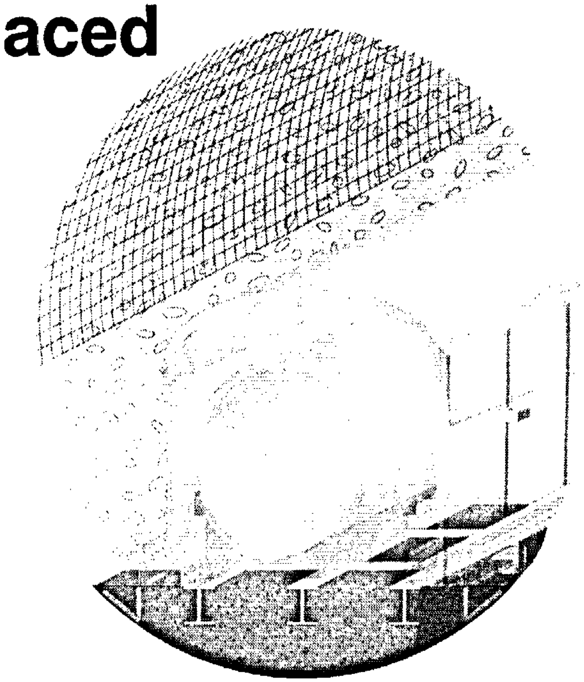
- Saturated zone fault zone hydrology (159a)
  - Deep borehole tests
  - Faults affect flow paths and rates

Cladding, Waste Form, and Invert

- **The cladding, waste form, and invert are barriers important to waste isolation, and contribute to defense-in-depth, but they are less important to annual dose than other barriers and processes**
- **Consequently, less emphasis is placed on confirmation of these barriers**

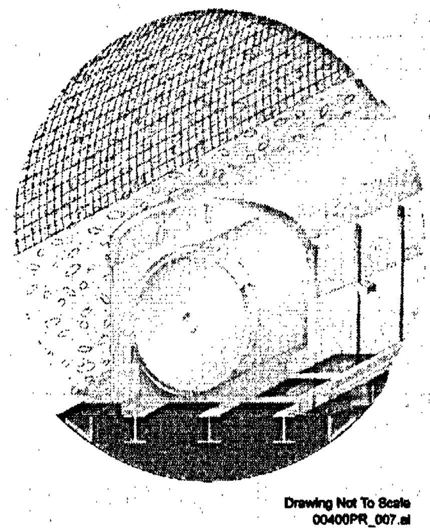


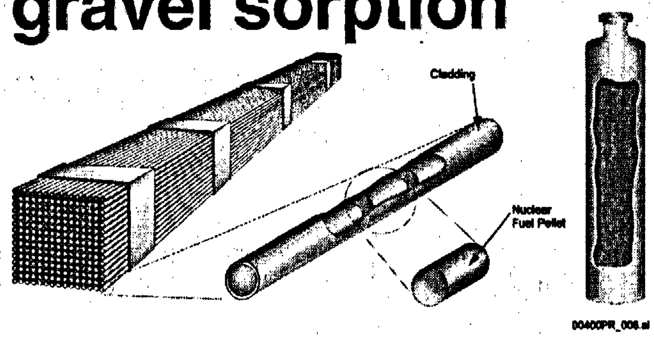




Cladding, Waste Form, and Invert
(Continued)

- Radionuclide inventory (199a)
  - From waste acceptance documents
- Sorption coefficients for waste form colloids (16a)
  - Laboratory tests
- Monitor cladding studies (1a)
  - From dry storage facilities
  - From academic and industrial research
- Measure invert tuff gravel sorption coefficients (36a)
  - Laboratory tests

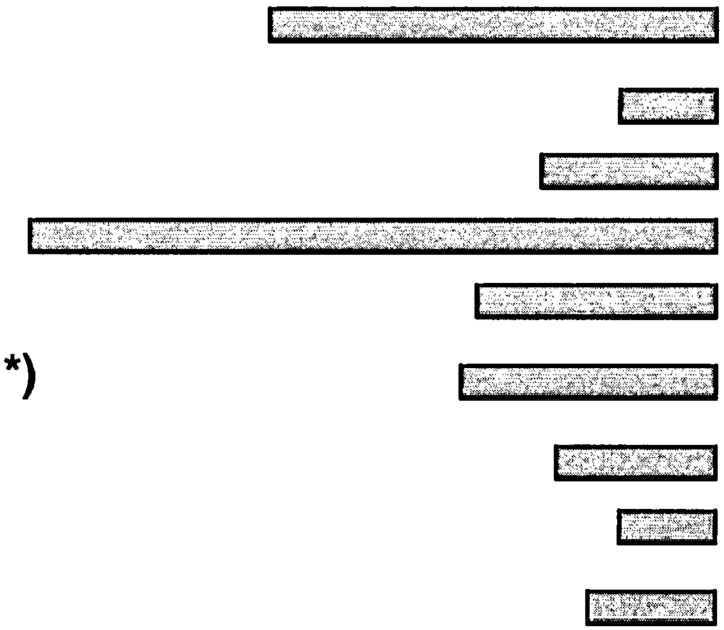




The Performance Confirmation Program Focuses on Importance to Waste Isolation

Number of Activities

- Igneous activity scenario class (13 activities)
- Seismic activity scenario class (3)
- Biosphere-related activities (6)
- Waste package and drip shield (22)
- Preemplacement environment (8)
- Surface barrier and the unsaturated zone (8+1*)
- Coupled thermal processes (5+7*)
- Saturated zone (3+1*)
- Cladding, waste form, and invert (4)



Scenario classes that contribute most to risk are well represented in the performance confirmation program

Barriers that contribute most to risk are well represented

Barriers that contribute least to risk are represented minimally

Caveat: The 72 activities have varying degrees of scope complexity and cost
*** The second number indicates activities included in a prior group**

Backup

Performance Confirmation Activities - 1 of 4

- 1a—Monitoring the literature regarding commercial spent nuclear fuel cladding during the preclosure period, including tracking empirical data on cladding failure in dry storage facilities as well as academic and industrial research on mechanistic processes affecting cladding degradation
- 16a—Laboratory testing of sorption coefficients (K_ds) for waste form colloids
- 36a—Laboratory testing of invert chemistry and sorption coefficients (K_ds)
- 51a—Monitoring of the air temperature and relative humidity at the exit of all emplacement drifts
- 52a—Monitoring and laboratory testing of quantity and composition of dust on engineered barrier surfaces in a thermally accelerated emplacement drift
- 53a—Monitoring and laboratory testing of the quantity and composition of dust in the air in the emplacement drifts
- 54e—Monitoring of gas composition, pressure, and radiolysis effects within a thermally accelerated emplacement drift using a remotely operated vehicle
- 56e—Monitoring, sampling, and laboratory testing of condensation water quantities, composition, and ionic characteristics, including microbial effects, from a thermally accelerated emplacement drift
- 57a—Laboratory testing of water conditions, including thin films, on engineered barrier system components
- 58e—Monitoring, sampling, and laboratory testing of microbial types and amounts on engineered barrier surfaces in a thermally accelerated emplacement drift
- 59a1—Rockfall monitoring and aboveground motion sensing throughout the underground facility using acoustic or seismic tomography with sensors located in accessible areas, which can also measure strong ground motion
- 59a2—Inspection of the underground facility, waste package and other engineered components, with a remotely operated vehicle, when indicated by the results of the acoustic or seismic monitoring of the underground facility
- 60b—Monitoring drift shape, drift degradation, waste package, and drift components of a thermally accelerated emplacement drift with a remotely operated vehicle
- 68a—Laboratory testing of passive current density on Alloy 22 and Titanium Grade 7
- 69a—Laboratory testing of the weight loss rate of Alloy 22 and Titanium Grade 7
- 70a—Laboratory testing of surface dissolution of Alloy 22 and Titanium Grade 7
- 71a—Laboratory testing of surface composition and passive film of Alloy 22 and Titanium Grade 7 coupons from a thermally accelerated emplacement drift

Performance Confirmation Activities - 2 of 4

- 72a—Laboratory testing of the mechanical properties of passive film on Alloy 22 and Titanium Grade 7 coupons from a thermally accelerated emplacement drift
- 73a—Laboratory testing and analysis of phase transformations of Alloy 22 coupons from a thermally accelerated emplacement drift
- 74a—Laboratory testing and analysis of the open circuit potential of Alloy 22 and Titanium Grade 7
- 75a—Laboratory testing and analysis of the critical potential of Alloy 22 and Titanium Grade 7
- 76a—Laboratory testing and analysis of the critical ionic concentration, both abiotic and biotic, on Alloy 22 and Titanium Grade 7
- 79a—Laboratory analysis of waste package and drip shield stress sources using Alloy 22 and Titanium Grade 7 specimens and manufacturing mockups
- 83a—Monitoring the internal pressure of the waste packages using mobile radiation detectors to detect the shadow of pressure-sensitive internal sensors
- 84b—Precipitation monitoring and analysis of precipitation composition
- 96b—Measurements of moisture content and potential in surface soils after significant rainfall events
- 105a—Mapping of fracture characteristics in all drifts and shafts during repository construction
- 106a—Mapping of fault zone characteristics in all drifts and shafts during repository construction
- 107a—Mapping of stratigraphic contacts of geologic units in all drifts and shafts during repository construction, including revisiting the geologic framework model if necessary
- 108a—Mapping of lithophysal characteristics in all drifts and shaft walls within the lithophysal host rock units during repository construction
- 109a—Evaluation of the hydrologic properties of fractures using a combination of gas and liquid tracer tests as well as laboratory testing of moisture retention properties of the fractures
- 111b—Evaluation of the hydrologic properties of any previously undetected faults found during repository construction
- 119a—Laboratory analysis of chloride mass balance, based on samples taken throughout the underground facility
- 120a—Laboratory analysis of isotope chemistry (U, Sr, O, H, ^{36}Cl, ^{3}H, C) within the unsaturated zone, based on samples taken throughout the underground facility
- 125a—Monitoring of rock mass moisture content in boreholes in the near-field rock of a thermally accelerated emplacement drift

Performance Confirmation Activities - 3 of 4

- 128a—Air permeability testing to measure fracture permeability in the near- field rock of a thermally accelerated emplacement drift
- 129b—Monitoring of temperatures and thermal gradients in the near- field rock of a thermally accelerated emplacement drift
- 131a—Collection and laboratory analysis of water chemistry in the near- field rock of a thermally accelerated emplacement drift
- 133b—Monitoring, collection, and laboratory analysis of seepage water from bulkheaded alcoves on the intake side of the repository
- 133c1—Monitoring, collection, and laboratory analysis of seepage water from a thermally accelerated drift, using a remotely operated vehicle
- 133c2—Monitoring, collection, and laboratory analysis of seepage water from emplacement drifts, using a remotely operated vehicle
- 137a—Testing of transport properties and field sorptive properties of the crystal- poor member of the Topopah Spring Tuff (Tptp)
- 150a—Monitoring, sampling, and analyzing saturated zone water from Nye County and site wells for water levels, Eh, and pH
- 151a—Monitoring, sampling, and analyzing saturated zone water from Nye County and site wells for radionuclide concentrations
- 153a—Laboratory studies of the characteristics of natural colloids from saturated zone water samples, including colloid concentrations, particle size distribution, and mineralogy
- 159a—Hydraulic testing of fault zone hydrologic characteristics, including anisotropy, in the saturated zone
- 162a—Periodic surveys of the habitats and characteristics of the reasonably maximally exposed individual and dust levels associated with occupational activity
- 166b—Natural analogue studies of the fraction of radionuclides from the soil captured by the water table
- 167a—Monitoring regional seismic activity, if such data are not available through other programs
- 170a—Observation of subsurface and surface fault displacement after significant local or regional seismic events
- 173a—Laboratory testing of rock and soil dynamic properties using higher strains than have been tested during site characterization
- 180a—Drilling of aeromagnetic anomalies for volcanic event count modeling

Performance Confirmation Activities - 4 of 4

- 181a—Update probability estimates for volcanic intrusion by updating the probabilistic volcanic hazard analysis using expert elicitation
- 182a—Update estimated consequences of an igneous intrusion using expert elicitation
- 185a—Updated modeling and analogue studies of the number of waste packages hit from igneous events
- 191a—Updated modeling and analogue studies of initial mass loading of ash
- 192a—Field measurements of the resuspension and redistribution of volcanic ash in analogues
- 193a—Experimental and analogue studies of the resuspension and redistribution of ash resulting from human activities (e.g., plowing)
- 199a—Monitoring of average codisposal and commercial spent nuclear fuel waste package radionuclide inventory by tracking the waste stream receipt certification
- 200a—Laboratory testing of effectiveness of ramp, borehole, and shaft seals prior to submitting a license amendment to receive and possess waste
- 204a—Laboratory testing and literature review of radionuclide transfer factors, root uptake
- 205a—Laboratory testing and literature review of radionuclide foliar translocation factor
- 206a—Laboratory testing and literature review of radionuclide foliar interception factor
- 207a—Laboratory testing of sorption coefficients (K_ds) for ash particles in soils
- 208a—Laboratory testing for inadvertent soil intake containing radionuclides by humans and animals
- 214a—Laboratory testing for radionuclide activity partition by ash and soil particle size
- 215a—Laboratory testing and literature review of airborne volcanic ash level stabilization
- 216a—Laboratory testing for waste particle dissolution and migration in ash and soil
- 217a—Analysis of ash particles for dimensional changes due to weathering
- 220a—Drift Scale Test in the lower lithophysal unit
- 221a—Geodetic monitoring of extensional tectonics in the Yucca Mountain region using global positioning system satellite monitoring as a potential indicator of future igneous activity
- 251a—Monitoring of ventilation system exhaust gas for radionuclides

Performance Confirmation Activities and Regulatory Requirements - 1 of 5

- 10 CFR 63.131(a)(1)
  - "The performance confirmation program must provide data that indicate, where practicable, whether: Actual subsurface conditions encountered and changes in those conditions during construction and waste emplacement operations are within the limits assumed in the licensing review"
  - 51a, 52a, 53a, 54e, 56e, 58e, 59a1, 59a2, 60b, 105a, 106a, 107a, 108a, 109a, 111b, 119a, 120a, 125a, 128a, 129b, 131a, 133b, 133c1, 133c2
- 10 CFR 63.131(a)(2)—Total system performance, nominal scenario class
  - Directly affects total system performance, not through a barrier: "The performance confirmation program must provide data that indicate, where practicable, whether: ...Natural and engineered systems and components required for repository operation, and that are...assumed to operate as barriers after permanent closure, are functioning as intended and anticipated"
  - 83a, 151a, 251a
- 10 CFR 63.131(a)(2)—Surface topography, soils and bedrock barrier
  - 51a, 84b, 96b, 133b, 133c1, 133c2
- 10 CFR 63.131(a)(2)—Unsaturated zone above the repository barrier
  - 51a, 105a, 106a, 107a, 108a, 109a, 111b, 119a, 120a, 125a, 128a, 129b, 131a, 133b, 133c1, 133c2, 220a
- 10 CFR 63.131(a)(2)—Unsaturated zone below the repository barrier
  - 105a, 106a, 107a, 108a, 109a, 111b, 119a, 120a, 125a, 128a, 131a, 137a, 151a, 220a

Performance Confirmation Activities and Regulatory Requirements - 2 of 5

- 10 CFR 63.131(a)(2)—Saturated zone between the repository and the accessible environment barrier
  - 150a, 151a, 153a, 159a
- 10 CFR 63.131(a)(2)—Drip shield barrier
  - 53a, 54e, 56e, 57a, 59a1, 59a2, 60b, 68a, 69a, 70a, 74a, 75a, 76a, 79a
- 10 CFR 63.131(a)(2)—Waste package barrier
  - 51a, 52a, 53a, 54e, 56e, 57a, 58e, 59a1, 59a2, 68a, 69a, 70a, 71a, 72a, 73a, 74a, 75a, 76a, 79a, 129b, 133b, 133c1, 133c2
- 10 CFR 63.131(a)(2)—Commercial spent nuclear fuel cladding barrier
  - 1a
- 10 CFR 63.131(a)(2)—Waste form barrier
  - 16a, 199a
- 10 CFR 63.131(a)(2)—Drift invert barrier
  - 36a
- 10 CFR 63.131(a)(2)—Total system performance, disruptive scenario classes
  - Directly affects system performance, not through a barrier
  - 162a, 166b, 167a, 170a, 173a, 180a, 181a, 182a, 185a, 191a, 192a, 193a, 204a, 205a, 206a, 207a, 208a, 214a, 215a, 216a, 217a, 221a

Performance Confirmation Activities and Regulatory Requirements - 3 of 5

- 10 CFR 63.131(d)(2)
  - "The program must be implemented so that: It provides baseline information and analysis of that information on those parameters and natural processes pertaining to the geologic setting that may be changed by site characterization, construction, and operational activities"
  - 51a, 52a, 53a, 54e, 56e, 58e, 59a1, 59a2, 60b, 96b, 105a, 106a, 107a, 108a, 109a, 111b, 119a, 120a, 125a, 128a, 129b, 131a, 133b, 133c1, 133c2, 150a, 151a
- 10 CFR 63.131(d)(3)
  - "The program must be implemented so that: It monitors and analyzes changes from the baseline condition of parameters that could affect the performance of a geologic repository"
  - 51a, 52a, 53a, 54e, 56e, 58e, 59a1, 59a2, 60b, 84b, 96b, 105a, 106a, 107a, 108a, 109a, 111b, 119a, 120a, 125a, 128a, 129b, 131a, 133b, 133c1, 133c2, 150a, 151a, 167a, 170a
- 10 CFR 63.132(a)
  - "During repository construction and operation, a continuing program of surveillance, measurement, testing, and geologic mapping must be conducted to ensure that geotechnical and design parameters are confirmed and to ensure that appropriate action is taken..."
  - 51a, 52a, 53a, 54e, 56e, 58e, 59a1, 59a2, 60b, 105a, 106a, 107a, 108a, 125a, 128a, 129b, 131a, 133b, 133c1, 133c2, 167a, 170a, 173a
- 10 CFR 63.132(b)
  - "Subsurface conditions must be monitored and evaluated against design assumptions"
  - 51a, 52a, 53a, 54e, 56e, 58e, 59a1, 59a2, 60b, 125a, 129b, 131a, 133b, 133c1, 133c2

Performance Confirmation Activities and Regulatory Requirements - 4 of 5

- 10 CFR 63.132(e)
  - "In situ monitoring of the thermomechanical response of the underground facility must be conducted until permanent closure, to ensure that the performance of the geologic and engineering features is within design limits"
  - 51a, 59a1, 59a2, 60b, 129b, 220a
- 10 CFR 63.133(a)
  - "During the early or developmental stages of construction, a program for testing of engineered systems and components used in the design, such as, for example, borehole and shaft seals, backfill, and drip shields, as well as the thermal interaction effects of the waste packages, backfill, drip shields, rock, and unsaturated zone and saturated zone, must be conducted"
  - 1a, 16a, 36a, 51a, 52a, 53a, 54e, 56e, 57a, 58e, 59a1, 59a2, 60b, 68a, 69a, 70a, 71a, 72a, 73a, 74a, 75a, 76a, 79a, 125a, 128a, 129b, 131a, 133c1, 133c2, 167a, 170a, 199a, 200a, 220a
- 10 CFR 63.133(d)
  - "Tests must be conducted to evaluate the effectiveness of borehole, shaft, and ramp seals before full-scale operation proceeds to seal boreholes, shafts, and ramps"
  - 200a
- 10 CFR 63.134(a)
  - "A program must be established at the geologic repository operations area for monitoring the condition of the waste packages. Waste packages chosen for the program must be representative of those to be emplaced in the underground facility"
  - 83a, 151a, 251a

Performance Confirmation Activities and Regulatory Requirements - 5 of 5

- 10 CFR 63.134(b)
  - "Consistent with safe operation at the geologic repository operations area, the environment of the waste packages [chosen for the program] must be representative of the environment in which wastes are to be emplaced"
  - 51a, 52a, 53a, 54e, 56e, 57a, 58e, 59a1, 59a2, 133b, 133c1, 133c2
- 10 CFR 63.134(c)
  - "The waste package monitoring program must include laboratory experiments that focus on the internal condition of the waste packages. To the extent practical, the environment experienced by the emplaced waste...must be duplicated in the laboratory experiments"
  - 1a, 16a, 69a, 71a, 72a, 73a

U.S. Department of Energy
Office of Civilian Radioactive Waste Management

YUCCA MOUNTAIN PROJECT

Documentation and Further Development of the Performance Confirmation Program

Presented to:
Advisory Committee on Nuclear Waste

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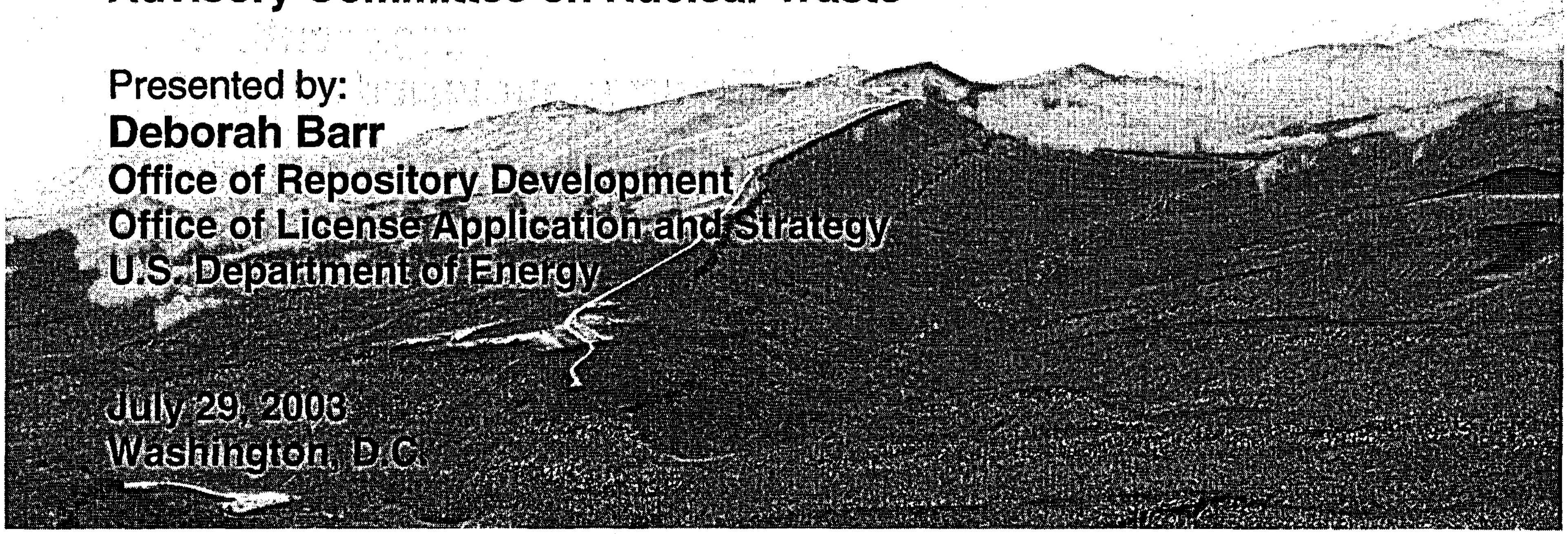


Path Forward - Revision 2

- Revision 2 of the *Performance Confirmation Plan* is currently in U.S. Department of Energy review
  - U.S. Department of Energy review completion - August 2003
  - Changes and corrections (if necessary) - September 2003

Path Forward - Revision 3

- Revision 3 of the *Performance Confirmation Plan* is scheduled for spring of 2004
  - Define activities (what, when, where, and how)
  - Establish expected baseline for performance confirmation activities
  - Establish bounds and tolerances for parameters
  - Management and administration
  - Identify needed test plans
  - Define process for reporting variances and describe the appropriate corrective action steps

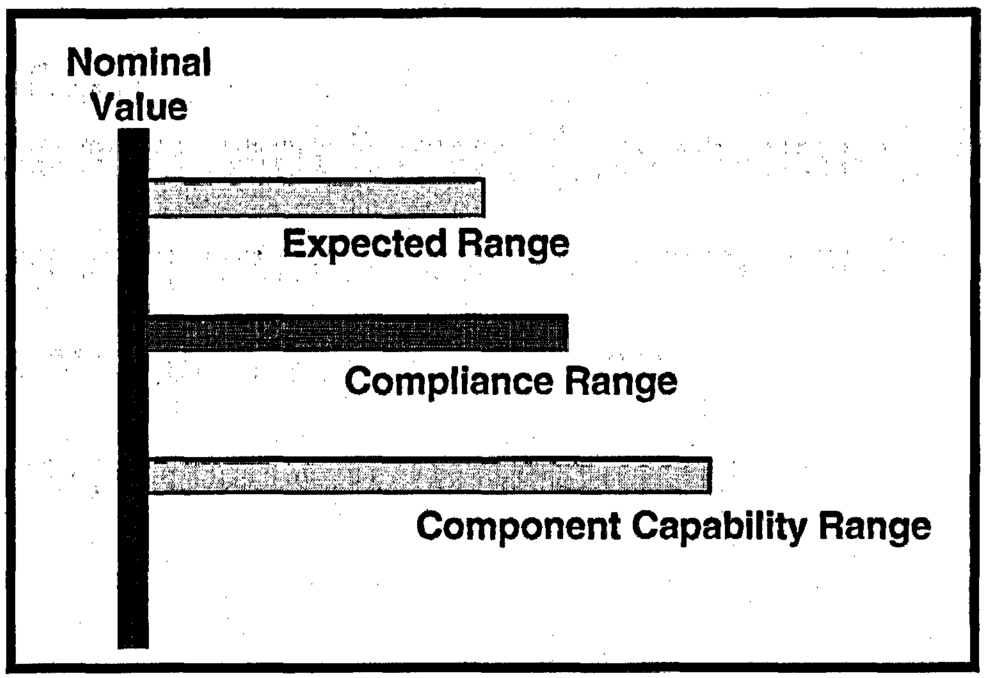
* The following slides will give more details on each of the above bullets

Path Forward - Revision 3
(Continued)

- **Define activities (what, when, where, and how)**
  - Crosswalk to current and previous testing
  - Specify the spatial range over which data will be collected
  - Specify whether data needs to be collected continuously or at specified time intervals
  - Specify whether data will be collected using a remotely operated vehicle, in a laboratory setting, or with persons wearing personal protective equipment
  - Specify the type of power and communication instrumentation needed

Path Forward - Revision 3
(Continued)

- **Establish expected baseline for performance confirmation activities**
- **Establish bounds and tolerances for parameters**



Path Forward - Revision 3
(Continued)

- Management and administration
  - Identify general test procedures
  - Organizational structures for conducting the program
- Identify needed test plans ("one-time" tests and multiple tests)
  - Adequate level of detail on activity definitions to implement tests
  - Establish test decommissioning process

Path Forward - Revision 3
(Continued)

- Define process for reporting variances and describe the appropriate corrective action steps
  - Routine reporting (all tests)
  - Variance analysis based on data trends and forecasts
  - Reporting of actual data outside regulatory limits
  - Corrective actions can include model improvements, test modifications, repository design/construction changes, removal of waste packages, waste retrieval (all in conjunction with NRC and stakeholder reporting and interaction)

Path Forward - Revision 3

(Continued)

- **Provide design requirements and further details on:**
  - Accelerated drift tests
    - Drift scale test in the lower lithophysal unit
    - Thermally accelerated drift focused on near-field coupled processes
    - Thermally accelerated drift focused on in-drift coupled processes
  - Exhaust mains instrumentation/monitoring systems
  - Seepage/H_2O collection system
  - Rockfall monitoring system

Path Forward - Implementation

- Implement *Performance Confirmation Plan*
  - Monitor, test, and collect data
  - Analyze and evaluate data
  - Take corrective actions should significant variances arise

YUCCA MOUNTAIN PROJECT

Technology Development Areas

- **Several performance confirmation activities require feasibility evaluation and/or technology adaptation/development**
  - Remotely operated vehicle (with reduced dependence on infrastructure)
  - Radionuclide sensors with increased sensitivity (e.g., measuring in the exhaust mains)
  - Seepage detection via humidity spikes
  - Rockfall or engineered barrier system collapse detection via acoustic/ seismic tomography
  - Waste package hermetic seal via non electronic internal pressure sensors
  - Fast, effective mapping
  - Automated monitoring of drift deformation
- **The performance confirmation staff is currently pursuing each of these areas**
  - Some activities may be deleted and replaced as a result

Upcoming Milestones

- *Performance Confirmation Plan* Rev 03 - March 2004
- *Safety Analysis Report,* Chapter 4 - December 2004